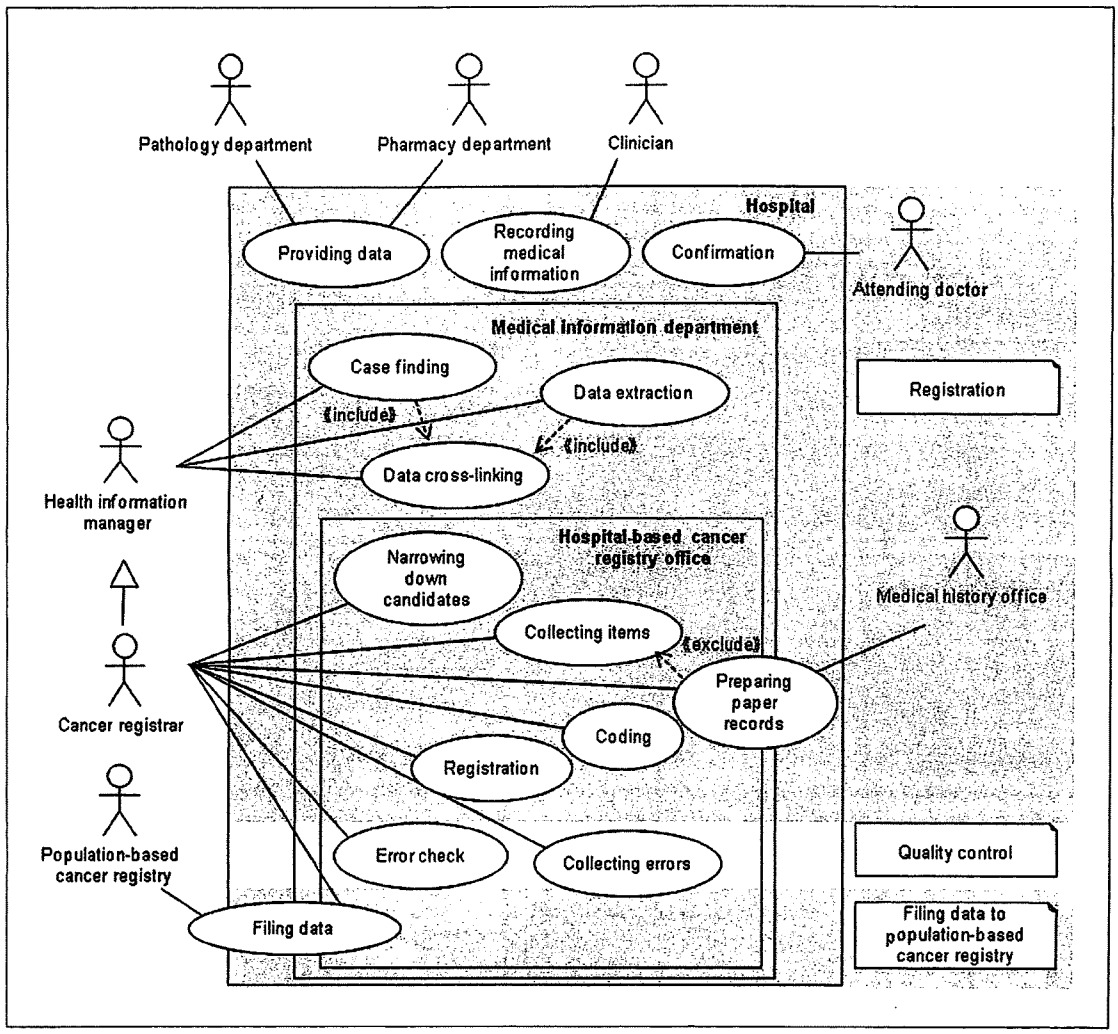

Fig. 1 Use-case diagram for a hospital-based cancer registry

this investigator and the three HCR staff members once a month from July to September in 2008. The first meeting lasted approximately two hours to gain information about the outline of HCR procedures, and the UD, CD, and AD were also inspected. Next, an overview survey, which included the TMS and interviews, was compiled to determine the times required to perform each task as represented by ADs. This took about four hours. We summarized the results of the interviews and observational surveys regarding processes involved in TPD using enhanced UML. At the final meeting, the results of the TPS were discussed with the investigator and the HCR staff over a period of two hours. We subsequently both improved and confirmed the results of the TPS by sending several e-mails after which the survey was completed. Approximately eight hours, in total, were required for completion of the interviews with the HCR staff.

