Administration Service for the Tourist Information System (TIP)

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Abstract

The modern day tourists do not want to deal with the hassle of using a large number of travel guides and paper maps while travelling. They would prefer to be able to access required information via their mobile phones or Personal Digital Assistants (PDAs). We realise that the delivered information may be originally available in numerous information formats. To support the administrator of the tourist guides the programme is required to help sorting information from these different sources and to help inserting them into a system.

Our goal with this project is to develop a software support for processing information import via a graphical user interface, to support the administrator in identifying and extracting the appropriate sight information from various resources. The interface also helps in transferring and storing the structured and unstructured data into the TIP database.

Acknowledgement

It has come to the end of my thesis and it is time to thank those people who have assisted and supported me while completing it.

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Section 1 Introduction

Information systems for hand-held devices are fast becoming a valuable aid to tourists. Tourists no longer need to deal with a large number of travel guides or paper maps while enjoying their vacations. Instead, they can access required information, such as travel routes, sight-related information, or other information they are subscribed to based on their interests or requirements, using their mobile phones or Personal Digital Assistants (PDAs).

However, delivered information may be issued originally from various service providers, and each of the service providers may use numerous formats or frameworks to present their information. In order to provide tourists with complete information from the service provider, an assistant is required that helps when carrying out a series of administration tasks to identify, extract, and convert various formats of information, and store them into a structured database.

To accomplish the above idea, this project concentrates on the information import service for a tourist information system. This thesis is part of the ongoing project *TIP – A Mobile Tourist Information Provider* in the Information System and Databases (ISDB) group in the University of Waikato[1]. This project is developed to work within the existing Tourist Information Provider (TIP) system.

1.1 Aim of the Project

The intention of this project is to improve the TIP system, in particular, to provide more facilities for the administrator by providing an information import service. This project focuses on information import via a graphical user interface to support the administrator in identifying and extracting the appropriate sight information from various resources, as well as in transferring and storing structured and unstructured data into the TIP database.

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[1] http://isdb.cs.waikato.ac.nz/TIP

Therefore, in this project, we[2] studied and evaluated the existing administration interfaces in the TIP system to identify the current information import issues. Then we clarified the requirements for the new administration interfaces, and designed and created a new administration panel based on the requirements. Our emphasis was to examine the newly-created interfaces regarding the user's satisfaction, and discover an appropriate interaction model to import sight information into the TIP database using these interfaces.

1.2 Purpose of the Document

This document outlines the author's COMP594 Masters Thesis research regarding information import in the TIP system. Its purpose is to analyse the project in order to describe the working procedure for developing and evaluating the information import service.

The document sketches out the issues of the existing administration interfaces and how they have impacted the information import in the TIP system. In addition, it specifies the requirements of the proposed prototypes and how they have matched up to the sequences of each administration activity. It also confers on other aspects of the project, such as the works that have been completed during the creation of interface and the evaluation, and possible directions for future extensions of the TIP's administration service.

1.3 Document Overview

The remainder of this document is made up of nine sections to present the contributions of this project, including Current System Overview (Section 2), Scenario and Requirements Analysis (Section 3), Design Models for the Administration Interface (Section 4), Design Concerns (Section 5), Screenshot Prototypes (Section 6), Interaction Concern Solutions (Section 7), Evaluation (Section 8), Related Approach and Future Work (Section 9), and Summary (Section 10). The following subsections clarify these contributions.

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[2] Note that the personal pronoun "we" in this report refers to just myself, since I am the only person who doing this project.

- *Current System Overview*

  Section 2 studies the current TIP system to analyse the services that are provided for its tourism information support and its administration support. This review strongly focuses on the existing administration interfaces to investigate the features that are provided by the existing interfaces, as well as to understand their interactions with the TIP system. At the end of this study, we identify complications and issues when using the existing administration interface.

- *Scenario and Requirement Analysis*

  Section 3 studies a comprehensive user scenario to analyse the administrator's interactions with the administration tool, as well as to clarify the requirements for the proposed interface. Within this study, the essential supports for the new administration interface are distributed into functional or interface requirements, and each support is introduced with corresponding administration activities. In the end, we use use-case diagrams and UML activity diagrams to present possible sequences for each administration activity.

- *Design Models for the Administration Interface*

  Section 4 presents and discusses possible designs for the proposed administration interfaces. Within this study, interface designs are discussed for a number of administration aspects. We are using sketch prototypes to assist us to understand the structure of possible designs and the system features they can provide.

