Implementation of an Integrated Common Platform for Zoo Operations

Tatsuya Ohyanagi[1]* and Tomoyuki Ishida[2]
[1]Ibaraki University, Hitachi, Ibaraki 3168511 Japan
17nm704r@vc.ibaraki.ac.jp
[2]Fukuoka Institute of Technology, Higashi-ku, Fukuoka 8110295 Japan
t-ishida@fit.ac.jp

Abstract

In this research, we conducted a questionnaire survey on the systematisation of zoo operations in zoos nationwide and we constructed the Integrated Common Platform for Zoo Operations based on the results of the questionnaire survey. We realised the unified management of various kinds of information in zoo operations by constructing a common platform. Moreover, we realised the education (environmental and conservation education) and the research and study aims by utilising the data in the database. We helped increase the time spent on environmental enrichment by improving the efficiency of zoo operations. To evaluate the operability, the necessity, the functionality, the effectiveness, and the readability of the Integrated Common Platform for Zoo Operations, we carried out a questionnaire survey of 19 Kamine Zoo staffs.

Keywords: Integrated Common Platform, Zoo Operation, Medical Record, Animal Feed, Animal Ledger

1 Introduction

The Japanese Association of Zoos and Aquariums (JAZA) cites species and nature conservation, education (environmental and conservation education), research and study and recreation as objectives for zoos and aquariums [1]. The first of these, species and nature conservation, aims to conserve wild animals for the next generation. The second, education (environmental and conservation education), aims to link environmental education by understanding the ecology of animals. The third, research and study, aims to allow animals to live comfortably in zoos and aquariums by understanding their ecology. And the fourth, recreation, aims to show people the importance of life and the beauty of living [4]. Moreover, according to the World Association of Zoos and Aquariums, the main goal of zoos and aquariums is the protection of endangered species and ecosystems [6].

The membership of JAZA includes 89 zoos and 62 aquariums [5]. Due to the recent diversification of other recreational facilities, smaller families, the deterioration of zoo facilities and the increasing popularity of other recreational facilities, the number of zoo visitors in Japan has been decreasing every year. Kamine Zoo in Hitachi City, Ibaraki Prefecture, is no exception. Therefore, Hitachi City has established facilities, such as the Forest of Chimpanzees and the Pasture of Elephants, through the Kamine Zoo development project, to restore the attractiveness and the prosperity of the zoo [1]. There were about 460,000 visitors in 1970, but only about 260,000 in 2008. Numbers recovered to about 360,000 visitors in 2014 due to the improvement of its facilities [8], but this is far below the peak. Even now, Kamine Zoo has problems attracting more visitors, preventing the deterioration of its facilities, promotion activities, etc.

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*Corresponding author: Graduate School of Science and Engineering, Ibaraki University, 4121 Nakanarusawacho, Hitachi, Ibaraki, 3168511, Japan, Tel: +81-294-38-5138

Under these circumstances, the workload of zoo staff throughout Japan is increasing due to staffing shortages and financial difficulties. This may lead to staff having to take on too many roles and the deterioration of zoo services. The diversification and complexity of work hinders efforts to improve environmental enrichment in zoos. Moreover, the analogue management of zoo operations hinders smooth and efficient running and makes it difficult to access and analyse records. Specialist zoo operations are hardly systematic in zoos nationwide. Therefore, there is a strong need for the systematisation of zoo operations, cross-functional collaboration, efficiency improvements and the sharing and analysis of information through the digitisation of zoo operations.

In this research, we conducted a questionnaire survey on the systematisation of zoo operations in zoos nationwide. We used the results to construct the Integrated Common Platform for Zoo Operations. The questionnaire items are as follows.

- Question 1 : To what extent are zoo operations systematic?
- Question 2 : What zoo operations are systematic?

We received responses from 60 zoos out of 89 nationwide. A summary of the answers to Question 1 is shown in Figure 1. No zoos answered that 'Almost all operations are systematic'. On the other hand, 32 zoos (53%) answered that 'Some operations are systematic' and 28 zoos (47%) answered that 'No operations are systematic'. Thus, in about half of the zoos, operations are not systematic at all.

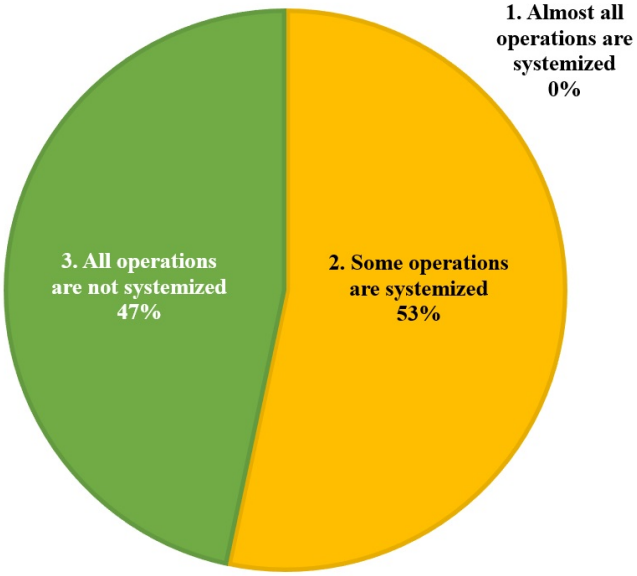

Figure 1: Systematisation of zoo operations (n = 60)

A summary of the answers for Question 2 is shown in Figure 2. Question 2 was answered by the 32 zoos that answered 'Some operations are systematic' in Question 1. Multiple answers were possible for Question 2 and we received 53 responses. Of these, 15 zoos (28%) answered that 'The animal ledger is systematic', seven zoos (13%) answered that 'The animal diary is systematic', six zoos (11%) answered that 'The veterinarian diary is systematic', five zoos (10%) answered that 'The animal health record is systematic', five zoos (10%) answered that 'The animal feed management is systematic', four zoos (8%) answered that 'The injury and disease wildlife record is systematic', three zoos (6%) answered that 'The event proposal and reports are systematic', one zoo (2%) answered that 'The management of medicine is systematic' and seven zoos (13%) answered that 'Other zoo operations are systematic'.

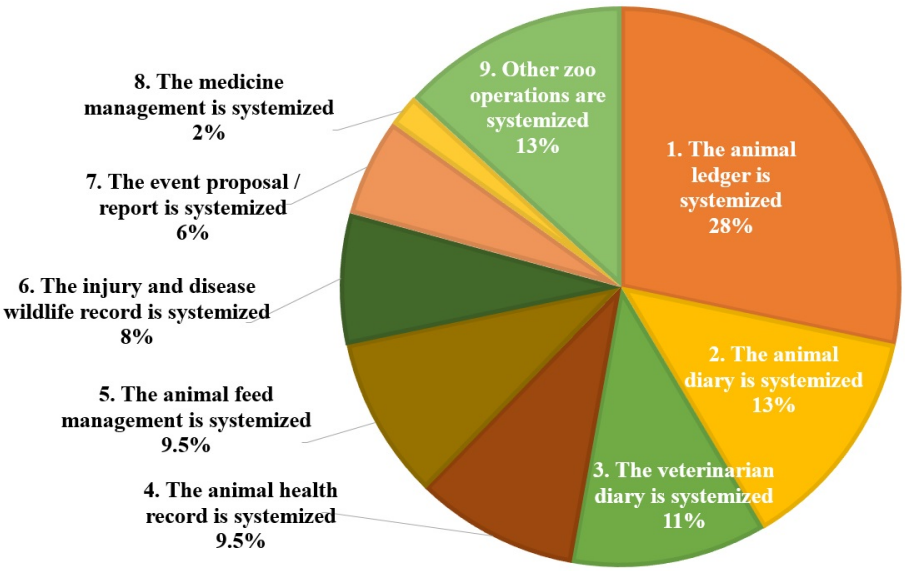

Figure 2: Systematic zoo operations (n=53)

At Kamine Zoo in Hitachi City, Ibaraki Prefecture, many of the daily zoo operations are managed on paper. As shown in Figure 3, the veterinarian diary, the animal diary and the animal ledger are managed on paper. Therefore, the zoo staff needs a huge amount of time to refer to past information.



