RESEARCH ON THE EVALUATION INDEX SYSTEM AND METHOD FOR INTELLIGENT PERFORMANCE OF SMART SPACE BASED ON INTERNET OF THINGS TECHNOLOGY

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Abstract: This article firstly defines the smart living space and it's six application aspect which is widely used under the Internet of Things, subdivide and analysis the researches home and abroad when study the relative issues about smart living space assess theory system of the "Internet of Things" technology, concluding the grey multi-levels methods on the basis of "Internet of Things" technology assess theory system at last. Then specify the evaluation of the intelligence storage.

1 GENERAL

This article firstly define the smart living space and it's six application aspect which is widely used under the Internet of Things, subdivide and analysis the researches home and abroad when study the relative issues about smart living space assess theory system of the "Internet of Things" technology

Smart living space (Smart Space) is a working space embedded with calculation and information equipment, in order to letting users search information and get computer service conveniently, working more efficient isolated or collaborated (NIST).

We define Internet of Things (The Internet of Things) as "material objects which connected to the Internet", using radio frequency identification (RFID) devices, infrared sensors, global positioning systems, laser scanners and other information sensing equipment, as agreed in the agreement, make everything connected to the Internet, and try to exchange and transfer information, and to achieve intelligent identify, locate, track, monitor and manage a network (Lin, 2010).

Fields of application of smart space based on internet of things technology (smart buildings, smart home, smart grid, smart campus, smart storage, smart highways)

1. The application of smart buildings based on "internet of things "technology mainly includes security systems, equipment management systems, fire alarm systems, property management systems and so on.

2. The application of smart home based on "internet of things "technology mainly includes appliances control, lighting control, home theater and control the most basic functions of life and intelligent life and so on.

3. The application of smart grid based on "internet of things "technology mainly includes sensing layer, network layer and application layer.

4. The application of smart campus based on "internet of things "technology mainly includes automatic identification of students and teachers, data management and application integration and sharing. The main three-tier system includes application data service layer, network communication layer and end-user layer.

5. The application of smart storage based on "internet of things "technology mainly includes RFID automatic identification technology and production which plays an important role throughout the supply chain, transportation, storage and other aspects.

6. The application of smart highways based on "internet of things "technology mainly includes electronic toll systems (Electronic Toll Collection,

referred to as ETC) and other aspects of the great role.

The six aspects are selected for detailed study based on the following considerations:

1. The six directions are a crucial aspect of national economic development, related to the process of building a socialist harmonious society, it is a break point of achieving low-carbon-saving targets, promote independent innovation saving and low carbon goal to, improve service level of an important breakthrough, to deepen reform, A necessary requirement to improve the level of openness.

2. The six directions are closely linked as a whole, smart building research is bound to lead smart home smart grid and smart campus research, smart home and smart grid with the development of intelligent building has become an inevitable direction. The development of smart highways will inevitably bring the upgrading of China's logistics industry which will surely continue to promote the modernization of logistics technology and thus promote the logistics storage level

3.The six directions respect the development of China's national conditions and we must develop them rapidly.From foreign research point of view, this six researchs have become the consensus of all countries, and from April 2010 the State Council issued the "National ten" can be seen that they are not only an academic problem, but is related to Long-term stability of our country's important political issue.

2 DEFINITION AND SIGNIFICANCE

2.1 Definition of Related Concepts

Intelligent quality is used to evaluate the level of achievement of intelligent control system according to certain algorithms evaluation index system and evaluation, quantitative assessment. Intelligent Building is equipped information and communication, office automation and information services building automation of various functions, easy to govern activities which the buildings need

Smart Home is to use advanced computer technology, network communication technology, integrated wiring technology, according to ergonomic principles, integration of individual needs, associated with the various subsystems home

life together, in order to achieve user-centric experience at home (Pinghua, 2010).

Smart Grid refers to the immediate connection interactive between customers to, customers and to power companies, Achieving to read data timely, efficiently in a dually way, that will lead to promoting the comprehensive efficiency of the integrated power grid (Guangyu and Yingyun, 2010).

