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Principles and Methods of the Utility Management

Bin Yan

Library, Nanjing University of Posts and Telecommunications, Nanjing, Jiangsu province, P. R. China

Email address
yanb@njupt.edu.cn

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Abstract
Utility management appears the whole process of utility for articles on desire, preference, satisfaction and efficacy. The utility management takes utility value as its theoretical foundation, total utility solved the best allocation to resources, maximum utility evaluated using efficacy to existing resources, management means promoted to increase total utility of articles. The utility management of article resources will supplement the current economic management with methods as its goal. A theoretical model in the utility management was constructed by the principle of Bellman equation. And it presents some evaluation concepts about use diversity of the article and species diversity of the article. The first time makes multi points to multi points to be a copy model for storage management of big data. The collection books as an example were described their mathematical meaning about book usage factor, book usage half-life, dynamic programming, elasticity substitution coefficients, using risk and verification formula of calculation repeated.

1. Introduction

Fig. 1. *The book cover of Research on the Utility Management.*

The book *Research on the Utility Management* (Chinese) by Bin Yan (author oneself) had been published by the Beijing Posts and Telecommunications Publishing in October 2014 and see Fig1, and now the paper introduces and explains its main principles and

methods in the book with English. The many principles and methods in the book had been published in some journals domestically and abroad respectively in the form of paper. The paper is only systematically summarized together and some references omitted.

1.1. The Utility Management Proposed

Theoretical principles of the utility management had been gradually established and improved in process of my research project for three years that title was *Research on Book Evaluation Measure Model Based on Utility* supported by the Research Foundation of Humanities and Social Sciences of Ministry of Education of the People's Republic of China in 2010. In course of the research on the utility, the abstract and vague word was discussed, the utility theory related to application was combed, and theoretical research was applied in my familiar information management technology and library management. So the utility management can be integrally formed a kind of the management method. At the beginning of the research I found at domestically and abroad on the utility that has completely different understanding. In China the utility is often understood as objective article efficacy in thing management, while in foreign countries the utility as subjective mental state is applied in micro economic management. All the utility applied in management has not formed relatively complete utility management theory. This is very regrettable. Articles are fundamental to human survival which people could not have money but couldn't have any articles. When material production was not enough to satisfy the need of people's lives, articles were used to maximum effect, and when the mass of material production satisfied parts of consumer demand, consumer satisfaction became a kind of market judgment, and value chain made material production swing. In today's society, economic management theory has little concerned activity law about social material production and reproduction. Social production has began to become from material goods production to monetary investment, electronic business, live service and social service of consumption etc., which has resulted actual management in material production how to gain more money profit as a major premise. Effective theory guidance in social service management is lacking and many economic management theories themselves cannot use their principles to make their consequences such as product quality shorten its service life, the excess capacity made products dumping and lag, over exploitation of raw resources, waste rapid increase, serious environmental pollution, and treatment waste means less and so on. In social service there are many high bindings e.g. filled with bad as good, counterfeit brand, give short weight or give short measure, high priced to low discount, various additives harmed human body and so on. These make the economic management be into a client thing of the financial management (or capital management) and so new management theory needs to add and solve problems the economic management can not solve.

The utility management is proposed under a background that goods are extremely rich and resources have been great waste and environment suffers serious destruction. It emphasizes to make full use of existing articles maximized using utility. The book *Handbook Utility Management* by Andreas Bausch and Burkhard Schwenker who organized many authors, Springer Verlag Berlin Heidelberg published in 2009 and was about public utilities management field in the role for exploration and practical application. Their goals are different between utility management and economic management. The utility management is based on articles as managing object, and article utility maximum combines consumption utility with use utility as managing process. Utility evaluation model can judge the use diversity of the article and the species diversity of the article to reduce resource consumption with one-time use and increase renewable resources. The vast amount of data (or big data) management will setup a kind of judgment model as evaluative data sources to curb phenomena of the excess capacity and excessive consumption. The utility management will achieve goal of reasonable allocation for social resources and maintaining ecological balance to improve operation achievements in environmental protection. The utility management should be returned to the original appearance of human survival management. While the economic management has transmuted to the capital control as the principle accomplice, that is always around the group of economic interests and economic development as the starting point. It must cause many inharmonious social contradictions and conflicts among interest groups. This does not conduce to people's livelihood in the development of the social production.

1.2. The Difference between Utility Management and Other Management

One of research goals on the utility management wants further to discern Karl Marx said long ago in *Capital* (1995) that every useful article "use value is only realized in the usage or consumption" and his relevant discussion that articles could be effective in a variety of different ways, a utility of the article was endowed it with use value. In utility management the utility is not only contents of economic activities as to the production, management, consumption, but also the article to display the biggest effectiveness in the process of the use diversity outside the property of commodity. It requires realizing ones with contents and methods of the management. The management to people needs to design and maintain a kind of better environment, which makes every person to accomplish decided goal efficiently in a group. The kind of management takes the whole people as fundamental organization and managerial time as measurement that pointed out a manager at different post to spend different time, who is high position to spend more time on planning, organization, and low position to spend more time in leadership.

The works queried on management at present show many books about enterprise management e.g. human resource

management, financial management and macro management and micro management, which contents mainly focus on the production management and market management of enterprises in respect of understanding and definition of management. This management becomes guiding activities to enterprise production and operation and makes every person complete efficiently decided goal with thought foundation and behavior principles in his group. All these managements aim at people or control persons through some means such as information to produce more benefits as manager's goal. Information has permeated every corner based on information organization for system innovation. The management levels will decrease rapidly, and entrepreneurs and managers have got new quality character. But there is no management theory about article and not also to approach management theory to article that derived out social management, resource management, merchandise management, logistic management and others.

2. Utility Management Principles

2.1. Roles in Utility Management

This word "utility" in many Chinese dictionaries has been explained as the effect and role. In all of the Chinese-English or English-Chinese dictionaries, "utility" is translated as effective and useful, effectiveness, usefulness (DEO, 2002). In English-Chinese dictionaries "utility" is translated into: (a) utility, utilitarian, actual gains; (b) useful article (Zhang Qi-chun and Cai Wen-ying, 1972), and further meaning (a) the degree of usefulness; (b) public enterprise (Della Summers, 2005). Similarly, on translation homepage of Google Company, "utility" chosen first the same word with cross translation. In Baidu online "utility" was translated as practical and "utility" (Chinese) was translated as effectiveness, efficacy, efficiency, utility and avail. These explanations in many Chinese dictionaries and original meaning in English have different understanding, or there are differences on the interpretation. The utility in Chinese is strong for efficacy as original meaning. However loanword "utility" originally in commodity economy said consumers through consuming or enjoying made their own needs and desires get satisfaction as a kind of measure, i.e. articles could satisfy desire to be ability or power for person, its purpose wanted to challenge the expected value of money to the decision criteria. If it was linked utility of the article with its usefulness, use value and satisfied desire together as the starting point of commodities, and when the economy showed development rapidly and the gap between rich person and poor person was widened, then surplus value was no longer to become main means of wealth accumulation, the commodity utility of the article would embody main value via person possessive degree for the satisfaction.