3.3 Result of the Time Process Study at the Hospital

The UD for the HCR procedure is shown in ▶Figure 1, where each use case is the function needed for the HCR and actor is the staff engaging HCR.

Based on interviews, three tasks and 14 functions were extracted with regard to formulating registration processes. The HCR system consisted of the registration task, quality control task, and filing data to the population-based cancer registry. Registration tasks consisted of 11 functions: providing data, recording medical information, case finding, data extraction (extracting data from registration candidates regarding anticancer agents, radiation therapy, and disease name), data cross-linking (integrating extracted data into one patient with one value for one record), narrowing down candidates, preparing paper records, collecting items, coding, confirmation, and registration. Quality control tasks consisted of two functions: error checking and correcting errors. A majority of these functions were carried out in the hospital information office or HCR office.

CD in relation to information utilized in HCR tasks is shown in ▶Figure 2. By using CD, the arrangement of information was exposed and the limited availability of pathological reports was identified. Within the hospital, it seems that the pathological division had not been adequately computerized, to the extent that pathological

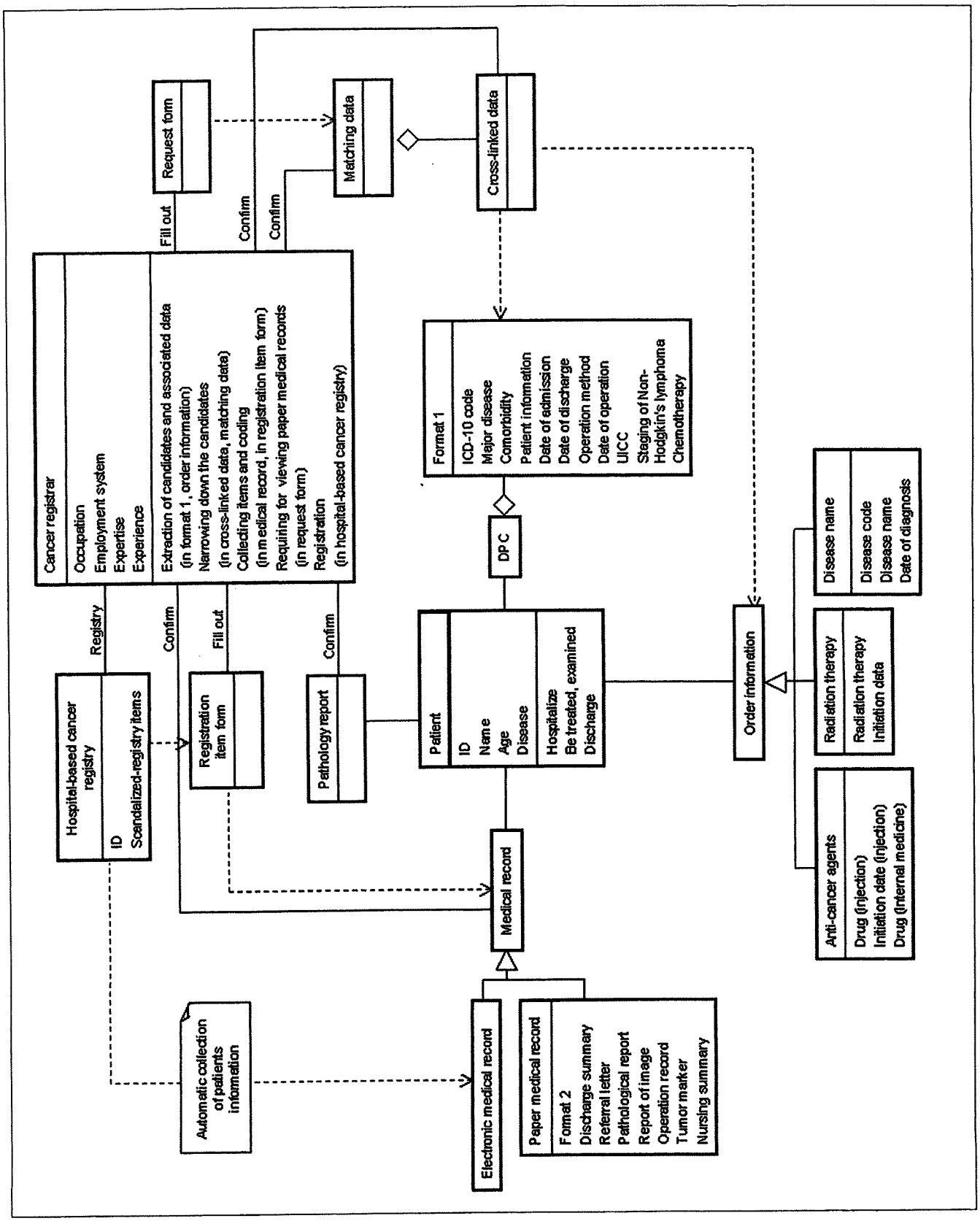

Fig. 2 Class diagram for information utilized in a hospital-based cancer registry

information was of limited use and applicability.

AD was investigated as a means of clarifying job procedures in relation to HCR tasks and the time required for each task was studied by way of both interviews and TMS that allowed information to be added to the AD. In ▶Figure 3, TPD, which involved part of the "registration task", is shown as an example, with the departments implementing the processes indicated at the top of each column and the required time shown separately in the row along the right-hand margin.

In the registration task at the hospital, around 1000 cases were extracted as candidates for registry from the case findings, approximately 250 cases were examined to check whether they were registered or not using paper medical records, and approximately 200 cases were finally registered monthly. The quality control task and data filing into the population-based cancer registry were conducted every six months for approximately 1000 cases.