Smart campus is using the school as a platform, using the integrated wiring technology, network communication technology, intelligent campus - security system design technology, automatic control technology, audio and video technology which will be integrated campus-related facilities, in order to build efficient infrastructure and the schedule of campus affairs Management system to improve campus safety, convenience, comfort, artistry, and to build an environmental-friendly campus. [5].

Smart storage combine the real-time computer software with the advanced information technology, sensor technology, operational research, artificial intelligence and system technology to apply in storage management, in order to optimize the information, resources, behavior, inventory and distribution behaviors according to the regulations and rules of logistical act, maximizing the effective throughput and precision to meet the management requirements of the intelligent system [6].

Smart highways refers to the advanced infor-mation technology, data communication technology, control technology, sensor technology, operations re-search, artificial intelligence and system integration to effectively integrate technology used in highway construction and management, it has a language, math, logical reasoning , Visual simulation or re-placement body parts movement, thereby strength-ening vehicle, road, the links between users, the for-mation of a safe and efficient transport system [7].

2.2 Research Significance

2.2.1 Smart Building

Building associated with theoretical research will enrich the quality assessment of the Chinese theory of intelligent building, and will provide theoretical support to the development of intelligent buildings in China. Intelligent Building Intelligent quality assessment system is mainly reflected in the social significance of a healthy lifestyle, awareness of the public participation.

2.2.2 Smart Home

May 21, 2008, "2008 (second session), China Digital Home Industry Summit " was solemnly held in Guangzhou, the digital home industry started the development of the smart home industry to a life. This involves many areas of the digital home industry in the relevant departments of the strong government's support and many related industries, driven by the rapid development and will bring together accelerating the development of smart home industry. conducted the quality assessment of the relevant theoretical studies, the development of intelligent home country has become a necessary requirement, this assessment will be able to promote the formulation of the theory of intelligent smart home system of quality assessment and evaluation methods of development and promote smart home in China Better development.Smart quality assessment system is mainly reflected the following aspects of social significance

1. Smart home will make people's way of life a new look
2. Smart home provide more job options for people to
3. Smart Home will lead to the rapid development of many industries
4. Open up a new big market

2.2.3 Smart Grid

We want to feasible with Chinese characteristics Combination of smart grid of the concrete reality as soon as possible which will promote our city's overall healthy development of smart grid effectively. And makes the intelligent system be more effective and rational use of resources, avoid resource, excessive waste of energy finally, reduce the load on the ecological environment, reduce costs, and achieve the human grid and nature the harmony of the three

2.2.4 Smart Campus

We want to make contributions to the theory and practice for the development of smart schools in China Through our research. And make campus environment be extended in time and space and realize multi-campus management; intelligent campus intelligent quality assessment system is mainly reflected the social significance of the following areas:

1. to improve the efficiency and save cost of school management
2. to protect the safety of students and teachers effectively
3. to change the traditional form of storage resources
4. to provide schools with services of foreign exchange window
5. to provide important decision support for the school leadership

2.2.5 Smart Storage

The general situation of warehousing In 2008 [9].

Table 1: Logistics costs in the cost of custody.

	Amount (million)	Increase (%)	Increase compared to 2007
Total Logistics	17508	22.6	Rose by 5.2 percentage points
Storage	1122	41.8	Down 13.2 percentage points

Source: China Industry Development Report Storage Analysis: The investment in the logistics industry, as a whole, has continued to increase; warehousing investment growth dropped largely, and we can draw a conclusion that it is unreasonable draw investment to simply rely on earnings growth for storage is and, therefore, intelligent storage research will become a necessity

Logistics costs in the cost of custody.

	Amount (million)	Increase (%)	Increase compared to 2007
Logistics costs	154542	16.2	Down 2 percentage points
Storage	18928	21.8	Rose 0.6 percentage points

Source: China Industry Development Report Storage Analysis: National Logistics total cost increase is downturn, accounting GDP proportion also decreased slightly; but custody fees increase rose slightly, higher than transportation costs and management fees, so intelligent warehousing studies

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and regard improving warehouse Efficiency of the logistics industry as the first consideration [10].