- *Design Concerns*

  Section 5 presents the concerns based on the sketch prototypes and the administrator's interactions to perform sight information insert and information search. We particularly address the concerns for the sketches and the insertion of sight information. The concerns are described based on the cause and the drawback that affects the administrator in performing administration activities.

- *Screenshot Prototypes*

  Section 6 analyses the solutions for the concerns of sketch prototypes. We use two screenshots to present the refinements for a sketch in each solution. Each screenshot is emphasised on its pros and cons, and its design to solve the corresponding concern. We then justify a most appropriate design for each solution based on the developer's (our) view.

- *Interaction Concern Solutions*

  Section 7 proposes the solutions for the concerns identified in the operation of sight information insert. Each solution represents an interaction model that supports in the insertion of sight information. We use screenshots to walk through each model and discuss its pros and cons.

- *Evaluation*

  Section 8 analyses the evaluations for the screenshot prototypes and the administrator's interactions to insert sight information. Within this study, we first evaluate the screenshots regarding the user's (the participant) satisfaction. We then test their accessibilities according to the requirements identified in Section 3. At the end of this section, we evaluate the participant's action to perform sight information insert through three tasks, to discover a most appropriate interaction model for the sight information insert operation.

- *Related Approach and Future Works*

  Section 9 investigates an external approach that has been completed by another research group. This investigation focuses on the information transfer techniques supported by the external approach. We compare it with the interaction models we designed for sight information insert. At the end, we introduce the sight information insert operation that supports the administrator in inserting sight information using a different information transfer technique. Also, we describe possible future works for TIP's administration service.

- *Summary*

  Section 10 summarises this project based on the outcome of the study. We provide an overview on the works that we completed in this research.

Section 2 Current System Overview

The Tourist Information Provider (TIP) is an advanced tourist information system [1]. Seen from the tourist's perspective, it delivers different types of travel information and recommendations, including tourist sights, transport, events, tours, and travellers' experiences and journeys. Delivered information is selected via various system services (see Section 2.1), based on the tourists' personal preferences, their current travel routes, and their preferred sight-related information.

On the other hand, the TIP system is also concerned with the import of tourism information by the administrator. It runs an administration service (see Section 2.2) to store appropriate sight-related information through existing administration interfaces. These interfaces intend to provide the administrator with facilities to process manual information import, to enrich the information in the TIP database and to provide more appropriate sight information for tourists.

In this section, we give an overview of the existing TIP system's tourist information support and administration support, to study the services that are provided in the current TIP system. We conduct this investigation with emphasis on the administration interfaces, to understand the functionalities provided in the current interfaces and the procedure of information import.

2.1 Tourist Information Support

A number of systems have been developed to support tourists with requested travel information (such as GUIDE [2], Cyberguide [3], CRUMPET [4], and AccessSights [5]). Other systems have been developed to provide recommendations that match tourists' contexts (such as CBCF [6], Fab [7], LIBRA [8], MRS [9], and FindMe [10]).

With the purpose of providing both services, the TIP system has been developed to deliver various types of travel information and recommendations. For example, the landmarks that are recognised on tourists' current travel routes, the events that occur

at tourists' preferred places and the adventures that are mentioned in tourists' favourite books.

This information and recommendations are delivered via various system services that have been developed in the TIP system. The following paragraphs describe four sample system services: the Context-Awareness Information Service, the Recommendation Service, the Map Service and the Audio-Awareness Service.

2.1.1 Context-Aware Information Service

The context-aware information service [6] provides user-dependent information; the system has the ability to collect and deliver the sight-related information based on user-predefined criteria. The criteria include the user's current location or any of the user's personal preferences (e.g., the user's preferred places, or travel history).

This service is activated by comparing sights that are nearby and their information with the data stored in the user's preferences. Whenever a detected sight and its related information match the user preference, the TIP system identifies and displays the location of this sight on the map and presents sight-related information in the browser.

2.1.2 Recommendation Service

In addition to the context-aware service, the TIP system provides recommendations based on the user's preferences [11]. However, unlike the context-aware information service, the sights and information provided by the recommendation service do not only describe the facts for each individual sight. The provided recommendations may include other people's experiences of each sight, their journeys, and feedback.

Also, the provided recommendations are created based on more information than the user-close-by sights or user-predefined sights. The locations that have been mentioned in travellers' favourite novels or the landmarks that have been visited by a famous people could also be the basis for delivered recommendations.

