Organization Design Initiated by Information System Development

- Methodology and Practice -

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Abstract

The purposes of the present study are to propose a methodology of using information system development for effective organization design and designing and to acquire theoretical and practical knowledge by actual application to a Japanese manufacturing industry.

At present, many organizations have information systems that were constructed and implemented in an attempt to enhance work efficiency. The positive application of information technologies and systems is now an important element in executing organization work. Several information systems, however, are not necessarily practical for actual organization work. The longer an information system stays in service, the greater the divergence from organization work becomes. This can lead to serious problems with respect to business.

In order to solve this problem, attempts have been made to improve methodologies for information system development. Many of these attempts, however, do not adequately consider organization design and are focused on the development and implementation of efficient information systems from the viewpoint of system developers. Although organization design processes are also currently under investigation, avoiding the aforementioned problem is difficult in studies that do not consider information system design.

The present study reviews the waterfall methodology as the conventional information system development methodology and the Soft Systems Methodology (SSM), which has been attracting public attention as a methodology for organization design. After the review, a methodology for supporting general processes is proposed. This methodology was developed to design organization through the process of information system development.

In order to verify the effectiveness of the proposed methodology, the author applied the proposed methodology to an actual project in the Japanese foods manufacturing industry. The proposed methodology was proved effective and was found to be helpful in avoiding conventional problems, such as specification changes after development phase. Unlike the conventional methodologies for information system development, the proposed methodology allows the people involved to concentrate on the discussion of work because all the development work occurs at the end of the methodology. This enables the development of an information system that is fit to the work.

1. Introduction

The purposes of the present study are to propose a methodology of using information system development for effective organization design and to acquire theoretical and practical knowledge by actual application to a Japanese manufacturing industry.

At present, many organizations have information systems that were constructed and implemented in an attempt to enhance work efficiency. The positive application of information technologies and systems is now an important element in executing organization work. Several information systems, however, are not necessarily practical for actual organization work. The longer an information system stays in service, the greater the divergence from organization work becomes. This can lead to serious problems with respect to business.

In order to solve this problem, attempts have been made to improve methodologies for information system development. Many of these attempts, however, do not adequately consider organization design and are focused on the development and implementation of efficient information systems from the viewpoint of system developers. Although organization design processes are also currently under investigation, avoiding the aforementioned problem is difficult in studies that do not consider information system design.

The present study first reviews the waterfall methodology as the conventional information system development methodology and the Soft Systems Methodology (SSM), which has been attracting public attention as a methodology for organization design. After the review, a methodology for supporting general processes is proposed. The proposed methodology is then applied to an actual project of information system development and organization design in the food manufacturing industry of Japan in order to verify the effectiveness of the proposed methodology.

2. Organization Design and Information System Development

2.1 Methodology of Organization Design and Information System Development

Conventional organization design has been carried out using information system development. In other words, a whole-company project of information system development is initiated upon the decision by top management, and individual organization work is clarified through the process of development. Priority is given not to the opinions of organization members, but rather to securely the performing the duties assigned to the organization by the top management [1].

The waterfall methodology is the information system development methodology supporting this development process. This is the most basic methodology and is more popular and prevalent than any other information system development methodology. Many information systems have been developed using this methodology. The standards of International Standard Organization (ISO) and the Good Manufacturing Planning (GMP) standards by Japan's Ministry of Welfare and Health are also based on this methodology.

This methodology feature a unique procedure in which the discussion process is divided into phases and the contents of discussion at each phase are clarified. The results of discussion at each phase are recorded using specified forms, and the next phase does not begin until approval is obtained from the administrator. As a rule, the process is not permitted to return to the previous phase after a new process has started (Figure 1).

The waterfall methodology is used in top-down organization design because the development process does not progress without the approval of top management. Therefore, in many cases, planned specifications may strongly reflect the intent of the top management while showing a great discrepancy from the actual organization work. Consequently, the waterfall methodology may produce an information system that is difficult or impossible for organization members to use [2].

