Knowledge collaboration through enterprise information services

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Abstract
An analysis methodology is proposed for sustainable knowledge collaboration services. The methodology consists of three layered knowledge collaboration architecture, knowledge collaboration community analysis method, knowledge collaboration architecture analysis method, knowledge collaboration structure analysis method, and knowledge collaboration metrics. In this paper, a way to integrate above methods is considered to develop sustainable knowledge collaboration service analysis methodology. The knowledge structure of the methodology is also discussed.

1. Introduction

It is necessary to provide the mechanism which enables people to collaboratively reuse the common knowledge from the different information systems in the enterprise services. The reality is such knowledge collaboration services have been discretely built so that there are issues such as changes in the information systems, needs to rebuild whenever there are additions with them, and inconvenience in the whole organization because of its dependency on manual operations, because of the following 2 reasons.

1. The knowledge collaboration has not been visualized yet. For example, the procedure to cooperate knowledge has not been well documented as a manual. Individuals are often scrappily collecting and keeping the knowledge of knowledge collaboration systems, dependently on each person.

2. The knowledge collaboration systems have not been structured so that they cannot respond to the changes of information systems. For example, the collaborative knowledge depending on information

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technology and the one depending on operations co-exist. We cannot limit the area of changes in the collaborative knowledge in accordance with the change of information systems so that we have to review the whole collaborative knowledge, which makes difficult to maintain the knowledge collaboration services.

Therefore, volatile issues of collaboration, which make the knowledge collaboration services unable to maintain, occur in case of changes in the information services and operational forms, even if we could build the information collaborative services at a certain time. In order to solve the issues concerning the sustainability of knowledge collaboration systems, it is necessary to study the methodology of analytical theory of the sustainable knowledge collaboration systems.

In this paper, a case study on a Japanese University is described to show the effectiveness of the proposed method to develop the visualizing information infrastructure for research activities. To develop the information infrastructure, an analysis methodology for these activities is needed.

The knowledge collaboration systems are of social technological services described as above. Therefore, it is necessary to establish the cross-scientific analytical methodology of the knowledge collaboration services, by combining the results of academic studies such as requirements engineering and enterprise architecture, and the social scientific research such as Actor-Network Theory and Activity Theory.

The characteristic of this study is to have enabled the analysis of the ideal figure of sustainable and flexible knowledge collaboration services in view of user community by cross-social and technological studies. By utilizing this study's results, we can promote the effective usage of the infrastructure of the information society and intend to streamline building the knowledge society.

Therefore, in this paper, as a process to establish the sustainable knowledge collaboration services, a 2 tier analytical process is proposed based on the analyses of the community and architecture.

The structure of this paper is as follows: The background of this study is described in section 2. The structural process of the sustainable knowledge collaboration services and overview of the analytical techniques is shown in section 3. Case studies of the proposed method are introduced in section 4. Section 5 provides a consideration of the proposed method. Summary and future issues are described in section 6.

2. Related work

There are related studies to requirement engineering as a part of the academic engineering field concerning this study. Also, there are studies such as The Open Group's TOGAF (The Open Architecture Framework) in order to optimize the whole enterprise information systems, as well as Architecture Description Language and ATAM (Architecture Trade-off Analysis Method) to optimize the whole enterprise architecture (EA). These technologies aim to analyze the structures among the plural information systems in view of architecture. However, there has been an issue of lack of specific analytical procedure in the analytical method concerning the sustainable knowledge collaboration services and relations with the users' community. Therefore, in this study, I will promote the formulation on the sustainability of the knowledge collaboration services based on community and architecture. The reason is, there have been activities implemented in the operating sites of the knowledge collaboration systems, which were not academic studies' subjects, with scrappy measures, which did not make the procedure to comprehensively decide the sustainability of the knowledge collaboration systems.

Also, there are Actor Network Theory (ANT) and Activity Theory (AT) as parts of social science related field concerning this study. These theories are increasingly pointed as applicable to the analysis of social acceptability of information systems. However, the reality is these 2 theories are independently applied to individual information system. This has been an issue that there is no unified analytical method in the knowledge collaboration systems. Concerning AT, the researchers of groupware have been focusing in the past. There is a case study of application of AT to the information systems development, however, there is no case to
be applied to the knowledge collaboration systems. Although there was a case study of application of AT to the requirement engineering, there has been no case concerning the knowledge collaboration systems. As for ANT, there is no case of application to the requirement engineering.