2.1.3 Map Service

The map service in the TIP system is implemented as a zoomable map application [12]. Its purpose is to display the contexts detected within the user's surroundings, for the user to navigate in his/her current physical location. The contexts may include routes, landmarks, sights, etc, and each context is presented or indicated using a specific graphical icon or a pre-defined sight name.

The map is usually centred at the user's current location; however, the user can follow his/her own inclinations to travel to other places on the map. The user's location is determined via a Global Positioning System receiver (GPS receiver) and delivered to the TIP system through the event-based communication layer.

2.1.4 Audio-Awareness Service

The audio-awareness service [13] consists of the audio icons and the audio book service. It has been developed as a new system service in the TIP system. The audio icon service aims to present the route signs using audio sounds, to signal the user about the close-by contexts. Each chosen icon is uniquely defined to represent a different individual sight.

The audio book service enables story-telling function, in which the content from a travel guide or a story book is recorded into an audio file (for example a MP3 file). The user is able to listen to those recorded descriptions that are related to his/her current location. This service also contains the ability to cooperate with a digital library (e.g., Greenstone[3]), to play digital library content related to the user's current location.

2.1.5 Other Services

As an ongoing project, the TIP system is being developed to suit the demands of different users. Therefore, in addition to the above four services, other system services have been developed to strengthen TIP's capabilities (e.g., Community-Based

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[3] http://www.greenstone.org

Interaction Service [14], Travel Planning Component in TIP [15], and Travel Itinerary in TIP System [16]), and some others are still proceeding as ongoing research (e.g., Ad-hoc Networking for Cooperating Services in Mobile Environments [17], and Information Broker and Information Repository in Mobile Environments [18]).

The above services are presented for readers to understand the variety of services that TIP provides for tourists. The main focus of our project is the improvement and development of the administration service to support the administrator in performing information import. The administration service needs to support the data formats used in the services described above. The following section describes our project in more details.

2.2 Administration Support

Other than the system services that are mentioned in Section 2.1, the administration service also takes part in the TIP system. It is developed as a support for the administrator to process various administration activities, such as inserting new sight information and editing existing TIP resources.

2.2.1 TIP Database Structure

The existing administration service consists of 18 administration interfaces and the TIP database in previous research [19]. The database is created in PostegreSQL[4]. It consists of 17 entities and appropriate relationships (see Appendix I for the complete TIP database ER diagram) to store TIP resources according to five categories:

- Sights – Resources stored in this category include specific locations, identifiable natural, or man-made geographic features (e.g., University of Waikato, Lake Taupo, Sky Tower).
- Sight Information – This is the information that is related to a sight. In the TIP database, each piece of sight information is stored according to its related topic, and is refined into levels of detail.

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[4] http://www.postgresql.org

- Sight Groups – In the TIP database, each sight group is a category that holds a number of corresponding sights (e.g., Sky Tower and Eiffel Tower are members of the sight group *Towers*).

- Topics – Each resource stored in this category is a subject that describes corresponding sight information (e.g., General, Architecture, and Uses).

- Facts – In the TIP database, facts structure the information available for each sight and are pre-defined for each sight group and topic.

Topics	Sky Tower ← – – – – *Sight Name*	
General	**Architecture**	**Uses**
The Sky Tower is an observation and radio tower located on the corner of Victoria and Federal Streets in the central business district of Auckland, New Zealand.	It is 328 metres tall, as measured from ground level to the top of the mast, which makes it the tallest free-standing structure in the Southern Hemisphere.	The upper portion of the tower contains two restaurant levels (one, 'Orbit' with revolving seating turning 360degrees once every hour) and one cafe level.
This landmark is part of the SKYCITY Auckland casino complex, owned and operated by SKYCITY Entertainment Group.	The tower is constructed of reinforced, high-performance concrete. Its 12-meter diameter shaft is supported on eight legs.	The upper portion of the tower also contains two observation decks (including some with sections of glass floor).
The complex of the Sky Tower building is originally built for Harrah's Entertainments.	The upper levels were constructed from composite materials, structural steel, precast concrete and reinforced concrete.	The tower also features the Sky Jump, a 192-metre 'fan descender' jump (an experience between a bungy jump and a base jump) from the observation deck.

Sight information is refined in levels of detail, starting from level zero.

Figure 2.1: Sight information structure.

(Texts are taken from: http://en.wikipedia.org/wiki/Sky_Tower last visited on 12/06/2008)

The database model has also been designed to fulfil four data structure requirements [6]:

- Sight information is organised according to the characteristics of each sight.
- Information about each sight is categorised into various topics.
- Sight information is refined in a hierarchical structure.
- Sights are grouped into clusters and arranged in semantic order.

