ICMEM

The 8th International Conference on Management in Emerging Markets

Harnessing the Traditional Japanese Shikinen Sengu System for the Evolution of Information Systems

Takao Terano[1]

[1]Chiba University of Commerce, Japan

Abstract: *Modern ICT systems often experience failures due to their complex and evolving nature. Inspired by the Japanese Shikinen Sengu tradition, where shrine structures are rebuilt every 20 years to preserve craftsmanship and cultural heritage, this approach can be applied to ICT systems. Periodic renewal and modernization, regardless of current stability, prevent obsolescence and ensure robust performance. This strategy also facilitates knowledge transfer, strategic resource allocation, and better maintenance cost forecasting. Integrating these renewal costs into lifecycle planning ensures the reliability and security of critical infrastructure in a rapidly advancing technological landscape. Agent-Based approach is an effective framework to study such modern complex ICT systems.*

Keywords: *ICT system evolution, shikinen sengu system, agent-based approach*

I. INTRODUCTION

The incidents, failures, and accidents often occur in modern large scale ICT systems. For example, a global system outage caused by the security software update error of ClowdStrike was fresh in our memory. While such incidents often evoke a sense of "not again!", it's important to recognize that ICT systems are inherently prone to issues. Generally, systems are invisible and become outdated the moment they start operating. Although software, once developed, does not degrade, the hardware it runs on and the surrounding societal systems and environments do.

Regarding core operations like those that encountered trouble, the specifications essentially remain unchanged. This is why the system could be used for 50 years. However, the software's commissioners and managers tend to believe that once an ICT system starts running, it's all set, leaving maintenance as the only concern. Consequently, the operational knowledge and know-how embedded in ICT systems are not passed down, causing delays in responding to issues..

II. WHAT IS SHIKINEN SENGU SYSTEM

I believe that the concept of Shikinen Sengu, a tradition of the Ise Jingu Shrine that started 1,300 years ago, is crucial. Shikinen Sengu involves rebuilding the shrine's main buildings and treasures every 20 years to enshrine the deity anew [1]. The next Shikinen Sengu is scheduled for 2033, with preparations already underway.

Shrine buildings and treasures do not degrade significantly in 20 years. As seen with Horyuji Temple, carefully maintained structures can last hundreds of years. The deity would likely not complain about being enshrined in an old building. However, for the shrine carpenters and related personnel responsible for the Sengu, 20 years is an ideal interval. Here are three irreplaceable advantages:

1. Individuals gain valuable experience three times in their lifetime: as novices, as veterans, and as leaders.
2. Know-how and knowledge associated with Shikinen Sengu, including construction techniques, are naturally inherited as tacit knowledge.
3. Long-term management of resources, materials, and human resources is possible in preparation for the next Sengu.

In essence, Shikinen Sengu is a unique ecosystem that ensures the continuity of tradition by continually

renewing the shrine buildings. This is an excellent system unique in Japan.

III. UNDERSTANDING KNOWLESDGE TRANSFER PROCESSES THROUGH ORGANIZATIONAL LEARNING

About the process of Shikinen Sengu, they always learn their expertise organizationally. The concept of organizational learning has been first proposed by Argyris et al. [2] in the context of management organization theory. They defined Model I as collective problem-solving behavior by bounded rational agents and corrective behavior for difficulties, and Model II as behavior to transform Model I, including organizational relationships. They have called the behavior of reevaluating goals and values under uncertain circumstances "double-loop learning.
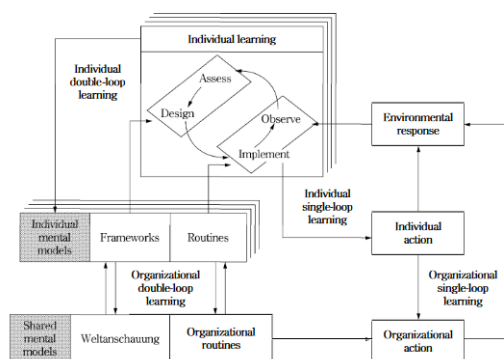

Figure 1. Organizational Learning Model by Kim

Furthermore, Kim [3] has formulated that the concepts of organizational learning consists of four types of learning: individual single-loop learning (the cycle of observation, evaluation, design, and implementation), individual double-loop learning (changing the framework or routine of the problem to be solved), organizational single-loop learning (transforming organizational behavior), and organizational double-loop learning (changing organizational goals or routines) (See Figure 1).

