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基于熵信息含量的 管理复杂性评价指标体系研究

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Abstract

The purpose of this monograph is to explain the theories of General and Specific management entropy. The resulting work stands at the cutting edge of management complexity theories. To achieve this goal, the author has not only applied the basic principles of entropy theories to management circles, but has detailed the basic concepts, definitions, and principles of these theories to effectively manage entropy. Additionally, their functions, mathematics models, metric methods, applying ranges and properties also have been established. It is in this way that the author constructs the systematical theories of general-special management entropy.

This monograph establishes new metric models of vectorial space, using universal mathematical models for assessing the information and it's force. This work is based not only on the basic theories of entropy, but also puts forth the concepts, definitions, theorems and research scopes of the general informational force, as well as its energy and complexity. This results in an enlarging of Newton's force metaphor. The author establishes a new way of looking at metrics for not only assessing the informational force and models of vectorial space, but also universal mathematical

models.

This work analyzes both the macro and microenvironments of an enterprise's dissipative systems and the making of Dynamic Production Planning for enterprise systems. Critical problems are addressed, such as how does the enterprise suit itself to changeable circumstances, and in turn draft a rational plan to ensure implementation of the goal? By applying the fuzzy-random decision-making methods and theories of the multi-step, multi-goal and multi-factor system, the author solves these problems.

This monograph also establishes the all-state transferring matrix, stochastic weight and the ways of assessing complexity for a dynamic determining network. By applying the theories and models of physics, mathematics, dynamics, information and management science and statistics, the author puts forth the concepts, definitions, basic theorems and research scopes of the management force, energy and complexity. Furthermore, he establishes a new metric set for assessing management complexity and the models for vectorial space. Ideas about enhancing the managing effectiveness and efficiency have also been proposed. This monograph has tried to enrich the theories of the complexity theories in management circles by way of a verified case study.

Based on the concept of information entropy, the author assesses the synergistic complexity for a typical organizational enterprise. This involves a series of conceptions regarding synergic parameters, such as the synergic dynamic field, the synergic path, synergic span, synergic cohesion, and functional cohesion and span. The synergic matrix is established and assesses mathematic models of synergic complexity. The decreasing dimensional methodology has been adopted to suit the problems of

different dimensions, and attempts to make these theories and methods workable and normalized. Once again, a case study serves to verify this.

This work also assesses the concept of operating disorderly complexity for The Discrete System. Using the basic theories of the information entropy, the monograph puts forth the research scopes of the operating disorderly complexity for discrete production systems, and establishes a new set of metrics for assessing the operating disorderly complexity and its models of the vectorial space. A case study of a mining working face has been enacted and verifies the research.

Applying the methods of the complex study, the author researches the innovating and developing course of Shendong Company, carries out the dynamic causality analysis for its innovation systems, including the subsystems of conception innovation, management innovation, technological course innovation, technological innovation, which are the conception systems, puts forth the new way of the complexity evaluating methodologies for this conception and non-structured system. Meanwhile, the research uses the above entropy information content of complexity to establish the new metrics for their evaluations. Hopefully, So the author attempts to decode the mystery of Shengdong Company innovation marvel and explains the true essence of modernization enterprise's jumping development.

This monograph is suitable for undergraduate, graduate students, researchers, and scholars who are interested in complexity theories. It is the author's hope that this work will enrich the theories of management complexity and system research, and contribute to the development of the relevant theories. It is, of course, not sufficiently developed at this stage,

and the author would, accordingly, welcome constructive criticism and comments from all scholars, students and teachers in the fields of management science, as well as other cognitive disciplines. The author has attempted to acknowledge all those whose ideas have contributed to this work and has thereby enriched its research.

Preface

Tracing back the development history of management theories, we can divide it into three stages roughly: empirical, scientific and modern management. With the rapid development of scientific theories and production technologies, the modern management theories have been innovated incessantly; especially, the developments of compute technologies at the modern time have made the managing means more advantaged. Meanwhile, we should notice that management objectives faced the 21-century of knowledge economy and information time will be more complicated. The compositions and features of management objectives become the integrations of martial, energy and information, are more diverse; the fierce competitive and changeable enterprise environments make management elements more uncertain, even in chaotic states. Consequently, the complex system's characteristics of enterprise system will be more obvious.