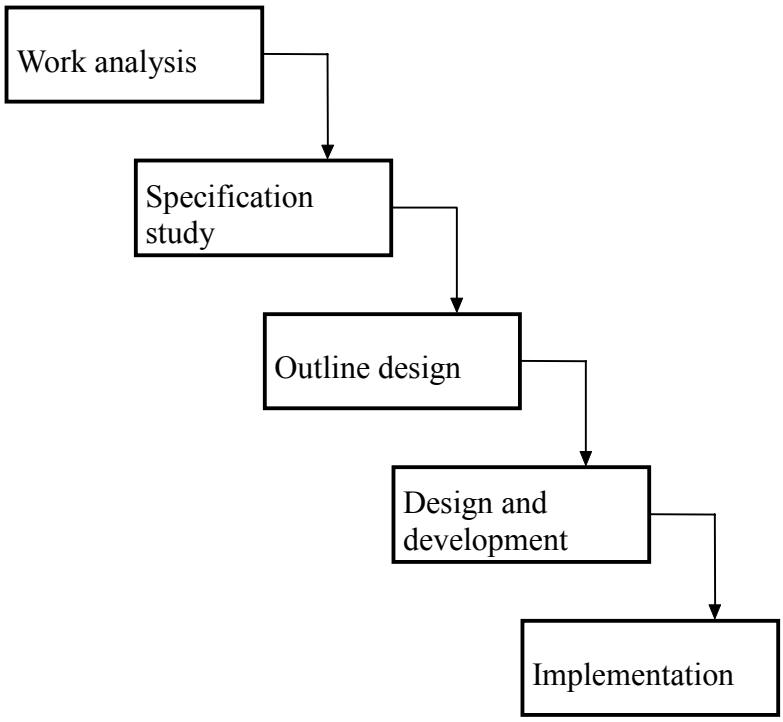

Figure 1 Concept of the waterfall methodology

2.2 Necessities of Organization Design and Problems in Development Methodology

As the problems of top-down organization design have become more widely recognized, the need for bottom-up organization design has grown, making the development of an information system that supports such design essential. Bottom-up system studies are needed in order to reflect environmental changes quickly.

When the waterfall methodology is applied to bottom-up planning, specifications are often changed after they have been determined. This problem causes a development delay. In order to avoid this risk, a full specification check is expected. Methodologies have been proposed but have not yet been established. One of the proposed methodologies is the spiral methodology or prototyping [3]. When specifications have been compiled to a certain extent, a prototype is created specifications. This methodology allows development to start after specification problems are solved. However, since users often evaluate a prototype mainly with respect to interfacing and performance, such as screen layout and operability, it is difficult to verify that the specifications conform to the actual work. It is especially difficult to verify that the exception processing is adequate. In addition, development schedule management is difficult because time is required in order to develop and verify a prototype for satisfactory evaluation, and also because it is unclear how many prototypes be created.

In order to solve this problem, the rapid application development (RAD) methodology, which gives priority to development management, is proposed [4]. An information system that is to be developed is divided into several subsystems, and a small number of people develop each subsystem in a limited time. This methodology features user participation in specification review. A technique called joint application design (JAD) is used to make users feel responsible for development during the specifications review phase. According to a survey [5], although JAD prevents a development delay for developers, users are suspicious about the effectiveness of agreed management or use approval on specifications. More specifically, the user informs the developer of the specifications, which are recorded precisely by the developer. Minutes should be signed in order to prevent unintended changes. Here, specification review refers to a process of embodying and recording specifications thought up by the user and

creating information system specifications in written form. In order to capture specifications clearly, the user should compile specifications sufficiently beforehand.

In an actual project, the user is very familiar with the work and is conscious of problems, but has almost no idea about how to design work or which part of work should be assigned to an information system in order to improve organization work. Many specifications are produced by free discussion with an information system developer and are finally determined after several corrections.

Development methodologies that substitute the waterfall methodology often disorder development processes because the fundamental problems of the waterfall methodology have not been solved. Since they are designed from the viewpoint of information system developers, development methodologies cannot be expected to help organization members to design the organization effectively. Conventional information system development methodologies cannot be used for organization design because they are based on the top-down concept.

2.3 Methodology that is Effective for Organization Design and Its Problems

SSM is a methodology for deepening the understanding of work among organization members and is attracting public attention as a methodology that can clarify the requests of organization members appropriately. By considering organization work as a human activity system in which workers are involved [6], Checkland proposed the SSM, in which organization members select the subject of discussion and search for a desirable solution.

As the procedure in Figure 2 shows, the work discussion range is determined, the elements of work in the range are clarified using CATWOE, and basic problems are defined. A system is conceptualized from the viewpoints of various workers and the conceptual model is compared with the real in order to improve the real world. In SSM, the real world and system thinking are clearly distinguished from each other in the discussion.