The sight information stored in this model is refined into levels of detail using hierarchical structure, as shown in **Figure 2.1**. Within this diagram, the information about Sky Tower (the sight) is categorised in three topics: General, Architecture and Uses. For each topic, the information is refined in levels of detail, starting from level zero.

2.2.2 Architecture of Information Import Service

The existing administration interface is designed and developed using the Struts framework[5], in which the model components are written in Java, and the view components are developed in JSP. The administrator can use the interface to import, update, and store sight-related information, as well as to categorise information into details of sights, sight information, sight groups, topics, facts etc.

The architecture of the current administration is shown in **Figure 2.2**. According to the original design description of administration service in [19], each of the view components maps to an action class (model component). Whenever a request is posted from a JSP page, the controller starts the procedure of request allocation to assign the request to the corresponding action class. Then the action class processes the request and sends back the results as a response.

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[5] http://struts.apache.org
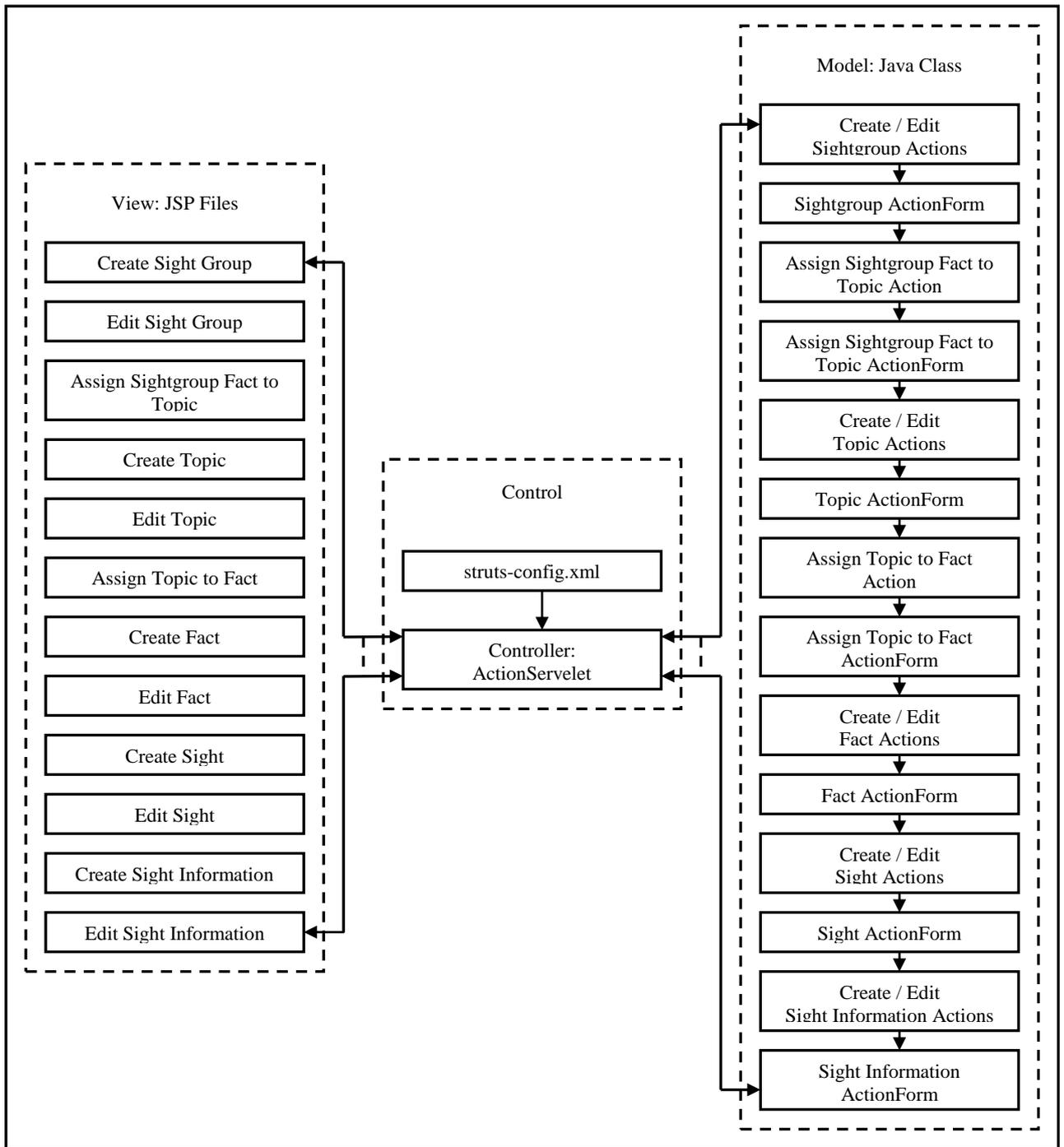
Figure 2.2: Architecture of Administration Services in TIP system. This image is taken from [19].