Figure 3: Paper version of the veterinary diary

The rest of the article is organised as follows. Related work is described in Section 2. The purpose of our research is described in Section 3. The system configuration and the architecture of our proposed

Integrated Common Platform for Zoo Operations are explained in Sections 4 and 5, respectively. The platform is described in Section 6 and evaluated in Section 7. Finally, we conclude our findings in Section 8.

2 Related Works

Maruyama Zoo in Sapporo City, Hokkaido, uses a Rearing and Exhibiting Operation System [9]. This system includes an animal ledger management function, a rearing animal list function, a monthly reporting function, etc. However, this system specialises in managing rearing operations, and other zoo operations are managed in analogue form. Therefore, data sharing and data summation are issues.

Naito et al. [2] developed an information system for the captive management of oriental white storks. This is a platform-independent web system with an intuitive interface so that even inexperienced users can operate it easily. However, data cannot be exported from this system.

Yoshida et al. [3] developed an animal husbandry management system for zoos using data from sensors. This system includes rearing management with integrated animal diaries, veterinarian diaries, anaesthesia records, blood records and the like. Moreover, this system acquires data on animals from sensors installed in the zoo and stores them in the database. However, not all zoo operations are implemented in this system.

3 Purpose of This Research

In this research, we construct the Integrated Common Platform for Zoo Operations to enhance the smooth and efficient operations of Kamine Zoo. The platform unifies the management of various kinds of information in zoo operations. We realised the education (environmental and conservation education) and the research and study objectives by utilising the data accumulated in the database. Moreover, we increased the time spent on environmental enrichment by improving the efficiency of zoo operations.

Zoo staff can quickly access data from the system using SQL due to the digitisation of animal diaries and animal health records. This platform can export data from all systems using PDF templates. This greatly reduces the time needed to enter diary and health records, and further strengthens the data backup function. In addition, this platform enables information to be shared among zoos across the country. Zoo staff can easily send PDF data by email to other zoos. In addition to the database backup function, this platform can save PDF data in an external storage medium. For this reason, this common platform will improve the business continuity of zoo operations.

The Integrated Common Platform for Zoo Operations consists of an animal ledger management system, an animal health record management system, an animal diary management system, a veterinarian diary management system, an event management system, an animal feed management system, a veterinarian data management system, a basic information management system and a zoo staff management system.

4 System Configuration

The system configuration developed in this research is shown in Figure 4. This configuration consists of three agents, 19 application servers and 19 database servers. It digitises zoo operations such as health records and animal ledgers. Various pieces of information are stored in the database servers through the application servers. The platform supports the following types of user:

- Users permitted to register, edit and delete operations on all systems (administrator account)

- Users permitted to register, edit and delete operations on some systems (general account)
- Users permitted only browsing operations (browsing account)

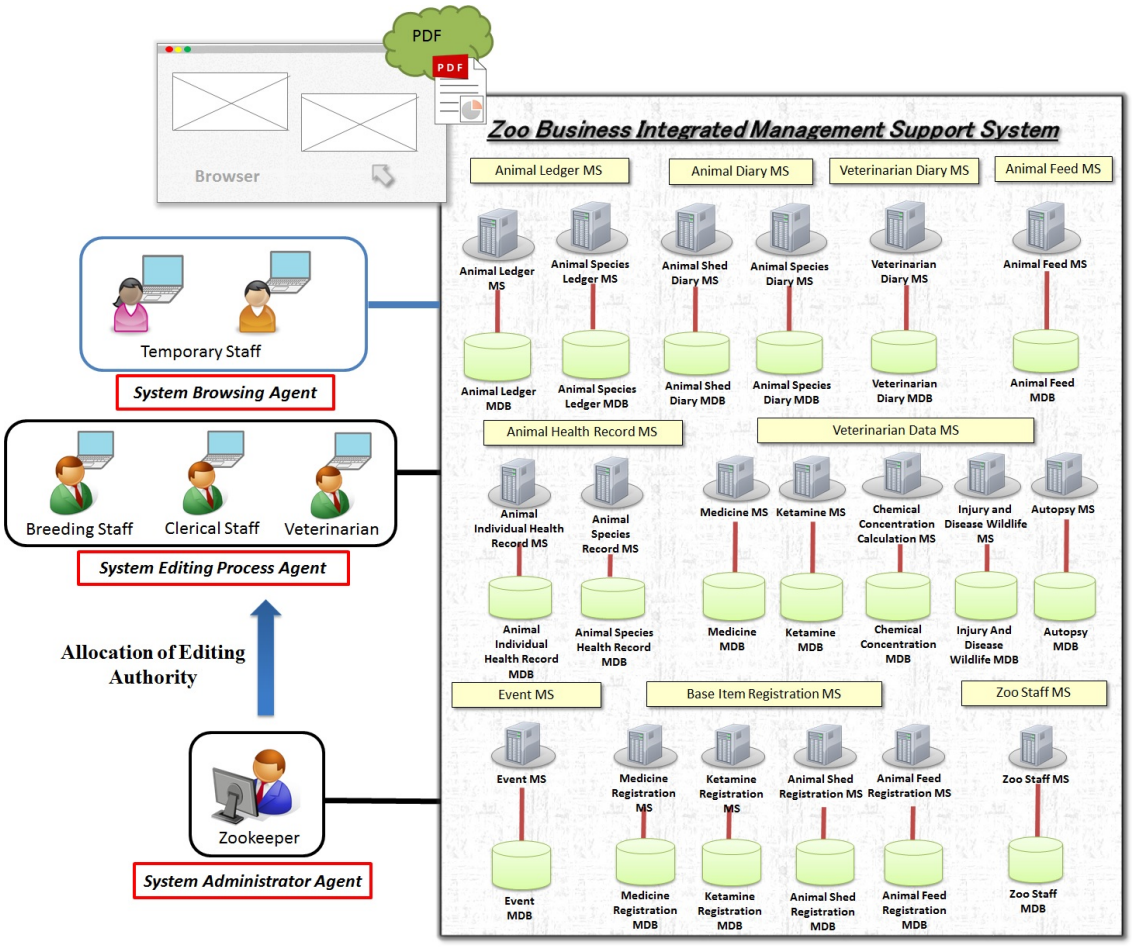

Figure 4: System configuration

5 System Architecture

The system architecture is shown in Figure 5. This system consists of the integrated management support system for zoo operations and the basic information management system. The integrated management support system for zoo operations consists of an animal health record management system, an animal ledger management system, an animal diary management system, a veterinarian diary management system, an event management system, an animal feed management system and the veterinarian data management system. The basic information management system consists of the registration systems for base items and the zoo staff management system.