If the phrase "utility management" in English must reflect meanings of the utility in the economics and application in management, the "utility management" in English would only refer to the management of public utility. We have understood from the book *Utility Management* by B. Murray, John Wiley and Sons that mainly with utility restructuring for administrative functions improved in power new energy market, with all kinds of complicated links of value chain and reach the final user price, as well as the influence by clean coal, carbon capture and other new technologies on the market performance. And the phrase "public utility management" should be more used in Chinese about public management and also used to translate into English. This is two areas on management discipline between utility management and public utility management.

After integrating various theories through scientific management, target management, humanistic management and knowledge management in various periods, the management leading to people is still difficult to reverse dilemma fundamentally in the short time. Then, configuration management to material resources has become an urgent problem to be solved. The use of resources should not become simple economic interests as the starting point, but it should balance the maximum utility of resources between article diversity being and diversity using. Use value of the article has different utility value for user, and different kinds and number of article for user also have utility value himself. It needs to realize interfusion potential use value and actuality utility value together. This requires responding to environmental changes to avoid the subjective and one-sided decision with objective factors, reliable data and influence weight.

The basic concepts of the utility management based on various expositions above all can be extracted from the utility (Say 1982) and the utility value (Zheng 2003) (Yu and Hu 2007) and the utility function (Zhang and Chen 2000) (Koksalan and Ozpeynirc 2009) and the utility theory (Farquhar 1984) (Dong 2007) as a management theory. All of the discussion about utility, utility value, utility theory and use value will become theoretical base on the utility management, and it will be come into the various process of the utility management about desire, preference, satisfaction, efficiency and effect. We have established a model by changing Bellman equation as one of the basic mathematical models of the utility management that included (such as books) usage factor, usage half-life, dynamic programming, elasticity substitution coefficient, use risk, formula of verifying repeated calculation and so on. A mathematical model for data read repeatedly in data management has been proposed to replicate store and realize the multipoint to multipoint for optimal data read and data utilization. It will provide one solution to the back-end data store for data analysis.

2.2. Existing Principle of Diversity in Article Species

Article diversity is inevitable of the same result in social and natural development as biological diversity. Biodiversity is environmental needs to maintain ecological balance, sustainable development, and then article diversity is also guarantee for human and living environment in harmony long-term. In the natural economy era, science and

technology solved mainly the food problem to human survival, and the society of agriculture dominated appeared a state of variety selection for lead life security that food species diversity was more than life use kinds. In industrial economy times, science and technology into goods production made products become profit-making purposes. When mankind satisfaction main needed the life quality, society appeared a state that life goods species diversity was significantly more than food varieties of life essential. Article species diversity and biological diversity are also same existence as the survival rule "survival of the fittest", but this violates the balance principle of existing diversity in natural environment. Modern science and technology has many things not to protect existing natural species to avoid the destruction, but the species diversity is artificially suppressed. These results have bring about single food type, available for people to choose varieties articles decreased rapidly, quality of artificial cultivation articles been low down, species in natural survival exterminated rapidly, and the immune function for human threaten directly. And to meet the psychological needs to people's life quality, it shows numerous and big amount of the various materials for life use, but a large number of eliminating them quickly during industrialized production. The progress of technology makes the number of invention patents increase rapidly and innovation products in market are scanty, varieties of the cultivating food by the natural growth are less and less. Artificial intervention makes production cycle shorten and yield increased, but natural growth would increase the cost of production. These are the main factors of fewer species and quality decline of articles.

Article species diversity and biological diversity have the same performances: (a) if its volume or occupied space is large, species in number is less inevitably, on the contrary, species occupied small space is many in quantity inevitably; (b) the higher richness degree of species is, the smaller equability degree is, otherwise the lower richness degree is, the greater equability degree is, which equability is not equivalence in number; (c) environment for species number has great impact, which bad social environment and market environment will lead to the decrease in number and species and new species appeared slowly; (d) the top species are few, but they has dominated each link of the diversity chain. Because there are income gap and consumption capacity constraint as well as the different living habits and cultural background, people have different preferences for types, brands and styles of commodities, and goods diversity can be accepted by all levels of consumers.

Prices become a major factor in distinguishing consumption ability, so goods diversity generally reflects in price. The high price takes often a sign of well-known brands, and in turn a well-known brand has certainly high commodity prices. But only a small number of consumers can afford high consumption to obtain satisfaction for the well-known brand, the majority of consumers remains income level within the general public although they also have desire to obtain well-known brands. If the same well-known brands are very much, these commodities do not have prominent characteristics and their sales will appear problem, which must divide difference in price. Another kind of diversity is a style, but the style shows the short effective time. The brand has long effectiveness that can be as a basic unit of the measure but the style can be not. A well-known brand must also be primary one or a few styles as a brand is same. There are no obvious characteristics because of many same styles, and it must be divided in the price from a few styles or dominated ones. New style must be higher than old style in the price. If similar products appear many well-known brands in this area, there is also mutual competition among them. The result will make some brands to exit this area and the others are arranged in anther area to distinguish gap. Species diversity of articles can reflect more choices to different consumers or users, and this also is a kind of regular for the existence and development of species diversity. Evaluation for article species diversity should obey the utility principle "the unification but different" and the measure method at layering level "universal to be more credible". Theory of utility management plays a role in solving article species diversity, which make use of existing resources to achieve the maximization.

2.3. Use Principle of Diversity in Article Use

Multipurpose article means always one kind of main use and other uses as supplement to form multi uses, so that there can be long to use time. Number of the articles in use value is measured by time and efficiency, e.g. commodity use period, food shelf life, a car scrapped by time limit and mileages etc.. If a car has expired use but its condition is good, it is that the car's use efficiency is not high and needs to improve mileages. These examples point to a kind of use within safety use time. Time is inversely proportional to efficiency, then the longer time an article used and its use efficiency descended, the higher use efficiency an article would shorten use time. All of the articles have certain service life limit. To achieve higher time and efficiency, article itself should have very high use value. Some fake and shoddy products and disposable products themselves do not have high use value. These products may only consume more original resources and produce more renewable resources. This is not identified by human ability.