2.2.3 Administration Interfaces Issues

The existing administration interfaces allow the administrator to execute the administration activities: to input and categorise requested sight information into appropriate categories. However, some issues can still be found while processing information import. For example, the insertion of duplicate sight information,

complicate action flow while creating a new resource, and missing contents while accessing stored information. In this section, we describe the issues with the existing administration interfaces. Each issue is described with its related administration activities, and the administrator's interactions with corresponding interfaces.

This section focuses on the issues with the administration interface. Thus, we do not present all interfaces in detail here. A description of all screens in administration service can be found in [19]. Also, some particular issues may occur in more than one interface; we present one sample interface for each issue to support the problem description. For clarity, sample interfaces are presented as screenshots captured from the personal computer rather than a mobile phone as screenshots from a mobile phone would be fuzzy and unclear.

I1: Insertion of duplicate sight information

Figure 2.3 shows the image captured from the Wikipedia page for the Sky Tower and sample information contents that are provided in the web page. The web page is a possible information source. A user might want to use its information in the TIP system.

We assume that the administrator intends to import the information into the TIP database using the data input page that is presented in **Figure 2.4**. This interface is developed for the administrator to create new information for a sight. Generally, the administrator can simply select the sight name and the topic from combo boxes, and key in the new sight information and its hierarchical level into the textbox and text area, to assign the collected information to a particular sight. After that, s/he can click the "Submit" button to store the information into the database.

However, while inserting the information into this interface, the administrator is not able to see sight information structure of the selected sight. Thus, it is not possible for the administrator to notice whether the inserted hierarchical level and sight information has been defined for the selected topic. Due to this, it is easy to enter the hierarchical level defined for the selected sight incorrectly. Also, it is likely to have duplicate information inserted according to the selected topic.

Uses   [edit]

The upper portion of the tower contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[4] and one cafe level, as well as two observation decks (including some with sections of glass floor).[4] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[5]

The tower also features the SkyJump, a 192-metre[6] 'fan descender' jump (an experience between a bungy jump and a base jump) from the observation deck, during which a jumper can reach up to 85 km/h (53 mph). The jump is guide-cable-controlled to prevent jumpers from colliding with the tower in case of gusts.[7] Climbs into the antennae portion (300 m/980 ft heights) are also possible for tour groups.[6]

As well as for entertainment, the tower is used for telecommunications and broadcasting with the Auckland Peering Exchange (APE) being located on Level 48. Several radio broadcasting companies co-locate transmitters and share antenna systems, while television company Canwest (who runs the TV3 and C4 channels) has secondary transmitters on the tower, their primary one being at Waiatarua.[citation needed]

Sky Tower in the Auckland skyline.

Sight Name:	Sky Tower
Topic:	Uses
Level:	2
Information:	The tower also features the Sky Jump, a 192-metre 'fan descender' jump (an experience between a bungy jump and a base jump) from the observation deck, during which a jumper can reach up to 85 km/h (53mph). The jump is guide-cable-controlled to prevent jumpers from colliding with the tower in case of guests. Climbs into the antennae portion (300m/980ft heights) are also possible for tour groups.

Figure 2.3: Sample sight information from the Wikipedia page for the Sky Tower.

(http://en.wikipedia.org/wiki/Sky_Tower last visited on 12/06/2008)

Figure 2.4: Existing administration interface for inserting sight information.

