การจัดการความรู้ : การประยุกต์ใช้แบบจำลองวงจรความรู้ เซกิ ในสายการผลิตหัวอ่านเขียนในอุตสาหกรรมฮาร์ดดิสก์

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บทคัดย่อ

ในภาคการผลิตของอุตสาหกรรมทั่วโลกมีการนำวงจรการสร้างความรู้ในองค์กร "เซกิ" ไปใช้อย่างกว้างขวาง โดยทีมโปรเจ็คได้รับการยอมรับว่าเป็นพื้นฐานของกระบวนการสร้างความรู้ "เซกิ" ซึ่งถูกนำไปใช้กันทั่วไปตามอุตสาหกรรมต่างๆ ด้วยเช่นกัน มีการนำทีมโปรเจ็คไปใช้ในอุตสาหกรรมฮาร์ดดิสก์ไดร์ฟเพื่อการแก้ปัญหาในสายการผลิตด้วยเช่นกัน แต่เนื่องจากอุตสาหกรรมฮาร์ดดิสก์ไดร์ฟเป็นอุตสาหกรรมที่มีการเปลี่ยนแปลงทางเทคโนโลยีอย่างรวดเร็ว มีผลทำให้ทีมโปรเจ็คที่ตั้งขึ้นมาประสบปัญหาในการหาข้อมูลความรู้ในสายการผลิตเพื่อทำการวิเคราะห์หาสาเหตุของปัญหา ดังนั้นงานวิจัยฉบับนี้ได้ทำการวิเคราะห์ และสรุปว่า ปัญหาเกิดมาจากช่องว่างความรู้ระหว่างส่วนงานที่เป็นทีมโปรเจ็คกับส่วนงานประจำขององค์กร ทำให้การแก้ปัญหาของทีมโปรเจ็คไม่ประสบผลสำเร็จเท่าที่ควร งานวิจัยได้เสนอให้องค์กรจัดตั้งส่วนงานหรือบุคลากรพิเศษที่ทำหน้าที่เชื่อมต่อช่องว่างความรู้ ซึ่งเรียกว่า "นายหน้าความรู้" สุดท้ายงานวิจัยฉบับนี้ยังได้นำเสนอแบบจำลองในการทดสอบความสามารถในการสร้างความรู้ของทีมโปรเจ็ค เพื่อนำไปใช้ในอุตสาหกรรมต่างๆ

คำสำคัญ : สไลเดอร์ / สไลเดอร์ แฟบริเคชั่น / เซกิ โมเดล / เฟมโต / แอร์ แบริ่ง เซอร์เฟส / การจัดการความรู้ / การสร้างความรู้

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Organizing Knowledge Creation: The Implementation of SECI Model in Slider Fabrication in Hard Disk Drive Industry

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Abstract

The SECI model for organizational knowledge creation has been adopted by a number of manufacturing facilities worldwide. Team project is described to be a platform for the SECI model and is currently being implemented. It was Hard disk drive business where a fast changing in technologies makes it difficult for the Team project to find the right solution for a shop floor problem. This paper analyzes in detail and concluded that there is a missing link between team project (Nonhierarchical) and production operators (Hierarchical). This paper proposes a technique to assign personnel as a "Knowledge Agent" to bridge the gap in an organization. Lastly, this paper proposes a methodology to assess Knowledge Creation in team project based on the SECI model.