The time required for the registration task amounted to approximately 123 hours/month/person, and for the quality control task, 6.5 hours/half a year/person, with the filing of data for the population-based cancer registry coming to 0.5 hours/half a year/person. The functions requiring the most time included "collecting items" and "coding" in relation to the registration task, with the actual monthly average coming to nearly 88 hours per person. These tasks required highly specialized knowledge so that there was a large difference in the time required for tasks (from as little as 55 up to 144 hours per month) which depended on the proficiency of workers and the quality of the medical records.

4. Discussion

TMS is an effective method for job analysis; however, it demands a great deal of time and effort on the part of subjects as well as researchers for gauging the time required for targeted tasks, particularly those that function between tasks, run in parallel with other tasks, or are under the control of several departments.

Although UML can be a useful tool for clarifying the processes involved in an occupation and there is report of enhanced UML that includes timeline [19], there is no report of using UML with time information for investigating required time and manpower.

The characteristic of TPS is using UML with time and manpower information. By employing UML, work content and task procedures can be more easily identified, to the extent that carrying out a field survey becomes more straightforward and the evaluation of task contents is, as a result, facilitated.

In this study, TPS was used to investigate the HCR system. We investigated a business model by employing UML, and carried out interviews and TMS for the tasks identified, as a part of TPS. In the present TPS, the survey took a total of only eight hours. If we had carried out a TMS for HCR in the same situation, at least three observers and more than 20 days would have been required to complete the investigation. Thus, TPS provides a much more efficient type of survey and, in this regard, is a great improvement when compared to other approaches.

We confirmed the HCR tasks in the hospital in relation to UD, CD, and TPD, which is an enhanced AD with time and manpower information. Even the functions required in HCR tasks would differ depending on the characteristics of the medical institution, the obtained diagrams could be effectively displayed to investigate the efficiency or to show difference of the procedure among institutions.