The phrase "the best using everything" appears that article's function and effect are turned into full play, that is to say as far as possible to play utility of every thing and do not waste a little. Not only will a single use way exhaust article's efficacy, that is to say, also includes other possible use ways to generate and convert into. Article's single efficacy is one use way after another and also has multiple use efficacies at the same time. People in using article found often more other use ways, which if a kind of article use diversity is better and abundant, and then it exists more long time, i.e. its use value is higher. For example, drinking water has the highest value and washing water second, and irrigation water the lowest. Because various use ways have different satisfaction at the same time, it is not suitable to compare utility value among different purposes. What actual function has multiuse

purposes of the article? Waste should not be simple raw material as art. Many producers and users can not known other use ways of the article, so the use diversity becomes imagine of producer and user who have the most temptation to potential innovative, which require users to try and be perfected in innovative products. Method of determining diversity mainly may rely on usage half-life that all the possible use time adds up to calculate half value of the usage half-life under the longest time and efficacy, and with this result we can predict existence of use diversity. Time of socially necessary labor can determine to produce value amount of use value, then an article use should determine utility value. In conclusion, the use value reflects general character of value amount of a product, and the utility value reflects personality of value amount of a kind of article.

2.4. The Link Principle of Minimum Value in Data Analysis

The phrase "like attracts like" means a main method for data analyze of articles, and it is a prerequisite that divided species of articles and classified for effective analysis. When a series of articles was computed on same type statistics, the big data values were often taken as the general rules for judgment to deal with affair, and the small data values were ignored as the first object to be eliminated. As the statistics, it was the calculated results of fact data in the past, and was descriptive for a hysteresis phenomenon. These regularity values may be a certain development trend now or in the future and caused "inertia stretch". But in most cases, the "inertia stretch" does not appear. Most of the statistics compare only results to compute previous numbers at the same time and are possible for influence factors and explain these phenomena. Statistic method by acquisition the maximum value can provide some data for statistical results, but it can not represent and explain what. In utility management, data analysis just needs these negligible values that effectiveness links among to discover potential rules by people neglected. The minimum value link may become an opportunity of business development in the future.

People often follow trend to do and do not attempt to "the first person to eat crabs" in order to avoid risk. Innovative products also as same need to put many cost from an idea to research and development, and the acknowledgment in market may need to undertake great risk. Although the market is led by consumers, the government's administrative intervention and regulatory constraints can direct and open up new products in market. This is the combination with planning and market economy that is a new type of the economy system. Many innovative products are killed that have many reasons unaccepted by consumers. The first reason is the product what needs to supply? The second is the existing laws and regulations what limit? The third is how much the risk the consumer accepts this product?

If a person's pain generated because of the loss of a certain amount of income is greater than he gotten the same amount of income with satisfaction, his project can be avoided the risk. Greater expected utility means that result is bigger probability, which is only used to judge different person on risk for different preference. But when facing loss or profit because of psychological reflection effect, people often do not comply with expected utility maximization benchmark to judge. Risk aversion implies that increasing utility with a number of extra incomes is smaller than reducing utility by the same amount of incomes lost.

2.5. Principle of Multi Points to Multi Points in Data Management

If data management is the first step in the realization of the utility evaluation management, efficient storage and extract for data can accelerate the process of statistical analysis in operation. After garbage data, man-made intervention data and replication data eliminated, remaining objective data can improve the credibility of statistical results. Therefore, the most important technical point is data management in constructing information management system, including the use of the data dictionary for cleaning non objective data to run efficiently storage data. Information system has different business design requirements for various business departments and production process. It is the most basic design functions around the data generated, data added, data mended, data saved, data read, data submitted and data searched.

Big data is a type of business model and technology platform as an indication generally on a large scale data management and data used, and it reflects a trend of future development about information technology. When data management independently and dispersedly converts to use management of big data, a super computer storage center will be established that can be fast, accurate, efficient and comprehensive around data transferring regularly to the storage center from individual management information system. According to searching data content, the storage center needs to establish elementary mathematical model including data between each column that is related, and then judged or analyzed nuances in them, and given results finally.

Cloud storage expresses a kind of data framing method that storage devices scattered in everywhere could be connected by a particular way as if they were big data hardware configuration. In these devices there must be a data management software system that could concentrate data efficiently on this management platform for different networks, different systems, different data formats and different users. Storage devices used high density disk array device and each set of the equipment would connect to cloud storage system through network, and the cloud storage devices in the storage pool would be allocated again. Primary data in the storage pool could realize multiple copies and storage separately in multi physical devices. When the capacity or bandwidth need to be extended, the capacity and performance would be realized by increasing the storage node according to the actual needs of flexible expansion, and it could be performed online increase in the system operation.

Multi points to multi points is a kind of storage technology that multiple users read data on multiple data storage points,

and specifically each frame structure in data format is stored in several or even dozens of other storage space with multi band technology. A problem of the multiuser process in slow addressing speed will be solved and avoided data interference with reading and writing operation at the same time. Service in the service platform is set according to business classification, and optimized automatically the best detection amount based on search conditions selected solution, and all of the data sharing requirements are able to realize at one web platform. When a user sends data addressing instruction, moreover if an access point of the cloud storage has data read time interval T_0 and data transmission time T_x together, a kind of method chosen copying data storage space is unsuitable, and it needs to consider transmission distance between $T_0 \geq T_x$. The daily operation at data management center should need to decompress data, import data, classify data, sort data and mend error data, check data dictionary to delete data, and ensure data accuracy and readability. These results of user statistical analysis can be more reliable. If multi points to multi points under data using utility framework become the basic construction for big data, cloud computing and cloud storage, data management can resolve bottleneck problems of data read time long and transmission efficiency low in the data processing because of concurrent multi users caused.