Through our own research with the specific expectations of the actual situation, we want to feasible with Chinese characteristics as soon as possible, the assessment system, which will effectively promote the cause of intelligent warehouse full and healthy development,

2.2.6 Smart Highways

As the research in intelligent highway just beginning in China, this advanced technology in learning from international experiences, combined with the actual situation of the specific form a workable evaluation system, and promote the cause of the continued development of intelligent highway

3 CONTENTS AND OBJECTIVES (QUALITY ASSEMENT OF SMART STORGE AS A CASE

3.1 Intelligent Storage Intelligent Design Quality Evaluation System

The evaluation system will use a combination of quantitative and qualitative methods to build intelligent storage intelligent quality assessment system, specifically shown in Figure 3-1.
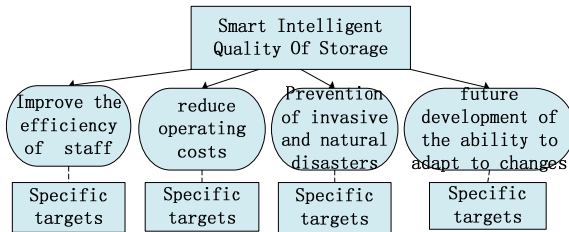

Figure 3-1: Intelligent Storage Intelligent Quality Assessment System.

3.2 Comprehensive Assessment of the Quality of Intelligence of the Multi-level Method based on Gray Intelligent Storage

3.2.1 Smart Storage Smart Quality Indicators to Determine the Weights

Currently, there are many methods to the determination of the weight, such as: the subjective weighting method, the expert scoring method, Delphi method,

AHP, etc., there are large differences between the four methods.

Table 3-1: Weight for comparison.

	Subjectivity	Science	Complexity
Subjective weighting	Strong	General	Not complicated
Expert score	Stronger	Better	More complex
Delphi	Stronger	Better	More complex
AHP	General	Good	Complex

3.2.3 Using the AHP to Determine Weights of the Steps

1. Establish the Levels of Hierarchical Structure
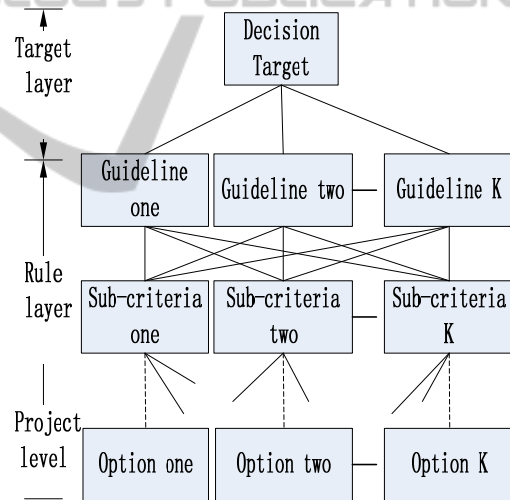

Figure 3-2: Hierarchy model of progressive.

2. Structure Matrix

After Level hierarchical structure established, the relationship of affiliation will be followed to establish between the upper and lower index, we can make fuzzy judgments by using AHP pairwise comparison method of the relative importance of each indicator , Finally quantify data in accordance with the scale of Satty , As shown in Table 3-2:

Table 3-2: The meaning of the importance of scale.

scale	meaning
1	That two factors are equally important
3	Another factor that slightly more than a factor of importance
5	One factor that was important than the other factors
7	Another factor more important than that a factor
9	One factor that is important than the other factors
2, 4, 6, 8	Between the above two cases between the adjacent

For n elements, it can get matrix A by compared pairwise comparison, namely:

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix}$$

For a fully consistent comparison matrix B has the following characteristics:

1）$a_{ii}=1$ 2）$a_{ij}=1/a_{ji}$

3）$a_{ij}=a_{ik}/a_{jk}$, (i, j, k=1, 2, …, n)