Keywords : Slider / Slider Fabrication / SECI Model / Femto / Air Bearing Surface / Knowledge Management / Knowledge Creation

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1. Introduction

Hard Disk Drive (HDD) industry is a rapidly changing business. As Clayton M Christensen stated "nowhere in the history of business has there been an industry like disk drives, where changes in technology, market structure, global scope, and vertical integration have been so pervasive, rapid, and unrelenting" [1]. In order to stay competitive, many management tools and technique have been brought into a shop floor which includes quality tools such as Fishbone diagram, FMEA, Six Sigma etc. Another technique being used organizationally alongside with quality tools is Team project. Team project was instructed to tackling the specific problem in production line which a routine operation could not solve. Quality tools together with Team project has proved to be an excellent match for problem solving until recently when the Slider became drastically smaller. This contributed to difficulties in gathering shop floor information to analyze by such a tool. When the Slider became very small, some aspects of the problem could not be told directly since it became tacit in nature (difficult to see causing difficult to tell). It became obvious that another aspect of the problem needed to be put into team consideration. The Knowledge aspect of the problem is the last piece in completing the jigsaw puzzle.

2. Slider Fabrication

Slider fabrication is one of the five main facilities of Hard Disk Drive manufacturing processed. Slider is the name of the Read/Write head of the hard disk drive. The main function of Slider fabrication is to transform the Read/Write head wafer into - more than 40000 sliders air bearing design pattern (ABS) by number of process steps and techniques including Grinding, Slicing, Lapping, FCA coating, Sputtering, Etching, Photolithography, Robot sorting, Inspection and Measurement. The entire process step includes both automated equipment and manual steps performed by manpower and a majority of the process still relies on manpower. As technology moves toward 600 - 1000 Gb/in2, the mechanical spacing between the head-slider and disk media must be further reduced to a level of 3 - 4 nm. Such a reduction of the head-disk spacing will be accompanied by many new challenges [2]. One of the challenges is that the slider platform will be a Femto form-factor which is dramatically smaller and fragile. Conversely, the market demand enforced slider fabrication to process faster with the lowest possible cost. Investment on fully automated production lines will not make slider cost very competitive. Consequently, making, adjusting and improving current manual process steps to minimize the problem becomes the only way to stay cost competitive alongside with progress in new technology introduction.

3. Knowledge Management

A. Knowledge Taxonomies

Nonaka [3] classified two types of knowledge normally found in organizations based on the work of Polanyi [4]. Tacit and Explicit knowledge. Tacit knowledge is knowledge that is difficult to transfer to another person by writing it down or verbalizing it. On the other hand, Explicit or codified knowledge is knowledge that is transmittable in formal, systematic language. Tacit knowledge can be further classified into two sub elements 1) a Cognitive element and a 2) Technical element. The cognitive element based on Johnson-Laird [5] is called "Mental models" in which human beings form working models of the world by creating and manipulating analogies in their mind. This includes

paradigm, belief and viewpoint. The Technical element covers know-how, craft and skill. These Tacit and Explicit classification can also be called "Episemological Dimension of knowledge".

B. Knowledge creation

Based on the Anderson ACT model [6], Nonaka has proposed his knowledge creation model called "SECI". In the ACT model Anderson classified knowledge into Declarative (Explicit) and Procedural (Tacit) knowledge. Anderson hypothesized that, in order for cognitive skill to be developed the declarative knowledge need to be converted into procedural knowledge. By observing that the Anderson conversion model was a one-directional conversion, Nonaka argued and addressed that the conversion can be bi-directional for cognitive skill or knowledge to be developed. By then four modes of knowledge conversion called the "SECI" model was proposed. The term SECI stands for Socialization (Tacit to Tacit), Externalization (Tacit to Explicit), Combination (Explicit to Explicit) and Internalization (Explicit to Tacit).

The socialization mode (tacit to tacit) involves sharing tacit knowledge between individuals. The externalization mode (from tacit to explicit) relies on analogies, metaphors, hypotheses, and models expressed through articulated language. The combination mode (explicit to explicit) involves converting explicit knowledge into more complex explicit knowledge. Finally, the internalization mode (explicit to tacit) converts explicit knowledge into tacit knowledge.

Each mode of conversion can create new knowledge individually but at the heart of the Nonaka theory was that the four mode of knowledge conversion work together systematically to create new knowledge organizationally. The SECI model is shown in Fig.1.