So that, the existing management theories and methodologies cannot satisfy the needs of new situations, to push their development and to constitute the new ones have become the historical responsibilities of

researchers who are in engage of management study.

The combination of complexity with management science is an important direction of management science development. The system science developed in 30-40s of 20 century, such as general system of Bertalanffy, cybernetics of Wiener, and information theory of Shannon, so called “old three theories”, embodied a kind of scientific thought and theory of wholeness, being basis to create the complexity theories. The three winners of Nobel Prize of Santa Fe Institute, United States, short in SFI, M. Gell-mann, founder of Quark Theory, P. W. Anderson, physician of the condensed state, and K. J. Arrow, mathematical economist, assembled a group of youth scientists who researched in the different disciplines and domains to conduct the interdisciplinary researches, named complexity researches, in 1984. The researches of them included the natural and social complexities, and abstracted the conceptions of complex adaptive system, such as living, immune, ecology, brain, and economic systems, etc. In fact, all systems have a kind of ability, which can make disorder to order, and chaos to particular equilibrium, called on the equilibrium point of edge of chaos. They thought: the theory being constituted by SFI was a strict scheme that can firstly substitute for linear and reductionism dominated sciences since Newtonian; this scheme could explain the various problems of current world. Mr. G. Cowan, the founder of SFI, said: they are creating the new science of 21 century ^[1]. The scientists of SFI applied these conceptions, such as self-organization, chaos, emergence, complex self-adaptive system, to study complexity, emphasized on the application of compute technologies to the complexity researches, and put forth the genetic and evolving algorithm, automata

network successively.

The complexity researches were in bloom at the scope of world in 1980's, and it was that time affected the management complexity greatly. The reference [2] had stated this process deeply. The school of management science applied the complexity new theories and mathematics technologies of entropy, nonlinear, dissipative structure, synergic, catastrophic theories, etc., to management field, and based on them to create a new science——management complexity study. Therefore, the complexity theories are the important theoretical pillars of this discipline^[3-10].

Recently, there are many management complexity symposiums on the world yearly. The many researching organizations and journals, such as the discussing group of complexity and management of New England Complex System Institute, Journal of Emergence, organized the international symposium titled 'Managing and Complex' at Boston of USA in March of 1999. The scholars, scientists and enterprisers attending the meeting discussed and exchanged warmly about problems of the relations between complexity and management science, and the application in the management practices. Meanwhile, a series of management complexity meetings and journals emerged around world; the complexity periodicals of "Emergence: A Journal of Complexity Issues in Organization and Management" was issued in April of 1999. At present, the complexities researches are in progress deeply, and form the schools of intersect, chaos theory, systematic dynamics, and self-adaptive system, structured based and so on^{[12][11]}

The start of complexity study in our China was little late. Based on

the research of system science, one group of scholars, headed by professor Qian Xue-shen, put forth the theories to solve opened complex giant system in the beginning of 90s. Furthermore, after ten years studying, they have constituted the complex researches methodologies named meta-synthesis, means synthesis and integration from quality to quantification and Hall for Work Shop of Meta-synthetic engineering; these supply the new methodologies for the complex studies of large system^[12] The Xiangshan academic meeting, titled the methodologies of opened complex giant system, was held, in 1994; it played very active role to the complexity research in our nation. Then, the 112 session of Xiangshan meeting of complexity science was held in March of 1999. The first session program meeting, titled complexity science and its application in management, was held by the philosophy section of Chinese social science institute in Jun of 1999. The department of science and technology of nation financed the programs to study the possibility that complexity science applies to management, the timely reacting ability to the outside environments and the new conceptions of management, etc. in that time.