3. The Utility Management Methods

3.1. Utility Function Determined

While utility of an article in utility management denotes a use role, total utility can be separated into basic utility and factor utility. The basic utility is an inherent use value of the article and it may get theoretical use role through the market assessment. The factor utility is a real use role of the article and it is uncertainty caused by various factors. If an article was not proper for management, it might cause the total utility to reduce. Otherwise if it was maintenance well, its total utility would extend or increase. The total utility may predict a concrete article how many to reduce or extend on the basis of actual usage data. For example books, because each library has its own structure of library preservation, different characters of each librarian make books existed utility as soon as collected after consumed and had not presented consumed utility for the library. The books in library preservation have the basic utility such as knowledge, appreciation, conservation, exhibit etc. and other utility as the factor utility will present use data in loan, read, citation, estimation and others. The utility management shows all practical use roles in total utility and can have a kind of books play a different utility in every region. On these grounds we become Bellmen equation (See Wiki Bellman equation, 2011) into follow Eq. (1) as a new mathematical model of utility function for book evaluation:

$$U(X) = \max_{0<t\leq\infty}\left[U(x_0 y_0, t)\right] + \max_{1\leq t_e\leq T}\left\{\sum_{j=1}^{n}\beta U\left[x_j^r(t_e), y_j(t), t\right]\right\} \quad (1)$$

Where the $U(x)$ is the value of optimal utility in Eq. (1), and it is divided into the basic utility $U(x_0, y_0)$ at the first term on the right side of the equation and the factor utility $U(x_j^r, y)$ at the second term on the right side of the equation. The basic utility of books had collection utility soon after books preserved by library that is reflected the inherent value and heritage value. The collection time $t=t_e$ can determine basic state x_0y_0 on all kinds of books, which is a continuous time function, that is to say the longer time is, the greater the basic utility is. In order to optimize resource configuration continually in the future acquisition, the book purchase will divide into time stages, which in the future (t+1) the decision optimized can use HJB equation. The factor utility of books is uncertain, and x_j^r is variables of different library preservation, where the r is the substitution elasticity constant. In Eq. (1) the β<1 is parameters converted or discount factor with use effect by readers. When time t_e and total preservation x are certain value, x_j is preservation variable at every preservation place, y_j is use variable by readers, they are a function of discrete random variables. The most optimal factors utility is required a utility function in utility management. The factor utility may divide into collection-related utility such as loan, download within the network, guided reading, recommendation, communication, display and so on, and utility of nothing to do with the collection such as references, reviews, awards and so on. If x= (x_1, x_2, ---, x_n)' and a= (a_1, a_2, ---, a_n)' consist of preservation distributed vector, $|A|$ is a quantity matrix of the preservation and if y= (y_1, y_2, ---, y_n) is usage vector, $|B|$ is an action matrix of the usage, so total utility is U=$|A||B|$.

In utility management of books, let x= (x_1, x_2, ---, x_n)' be all species of book distributed vector and y= (y_1, y_2, ---, y_n) be usage vector when collected time t=t_e, then utility time t (>t_e) is use time of readers. The factor utility of books is set $U = U(x^r, y, t)$ when the r is constant, the $y = y(x,t)$ and $U = U\left[y(t), t\right]$. The factor utility predicted in theory should have a fixed value U_m, and the utility management will present how to abridge or prolong the theory utility. And according to management effect, utility difference is $\Delta U = |U_0(x, y_0, T) - U(x_j, y_j, t)| \leq \varepsilon$. When $t=t_e$ and Ax= $\sum(a_jx_j)$, the a_j is volume quantity in preservation place j and x species; and when $t_e<t\leqslant T$ and actual usage quantity is y_m (x), the y_m is theory usage value. If $y_m \neq y_j$, then $0<|y_j - y_m|<\delta$ is existence. Assuming that $S(y)$ is a use function, theory use function S (y_m) =B, $|S(y)-B|<\varepsilon$, then $\lim_{y\to y_m} S(y) = B$. Same $\lim_{y\to y_m} U(y) = U(y_m)$ exists an extreme value in the factor utility. If the continuous time t is use time variables, management utility is a function of continuous time. Introducing Lagrange multiplier method may solve extreme value of the factor utility under utility time.

3.2. Explaining Factors of the Book Evaluation Model

If utility is a kind of satisfactory degree of goods or services for consumers, utility function means to establish a

function relationship in number between utility and the preference of goods or services. Let utility function $U(x)$ as a satisfactory function in the choice set x for each to specify degree of preference. The $U(x)$ is general value between 0 and 1 (Farquhar, 1984), which measures satisfaction for consumers feel from the consumption in specified combining goods. We can define some variables and derive some explicit functions from Eq. (1). The methods of book evaluation are as follows:

- At the right second term of Eq. (1), if the maximal value of total factor utility $U(x_j^r, y)$ equals to 1, the discount factor β is effective and the discount factor β as a utility weight can be artificially set. If $U(x_j^r, y)$ takes an arbitrary plurality, the discount factor β is ineffective and can also be obtained through use variables.
- At the right second term of Eq. (1), the multivariate of total use behaviors can be simplified to mono variable that makes up function with time t in order to obtain the optimum using quantity at each stage, the amount of usage is not direct proportion to the amount of the preservation. Assuming that it is an exponential relationship:

$$y(x, t) = (Ke^{-ax}+c)t \qquad (K\neq 0, \quad a\neq 0) \qquad (2)$$

When Eq. (2) is done the partial derivatives with time t, and we get the extreme value $Ke^{-ax}+c=0$, $x=-\ln(-c/K)/a$ that attain the maximum use amount of the preservation. Here the amount of the preservation is $x=(x_1, x_2, ---, x_n)$, which the n is places of the preservation, the a is species of books, the x is copies, and ax is the total copies of every species.

- After the right second term of Eq. (1) is simplified, assuming that the use behavior j and its variable y_j are an amount of loan books or days of reader holding books, the utility function $U=U(y_j, t)$ does the partial derivative with time t, and we get an amount of loan books or days of reader holding books at every piece time. If we need to solve the utility of different species of books, answers are an ordinal utility that reflects utility ordinal or grade according to the first, the second, the third, etc.. It is also an order ranked method that is usually a use method of the ranking list according to reader preference.
- After the right second term of Eq. (1) is done the partial derivative with $U(x_j)$, we obtain $\frac{\partial U(x)}{\partial U(x_j)} = \frac{1}{\beta}$, in which discount factor β is an actual utility factor for example the book usage factor (BUF) that can be obtained by empirical data.

$$BUF = \frac{\partial U(x)}{\partial U(x_j)} = \frac{loan \quad number \quad of\ one \quad species \quad books}{total \quad loan \quad number \quad of\ same \quad class \quad books} \qquad (3)$$

Here the Eq. (3) called as book usage factor to judge book diversity in similar species. When the value was $0.3<\beta<0.5$, its indication was lack for book used diversity in similar species, namely the using species were less than 3, so that readers could restrict to choose books in similar species.