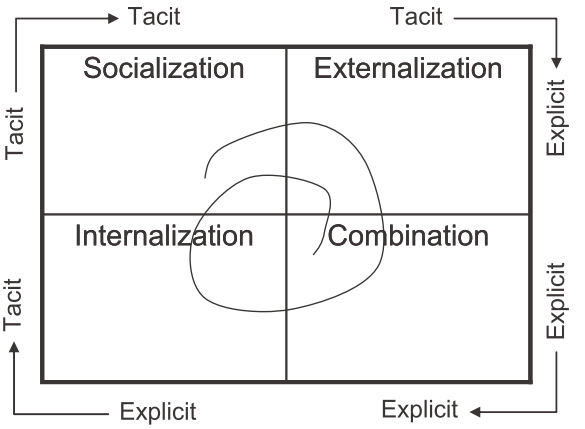

Fig. 1 The Knowledge Creation Model (SECI).

C. Management of the SECI model

In order for organization to create new knowledge based on the Nonaka SECI model, four modes of knowledge conversion need to be implemented. One way to implement the management of organizational knowledge creation is to create a "field" or "self organizing team" in which individual members collaborate to create a new concept [3].

Nonaka has further pointed out the "Hypertext organization" where organization is subdivided into two parts. One is called "Nonhierarchical" which refer to a self organizing team or project team. The other is called "Hierarchical" which refers to a normal routine operation. The important point to note is that the design of the hierarchy and self organizing teams should enable the organization to shift efficiently and effectively between these two forms of knowledge creation [3]. By establishing a proper organizational setting for these two activities, organization will maximize the efficiency of their operation.

By applying the SECI model and Fishbone diagram concept together, we created a new SECI diagram. For the SECI diagram, we can analyze any knowledge related aspect of a problem found on the shop floor more effectively. The SECI Fishbone diagram is shown in Fig. 2.

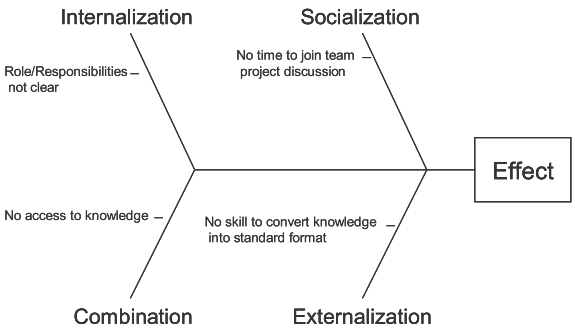

Fig. 2 The SECI - Fishbone Diagram.

By adopting the 2x2 decision making matrix with a 4 point Likert's scale questionnaire we are able to compare/prioritize the action. From the 4 points Likert's scale, we are able to have the decision making matrix as shown in Fig. 3.

Since we employed only 1 - 4 points, the matrix has become a 3x3 matrix. Based on the Importance and Existence dimensions of the matrix, the authors have placed strategic guidelines for action.

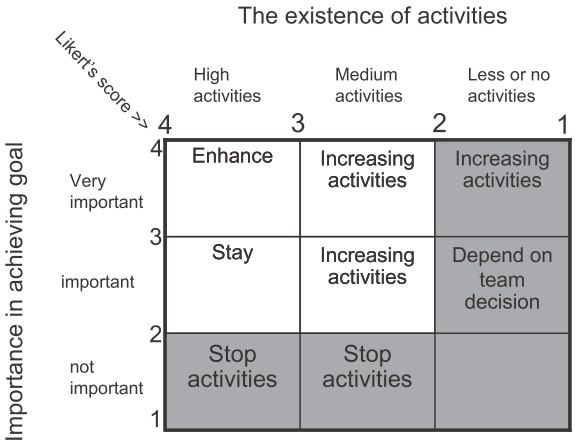

Fig. 3 The 4 point Likert's Scale Decision Matrix.