The 46th Annual Meeting of the International Society of the System Sciences with special topic of system complexity and the second session academic discussing meeting of complexity science in China were held in Shanghai in August of 2002. In addition, many symposiums, including complexity research topics, were held around China yearly.

Recently, there are some researching fruits in aspect of economic and financial system^[13-19] and organization management system^[20-53] and others.

Furthermore, to analyze the present situation of organization and

enterprise complexity studies in China and from the currently published research papers, we can know the studies mainly concentrate on the domains of economy and finance, and emphasize on the researches of chaos and nonlinear theories. Comparably, the management systems complexity studies, especially, the applying researches of structured based complexity theory are few^[2]. That means many management complexity studies to be need to develop further, especially, many aspects of the theories and practices of micromanagement complexity are rough, empty, and unworkable and the studies about the complexity mechanisms, main forms of manifestation, and evolving regulations are inadequate; some studies lack the deep and scientific researches about managing and controlling methods, which suite the managing complex systems, and stagnate in the simple applications of nonlinear and chaotic theories in management cycle. The breakthroughs of these aspects have become the important directions of management complexity studies.

After deeply researching the existing schools of complexity studies, according to the characteristics and relations of structure, substructure and non-structure of enterprise management systems, the many scholars have reached the consensus that the theories and methods of structure -based school of complexity studies are most suitable for management systems of enterprises or organizations^[2, 4, 11].

The structure -based school of complexity studies is the thoughts put forth by J. N. Warfield, G Vickers, C. S. Pierce, J. Piaget, etc. This school thinks: the complexity exists in the researchers' brain, and utilizes synthetically the management psychology, organizational behavior science, the mathematics methods of system analysis, relation theory, set theory,

graph theory, lattice theory, Boolean algebra to describe the complexities; it put forth the scientific design methods of Interactive Management (IM), Interpretive Structural Modeling (ISM) and General Design etc. to solve the complex problems for organizations; the twenty Laws, ten Taxonomies, and five indexes, short in LTI set, constituted the core theories of this school^[31].

The complexity modeling and metric researches of enterprise and organization management system are an important part of the theories and methodologies of complexity studies. This system integrates the manmade, machine, and microenvironment systems, and the research like this possesses the integrated complex features. To study this system's developing, evolving and self-adaptive regulations of organization structures, through relations with its environments, and to establish their complex evaluating metrics need to be crossed and mixed many theories highly. Theoretically, this research is challengeable, and practical, and very meaningful to solve the complexity problems that our enterprises or organizations faced, such as reconstruction, regroup, reform, optimization, efficiency and effectiveness of them.

The author has been engaged in complexity study combined many fruits of physics, natural science with management theories, social science, for many years, and put forth the research domains of management physics, the management entropy theory is one part of them. After many years research, the author comprehended the essences and attributes of entropy deeply and fully and put forth the basic conceptions and theoretical frames of general and specific management entropy theory in reference [32] and doctoral dissertation in 1995, including the conceptions of high

entropy engineering system, manmade entropy, structural entropy, environmental entropy and enterprise managing entropy, etc ^[33]. Incessantly, the author published two monographs, named general and specific management entropy theory—the theory and application of high entropy engineering systems in 1999 and the complexity evaluation of enterprise systems in 2004 and a series of research papers ^[32–53]

Resent years, aiming at the goals that complexity studies must go a way of the accurate science not only qualitatively, but also quantitatively ^[11], the author concentrates on the modeling and evaluation researches of enterprise complex systems. According to the principle of management theories innovation, based on the particular researching conceptions, the author establishes the modeling methods, complexity evaluating metrics, quantitative index system based on entropy information content in this monograph.