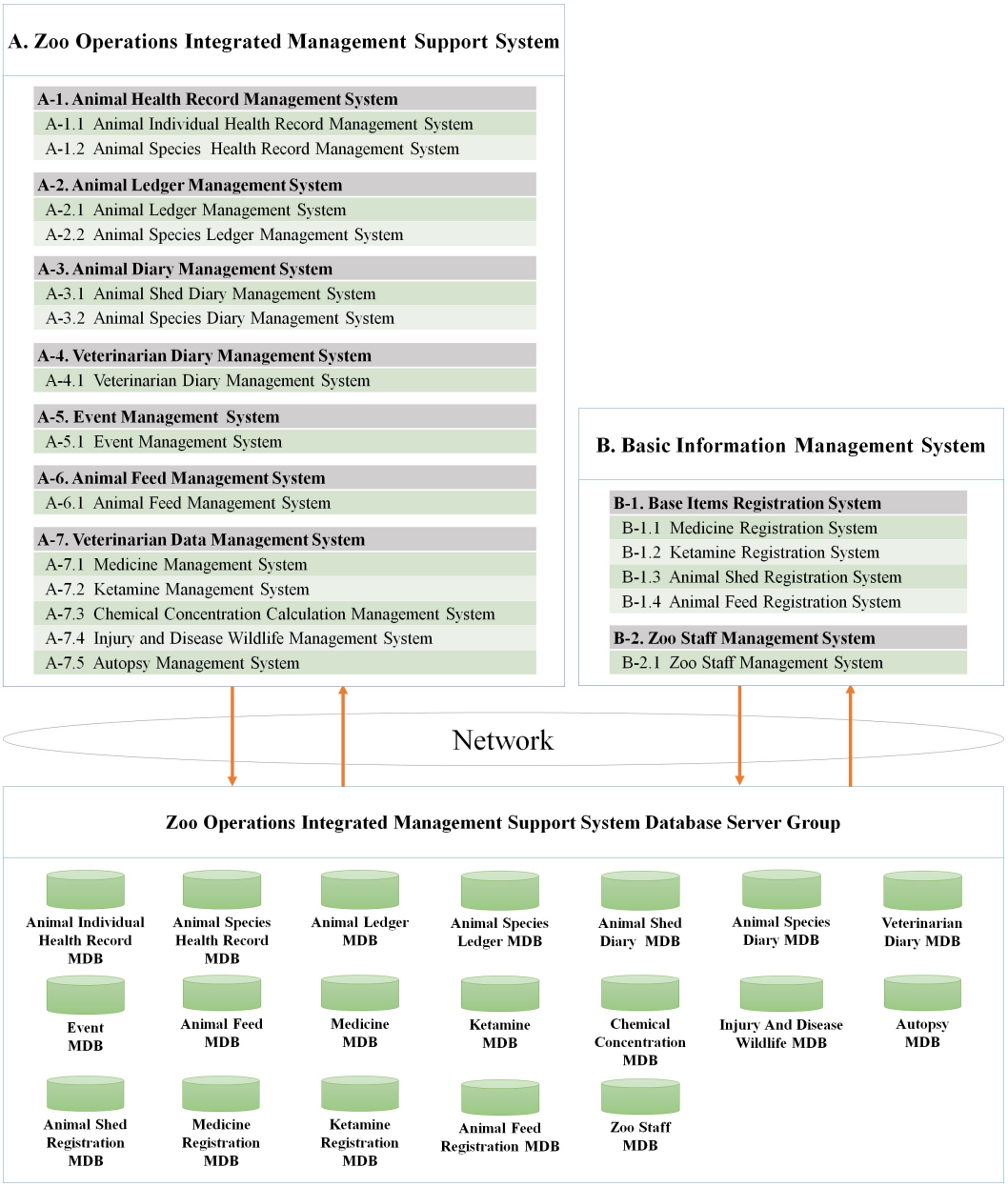

Figure 5: System architecture

6 Integrated Common Platform for Zoo Operations

The Integrated Common Platform for Zoo Operations is a web application. The login screen of the Integrated Common Platform for Zoo Operations is shown in Figure 6. When the user inputs an email address or a user ID and a password, the screen transitions from the login screen to the main screen as shown in Figure 7.



Figure 6: Login screen of the Integrated Common Platform for Zoo Operations

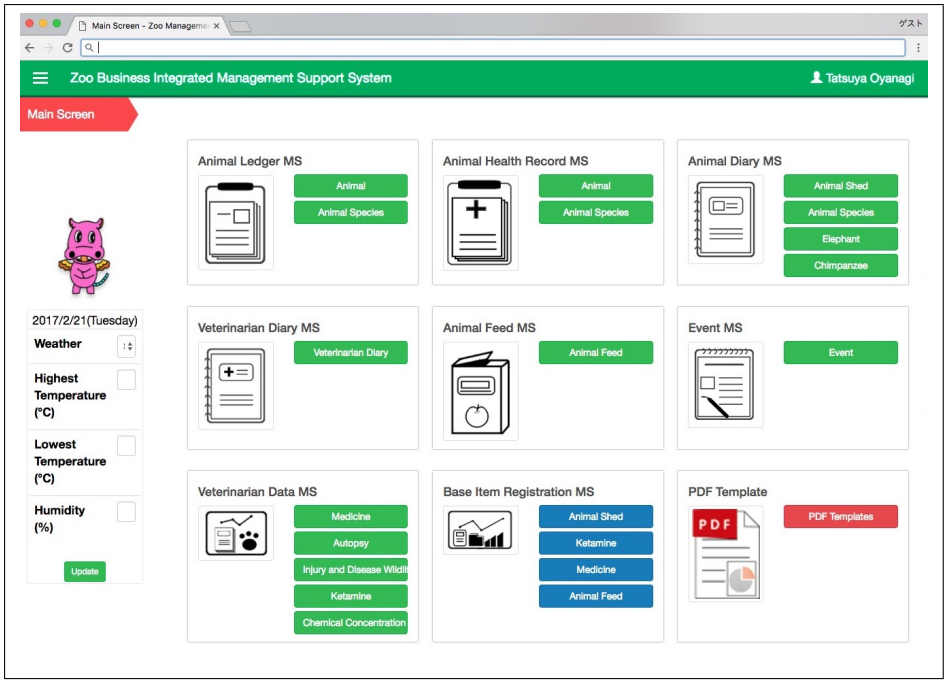

Figure 7: Main screen of the Integrated Common Platform for Zoo Operations

6.1 Integrated Management Support System for Zoo Operations

This system has digitised zoo operations that zoo officials previously managed on paper. A user can register various items of zoo operations data and can retrieve these data at any time. Moreover, the user can export the data in PDF format. The integrated management support system for zoo operations has several modules, as mentioned above, and we describe some of them here.

6.1.1 Animal Ledger Management System

The registration screen of the animal ledger management system is shown in Figure 8. This screen is used to store the registrant, the registration date, the animal species, the English name, the scientific name, the order, the Kamine number, the name of the individual animal, the microchip number, the domestic bloodline registration number, the gender, the method of conception, the birth date, the age, the father, the mother, any children, the import date, the import zoo, the export data, the export zoo, the death date, the age at death, the autopsy date, the cause of death and remarks. The registrant and the registration date are automatically recorded.

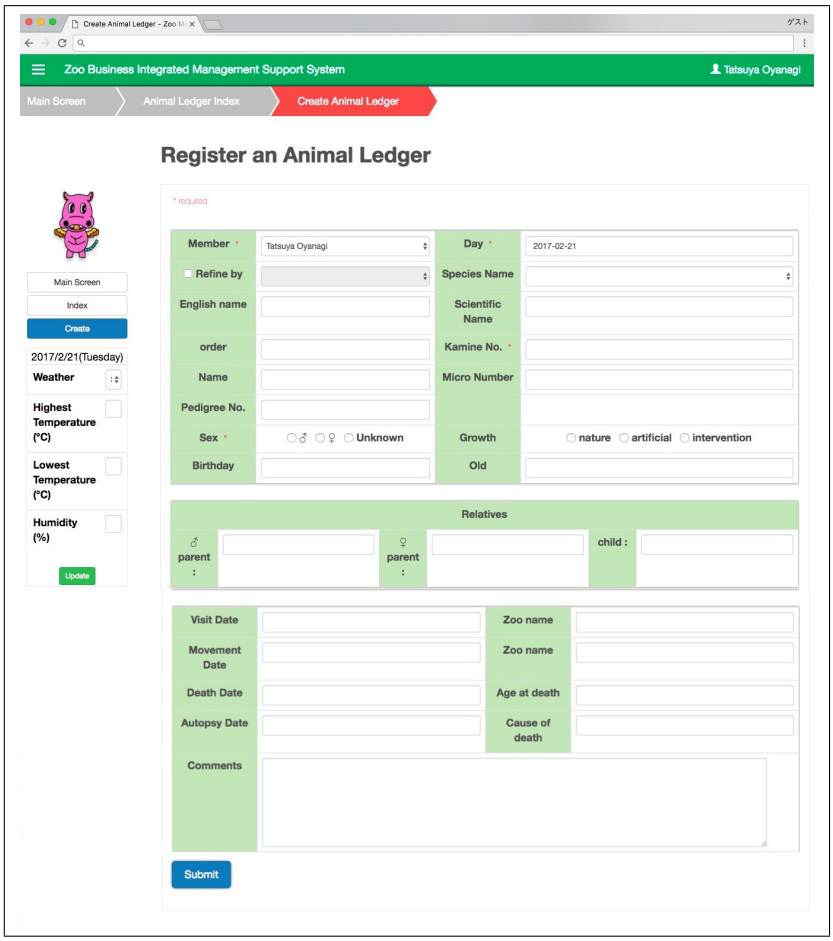

Figure 8: Registration screen of the Animal Ledger Management System

6.1.2 Animal Health Record Management System

The registration screen of the animal health record management system is shown in Figure 9. This screen is used to store the registration date, the registrant, the animal's ID or the name of the individual animal, the weight, the age, the gender, the symptom and condition, any treatment given and remarks. Files can also be uploaded. The registration date and the registrant are automatically recorded. When attaching files, the user can increase or decrease the number of files using jQuery.