In this paper, socio-technical methodology is proposed to establish the cross engineering and social scientific analytical methodology which enables users to flexibly utilize various knowledge created and accumulated in and out of organization and in society, by integrating the engineering studies such as requirements engineering, enterprise architecture technology, and the social scientific studies such as Actor Network Theory and Activity Theory.

Specifically, the environment of knowledge collaboration is designed with 2 layer such as a) the knowledge collaboration community comprised of users and the internal providers of enterprise information services, and b) the infrastructure of the knowledge collaboration comprised of various information systems, in order to find the validity with cases of the information environment at organizations. Therefore, the analysis method of the community is proposed to analyze the knowledge collaboration community and the analysis method of architecture of the knowledge collaboration is also proposed to analyze the infrastructure of the knowledge collaboration. This study enables the effective analysis on the sustainable knowledge collaboration services in and out of organization, and we can expect to expand to the intra-organizational knowledge collaboration services and knowledge collaboration services between industries and academies.

3. Building process of the knowledge collaboration services

The following 2 levels are studied in order to integrate as the analytical methodology of the sustainable knowledge collaboration services.

Problem Definition Level: Community Analysis Process
Problem Solution Level: Architectural Analysis Process

In this case, the problem is the knowledge collaboration, and its answer is the architecture and realization of knowledge collaboration services based on the reuse of knowledge. As shown in Figure 1, Community Analysis Techniques and Architectural Analysis Techniques which are responding to the above 2 levels respectively.

![Diagram](image_url)

In this proposal, I am showing with a dot line to connect between the development and the evaluation in the knowledge collaboration services, both of which are out of consideration in the process of solution space in this proposal.

The building process of the knowledge collaboration services, described as above, is shown in Figure 2.
4. Proposal of iterative analysis for knowledge collaboration

4.1. Analysis of the knowledge collaboration community

In the collaboration among various information systems, it is necessary to coordinate with the internal groups comprised of different people involved in information systems. Therefore, the method is proposed to analyze the building process with the people involved in information systems and apply dynamically based on the knowledge collaboration scenario. Especially, we can solve the conflicting issues generated in the procedure of knowledge collaboration by expressing the communications of knowledge collaboration with the 9 communication modes as follows:

a) Strategic mode
b) Preparatory mode
c) Mediating mode
d) Negotiating mode
e) Collaborative modes
f) Conflicting mode
h) Wait mode
i) Operational mode
j) Controlling mode

4.2. Analysis of knowledge collaboration Architectures

When the knowledge collaboration is performable among different systems, it is said that the group of the systems has the knowledge collaboration capability. We expect that the knowledge collaboration capability means the non-functional requirement concerning the group of systems. I propose the architectural analytical
method based on the non-functional scenario, focusing on that the knowledge collaboration capability is a non-functional requirement which is superior to the functions of individual systems.

Considering the plural non-functional requirements, we need to consider the conflicts between non-functional requirements in the method to design the architecture. A typical example of the conflicts between non-functional requirements is the one between flexibility and performance. In this case, we need to relax the non-functional requirement in order to make either or both of non-functional requirements exist. And, we can extract a non-functional requirement from the principle of non-functional requirement scenario because such a non-functional requirement has different interests per principle related to scenario. Now, we have to take care of the non-functional requirement \( N \), which is to be led from the principle \( A \) of the non-functional requirement scenario \( X \), is positioned below the non-functional requirement \( Q \) which non-functional requirement scenario \( X \) is close to achieve.