SSM is a general methodology that supports organization design and is not directly related to information system development. Therefore, applying SSM as-is is equivalent to discussing organization design independent of information system development that supports the design. This methodology does not allow a full discussion on the general work efficiency after an information system is put into operation. In order to apply SSM to information system development, it is necessary to combine SSM with an information system development methodology. Therefore, implanting and embedding were proposed as two combination methods [7][8].

In implanting, SSM is applied to the initial stage of an information system development methodology to clarify problems and propose corrective measures. The information system development methodology is then applied to the succeeding phases. Since implanting does not conform to the basic idea of SSM, in which users should solve problems themselves, SSM's function of organizational learning through discussion is not fully utilized. Therefore, SSM may be executed only in a single phase, and its application may become temporary.

In embedding, an information system development methodology is incorporated into SSM in order to produce a meta-methodology for solving problems. In SSM meta-level processing, the level of information system development methodology is assumed. In meta-level SSM repetition, attendees determine termination, continuation, and resumption. However, the following problems have been reported:

(1) Meta-level SSM does not control an incorporated information system development methodology.

(2) It is not clear who controls the meta-level processing.

(3) Meta-level SSM is different from narrowly-defined SSM.

An SSM that has so many objectives is difficult to combine with an information system methodology that has a single objective.

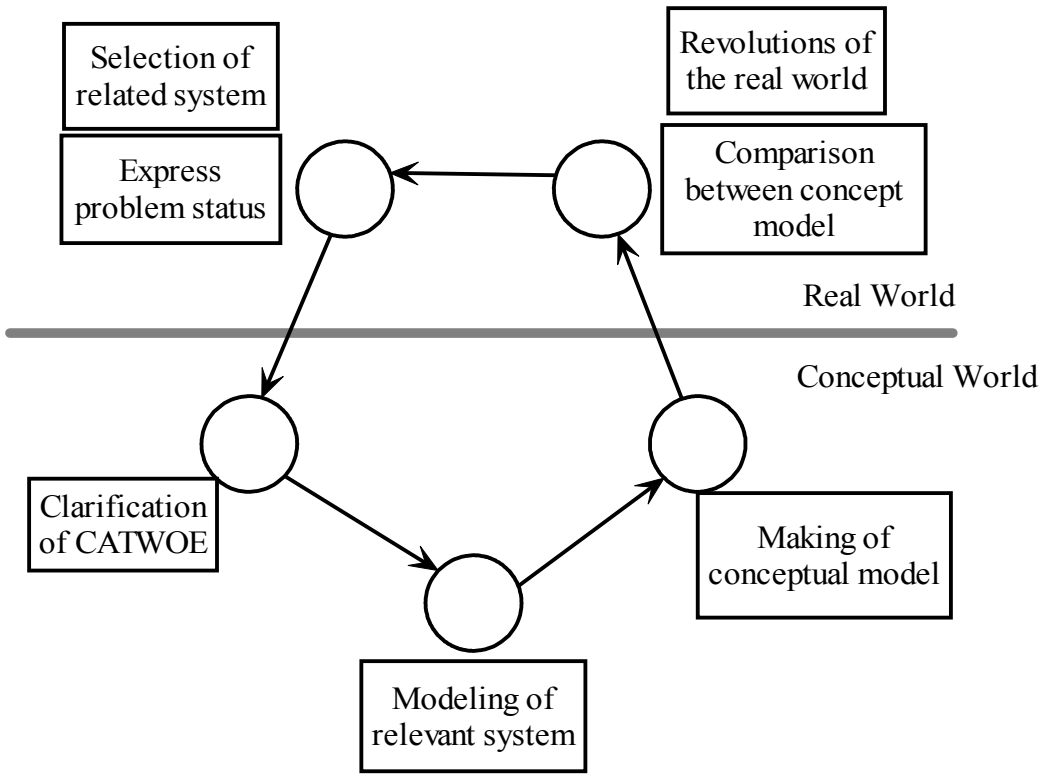

Figure 2 Concept of SSM

3. Proposal of Methodology for Organization Design at Information System Development

3.1 Basic Concept

The above discussions have clarified that although a methodology should be provided for bottom-up organization design of information system development for the support of the design, existing methodologies do not support organization design satisfactorily. This is because information system development methodologies are based on the idea that information system specifications should be discussed under the assumption that organization work exists.