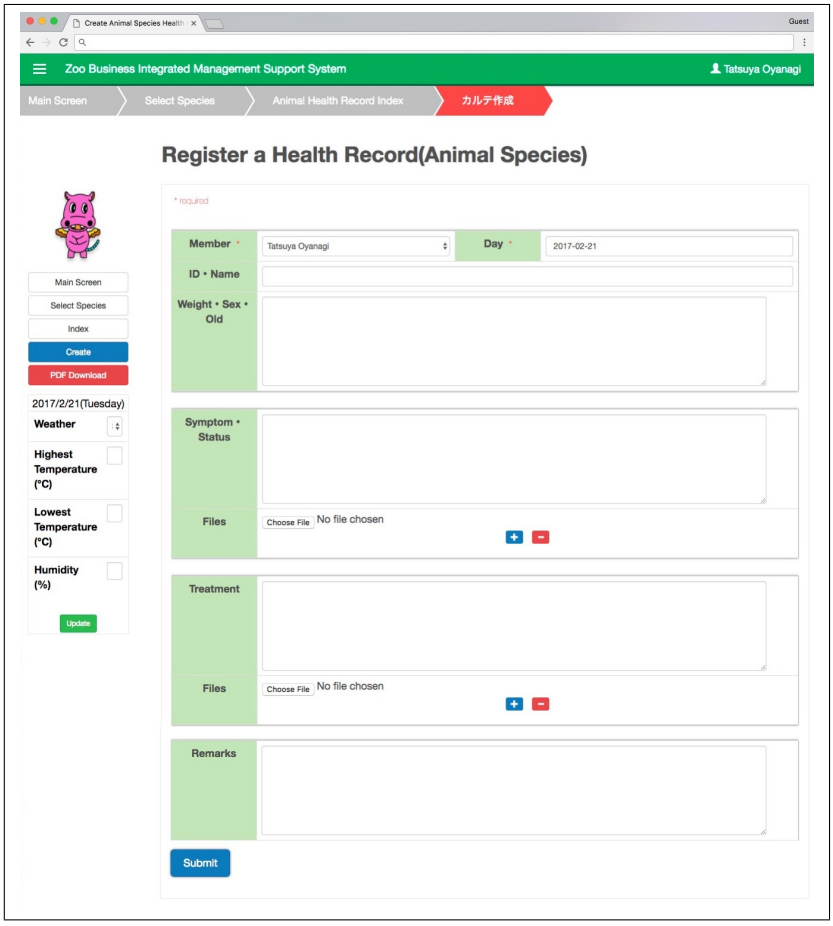

Figure 9: Registration screen of the Animal Health Record Management System

6.1.3 Animal Diary Management System

The registration screen of the animal diary management system is shown in Figure 10. This screen is used to record the registration date, the registrant, the weather (maximum and minimum temperature and humidity), the indoor temperature (maximum and minimum temperature), the time, the presence or absence of food, whether the area is clean, the number abnormality, whether the animal shed has abnormalities, the condition abnormality and remarks. The registration date and the registrant are automatically recorded.

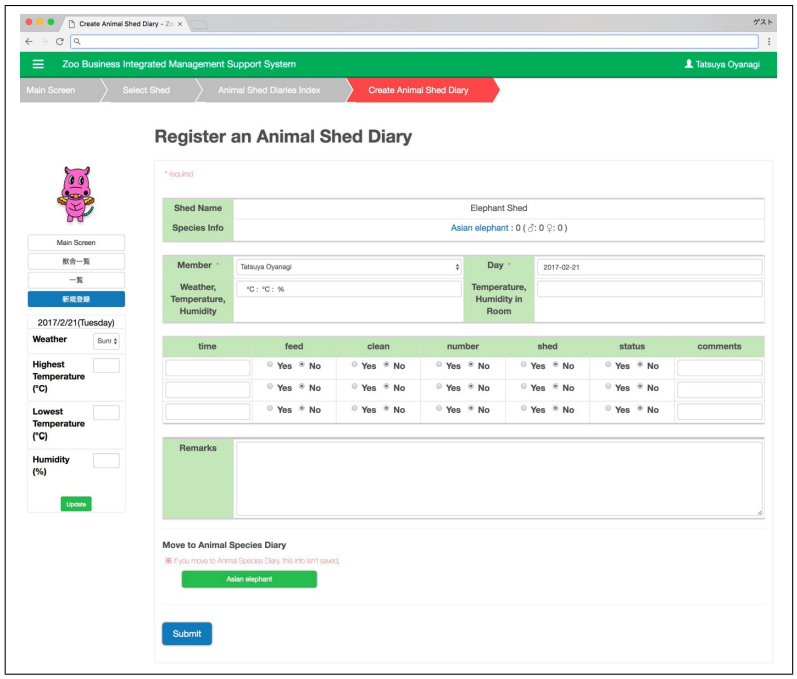

Figure 10: Registration screen of the Animal Diary Management System

6.1.4 Veterinarian Diary Management System

The registration screen of the veterinarian diary management system is shown in Figure 11. This screen is used to record the registration date, the registrant, the weather (maximum and minimum temperature and humidity), the ecology or general, the importance of the animal in terms of wildlife conservation, any isolations or hospitalisations, any abnormalities of the animal and any treatment given, and remarks. The registration date and the registrant are automatically recorded.

6.1.5 Event Management System

The registration screen of the event management system is shown in Figure 12. For an event, this screen is used to record the date the event plan was created; the planner; the event name; the person responsible; who wrote the city news report, the news on the homepage, the notice board announcement, the blog and the record; the purpose; the date of the event; the number of staff participants; the time; the place; any preparations; and details of the event (contents). The creation date of the event plan, the planner, the person responsible and who wrote the city news report, the news on the homepage, the notice board announcement, the blog and the record are automatically recorded.

6.1.6 Animal Feed Management System

The registration screen of the animal feed management system is shown in Figure 13. This screen is used to record the registrant, the registration date, the type of feed (name), the feed dosage in terms of calories, carbohydrates, proteins, lipids and dietary fibre and the unit price. When the user enters the feed name, the system acquires information on the feedstuff from the animal feed registration management database server using Ajax. When the user changes the feed dosage, the nutritional value of the feed is automatically calculated.