I2: Complicated action flow while creating a new sight group

We assume that the administrator plans to create a new sight group for the Sky Tower using the interface and the sample information that is given in **Figure 2.5a** and Figure **2.5b**.
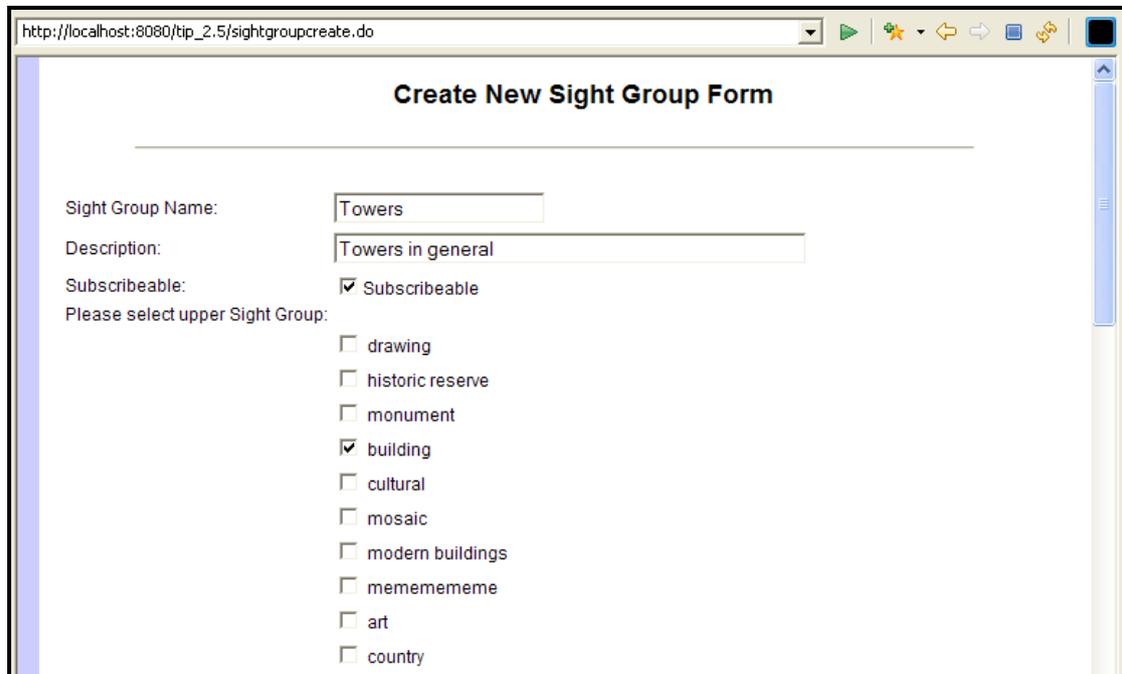
Figure 2.5a: Existing administration interface for creating a new sight group (top half).

Figure 2.5b: Existing administration interface for creating a new sight group (bottom half).

With this interface, the administrator is able to perform the operation to create a new sight group. This action can be achieved by filling in the sight group name and its

description into the textboxes, and select the upper sight groups and sight group facts via the checkboxes. The input information can be stored into the database by clicking the "Submit" button provided at the bottom of the interface.

During the procedure to create a sight group, if the fact of the sight group (e.g., Material – the rectangular area in **Figure 2.5b**) does not exist in the list, the administrator has to switch between administration pages to create the required fact before s/he can complete the sight group creation. This means that the administrator has to cancel the sight group creation procedure by leaving this page, while opening the fact creation page to create the related fact, and then come back to the sight group creation page to create a new sight group. This makes the action flow of sight group creation very complicated and inconvenient for the administrator.

I3: Missing contents while creating a new sight
Figure 2.6 shows the interface for creating a new sight. The administrator is able to perform the insertion of sight resource contents by inputting the required information, such as sight name, location, images, upper sights, and sight groups, using the provided textboxes and checkboxes. The information can be stored into the database by interacting with the "Submit" button that is placed at the bottom of the page.