3. Calculation of Weight

1) Calculate the matrix A determine the elements of each row in the plot

$$M_1 = \prod_{j=1}^{n} t_{ij}, i = 1,2,\cdots,n \tag{3-1}$$

2) Calculate the n-th root of the row values

$$\overline{W_1} = \sqrt[n]{M_i}, i = 1,2,3,\cdots,n \tag{3-2}$$

Formula, n is the order of matrix

3) $[W_1, W_2, \cdots, W_n]T$ be normalized, calculated as follows:

$$W_i = \overline{W_i} \Big/ \sum_{i=1}^{n} \overline{W_i} \, Fo \tag{3-3}$$

Formula, that is what we calculate the weight of each index

4. Consistency

(1) Calculate the the largest eigenvalue of determine matrix:

$$\lambda_{max} = \sum_{i=1}^{n} \frac{(AW）_i}{nW_i} \tag{3-4}$$

Formula, $(AW）_i$ is i-th component of AW

(2) Calculate the consistency index WI:

$$WI = \frac{\lambda_{max} - n}{n - 1} \tag{3-5}$$

(3) Calculate the consistency ratio CR:

$$CR = \frac{CI}{RI} \tag{3-6}$$

RI is a random consistency index, its value determined by Table 3-3.

Table 3-3: The average value of random consistency index RI.

n		2	3	4	5	6	7	8	9
RI		0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

When n<3, the determine matrix always has complete consistency. Usually, when CR <0.1, we determine the matrix is satisfied the full consistency. Otherwise, we need to adjust the matrix, which satisfies the conditions CR <0.1, making it consistent with the complete satisfaction.

3.2.4 Established Assessment Model based On Intelligent Multi-level Storage Gray

1. Determine the Weight of Evaluation Index
According to the established evaluation index system of storage automation capabilities, W represents a set of assessment indicators of $U_i(i = 1,2,\cdots,6）$, and its weight is $W = (W_1, W_2, \cdots W_6)$.
V represents two set of assessment indicators, Denoted as $V_{ij}(i = 1,2,\cdots,6; j = 1,2,\cdots n_1)$ its weight is $W_i = (W_{i1}, W_{i2}, \cdots W_{in})$, T represents three set of evaluation index, denoted as: $T_{ijk}(i = 1,2,\cdots 6; j = 1,2,\cdots, n_1; k = 1,2,\cdots n_{ij}$, its weight is. $W_{jj} = (W_{ij1}, W_{ij2}, \cdots W_{ijni}）$

2. Plan the Grade Standards of Evaluation Indicators T_{ijk}
by planing Index score standards of the level, we turn the qualitative indicators into quantitative indicators, with the use of expert score, which will be assessed three indicators T_{ijk} as "excellent ", "good", "medium "and"poor " , And give a certain score, score on behalf of indicators greater means more gifted

3. Organize the Assessment Experts to Score and Determine the Sample Matrix
Let the number of experts participating in ratings be m, that is m-assessment experts to assess the indicators V_{ij} by standard rating scale to rate

options. The system assumes m = 1,2,3,4,5, which has five scores experts. The first assessment-expert gives index $d_{ijk}^{(1)}$ score of $d_{ijk}^{(1)}$ and we can get the sample matrix D:

$$D = \begin{bmatrix} d_{111}^{(1)} & d_{112}^{(2)} & d_{113}^{(3)} & d_{114}^{(4)} & d_{115}^{(5)} \\ d_{121}^{(1)} & d_{122}^{(2)} & d_{123}^{(3)} & d_{124}^{(4)} & d_{125}^{(5)} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ d_{141}^{(1)} & d_{142}^{(2)} & d_{143}^{(3)} & d_{144}^{(4)} & d_{145}^{(5)} \\ d_{211}^{(1)} & d_{212}^{(2)} & d_{213}^{(3)} & d_{214}^{(4)} & d_{215}^{(5)} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ d_{741}^{(1)} & d_{742}^{(2)} & d_{743}^{(3)} & d_{744}^{(4)} & d_{745}^{(5)} \end{bmatrix} \begin{matrix} V_{11} \\ V_{12} \\ \cdots \\ \cdots V_{14} \\ V_{21} \\ \cdots \\ V_{74} \end{matrix}$$