- After the right second term of Eq. (1) is simplified, assuming that the use behavior j and its variable y_j are loan times or holding days, and the y_{ji} is loan times or holding days for species i of books, so in the function $F=f(y_{ji}, t)$, t as using time, r as loan times rate or holding days rate for derivative with time t.

According to the definition of the decay half-life, the number of atoms within interval time dt is proportional to the number of no decay atoms, when the number of atoms decayed to half the time required is called the decay half-life $t_{1/2}$, in which the minus added is decreasing atomic quantity. This definition can be introduced to the books as a usage half-life (BUHL):

$$r = -\frac{dy_{ji}}{dt} = ky_{ji}, \qquad kdt = -\frac{dy_{ji}}{y_{ji}}$$

After integrated $kt=-\ln y_{ji}+c$, let y_{jm} be a total number of loan times or holding days when $t=0$, $c=\ln y_m$. At the $t=T_{1/2}$, $y_{ji}=1/2(y_{jm})$, we obtain:

$$\ln y_{ji} - \ln y_m = -kt, \quad \ln\frac{y_{ji}}{y_m} = -kt, \quad y_{ji} = y_m e^{-kt} \quad T_{\frac{1}{2}} = \frac{\ln 2}{k} \qquad (4)$$

The $T_{1/2}$ as BUHL and k as a decay constant in Eq. (4), here k can be identified as a total number of loan-able volumes in the library. According to the definition of BUHL, we take the annual average $\tilde{y}_m$ of the sum loan books within three years (or 36 months) that were same class by *China Library Classification* (CLC) after the storage time t_e into library. When number of loan books reduced to a half of the annual average $\tilde{y}_m$, this year or the month would be a half-life of using books, meaning an aging degree of books or reader tendency for the books that continued to use of the class from the books collected time to lending the year or the month.

- A principle of utility maximization can judge a possibility of the greatest use risk. A person judging behavior, that is a decision-making, is only to obtain the maximum value of the expected utility, so called the preference, and not necessarily to gain the maximum benefits or usage. If some use amount y and satisfaction u consist of utility function $u=u(y)$, it has the first derivative equal to zero and the second derivative be less than zero. When the maximum total utility is unchanged, risk aversion constant a makes $u(y)=y^a$ and use variable $y^\alpha = (y_1^{\alpha_1}, y_2^{\alpha_2}, \cdots, y_n^{\alpha_n})$, $(\sum_{j=1}^{n} \alpha = 1)$ consisted of every kind of utility. Once some utility value gained the biggest one, it could make some minimum utility value in the calculation do not to appear even or be omitted, e.g.

$y^{\alpha} \approx y_2^{\alpha_2}, \left(y_2^{\alpha_2} >> \sum_{1,j=3}^{n} y_j^{\alpha_j} \right)$. There is some use risk replaced by other risk aversion constant α that was smaller.

- The factor utility is of substitution. If the r denoted a substitution elasticity coefficient, the $r = \frac{\Delta y_i}{x_i} / \frac{\Delta y_j}{x_j}$ was obtained. For example, the r at some time indicated that paper books x_i and electronic books x_j had different use quantity Δy_i and Δy_j in collection resources. A use amount of paper books was far greater than electronic books in the last century end, but paper books is now equal to use amount of electronic books, and sometime is even lower than electronic books and value r decreases. As electronic resources x_j once soared, the use amount Δy_j was unchanged, meanwhile some species of paper books x_i was reduced collection quantity, and its use quantity Δy_i was also unchanged. The r values returned to rise, and results would improve readers interested in paper resources. It is that readers have a substitute relation to choose an existence form of literature resources.
- We have defined total utility U that users used sum total K of a certain quantity and same classes but different species of articles within a certain time, and got effect of all use quantity y. Utility time $T=t_n-t_0+1$ of articles has relationship between a certain using time t and total utility U, and function relationship $y=f(x, t)$ is established between use quantity y and time t, then the area covered is the total utility U. But different uses of articles may have different using behavior variables, and each using quantity is different in the proportion of total utility, we must first determine using weights β for different purposes and are able to get total utility $U=U(y_1, y_2, ---, y_n, K, T)$.

$$U(y_1, y_2, \cdots, y_n, K, T) = \sum_{i=1}^{n} \beta_i u_i \sum_{j=1}^{m} (y, a_j x_j, t) \qquad (n \le m), \sum a_j x_j = K, \sum \beta_i = 1 \tag{5}$$

In Eq. (5) if vector subscript m of the collection was greater than or equal to vector subscript n of the use, it indicated that the collection quantity was forever greater than or equal to the use quantity. When some using weight was $\beta_{1j} >> \beta_{(n-1)j}$, a single use management utility value was $U(y) \approx \beta_1 k_1 y_1 + \beta_1 k_2 y_2 + ---+ \beta_1 k_n y_n$. The use duration was the sum of all using time after articles into the management, which the use way was determined by the use frequency or the use duration for articles. The service life is the average service time and get by article tested after fatigue testing, i.e. theory value. Once articles came into the management, using time began to calculate from t=0. According to service life of articles settled the utility time range, using time could be infinitely long and utility time was only limited time part. When durability article has using time $t \to \infty$, use quantity must be $y \to 0$. When $t = 0$, article itself has inhered utility $U(x) \to$ min and behavior utility of the article is $U(y) = 0$, when $t \to \infty$, then $U(x) \to 0$, $U(y) = 0$. When using time t is equal to a fixed value, synergic utility of the article has the maximum value $U(x, y) \to$ max, and the continuous time T included prior using time is determined as the maximum using time.

3.3. Multi Points to Multi Points in Data Using Utility Framework

We cite some theories (Aaron D. Wyner et al., 1998) from information theory to illustrate the use utility of data replicated. An access point in cloud storage has a basic storage space (X, Y, Z), then structured data sets ($x_1, x_2, ---, x_k$), semi structured data sets ($y_1, y_2, ---, y_m$), non structured data sets ($z_1, z_2, ---, z_n$), and $x \in X$, $y \in Y$, $z \in Z$, forms $x(a)=x(a_1, a_2, a_3, ---)'$, $y(b)=y(b_1, b_2, b_3, ---)'$, $z(c)=z(c_1, c_2, c_3, ---)'$. All possible various states consist of data sets $X(x)$, $Y(y)$, $Z(z)$ with time t for dynamic transformation φt: $x \to X$, $y \to Y$, $z \to Z | t \in (-\infty, +\infty)$. So, a state $x \in X$ changed with time t could become a state $\varphi t(x)$, and other states were $\varphi t(y)$ and $\varphi t(z)$.