While processing the input to define a sight's upper sights, the administrator can tick a checkbox to assign the sight to its related sights. However, with the growing of the TIP database contents, it would be hard and puzzling for the administrator to seek out the upper sights from an unordered list of resources (see rectangular area in **Figure 2.6**).
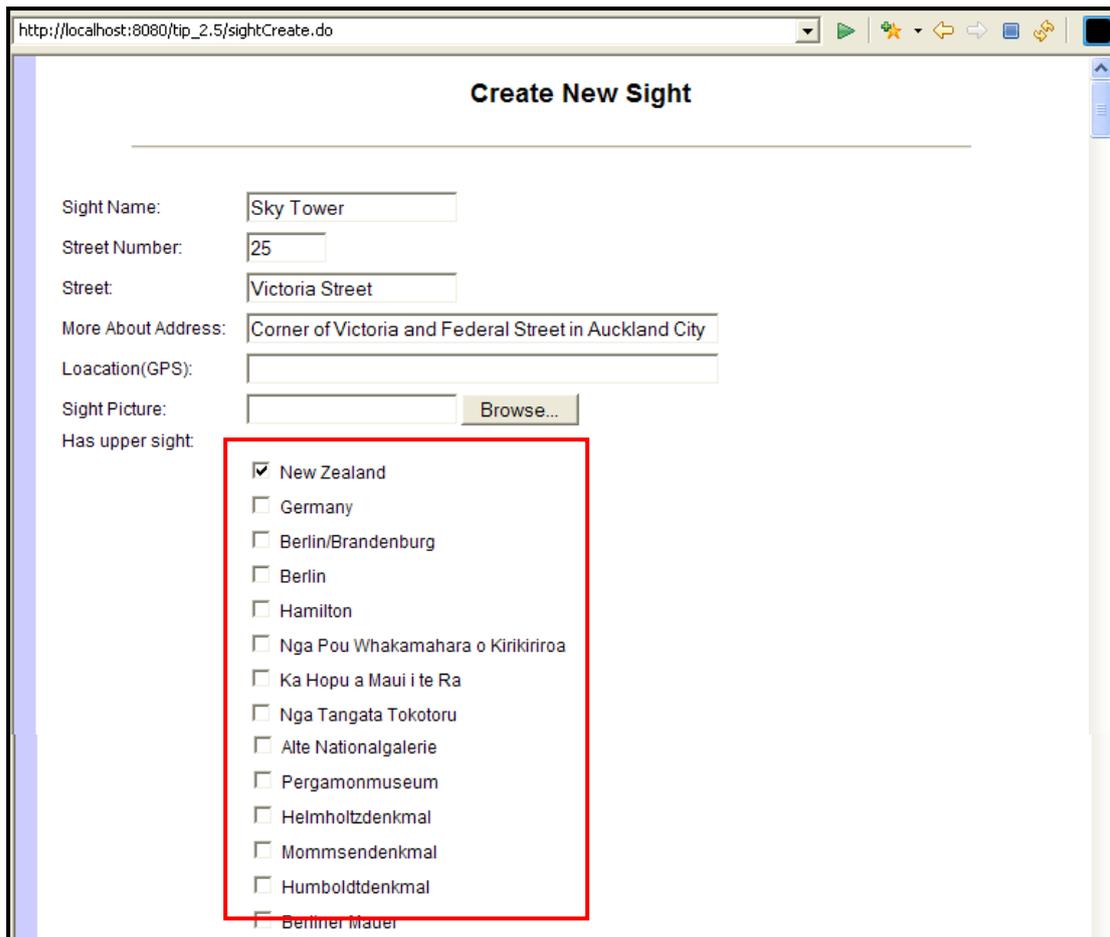
Figure 2.6: Existing administration interface for creating a new sight.

I4: Missing contents while accessing stored sight information

Figure 2.7 shows the administration page for sight information. This interface is shown when the administrator clicks on the sight information link on the administration home page (**Figure 2.8**). With this interface, the administrator is able to view and search through the sight information contents stored in the database. The administrator can click on any sight name to edit its stored information. Also, s/he can access other functional areas provided at the bottom of the page to create and delete sight information.

However, all the information contents defined for sights are displayed in this interface without proper grouping. With an increasing amount of information in the database, it becomes difficult for the administrator to look for a sight from a long table. Also, it is difficult for him/her to see the hierarchical structure defined for each sight.

Figure 2.7: Existing administration interface for showing stored sight information.

I5: Complicated action flow while accessing data retrieval functionalities

Figure 2.8 shows the home page of the administration service in the TIP system. This is the first interface shown on the screen when the user logs in as an administrator. It presents entries for five administration areas, including sight groups, facts, topics, sights and sight information. The administrator can enter each area to access or manage the resources stored in the corresponding category.
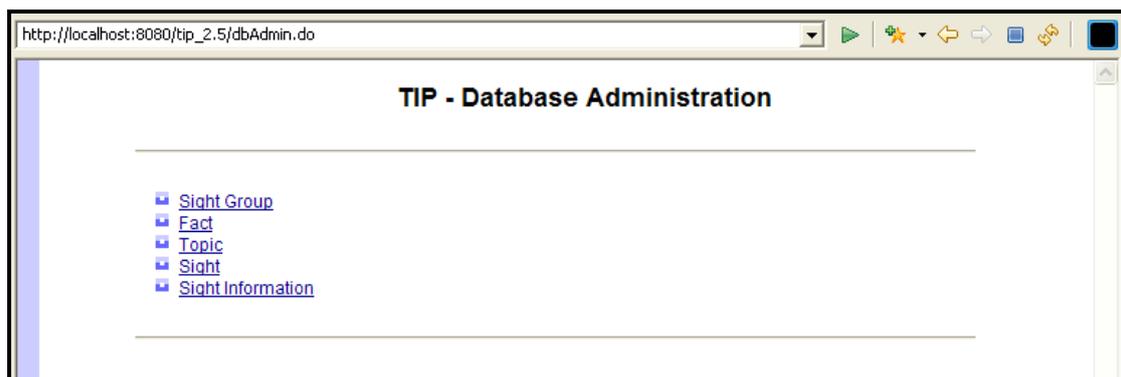
Figure 2.8: Home page of the existing administration interface.