The first line means the score of the first expert, and the other as follows

4. Determine the Gray Type of Assessment

the so-called determine the gray type of assessment is that determine the level of assessment of the number of gray type, the number of gray and gray categories Whitening weight function gray number. Let gray type of assessment the serial number for e = 1,2,3,4, they are "excellent ", "good", "medium "and"poor " , which corresponds to the number of gray And whitening weight function as follows:

Type 1 ash class "excellent"(e = 1), Gray (4,), the expression of the whitening weight function as follows

$$f_1(d_{ijk}) = \begin{cases} \dfrac{d_{ijk}}{4}, & d_{ijk} \in [0.4] \\ 1, & d_{ijk} \in [4,\infty) \\ 0, & d_{ijk} \notin [0.\infty) \end{cases}$$

Gray type of category 2 "Good"(e = 2), gray scale, the expression of the whitening weight function as follows

$$f_2(d_{ijk}) = \begin{cases} - & \\ 2 & d_{ijk} \quad d \quad \in [2.6] \end{cases}$$

Category 3 gray type, "in"(e = 3), gray, the expression of the whitening weight function as follows

$$f_3(d_{ijk}) = \begin{cases} - & \\ 2 & d_{ijk} \quad d \quad \in [2.4] \end{cases}$$

Category 4 gray category "poor"(e = 4), gray, the expression of the whitening weight function as follows

$$f_4(d_{ijk}) = \begin{cases} - & 1 & \\ 1 & & d_{ijk} \in [0.1] \end{cases}$$

5. Calculate the Gray Assessment Factor

Assessment indicators T_{ijk} , the first e options are assessed a gray kind of assessment factor recorded as X_{ijke} belonging to the class of the total ash gray assessment factor is denoted X_{ijk}, there are:

$$X_{ijke} = \sum f_e (d_{ijk}^{(1)}) \tag{3-7}$$

$$X_{ijk} = \sum X_{ijke} \tag{3-8}$$

6. Calculate the Weight Vector and the Right of the Gray Matrix Assessment

$$r_{ijke} = \frac{X_{ijke}}{..} \tag{3-9}$$

$$r_{ijk} = (r_{ijk1}, r_{ijk2}, r_{ijk3}, r_{ijk4})$$

$$R_{ij} = \begin{vmatrix} r_{ij2} \\ \wedge \end{vmatrix} = \begin{vmatrix} r_{ij21} & r_{ij22} & \wedge & r_{ij25} \\ \wedge & \wedge & \wedge & \wedge \end{vmatrix} \tag{3-10}$$

7. Make a Comprehensive Assessment of V_{ij}

$$B_{ij} = W_{ij}R_{ij} = (b_{ij1}, b_{ij2}, b_{ij3}, b_{ij4}) \tag{3-11}$$

8. Make a Comprehensive Assessment of U_i

$$R_i = \begin{vmatrix} B_{i2} \\ \wedge \end{vmatrix} = \begin{vmatrix} b_{i21} & b_{i22} & b_{i23} & b_{i24} \\ \wedge & \wedge & \wedge & \wedge \end{vmatrix} \tag{3-12}$$

$$B_i = W_i R_i = (b_{i1}, b_{i2}, b_{i3}, b_{i4})$$

9. Calculated the Value of Comprehensive Assessment of F

$$F = B * C^T \tag{3-13}$$

4 CONCLUSIONS

This article begin with the intelligence storage and qualification evaluation, choosing the intelligence living space and it's six application aspect which is widely used under the Internet of Things, then research and analysis the intelligence living space assess theory system on the basis of "Internet of Things" technology. This study results will play a role in enriching and deepening the theory and application of intelligence living space theory.

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