4. Research Methodology

This research was done on a real shop floor of a Slider fabrication plant in Thailand. The defect reduction experiment was done on a critical process step in order to prove the concept (the name of the process is confidential information held by the company).

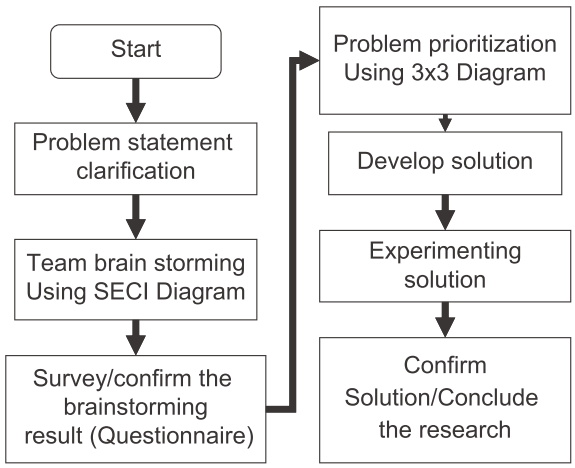

Fig. 4 The research work flow.

In order to reduce the defect called "C1" created on the Slider fabrication shop floor, team project was established including members from the Engineering section, Quality Section, Maintenance section and Production section. On the first run, the team implemented many solutions which later proved not to reduce the defect. The SECI diagram was brought into consideration by the team. Fig. 4 illustrates the flow chart of this research. Special project members were put into a special SECI team to brainstorm the failure of the first run using the SECI diagram. Possible causes of failure achieved from the SECI diagram were then re-confirmed with the rest of the organization member through the survey instrument using the 4 point Likert's Scales. The score received from the survey of each possible cause was placed into the 3x3 matrix to prioritize

the problem. Finally a solution was developed and an experiment was conducted in a real shop floor.

5. Result

A. SECI Diagram and possible causes of problem

The brainstorming session was done and a total of 12 possible causes of a problem were discovered as listed below :

a) Socialization 1(S1): Not have time to fully join the team.

b) Socialization 2(S2): Not willing to share their knowledge.

c) Socialization 3(S3): Do not know how to transfer what they know effectively.

d) Externalizations 1(E1): Do not know how to convert what they know into standardized and transmittable format.

e) Externalization 2(E2): No time and equipment to convert what they know into standardized and transmittable format.

f) Externalization 3(E3): Not willing to share their explicit/declarative knowledge.

g) Combination 1(C1): Not enough or No knowledge to be combined.

h) Combination 2(C2): Do not have access to explicit/declarative knowledge.

i) Combination 3(C3): Do not have sufficient skill to process all knowledge together.

j) Internalization 1(I1): The given role in the team was not clear.

k) Internalization 2(I2): Not able to create new knowledge.

l) Internalization 3(I3): Not able to create solution due to an ineffective combination (the created knowledge from inefficient combination directed to wrong solution).

B. Survey & decision making matrix result

From the 22 returned questionnaires, simple statistic were used to calculate the average score on each item on both Existence and Importance. The scores were put into the 3x3 decision matrix as shown in Fig. 5.

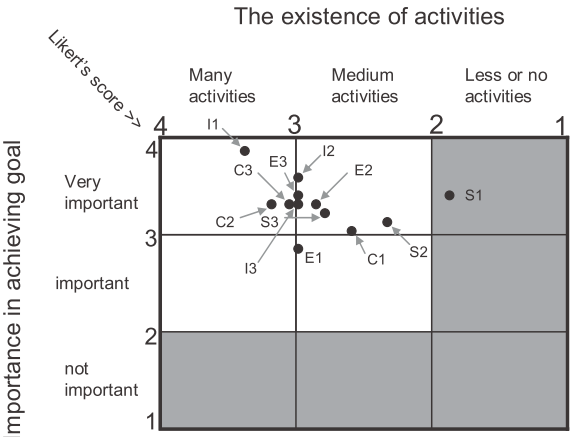

Fig. 5 The filled 4 point Likert's Scale Decision Matrix.