The main contents of this monograph as followings:

a. Standing the cutting edge of complexity theory, the author apples the basic principles of the theory of entropy to management circle, puts forth the concepts of, particularly, of managing entropy at the first time. In addition, the basic concepts, definitions, basic principles of the theories of managing entropy have been defined; their functions of entropy, mathematics models, metric methods, applying ranges and properties also have been established. In this way, the author constructs the systematical theories of the general-special management entropy, integrates entropy with other complexity theories and methods, entrusts to new meanings, takes the management entropy as a methodology to evaluate the complexity of management systems. Hopefully, these can enrich the theories of

management complexity and system research, and contribute to the development of the relevant theories.

b. Applying the theories and methods of the physics, mathematics, dynamics, information science etc, the monograph extends the conceptions of information and informational force, proposes the basic conceptions, definitions and theorems of enterprise force field, general informational force, energy and their measurement, constitutes the ball model of enterprise forces; based on entropy information theory, the author establishes a new set of the vectorial space, mathematical models of measuring metric for the enterprise system's information forces, especially, and utilizes these models to create the new assessing methodologies and metrics for enterprise complexity.

c. Facing the changeable, internal and external conditions, enterprise falls into dynamic, stochastic and fuzzy environments. Under this circumstances, how does the enterprise make its own the program of development, draft the rational plan and ensure the implementation of goal, these are critical problems. Under the changeable and dynamic internal-external condition, the author applies the fuzzy-random decision-making methods and theories of the multi-step, multi-goal and multi-factor systems to solving the problems of enterprise's planning, and the all-state transferring matrix and stochastic entropy weights have been put forth and made a contribution to develop the theories of the multi-step decision-making. Combining with the mining production, the practical case study has been carried out. Hopefully, This part enlightens the complexity theories and methods for enterprise dynamic system.

d. Applying the entropy theories and methods of general information

force proposed in this monograph, the author has a deep study about organizational management complexity, and quantify the management parameters, constitutes the relations among organization structures, functions and information transformations, management layers, management ranges, etc. Meanwhile, the evaluating models and index systems of each complexity parameters for enterprise micromanagement system and wholeness have been established. The author puts forth the management entropy and complexity decrease theorems, and verifies a case study.

e. The problems how to smooth the relations among organizations and to enhance the coordinating efficiency and synergy have been are very important and complicated issues. Based on the entropy theory, the monograph puts forth a series of conceptions about synergetic parameters, such as synergetic dynamic field, synergetic path, synergetic span, synergetic cohesion, functional cohesion and span, and establishes the synergetic matrixes and mathematic models of synergetic complexity assessment. Meanwhile, some modifications of the literature [21]'s model have been made in this monograph, and the decreasing dimension methodology has been adopted to suit for the problems of inhomogeneous dimensions. The author tries to make the workability and normalization of these theories and methods, uses a case study to verify them.

f. The monograph applies the theories and methods of the physics, mathematics, dynamics, information science, statistics and management science to put forth the concepts, definitions, basic theorems and research scope of operating complexity in a discrete production system, establishes the basic theories of information entropy and the new metrics for assessing

operating complexity. A case study involving the working face of a mine has been verified.

g. The author puts forth the concepts, definitions, basic theorems and mathematic models of the structure complexities of production systems. Based on the basic theories of the management entropy, it establishes a new set of the vectorial spaces, mathematical models of metric for assessing the production systems structural complexity and proposes the theorems of simplification and complexity decrease for production systems of enterprises. A case study has been verified.

h. Shenfu Dongsheng Coal Co. Ltd (abbreviation for Shendong Company) is a large state-owned enterprise mainly engaging in coal production. After 20 years of hard work, the company has experienced a soaring development and earned itself ten world records in the mining industry. In this process of development and achievement, the integrate innovations have played a very important roles. Applying the methods of the complex study, the author researches the innovating and developing course of Shendong Company, carries out the dynamic causality analysis for its innovation systems, including the subsystems of conception innovation, management innovation, technological course innovation, technological innovation, which are the conception systems, puts forth the new way of the complexity evaluating methodologies for this conception and non-structured system. Meanwhile, the research uses the above entropy information contents of complexity to establish the new metrics for their evaluations. Hopefully, So the author attempts to decode the mystery of Shengdong Company innovation marvel and explains the true essence of modernization enterprise's jumping development.