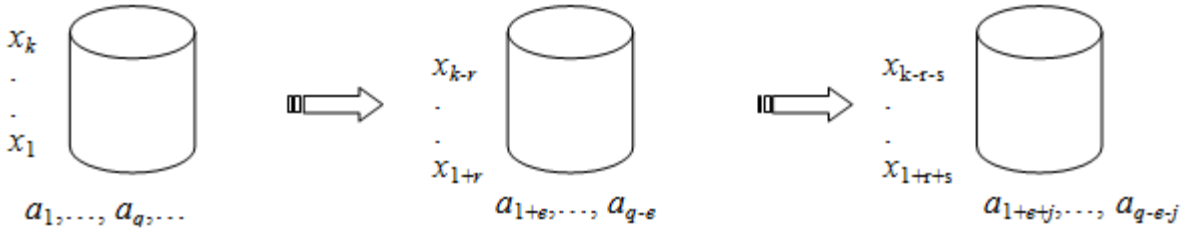

Fig 2. *Framework of repeated reading time and copy times.*

An example Fig. 2 shows a replication model about structured data sets from an access point in cloud storage. When the first continuous read a sub data sets x_r^e had interval time $T_0 = (t_1, t_2, ---, t_n)$, then the next time and after every time to read the sub data sets x_r^e had interval time $T_n > T_0$. This need to copy the sub data sets x_r^e into the other storage space. The normal time T_n read the sub data sets x_r^e was longer than interval time T_0, and replication need one time to ensure the effective read interval time T_0. In the storage space, the sub data sets x_r^e had been copied if the first continuous read a sub data sets x_s^j had interval time $T_m > T_0$ yet, then we would need to continue to copy the sub data

sets x_s^j to another replication data storage space, and became a process of cycle read interval time to determine copy times. Of course, each interval time T_0 to read sub data sets is different, and an array of interval time T_0 is formed. When many users at the same time read a sub data set on the storage space, the way does not limit to read only on a storage space, and it will automatically lead pointers to other storage spaces of the copy data to ensure the normal data read. We use typical characteristics of repeated read interval time T_0 to realize using utility for data management framework of multi points to multi points.

Another copy mode is that times j of read sub data sets x_r^e determine to copy times n. Let times j of read sub data sets be values $k(m)>2^n$ to copy, where $k(m)$ can have different settings for different sub data sets, and exponent n for copy times. If the first read times j was bigger than the set value $k(i)$, the value was $j\geq k>2$ to read the sub data sets x_r^e that was the first copied; and when read value was $j\geq k>2^2$ at next addressing sub data sets x_s^j in the x_r^e, the second times copied data sets x_s^j. So we can continue to add up reading times j of the sub data sets $x_s^j \leq x_r^e$ to copy data and so on. Because the scale of the data is particularly great and probability of repeatable reading sub data set is very low, copy times and the total replication quantity cannot be larger than big data themselves. Users began to read data from times $j+1(j>1)$ that was to read replication from the last times n, if they did not get need data that would return automatically to above data source gradually.

Above two kinds of copying data modes show that multipoint users login and read data sets simultaneously will improve data usage utility to realize the multi points to multi points' retrieval and statistics.

4. Case Studies

In respect of the practical application, utility management studied mainly case about books collection in library as articles management, and focused the research on the maximum utility evaluation of library resources, and put forward solving measures for book resources on the current library situation, and formed more systematic combing for utility management theory done ago, and constructed theory framework base on utility, utility value and using value, and applied and analyzed around article attributes, user preferences, article use and species diversity etc.. We have designed 17 functions in utility management system about the library resources such as data collation, library card analysis, reader analysis, resources analysis, book usage factor, loan book analysis, bookseller analysis, publishing analysis, discipline and specialty analysis, subject librarian analysis, circulation analysis, book state analysis, bookshelf space analysis, asset analysis, system management and parameter setting. These functions have described all design ideal and key technical points specifically for library information management and separately statistical analysis system. These functions have been inset to our developed the "Literature Resources Statistics and Analysis System" (LRSAS) in library preservation, Fig 3. The empirical analysis was carried out via collecting actual data in several university libraries in Nanjing, China.

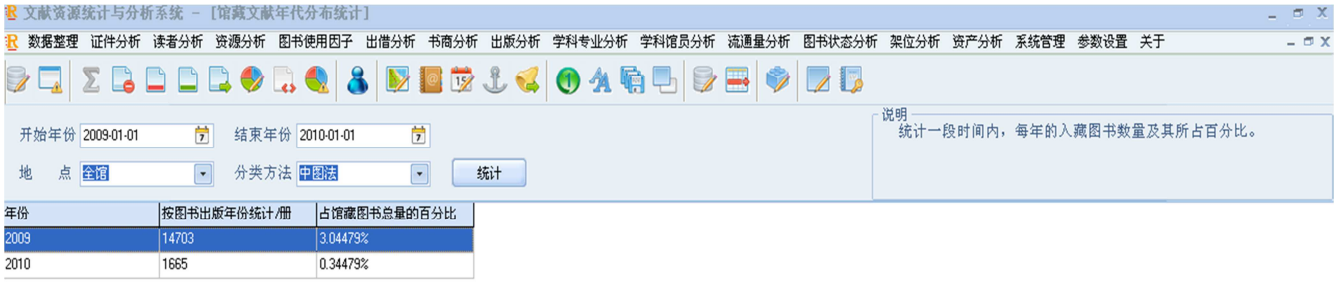

Fig 3. *Menus of LRSAS.*

It was proved that paper books in university libraries were mainly used a large number of students with empirical data, and reading behavior related to their professional learning. So the work of library management becomes necessary to strengthen paper books collection and circulation management, develop characteristic specialty books, and carry out regional interlibrary sharing. The various types and forms of book lists are not suitable for collection and management in library, but it is more appropriate that book evaluation in library can use the book usage factor, collection resources evaluation can use the book usage half-life, evaluation of the use relationship between e-books and paper books can use the substitute elasticity coefficient. The book evaluation needs to be established an information management system separated "pre-information management system" (PrIMS) and "post-information management system" (PoIMS) each other. PrIMS will provide the data source for PoIMS that will provide conclusions of statistical analysis for PrIMS, which supplement preceding one and parallel running and do not replace each other. It has been proved differences between transmission capacity and the actual transmission data with experimental data. It has also been proved that the idea of all functions integrated into a management system has fatal technical bottlenecks, and also provided the theory support for the separate management and statistics system. It clearly put forward that utility management should be adopted in library management as a supplementary of the collection management, and utility management theory and application methods were preliminary established.