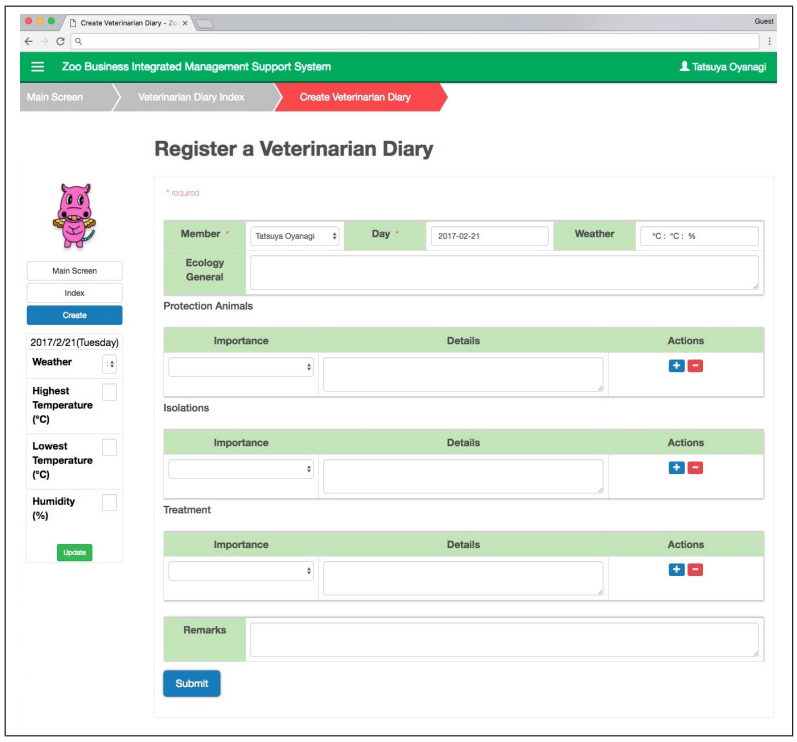

Figure 11: Registration screen of the Veterinarian Diary Management System

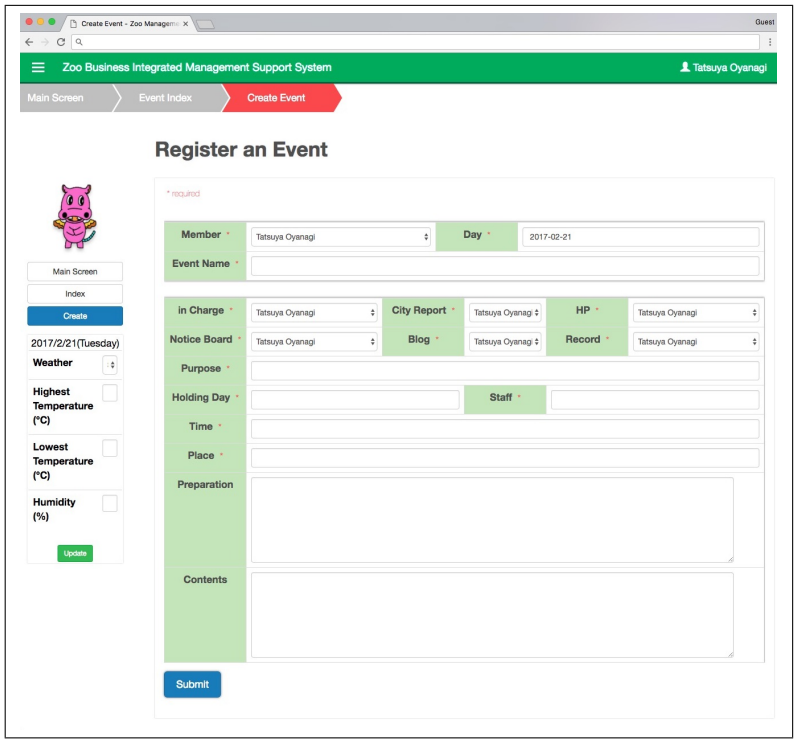

Figure 12: Registration screen of the Event Management System

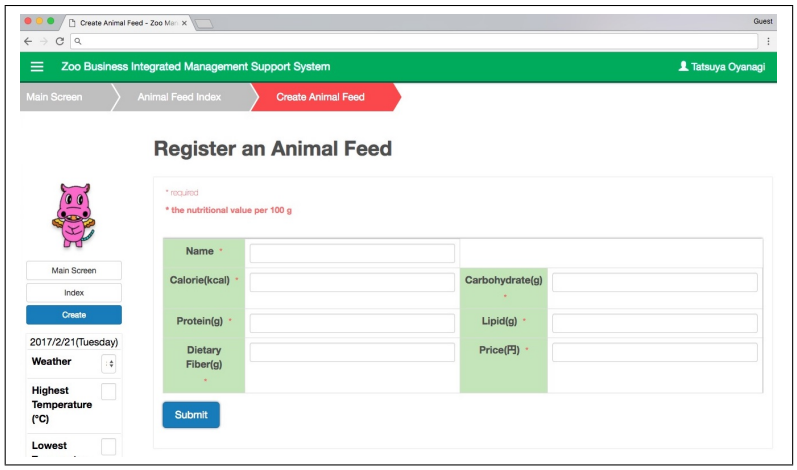

Figure 13: Registration screen of the Animal Feed Management System

6.2 Basic Information Management System

The basic information management system consists of the animal shed registration management system, the animal feed registration management system, the medicine registration management system and the ketamine registration management system, as shown in Figure 14.

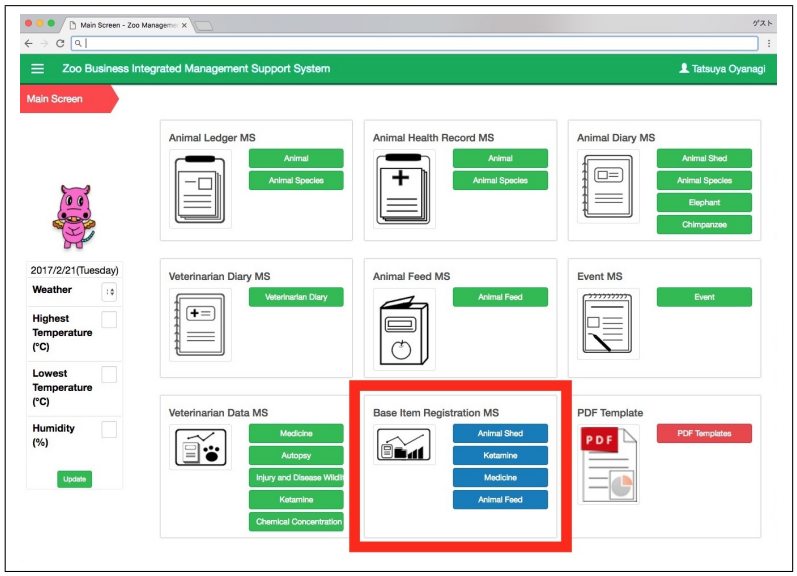

Figure 14: Basic Information Management System

6.2.1 Animal Shed Registration Management System

The registration screen of the animal shed registration management system is shown in Figure 15. To register a new animal shed, the user clicks on the ‘Create’ button. After entering the name of the shed in the text box, the user registers the animal shed by selecting the ‘Submit’ button.

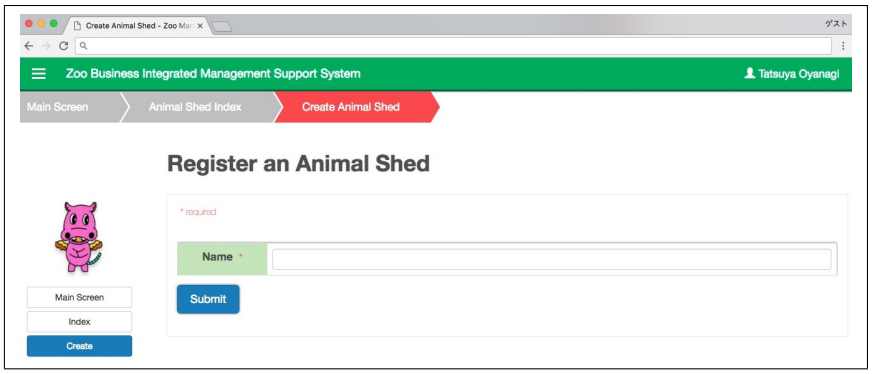

Figure 15: Registration screen of the Animal Shed Registration Management System

6.2.2 Animal Feed Registration Management System

The registration screen of the animal feed registration management system is shown in Figure 16. To register a new type of animal feed, the user selects the 'Create' button. The registration screen stores the number of calories, the amount of carbohydrates, proteins, lipids and dietary fibre and the unit price. Each nutritional value is based on 100 grams. After entering the information, the user registers the animal feed by selecting the 'Submit' button.