From the matrix and based on the guideline, we summarized that activities S1,S2,S3,E1,E2 and C1 must be increased especially on E1 and S1. We concluded that the root cause of not being able to make a rigid solution for the C1 defect problem by the first run of team project was the lack of socialization between team members and outsiders especially between production operators and engineering staff. The number of production operators compared with the number of engineering staff made it very difficult to make socialization work effectively and organizationally. Furthermore, it was found that all levels of staff do not have the time and sufficient skill to convert what they know and transfer it to the rest of the organization which is indicated in E1,E2,S1 and S3. There is also a tendency towards hoarding knowledge as indicated in S2. S1, S2, S3, E1 and E2 lead to an ineffective combination mode as indicated in the C1 item.

The ineffective combination lead team project to the faulty conclusion and wrong solution.

C. Proposed Solution to team project

As stated the number of frontline production operators to higher level staff is not a good ratio. All information and knowledge found in frontline operation has a slim chance of becoming input to team project. Although member of the team already included production supervisors, we discovered that information was distorted and missing since tacit knowledge or know how as stated in portion 2 of the paper, is very difficult to transfer. When tacit knowledge is lacking, explicit knowledge is missing and new knowledge is not created. To fix the problem, we proposed that organization to have a "Knowledge Agent" who specializes in Externalization on all levels. The Knowledge Agent would also work between frontline production operators and higher level staff to bridge the gap. The model is shown in Fig. 6.

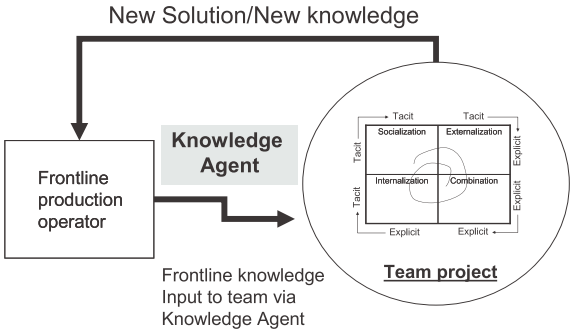

Fig. 6 Knowledge Agent and team project model.

The model was validated through a real campaign called "Small voice project". One Knowledge Agent was sent into the production line to socialize with operators in order to externalize the tacit knowledge. Quality Engineer was purposely selected to work as Knowledge Agent for the model validation due to the perception of a shop floor people toward Quality engineer as a middle man. The data was collected total 13 days of operation. One example of techniques used by the Knowledge Agent was role play, where the operator become a process trainer to train the Knowledge Agent. The engineering background together with the feeling of working as a real operator allowed the Knowledge Agent to externalize new tacit knowledge to team members. The experiment was then done on one machine to prove the knowledge externalized by Knowledge Agent and combination by project team members. Knowledge agent has brought out an insight from operators that long waiting time row tool before Mechanical Debond operation will make was very crucial to the defect called "Broken Bar". The insight was then confirmed with process engineering team and solution to the problem was raised/implemented. It was reported that the defect was reduced to 0.73%. from normal 1.36%.

6. Conclusion

In this knowledge based society, manufacturing needs to put their consideration towards how can they use knowledge to create new knowledge more effectively. Team project as the platform for knowledge creation has been implemented for manufacturing around the globe. A recent case on project team from Slider fabrication in Thailand has shown:

A. In the operator oriented manufacturing like Slider fabrication, the link between team project (Nonhierarchical) and production operator (Hierarchical) is missing. A Knowledge Agent is personnel assigned specially to bridge such a gap and the model is shown in Fig. 6.

B. The SECI Fishbone diagram is also proposed and proved very useful in analyzing knowledge related aspects of the problem.

7. Acknowledgement

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