At the Osaka University Hospital, the time required for HCR took approximately 123 hours per month per person for the registration task, 6.5 hours per six months per person for the quality control task, and 0.5 hours per six months per person for filing the data to the population-based cancer registry. Within the registration task, time taken to complete this by way of HIMs took roughly 116.5 hours per month per person. This is equivalent to working six hours a day per person. This demonstrates that at least one person is necessary to carry out HCR. Currently, there is a requirement in designated cancer care hospitals to maintain at least one registrar for cancer [13]. This figure, however, has not been based on any previous investigation or research. Because the number of patients and task procedures differ for each medical institution, the required manpower is also anticipated to be different. To establish and maintain the manpower that meets the conditions of each medical facility, it is important to study the time required for the completion of tasks. By simultaneously clarifying the functions and time required for tasks simultaneously, it is possible to assess the potential for implementing a more flexible distribution of personnel that is capable of coping with an increased work/task load.

It was also found in this study that the tasks requiring the most time with regard to HCR concerned "collecting items" and "coding" with respect to the registration task that also required a degree of technical knowledge. AD indicated that level of ability, such as personal experience and specialized knowledge, influences the time required to complete such tasks. In addition, the present study suggests that the quality of medical records also influences the time required. CD clearly showed how information was linked in complex ways throughout the hospital, and limited use seemed to be made of pathological records; these factors appeared to lead to an increase in workload. In order to enable tasks to be carried out over a shorter time, and as well as simply increasing the number of personnel and improving efficiency, it is necessary to study how record-keeping is implemented with regard to cancer registration including the linkage existing between the hospital information and registration systems [20]. UML is sometimes used for process improvement by visualizing task processes [21, 22]. By providing the task model and results of the time survey together in TPS, it is possible to identify the factors that influence the time required for tasks. In medical centers, part of the job process and time required depends on the hospital information system. UML is able to bring clarity to a complicated hospital information system by revealing how the system functions thereby providing an effective means for process analysis for tasks related to hospital information.

HCR is only just beginning to operate in Japan, and one of the reasons that HCR has not yet become more widespread is thought to be because there are insufficient registrars. TPS in the current study showed that HCR requires at least one full-time registrar who has good knowledge of HCR, but it may, nevertheless, be difficult for hospitals to employ such qualified personnel. In addition, it