4.1. BUF and BUHL

The book usage factors (BUF) in a university library were calculated in LRSAS. The book *Medicinal Chemistry* (Chinese) was written by You Qi-dong, published by Chemical Industry Press in 2004 January, ISBN 7-5025-4976-5, the call number R914/26, and 39 copies in library preservation. The statistic results were from 2004 to 2009 and saw Fig. 4, column chart shown in Fig. 5. Due to the same title with the same author and with the same publishing house and the same published year, but different publishing month and different ISBN, the book was also published in 2004 October, ISBN 7-5025-6036-X, and the book was published the second edition again by Chemical Industry Press, in 2008 October, ISBN 978-7-122-03155-6, total citation 291 times.

Since the book published and into collection recourses, it immediately got effective use and using quantity did not decrease and lasted 6 years in later. This proportion is rather higher in the same class books.

Book evaluation can proceed from calculated book usage factor. *Pharmacy* (Chinese) was written by Lu Bin and published by the Chinese Medical Science and Technology Press in 2003. Some university library has collected 10 copies of the book in 2005 and its call number is R94/34. Results of book usage factors from 2005 to 2010 are Tab.1 and Fig. 6.

Fig 4. *Book usage factors of Medicinal Chemistry.*

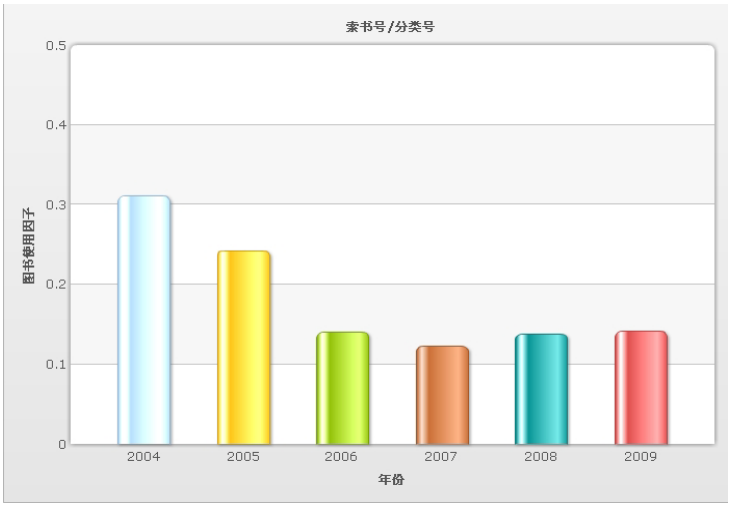

Fig 5. *Book usage factors of Medicinal Chemistry.*

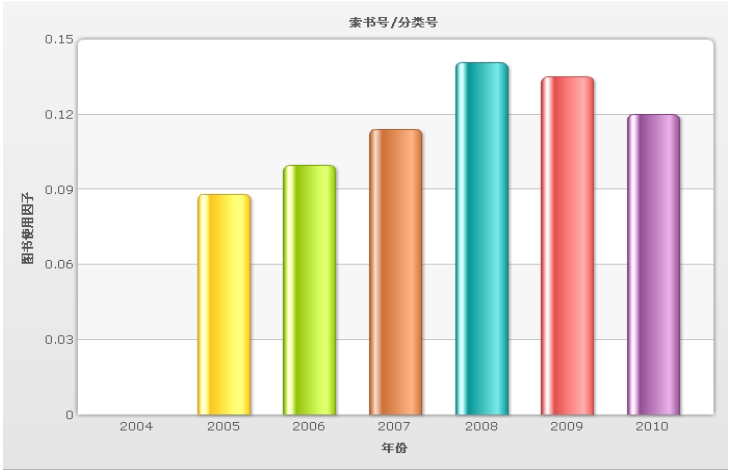

Fig 6. *Book usage factors of Pharmacy.*

Tab 1. *Book usage factors of Pharmacy.*

Year	2005	2006	2007	2008	2009	2010
BUF	0.08824	0.09968	0.11418	0.14077	0.13502	0.12016

Similarly in this university library there were 284 species and 1101 copies with CLC R94 as pharmacy in 2004. Book usage half-life (BUHL) of the classification up to 2010 April was follows Tab.2 and Fig.7.

Tab 2. *Book usage half-life of CLC R94.*

Year	2004	2005	2006	2007	2008	2009	2010
Loan	71	196	201	132	82	54	18

4.2. Subject Librarian Analysis

The specific readers such as academic leaders, subject leaders, and chiefs of the project were set as professional readers in LRSAS, and according to CLC classified all numbers of loan books in some period were calculated, and analyzed their interest or research fields in the recent time.

Fig 7. *Book usage half-life of CLC R94.*

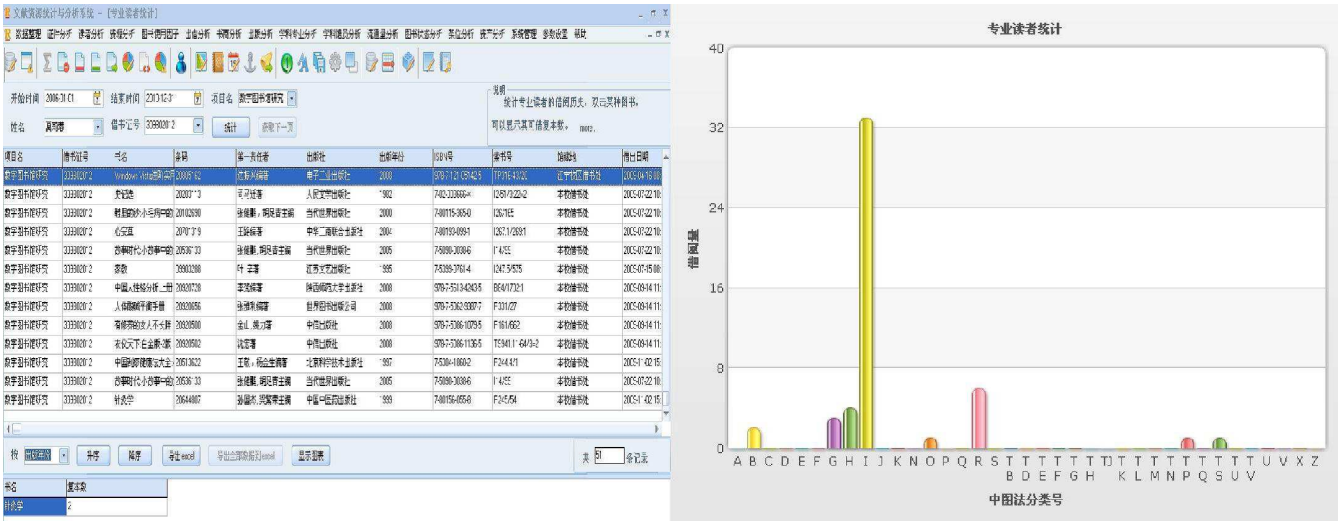

Fig 8. *Loan statistics and chart of specific readers.*

The special function for reader group, such as discipline team, research subject group, academic leaders, discipline leaders, chief subject men and so on, can give classification and discipline which they borrowed books belong to themselves research field, and analyze their recent interest relating to library preservation at present. Analysis given results which bibliographic books or literature can provide for members of the subject group and the project team. If the