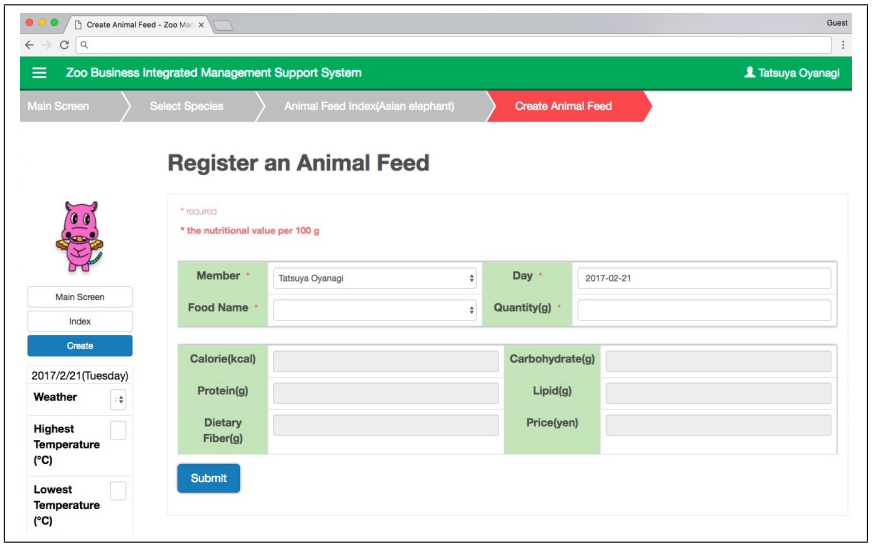

Figure 16: Registration screen of the Animal Feed Registration Management System

6.2.3 Medicine Registration Management System

The registration screen of the medicine registration management system is shown in Figure 17. To register a new medicine, the user selects the 'Create' button. After entering the name of the medicine in the text box, the user registers it by selecting the 'Submit' button.

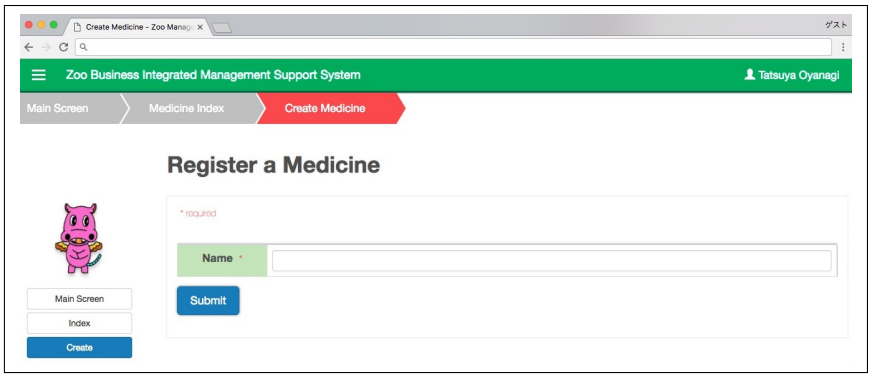

Figure 17: Registration screen of the Medicine Registration Management System

6.2.4 Ketamine Registration Management System

The registration screen of the ketamine registration management system is shown in Figure 18. To register ketamine, the user selects the 'Create' button. The registration screen stores the ketamine name and the unit price. The user registers the ketamine by selecting the 'Submit' button.

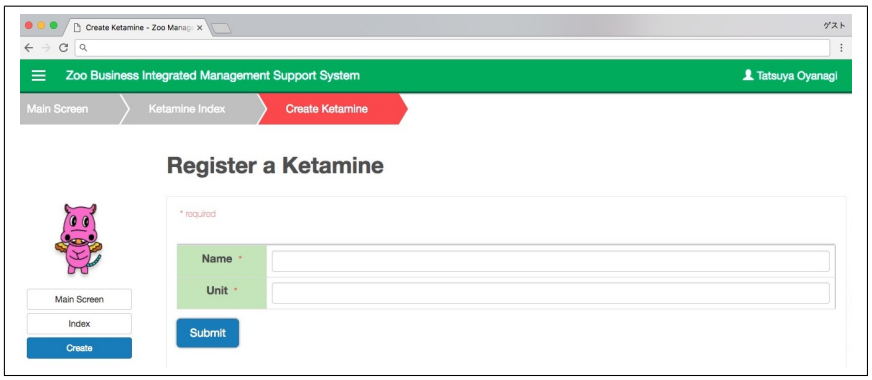

Figure 18: Registration screen of the Ketamine Registration Management System

6.3 Sequence Diagram

A sequence diagram of the overall system is shown in Figure 19. Information is retrieved from the database server through the application server depending on what the user is doing. Each system implements the registration function, the edit function, the delete function and the search function.

6.4 Database Relationship Diagram

A database relationship diagram for the overall system is shown in Figure 20. The database servers cooperate with each other, and it is possible to refer to data stored in the database server of another system.