About the knowledge transfer processes in the organization has been discussed by Nonaka [4]. He has focused on the transformation process among formal and tacit knowledge possessed by individuals or organizations. This is the famous SECI model.

He has stated that organizational learning will be deepened through the loop of the following four steps: (S) Socialization: Tacit knowledge of each individual is communicated with empathy as tacit knowledge within the organization; (E) Externalization: From tacit knowledge of each individual, concepts are expressed as articulated knowledge by explicit words and diagrams; (C) Combination: Existing articulated knowledge and new articulated knowledge are combined and systematized; (I) Internalization: Articulated knowledge is acquired through experience and internalized as tacit knowledge. Figure 2 shows Nonaka's conceptual diagram of organizational knowledge creation as a process of self-transcendence.
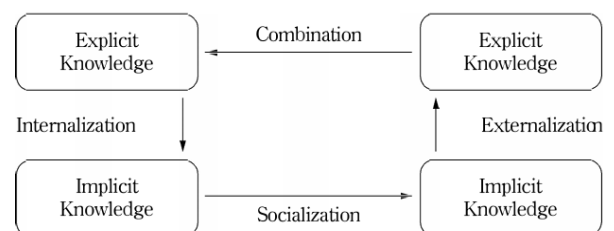

Figure 2. Organizational Process in SECI Model

IV. REPRESENTING THE KNOWLEDGE TRANSFER THROUGH AGENT-BASED APPROACH

The concept of organizational learning is intriguing; however, it is not directly applicable to ICT system evolution in its original form. Agent-Based approach is essential [5]. Therefore, we have adopted the Learning Classifier System (LCS), a problem-solving framework categorized as a genetic learning system. LCS is a complex system that integrates rule-based problem-solving, knowledge refinement through reinforcement learning, and rule generation via genetic algorithms (Figure 3).

We extended the concept of LCS to develop a framework that operates within a multi-agent environment, which we have named the Organizational Learning Oriented Classifier System (OCS). Each agent in OCS maintains the structure of an LCS and can exchange a subset of highly evaluated rules at appropriate times. Additionally, when dealing with similar problems, it can distribute previously learned rules to the group of agents.
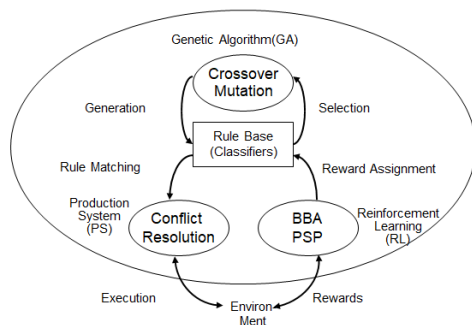
Figure 3. Framework of Learning Classifier System

Using OCS, we can build systems in which agents autonomously act and learn according to their local evaluation functions, while also sharing acquired knowledge to enhance overall organizational performance. We applied the OCS framework to the practical problem of component placement on printed circuit boards and demonstrated that the fundamental principles of organizational learning, as observed in practices like the Shikinen Sengu, can be effectively applied to real-world challenges.
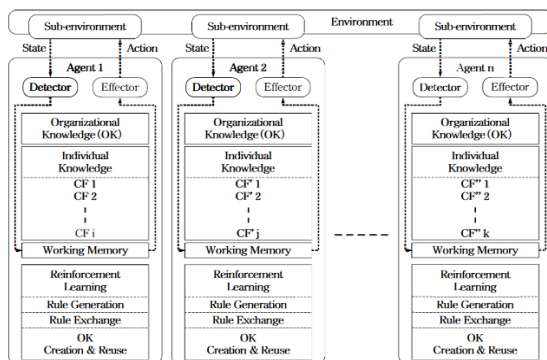

Figure 4. Architecture of OCS

V. DISCUSSION ON SHIKINEN SENGU, ORGANIZATIONAL LEARNING, AND SOFTWARE SYSTM ISSUES

In the realm of information technology, where systems are constantly evolving and the risk of obsolescence looms ever-present, we can draw invaluable lessons from the ancient Japanese tradition of Shikinen Sengu. This sacred practice, observed at the Ise Grand Shrine, involves the periodic rebuilding of the shrine every twenty years. Such a ritual not only preserves the physical structure but also ensures the transfer of intricate craftsmanship and cultural heritage to successive generations. By integrating this time-honored approach into the management and development of modern ICT systems, we can achieve a sustainable model of innovation and continuity.