The procedure of architectural analysis based on these conflicts among non-functional requirements is as below:

[Method of analysis] Architectural analytical method based on the conflicts between non-functional requirements.
[Procedure 1] Create a non-functional requirement scenario.
[Procedure 4] Explore the conflicting non-functional requirements.
[Procedure 5] End if there is no further conflict. If there are any conflicts, go to the procedure 6.
[Procedure 6] Solve the conflict between non-functional requirements by adding a component when we can solve the conflicts with an additional component. If it is not solvable with an additional component, embody a non-functional requirement and go to the procedure 4. (End of procedure)

We should think about a case to design the architecture based on this method via a non-functional requirement. We should assume that someone in charge of development expects flexibility and someone in charge of business expects performance respectively concerning the non-functional requirements. First, we should assume that it is necessary to add the hardware control component after making a decision on the architecture, which is ‘a separation between hardware and software’ to achieve the flexibility, concerning response to the expectation of someone in charge of development. This means, this addition of component contributes to the enhancement of the systems' flexibility, but does not contribute to the enhancement of systems' performance. Now, we should embody the condition for performance, and estimate the allowable capacity. If we realize the hardware component which is satisfactory in terms of capacity, we can design the architecture which achieves both requirements without making flexibility and performance conflict.

5. Case study

In the following, I will introduce the cases of the reuse at a Japanese university where the analytical techniques of the knowledge collaboration community and of the architecture of the knowledge collaboration capability have been respectively applied.

6.1 Cases of the analytical techniques of community

(1) Case 1
This information system is an administrative system. As the mediator had been in charge of this information system, we could start knowledge collaboration after negotiations with the people involved. The changes of knowledge collaboration status are as follow. This is a successful case of the knowledge collaboration. Where, the mark of '→' means the change of status.

**Strategy → Preparation → Mediation → Negotiation → Collaboration**

(2) Case 2

This information system is an information delivery system which involves the people in another strategic department. The following many conflicting issues were detected in the negotiation involving the first mediator.

1) No information concerning the knowledge collaboration was given.
2) There are gaps among the executives concerning the knowledge collaboration.
3) Some members are not good at performing the knowledge collaboration.
4) Knowledge collaboration has been done with papers.
5) There is no need of the knowledge collaboration because each member is delivering the information.
6) Privacy information protection is concerned in the knowledge collaboration.
7) Each department has its own format so that it is difficult to perform the information collaboration.
8) Timing is not suitable because the system updates have been scheduled afterward.

Because of the above reason, we moved to the operation phase and started the works. That means we ensured the control rules concerning the knowledge collaboration by consulting with upper management meetings for 1). For 2), we added the executive as a mediator, and heard that person's opinion concerning the strategy of the knowledge collaboration. For 3), 5) and 7), we decided to go ahead with preparation for a specific value in the knowledge collaboration. For 4), we demonstrated that paper has the limitation in the knowledge collaboration, and the more information is accumulated, the less content is available for the knowledge collaboration, as an opposite case. For 6), we showed the measure to limit the knowledge collaboration which does not become an issue concerning the privacy information protection. For 8), we decided to wait until a suitable timing.

The change of the status concerning the knowledge collaboration in this case is as follow. This is a case which we have not achieved the knowledge collaboration. Where, he mark ' | ' means the activities on parallel.

**Strategy → Preparation → Mediation → Negotiation → Confrontation → Operation → (Control | Mediation | Strategy | Preparation | Wait)**

In this case, the people at upper management of the organization are controlling the information systems in question so that multidimensional operational activities are needed involving the organization's upper layers.

(3) Case 3

This information system is of the information delivery systems for members in the organization, administered by the administrative department. We got a concurrence concerning the knowledge collaboration in the negotiation involving the first mediator. However, the system updates are scheduled so that timing is not suitable, and the format of information is different in each department so that we found it difficult to perform the knowledge collaboration. Therefore, we decided to standby concerning the knowledge collaboration, and to build an ontology structure to unify the format of information. The change of the status concerning the knowledge collaboration in this case is as follow.

There is a case which we have not achieved the knowledge collaboration, and are waiting.
6.2 Architectural analysis cases

In the following, I describe the cases of the techniques which applied the knowledge collaboration to the visualized budget system and the accounting system at the university. At that time, there were the users, some were in charge of operation, and others were in charge of the knowledge collaboration. Each person analyzed the architecture of the knowledge collaboration by making a scenario of the knowledge collaboration capability. When the knowledge collaboration is performable among the different systems, it is said that the group of these systems has the collaboration capability. The knowledge collaboration capability is thought to be a non-functional requirement concerning the group of systems.