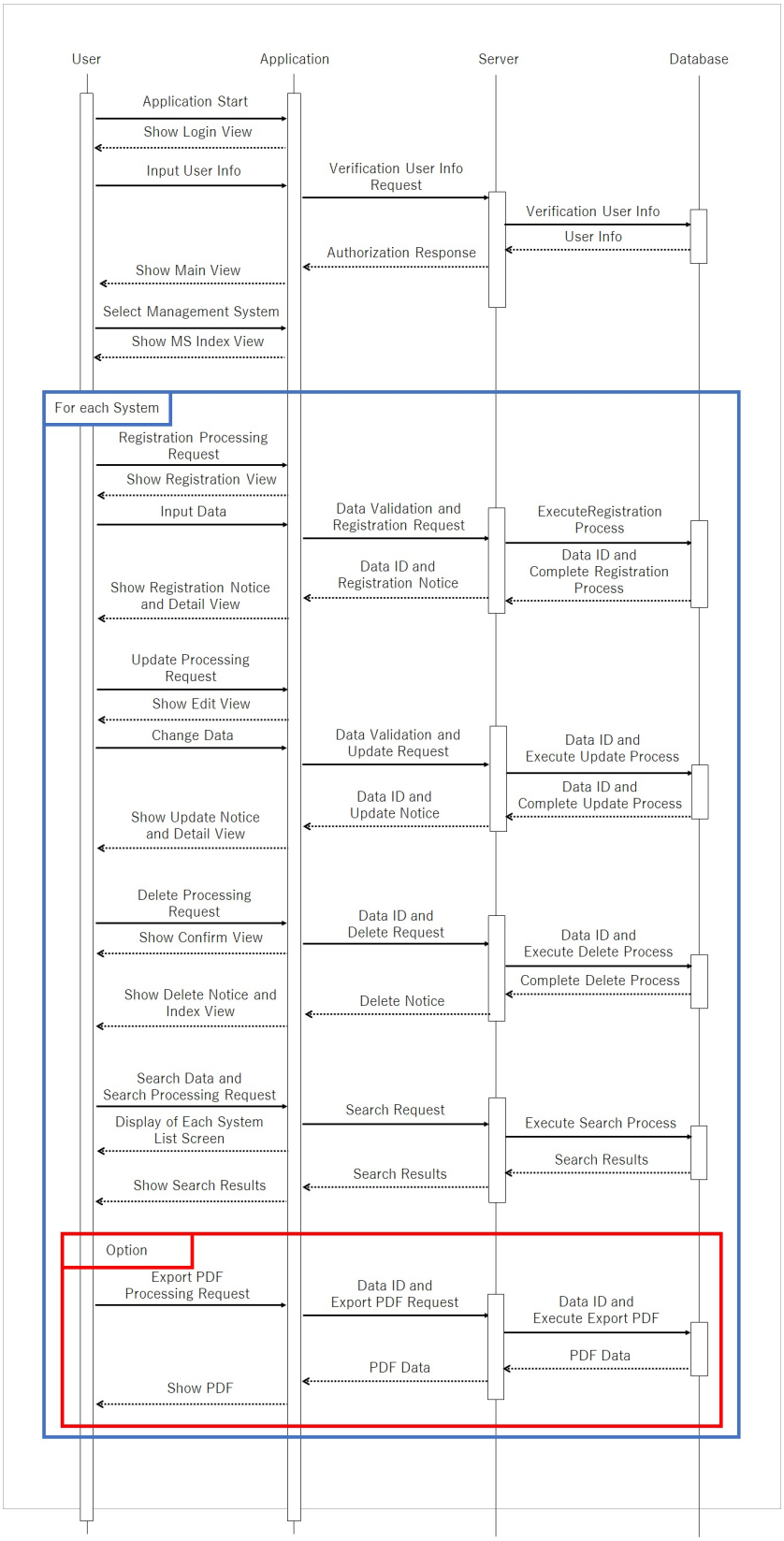

Figure 19: Sequence diagram

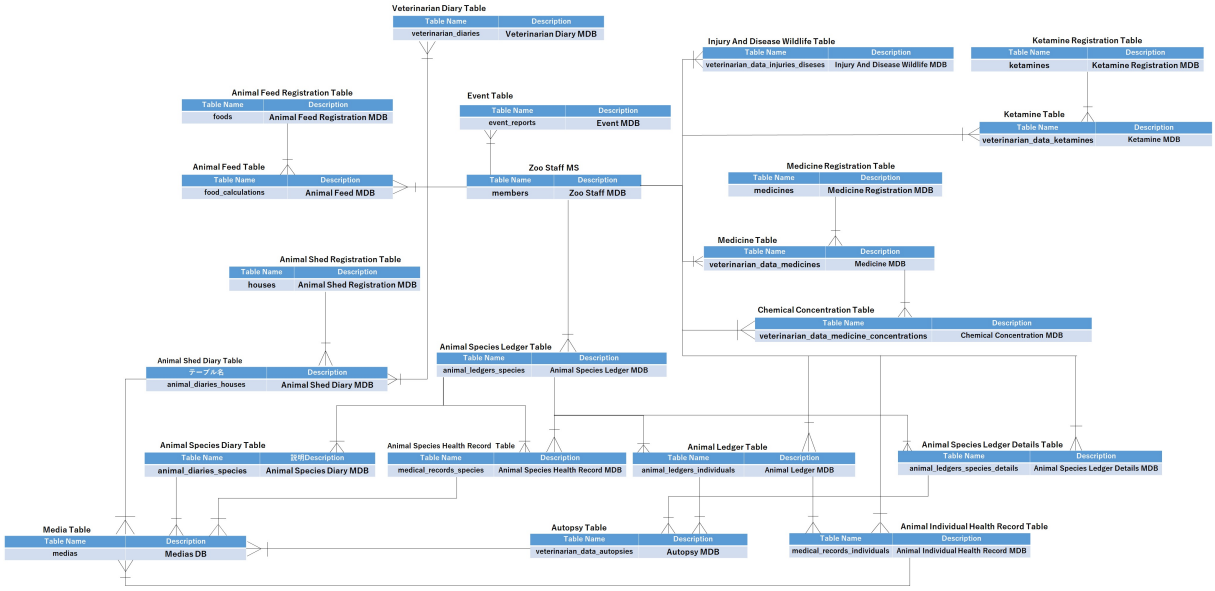

Figure 20: Database relationship diagram

7 Evaluation

To evaluate the operability, the necessity, the functionality, the effectiveness and the readability of the Integrated Common Platform for Zoo Operations, we carried out a questionnaire survey of 19 Kamine Zoo staff.

7.1 Operability of the Integrated Common Platform for Zoo Operations

The results for the operability of the Integrated Common Platform for Zoo Operations are shown in Figure 21. About 70 % of participants answered that it was ‘Easy’ or ‘Somewhat easy’ to use. On the other hand, about 30 % of people answered ‘No opinion’ or ‘Somewhat difficult’. Therefore, we need to improve the operability of the platform.

7.2 Necessity of the Integrated Common Platform for Zoo Operations

The results for the necessity of the Integrated Common Platform for Zoo Operations are shown in Figure 22. About 90 % of the participants answered that it was ‘Necessary’ or ‘Somewhat necessary’. Therefore, the results show that the platform was needed.

7.3 Functionality of the Integrated Common Platform for Zoo Operations

The results for the functionality of the Integrated Common Platform for Zoo Operations are shown in Figure 23. About 70 % of the participants answered that they were ‘Satisfied’ or ‘Somewhat satisfied’ with the platform. On the other hand, about 30 % of the participants answered ‘No opinion’ or ‘Somewhat dissatisfied’. Therefore, we need to improve the functionality of the platform.

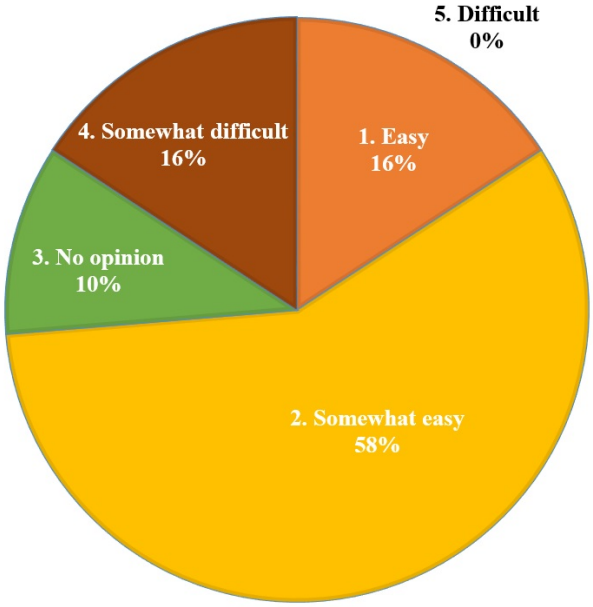

Figure 21: Results for operability (n=19)

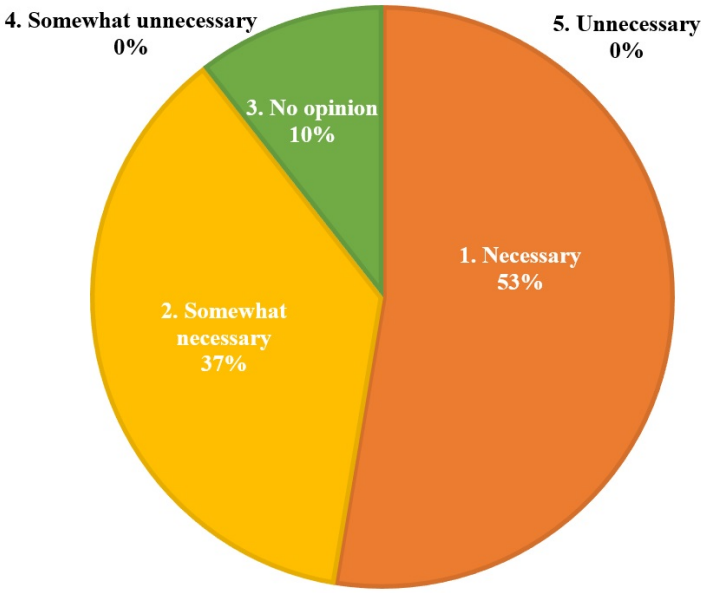

Figure 22: Results for necessity (n=19)

7.4 Effectiveness of the Integrated Common Platform for Zoo Operations

The results for the effectiveness evaluation of the Integrated Common Platform for Zoo Operations are shown in Figure 24. About 60 % of the participants answered that it was ‘Effective’ or ‘Somewhat effective’. On the other hand, about 40 % of participants answered ‘No opinion’ or ‘Somewhat ineffective’. Therefore, we need to change the user interface to improve the effectiveness of the platform.