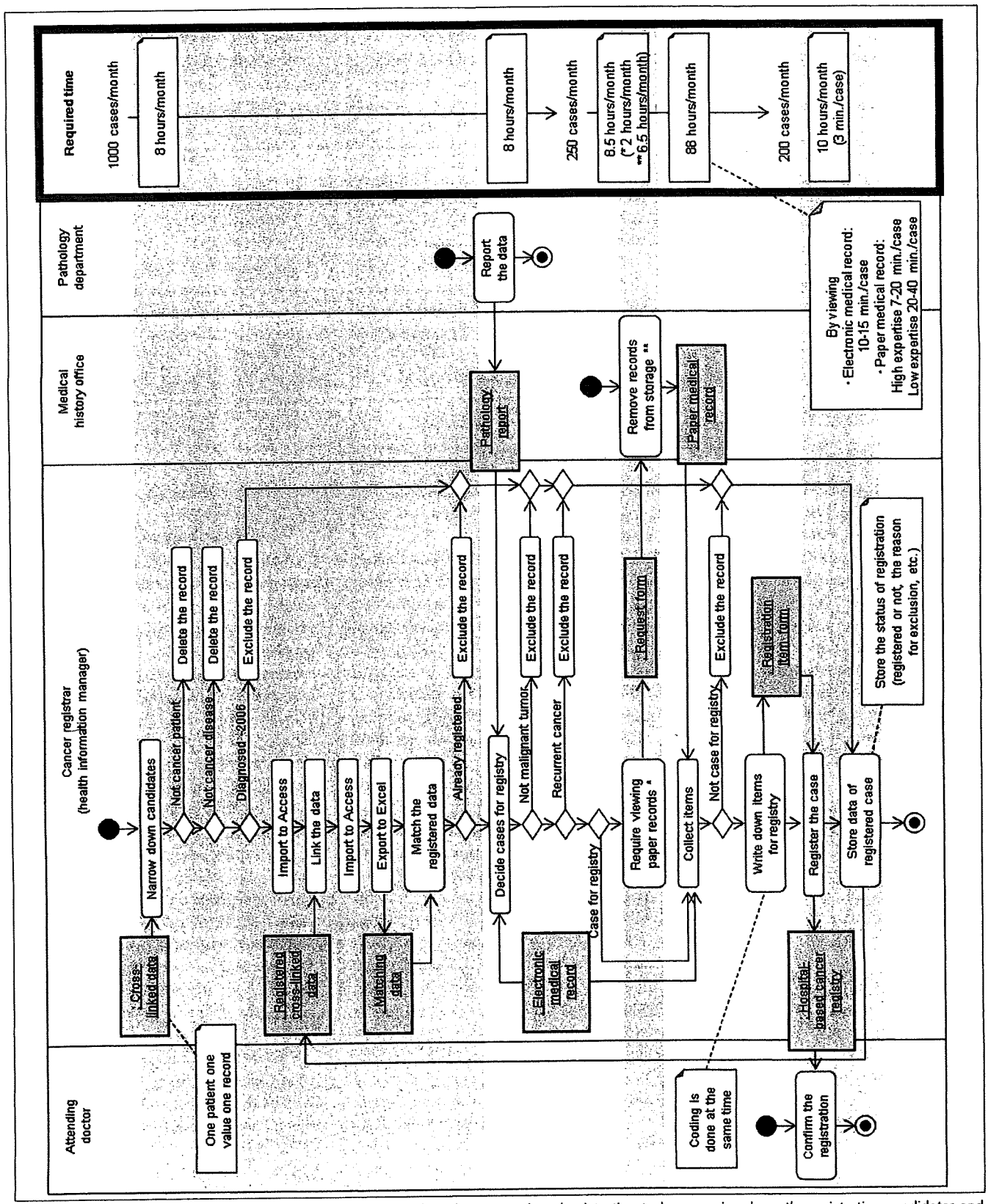

Fig. 3 Fragment from the time process diagram for a hospital-based cancer registry (registration task: narrowing down the registration candidates and registry)

has been shown that hospital information systems and medical records that are not applicable to HCR tasks lead to a complication of HCR processes, which therefore give rise to an increase in workload. In order to establish HCR, such problems need to be resolved. TPS can clarify the manpower required for each job process and identify factors that obstruct the implementation of HCR that will be help in the detection and resolution of problems so that HCR can be successfully introduced into every hospital.

The advantage of employing UML is that individuals without expertise in the field of systems will be capable of understanding UML models relatively easily, which makes the issues involved easier to share [19]. TPD that includes time required for parallel tasks is outstanding for sharing job processes and time information. To understand HCR tasks, it has been inferred that it is comparatively easier to have a common awareness of the objects of study even when the tasks are undertaken with multiple names, for example, exchanging information across multiple departments. In actuality, by sharing information easily, it was possible to discuss the study and its results even without the knowledge of UML.

There are, however, some limitations to the present study. There are difficulties concerning maintaining validity regarding defining "object" in the UML diagrams. Process analysis using UML requires a good understanding of UML as well as the tasks involved. It is therefore essential to discuss and assess validity according to the objective of the study with those familiar with the tasks concerned.

Although TPS possesses such limitations, the application of TPS would be useful in other fields. Modeling based on UML and TPS provides important resources in situations regarding cooperation between workers and departments with respect to the various roles and distributed tasks. A once-created TPD can be used when a similar study is being conducted elsewhere; in fact, it would be easier to use already existing UML diagrams and TPD. Furthermore, because UML constitutes a unified language, comparing task content would be possible. By storing data for business analysis at each medical institution, it would be possible to study how hospital-based cancer registration or other tasks based on the characteristics of a medical institution should be carried out.

5. Conclusion

A time process study (TPS) brings clarity to the stages and processes that may be involved in a task through employing UML, and systematically collects and organizes information about time and manpower required for such tasks. By presenting task and time information together, it is possible to evaluate tasks qualitatively. This represents a straightforward and useful business analysis technique for presenting specific fundamental data in relation to studying the distribution of personnel and for improving task performance. Thanks to these advantages, we anticipate that this technique will also be exploited by various industries in the near future.

Acknowledgments

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