However, since organization work is actually formed through the process of information system development discussion, an information system should not be designed by asking the requirements of information system users. The conception should be changed from "user" to "organization planner" of organization design, with information system development as a catalyst. Therefore, the present paper proposes a methodology for organization design at information system development.

The proposed methodology follows the waterfall methodology the phased approach of dividing the development process into several phases for the following reasons:

(1) This idea, which is already prevalent for information system development in organizations, especially in companies, seems to be effective for general schedule management.

(2) Public organizations audit and supervise information system development according to this concept.

In order to use the organization design capability of SSM, the SSM discussion process is mapped on the waterfall methodology for organization design and information system development synchronously. In other words, the discussion process is intended to bring out voluntary activities from organization members. SSM is used to determine problems in the initial stage of discussion and to keep the purposes of the discussion in mind throughout the process of discussion. Organization members should do assigned work voluntarily in each phase and acquire a

deep understanding of work before studying an information system. This methodology integrates the waterfall methodology more closely with SSM in order to bring out the respective advantages of these methodologies and compensate for their disadvantages.

Emphasizing SSM for the purpose of each phase enables attendees to take part in discussions while placing priority on the purpose of each phase as well as comprehending the entire work and studying improvements. For emphasis, each SSM phase is set so as to correspond to each phase of the waterfall methodology. This derives the best conclusion with the least problems from the general viewpoint of work in the current phase in order to prevent a specification change from causing a significant schedule delay.

3.2 Phases and Procedure

This methodology realizes work improvement and information system development by the procedure that is outlined in phases in Table 1.

Table 1 Five phases of the methodology for synchronous organization design and information system development

Phase	Objective of waterfall	Objective of SSM	Objective of organization design
Phase 1	Work analysis	Expressing problem status	Promoting the understanding of work
Phase 2	Specification discussion	Defining basic problems of related systems and clarifying CATWOE	Arranging necessary functions
Phase 3	Design compilation	Creation of conceptual model	Arranging specifications
Phase 4	Detailed design and development	Comparison of the conceptual model and the real	Discussion of the entire process by all personnel
Phase 5	Implementation	Innovating and improving the real	Clarifying operations

In phase 1, work is analyzed mainly by expressing the problem status in order to facilitate an understanding of the work. This corresponds to the phase of analyzing work in the waterfall methodology. SSM in this phase is adjusted to emphasize the objective of promoting the understanding of work. More specifically, priority is given to the selection of a relevant system. The range of work to discuss is determined together with organization members; however, work under an information system should be conceived before the system is actually implemented.

In phase 2, the basic problems of relevant systems are defined in order to compile the necessary functions, and specifications are discussed while CATWOE is being clarified. This corresponds to the phase of discussing specifications in the waterfall methodology, in which the necessary functions are compiled. SSM with priority on the clarification of CATWOE is expected to produce greater effects. At the second SSM discussion or SSM discussions thereafter, an earlier SSM discussion may be found to be wrong or a better solution may be found. In this case, the waterfall-type development methodology basically does not allow the development process to return to the previous phase but rather tries to find a better means for a possible solution at the current stage. This helps to avoid significant delays in the development schedule.

In phase 3, rough specifications are created using a conceptual model to compile specifications. This corresponds to the phase of creating a design in the waterfall methodology. In this phase, giving priority to the SSM stage of modeling a conceptual stage may promote the compilation of specifications. Developers familiar with the waterfall methodology should recognize again that the term "specifications" in this phase does not mean a database structure or screen interface but rather a statement that describes who does the work and for what purpose.

In phase 4, all members involved in the discussion create detailed specifications while comparing a conceptual model with the real in order to discuss new work processes. This phase corresponds to detailed design and development in the waterfall methodology. Since all organization members discuss all processes together, this corresponds to the phase of comparing a conceptual model with the real in SSM.

In phase 5, an information system is implemented for innovating or improving the real in order to discuss how to put the conceptual model into practice. This phase, which is an attempt to clarify operations, corresponds to the

phase of innovating or improving the real in SSM.

Thus, SSM at each phase forms a general system image. Figure 3 illustrates this procedure. Information system design guides work system design.