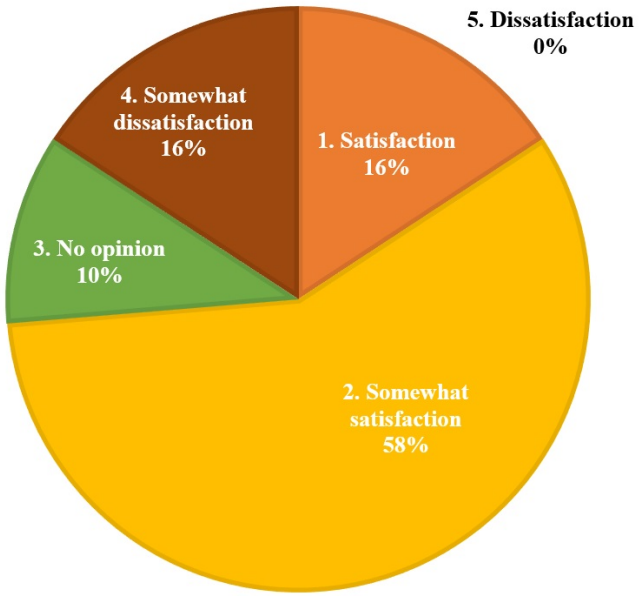

Figure 23: Results for functionality (n=19)

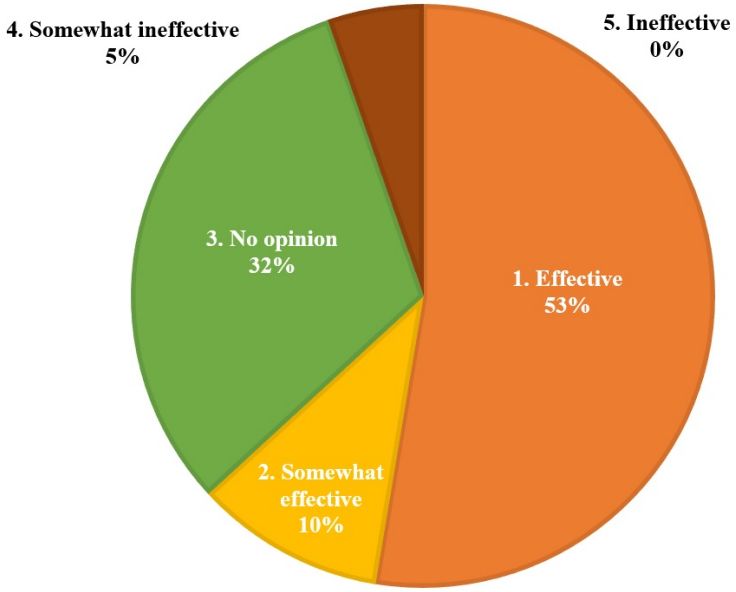

Figure 24: Results for effectiveness (n=19)

7.5 Readability of the Integrated Common Platform for Zoo Operations

The results for the readability of the Integrated Common Platform for Zoo Operations are shown in Figure 25. About 70 % of the participants answered that it was ‘Easy to understand’ or ‘Somewhat easy to understand’. On the other hand, about 30 % of the participants answered ‘No opinion’, ‘Somewhat hard to understand’ or ‘Hard to understand’. Therefore, we need to change the screen layout and the size of the characters to improve the readability of the platform.

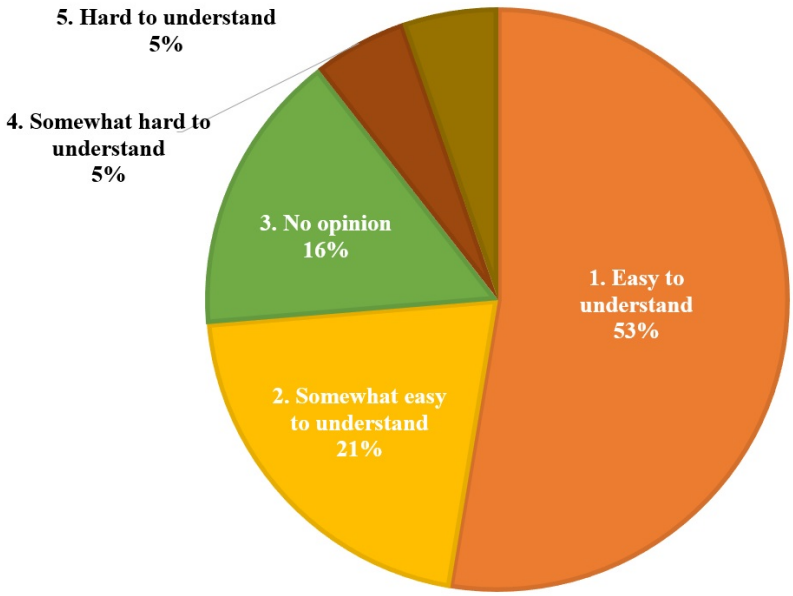

Figure 25: Results for readability (n=19)

8 Conclusion

In this research, we constructed the Zoo Operations Integrated Common Platform to enhance the smooth and efficient operations of Kamine Zoo. We realised the unified management of various kinds of information used in zoo operations. We achieved the education (environmental and conservation education) and research and study goals by utilising the data accumulated in the database. Moreover, we increased the time spent on environmental enrichment by improving the efficiency of zoo operations. In addition, this common platform allowed high-speed data retrieval using SQL due to the digitisation of animal diaries and animal health records. This common platform can output data using PDF templates from all systems. This considerably reduces the time needed to enter diary and health records, and further strengthens the data backup function. To evaluate the operability, necessity, functionality, effectiveness and readability of the platform, we carried out a questionnaire survey of 19 Kamine Zoo staff. As a result, we were able to confirm the great evaluation of all items. However, from the results, we should further improve the operability and functionality of the system. For effectiveness, we must further improve the user interface. Finally, from the results for readability, we must change the screen layout and the size of the characters.

Acknowledgments

This paper is an extended version of the work[7] originally presented at the 23rd International Symposium on Artificial Life and Robotics, Beppu, Japan, January 18-20, 2018. The authors would like to thank N. Namae for total assistance with the system construction. We also thank Kamine zoo staff for fruitful discussions and valuable suggestions.

References

[1] H. C. Assembly. Hitachi-city administrative activities case report. http://hitachi-gr-giindan.jp/photonews/image/2010-hitachi.pdf, [Online; accessed on April 2017].

[2] K. Naito, T. Yoshizawa, Y. Mitsuhashi, M. Sato, and Y. Ohsako. Development and maintenance of an information system for captive management of oriental white stork. *Reintroduction*, 2:75–80, December 2012.

[3] S. W. Nobuaki Yoshida, Masayuki Tanaka. Development of the zoo animal husbandry management system with sensor data. *The IPSJ SIG Technical Reports*, 2014-IS-130(8):1–8, December 2014.

[4] T. J. A. of Zoos and Aquariums. Four objectives. http://www.jaza.jp/english_new3.html, [Online; accessed on April 2017].

[5] T. J. A. of Zoos and Aquariums. Four objectives. http://www.jaza.jp/english_new5.html, [Online; accessed on April 2017].

[6] W. A. of Zoos and Aquariums. Structure of jaza. http://www.waza.org/files/webcontent/1.public_site/5.conservation/conservation_strategies/understanding_animals_brochure/Marketing%20brochure.pdf, [Online; accessed on April 2017].

[7] T. Ohyanagi, H. Ito, M. Iyobe, and T. Ishida. Proposal of an integrated common platform for zoo operation support. In *Proc. of the 23rd International Symposium on Artificial Life and Robotics, Beppu, Japan*, pages 576–581. ISAROB, January 2018.

[8] H. C. K. Zoo. *Annual Report 2014 of Hitachi City Kamine Zoo*. Hitachi City Kamine Zoo, 2014.

[9] M. Zoo. Chapter 3 business analysis. https://www.city.sapporo.jp/kansa/f02keka/documents/hoka260324_03.pdf, [Online; accessed on April 2017].

Author Biography



Tatsuya Ohyanagi received the B.S. degree in Engineering from Ibaraki University in 2017. Currently he is taking a master's course at Graduate School of Science and Engineering, Ibaraki University. His research interests include Web Application System, Common Platform, Business Management Support System, Decision Support System, and Environmental Enrichment.



Tomoyuki Ishida received the B.S. and M.S. degrees in Software and Information science from Iwate Prefectural University in 2004 and 2006, and Ph.D. degrees in the same University in 2010. Currently he is an associate professor in Department of Information and Communication Engineering, Fukuoka Institute of Technology, Japan. His research interests include Web Geographic Information System for local governments, Disaster Management System, Safety Confirmation System, Regional Disaster Prevention Planning, Virtual Reality and Tele-Immersion. He is a member of IEEE, Virtual Reality Society of Japan (VRSJ) and Visualization Society of Japan (VSJ).