In this case, the scenario of knowledge collaboration capability has the following:

a) Extraction of knowledge collaboration
b) Control of knowledge collaboration
c) Disclosure of knowledge collaboration. In accordance with the scenario of non-functional requirement, as described earlier, the following will be of the scenario. (Analytical method [Procedure 1])

1) The principle of the origin of the knowledge collaboration is a partnering system.
2) The request for disclosing the information from the partnering system is a factor to make the knowledge collaboration systems active.
3) The status which makes the condition to collaborate the knowledge is that the source system and the knowledge collaboration system exist.
4) Identification information of partnering system, the source system and the necessary items are for the entries to the knowledge collaboration activities.
5) The knowledge collaboration activities stimulated to be implemented include the extraction of collaborating knowledge, the management of collaborating knowledge, and disclosure of the collaborated knowledge.
6) It is the source system as an object for the knowledge collaboration activities.
7) It is the collaborating information which is published as a result in the information collaboration activities.
8) The condition to be met by the system’s output and response is the disclosure of the required collaborating information.
9) The contents of notice to be generated in the system, as a result of activities, are the disclosed information of collaborating system and the request for action in case of unavailability of the collaborating systems.
10) The persons in charge to receive responses from the system are the operators of the collaborating systems.
11) The evaluation standard concerning the validity of generated responses includes (not limited to) the performance of disclosure of collaborating systems and compatibility.

Next, the components of collaboration, management, and disclosure knowledge are extracted respectively. It is clearly showed in the scenario of knowledge collaboration capability of 5). In such a case, each person involved in the knowledge collaboration can extract the lower non-functional requirements. The persons in charge of the knowledge collaboration capability are the manager of source system, the manager of knowledge collaboration, and the manager and users of partnering system.

In the following, I will describe a case of extraction of collaborating information from the accounting system to the visualized budget system. First, concerning the persons in charge of collaborating information extraction, there are managers of accounting system, as the source system, and visualized budget system as the knowledge collaboration system respectively. The manager of source system is supposed to require the operability of business with the source system be unaffected because of the extraction of collaborating system. On the contrary, the manager of collaborating system is supposed to require the ease of extraction of collaborating
information. In this case, as conflicting points between operability and ease of extraction, it becomes obvious that operability will be affected by extraction of collaborating information, and on the contrary, the maintenance of operability prevents the extraction of collaborating information. Then, I found that I can extract the collaborating information without sacrificing the operability, by clearly defining the conditions of allowable operations with embodied operability. Therefore, the conflicting issues between operability and ease of extraction are solved.

Likewise, I solved the conflicting issues by embodying them in accordance with the scenario of non-functional requirement for the collaborating information management and disclosure of collaborating information, too.

6. Consideration

6.1 Knowledge reuse through constructing methodology

As described as above, the proposed methodology of the sustainable knowledge collaboration services combines the analysis techniques of community and architecture. As proposed in this paper, in the analytical methodology of sustainable knowledge collaboration services, plural methods are unified as one methodology after selection from both the social side of the knowledge collaboration community among the people concerned and the technical side of collaboration with the existing information systems. These techniques selected include the existing techniques. Therefore, the realization process of this methodology is also a process to reuse the knowledge of previous techniques.

6.2 Possibility of interdisciplinary science

In this paper, an integrated method has been constructed in a cross-sectional manner between engineering studies such as requirements engineering, enterprise architecture, and social scientific studies such as Actor-Network-Theory, Action Theory, and communication theory. Then, the proposed the socio-technical methodology on sustainable knowledge collaboration services was studied. The result showed that users can utilize it in the flexibly collaborated manners, and socially create and accumulate knowledge in and out of the organizations, and embody the possibility of the cross-knowledge integration.

7. Conclusion

In this paper, I have proposed the analysis methodology comprised of the analysis of knowledge collaboration community and architecture. The proposed methodology can be considered as a socio-technical knowledge building methodology by combining the engineering and social scientific methods concerning the knowledge collaboration services. Case studies were conducted to assure the effectiveness of the proposed methodology for knowledge collaboration services of a Japanese University.

Future issues include the quantitative evaluation and the improvement of the methodology based on the evaluation.

References