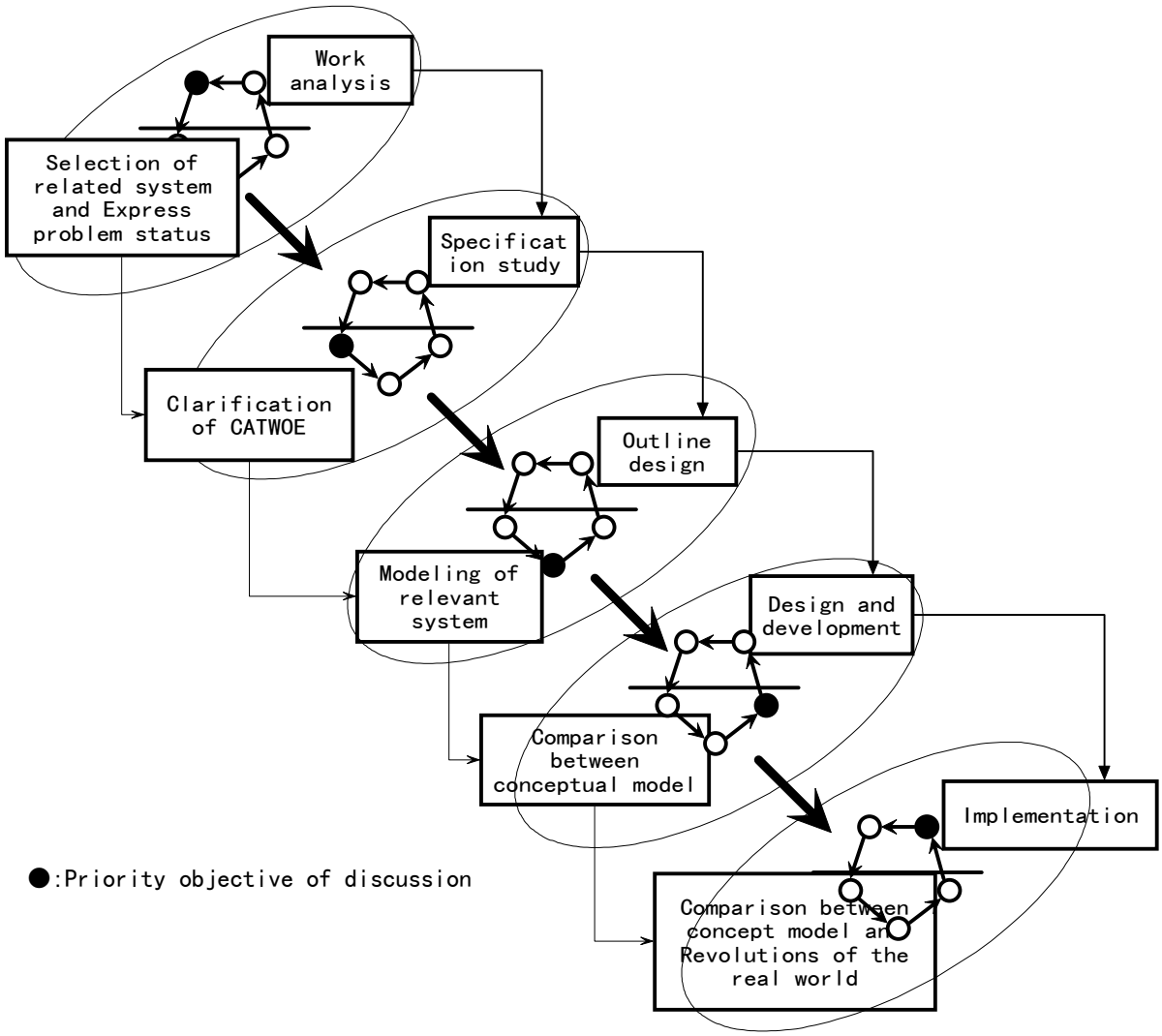

Figure 3 Concept of methodology for organization reform at information system development

4. Practical Application of the Proposed Methodology

The author applied the proposed methodology to an actual development project in order to verify its effects. The target of the proposed methodology was a project for developing an inspection information system in the Japanese foods manufacturing industry. The project was started in order to reconstruct an existing information system. Of the four factories in Japan, the new information system was put into operation first at the main factory, and then the other factories reconstructed their own work by evaluating the information system at the main factory. In Japanese manufacturing industries, it is common for production workers to attempt to improve their work themselves. When developing an information system, end users rarely participate in the actual design or development work. For the current information system development project, however, the existence of improvements to the work were verified while the information system development was in progress, with the proposed information system development methodology.