results in the system were connected to disciplines and subject to analyze and determine the literature extent to meet their needs, in order to develop better customized service for them in the future, see Fig. 8. Although there is the largest number of class I, subtle research clues can be further found from the other class TP and class TS.

4.3. Analysis Book Varieties in Library Preservation

Books in library preservation were retrieved in the management system of Nanjing University of Posts and Telecommunications (NUPT), and got BUF about all the books CLC number TN711, sees Fig. 9.

图书名: 分类号: TN711 院校: 南邮 查询结果数量: 250 搜索

馆校	书名	分类号	使用因子	出借次数	同类出借总次数
南邮	电网络理论 上	TN711	0.311688	24	77
南邮	电网络理论 下	TN711	0.298701	23	77
南邮	网论-网络流	TN711	0.181818	14	77
南邮	图网络与算法	TN711	0.064935	5	77
南邮	微波网络	TN711	0.038961	3	77
南邮	宽带匹配网络的理论与设计	TN711	0.025974	2	77
南邮	图、网络与算法	TN711	0.025974	2	77
南邮	非线性电路与系统	TN711	0.025974	2	77
南邮	电信网络	TN711	0.012987	1	77
南邮	电网络图论	TN711	0.012987	1	77
南邮	网络图论及其应用	TN711	0.000000	0	77
南邮	数字网络与噪声网络	TN711	0.000000	0	77

Fig 9. *Part retrieval results of books about CLC number TN711.*

There were 51 species of books (Chinese) collected by NUPT about CLC number TN711, network, by the end of 2009 and valid loan total times were 77 with 10 kinds between 2009 and 2011. The books in the top three were *Electrical Network Theory* (Volume one), *Electrical Network Theory* (Volume two) and *Net Theory - Network Flow*. The part retrieval results show fellow Fig. 9 by our program designed and the top five species of books are follow as Tab. 3. The books about CLC number TN711 did not lack seemingly, but many of them were actually "zero" loan times and all loan times concentrated in these 3 species. These shown that books chosen by reader were still lack of.

Tab 3. *Contrast BUFs among different species in same class of books.*

Title	BUF	Loan times	Total loan times
Electrical Network Theory (Volume one)	0.311688	24	77
Electrical Network Theory (Volume two)	0.298701	23	77
Net Theory - Network Flow	0.181818	14	77
Diagrams, Network and Algorithms	0.064935	5	77
Microwave Network	0.038961	3	77

Tab. 3 shows the first five species of books and 69 loan times, occupying 90% of total loan times. Other books were used less and even neglected to use. The books, they mostly use, are a few species and are published in recent 3-5 years. It is uncertain at book supple chain from publish, sell, collection and read.

5. Results

If utility expresses consumer's satisfaction to consume articles, so for managers, it is satisfied degree of user using quantity of articles managed. In utility management the modeling wants to establish a function relationship that articles managed combine with a number of using articles, and the function relationship will cause maximum utility through management factors. Of course every user may have different effects on using articles, but comprehensively various effects are possible to obtain social utility and economic utility, and then utility management wants to take evaluation for managing articles to produce synthetic utility with various effects after users using them. This use evaluation has got to reflect management factors on utility and can predict various factors for maximum utility possibly.

In the library application, utility management may improve method design to a large amount of data as new digital literature resources pole, and in high speed all optical networks and on cloud resources service platform, data storage utility has given the method on resource allocation and service management. In view of digital literature resources with distributed processing, independent preservation and use at present, the evaluation indexes have been used of needs analysis, and regional public scheme of the literature resources has been proposed. This management mode will be carried out unified management of the third party data trusteeship, unified procurement, unified processing, unified storage and unified logistics. The public management and user access service method will be carried for independent, characteristics and dispersible literature. Data resource will realize the multipoint distribution and storage according to configuration principle of read quantity to copy and transfer and smooth and concise multi points to multi points as service goal. It is primary in strip technology

from the start of data storage format. Data format will be converted from a single band storage technology to multi band storage now and put forward specific design requirements for cloud storage by calculating mode. The system can statistic automatically via reading data use quantity as soon as data memorized, and complete data migration, replication and backup according to analysis results that have realized multi points to multi points read request. Cloud storage data can also divide into these storage spaces by this definition, the data are not often read will be migrated to backup spaces, and data by read many times will be extracted and copied to many server groups to meet many users fast download simultaneously, and overcome data congestion with many access and share.

The utility management has attempted in application of the books, and it can get rid of the dilemma between library and book supply, and also provide a measure model for the traditional book evaluation or assessment, and provide an optimal path of the effective preservation for cultural resources and full use in existing resources. Study on the book utility evaluation based on utility value theory has applied to taking knowledge as carrier. It has designed a conversion equation of book loan standards for consistent statistical data, and has proposed the book usage factor as utility evaluation method that judge readers learned degree from book content and appraised utility value of the book, expounded book usage half-life to predict a trend of reading books for some class. All of mathematical equations need also many empirical data to illustrate reliability, and can set an evaluation early alarm for the using fluctuation between paper book and e-book in the long run.

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Biography

Bin Yan is a research librarian/professor and a postgraduate instructor and a former chief librarian in NUPT. And he was a member of the academic committee of NUPT. He was graduated from Peking University and has engaged in library technical and management theory research for over thirty years. He has published more than sixty theses and three books on contemporary information management and information system design in domestic and abroad academic journals and domestic press. His main study area is the theory and application of modern information management technology. He was a vice-director of the Modern Technology Committee of Academic Library of Jiangsu Province, China and a member of Digital Library Committee of Jiangsu Library Academy, China. Now, he had retired in 2014.