The practice of Shikinen Sengu epitomizes the balance between tradition and renewal. Every twenty years, skilled artisans meticulously reconstruct the shrine, passing down their expertise and preserving the essence of their craft. This cyclical process guarantees that the shrine remains resilient against the ravages of time and environmental factors, while also fostering a culture of continuous learning and adaptation.

In a similar vein, ICT systems, which are foundational to the infrastructure of our contemporary world, can greatly benefit from a structured approach to renewal and maintenance. Implementing a digital Shikinen Sengu involves periodically overhauling and modernizing systems, irrespective of their apparent stability or performance. This proactive strategy mitigates the risks associated with technological stagnation and obsolescence, ensuring that systems remain robust and secure in the face of evolving challenges.

Moreover, just as the Shikinen Sengu nurtures a lineage of master builders, a planned cycle of system renewal cultivates a cadre of skilled professionals adept in both legacy systems and cutting-edge technologies. These experts, akin to the shrine carpenters, carry forward institutional knowledge and technical prowess, bridging the gap between past and future.

This concept should be introduced to ICT systems as well. No matter how stable and efficient a system is, it must be periodically rebuilt. In the software world, reconstructing an existing system into a clean structure is called refactoring, which helps maintain and improve quality. Additionally, it allows for the retention and development of "experts" who understand the operations and systems, and the advance prediction and management of development costs and necessary resources.

The benefits of this approach extend beyond mere technical resilience. It allows for the strategic allocation of resources, better forecasting of maintenance costs, and the anticipation of future technological needs. By embedding the costs and efforts of periodic renewal into the lifecycle of ICT systems, organizations can avoid the pitfalls of deferred maintenance and unplanned outages. Objections like "We don't have the budget for such extra costs!" are likely to arise.

However, the concept of depreciation is commonplace for hardware such as buildings. Planning with the costs for Shikinen Sengu factored in from the start should suffice.

However, to practically implement the concept of Shikinen Sengu to develop and/or operate ICT systems, there remains various difficulties to operationalize the processes.

VI. CONCLUDING REMARKS

In the fast-paced world of ICT systems, progressing at the speed of "dog years," we cannot afford to spend 20 years on a digital Shikinen Sengu. We need to be prepared to rebuild systems every 5-10 years. In the financial sector alone, there are many long-used but potentially problematic systems like the Bank of Japan system and credit card systems, where failures could lead to social instability. The concept of digital Shikinen Sengu is crucial for the development of services like My Number cards and digital government services. I hope for a society where system engineers, akin to shrine carpenters, practice digital Shikinen Sengu across Japan.

In conclusion, the integration of Shikinen Sengu principles into the evolution of ICT systems offers a harmonious blend of continuity and innovation. It is a testament to the enduring wisdom of Japanese tradition, providing a robust framework for sustaining the integrity and functionality of critical infrastructure in an ever-changing digital landscape.

For the purpose, Agent-Based Approach is an effective framework to design, implementation, and analysis for complex modern ICT systems.

REFERENCES

[1] Shikinen Sengu: (cited 2024, August) https://www.isejingu.or.jp/en/ritual/index.html#sengu

[2] Argyris, C., Schon, D. A.: Organizational Learning. Addison-Wesley, (1978).

[3] Kim, D..: The Link between individual and organizational learning. Sloan Management Review, Fall, pp. 37-50 (1993)

[4] Nonaka and H. Takeuchi, "The Knowledge Creating Company," Oxford University Press, 1995.

[5] Terano, T.: A Perspective on Agent-Based Modeling in Social System Analysis in Metcalf, G. S. et al. (eds.), Handbook of Systems Sciences, Springer, 15pp., https://doi.org/10.1007/978-981-13-0370-8_5-1, 2020)

[6] Takadama, K., Terano, T., Shimohara, K.: Learning Classifier Systems Meet Multiagent Environments, Lanzi, P.L., Stolzmann, S., Wilson, S. W. (Eds.): Advances in Learning Classifier Systems, Third International Workshop, IWLCS 2000, Paris, France, September 2000. Springer LNAI 1996, pp192-212, 2000.

[7] Takadama, K., Terano, T., Shimohara, K.: Non-Governance Rather Than Governance in a Multiagent Economic Society, IEEE Transaction on Evolutionary Computing, Vol. 5, No. 5, pp. 535-545, 2001.

[8] Takao Terano, Understanding Tacit- and Articulated-Knowledge in Organizational Learning through Agent-Based Modeling (In Japanese), Magazine of JSAI (JINKOU CHINOU), Vol.39, No. 3, pp. 283-287, 2024.