4.1 Understanding the Problem Status

In order to ensure that personnel in the inspection and system divisions of each factory understand the information system in use at the main factory, factory data was entered into the system software at the main factory in order to simulate the information system environment of each factory. The simulated environment helped to understand how the information system changed the work. This environment is used to give an image of new work, such as a prototype in the prototyping methodology. However, the inspection division personnel at each factory can obtain a more accurate image from this environment than from a function-limited prototype because this environment is created from software that is in use at the main factory which uses data from each factory.

4.2 Expressing the Problem Status

Work before and after the implementation of the new information system was compared in order to extract unsuitable specifications at these factories. Since the production items differ depending on the factory, the workflow that was used differed greatly from that at the company. People in the inspection division of each of the respective factories can now understand the organization and work of the division and recognize the significance of designing new work.

4.3 Discussing Basic Problem Definitions

The factories other than the main factory extracted unsuitable specifications at the factory and brought the results to project meetings for discussion of the specifications of the information system together with the main factory. At the meeting, each factory explained non-conforming specifications, and then the inspection division personnel from the main factory explained why the system was designed so. This allowed the attendees to understand that the information system specifications should always be designed so as to satisfy work necessities with organization design in mind. In other words, the reason for work, the role of the worker should be defined.

4.4 Creating a Conceptual Model

By receiving explanations concerning the problems at the main factory, the inspection division personnel of each of the other factories understood the differences in work at each respective factory and that at the main factory. In addition, the reasons for the differences were also discussed. The discussion enabled the personnel to review the work and to discuss whether to improve the work, or to improve the information system specifications if the factory does not permit a work change. Each factory discussed their work on the conceptual level by comparison with that at other factories.

In this phase, organization design should always be kept in mind. Since organization design requires significant time, organization members may have to determine information system specifications without sufficient organization design when there is not sufficient time. However, it is important not to fall into a policy of changing information system specifications by setting parameters for each factory to branch processing. Necessary information system functions should be clarified with a thorough understanding of organization design.

4.5 Comparing a Conceptual Model with the Real

As the information system specifications were compiled, the work at each factory was reconstructed and the inspection division personnel at each factory gradually acquired an image of the new work and information system. The system division initiated development after confirming that the work and information system specifications were settled on. The completed information system was tested at each factory. The system division performed function tests on the system in order to verify that the new work at each factory was effective.

If defective specifications are found in this phase, it is important that redevelopment of the work without changing the information system specifications, because the phase of discussing specifications is already finished in the waterfall methodology. This prevents a delay in the schedule of information system development.

4.6 Innovating or Improving the Real

Through the above discussion phases, the information system was gradually implemented and new work was started at each factory. Since the organization members promoted the discussion from the initial stage, the information system and new work were quickly introduced and these contributed to the improvement of work efficiency and organization management efficiency.

Table 2 summarizes the knowledge acquired by practicing.

Table 2 Achievements obtained by practicing the proposed methodology

1	Voluntary participation by workers is important.
2	The methodology is easy to implement because the development process conforms to the prevalent methodologies.
3	It is important to mind the information system development phases.
4	Specifications are not created, but rather are determined naturally according to the work.
5	This is an effective means by which to clarify discrepancies in requested specifications between business establishments.

5. Conclusion

The methodology proposed in the present study was developed to design organization through the process of information system development. The methodology was introduced to an actual information system development project to verify its effect. This methodology enabled organization members to plan organization work and contribute to the enhancement of organization efficiency and competitiveness.

In order to verify the effectiveness of the proposed methodology, the author applied the proposed methodology to an actual project in the Japanese foods manufacturing industry. The proposed methodology was proved effective and was found to be helpful in avoiding conventional problems, such as specification changes after development phase. Unlike the conventional methodologies for information system development, the proposed methodology allows the people involved to concentrate on the discussion of work because all the development work occurs at the end of the methodology. This enables the development of an information system that is fit to the work.

In order to make the proposed methodology more effective, the author will attempt to develop human resources

that are capable of performing both organization design and information system design and that will apply the methodology to an even wider range. In addition, in order to make the proposed methodology more applicable to general purposes, target organizations will be studied with respect to their country- and industry-specific characteristics.

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