However, with the design of this interface, the administrator has to switch between the interfaces to access the resources stored and the functional areas (i.e., resource creation, deletion, or modification) supplied for each category. This brings inconveniences while performing the administration activities to access the TIP resource contents, to create a new resource, or to remove an existing resource.

I6: Lack of a search function

Currently, the existing administration service does not support the administrator in searching for information. S/he either has to use an external search engine (e.g., Google Search[6]) to discover appropriate sight information from the Internet, or to access the TIP resources one by one to explore the information stored in the TIP database. Thus, the administrator has to spend a lot of time and effort searching for sight information.

I7: Time consuming insertion of a large amount of sight information

As described in issue I1, sight information is currently imported into the database via the existing interface (**Figure 2.4**). Before that, the information is inserted through keyboard typing. Nevertheless, considering a large amount of information contents could be provided from a source provider (e.g., **Figure 2.3**), it would take time for the administrator to import all the information supplied.

Summary of the Interface Issues

Based on the above description, we summarise the identified issues in three categories:

1) Issues in performing data entry
   - I1: Insertion of duplicate sight information
   - I2: Complicated action flow while creating a new sight group
   - I3: Missing contents while creating a new sight
   - I7: Time consuming insertion of a large amount of sight information
2) Issues in accessing information contents or functional areas
   - I4: Missing contents while accessing stored sight information
   - I5: Complicated action flow while accessing data retrieval functionalities
3) Issues in performing the search
   - I6: Lack of a search function

Because of these issues, it is time consuming for the administrator to perform administration activities, and the sight information imported according to each topic

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and a sight could be filled with repetition. Thus, there is a need for a new interface to support the administrator in performing administration activities.

Section 3 Scenario and Requirement Analysis

With the purpose of clarifying the system requirements (including interface and functional requirements) for the new interfaces, a requirement analysis is conducted in this section. The analysis is provided of the usage scenario described in Section 3.1, and it intends to identify the essential features for the new administration tools.

The provided comprehensive usage scenario serves to analyse the user's interactions with TIP's administration service. It will be used as the reference scenario through this report to aid explanation of different examples in the following sections.

From now on, "the user" will be used to represent the administrator of the TIP administration service who performs administration activities.

3.1 Scenarios

Jason is the administrator of the TIP system. His job is to import and update the sight related information in the TIP database to provide sufficient tourism information to users who are utilising the TIP system as their travel guide. He owns a desktop at work and the computer is connected to both broadband and the TIP database server. This allows him to search for appropriate sight information from the internet and keep the contents of the TIP database updated. He enjoys this job, because he is able to receive the information about sights in the world.

One week after the establishment of the Sky Tower, he is trying to collect the information that relates to this landmark and import it as a new resource into the TIP database. He first logs onto the TIP system as the administrator, to access the administration service interface. Jason prefers to find out as much information as he can about the Sky Tower before inserting the sight information, so he asks the system to search for all information that relates to the Sky Tower from the internet. Based on Jason's request, the system has identified and displayed a number of results.

Jason would like to view the contents of each result. He selects each result one at a time and asks the system to extract and display the texts and images stored in the selected result. After viewing a couple of results, Jason finds that the search results contain a variety of information. He feels it is difficult to categorise them. He then asks the system to search the information again based on the general information about the Sky Tower. Again, the system finds several results and Jason is satisfied with them after viewing their contents. Before he requests to start off the insertion, he asks the system to check the TIP database to see if other administrators have imported this landmark before. When the system provides a negative feedback, he gets ready to import Sky Tower into the database.

Jason asks the system to present the data entry form for the insertion of sight resource contents. From there, he is able to define the properties of the Sky Tower and have the defined properties stored into the database in accordance with the TIP database model. He does not want to have duplicate information defined for the Sky Tower, so he is very careful in analysing the content of the resources discovered during the search. When he has reached required information during the process of analysing the contents, he inserts it into the data entry form through drag-and-drop input. At the end of insertion, Jason can always ask the system to check the validation of inserted information before storing them into the database. Thus, he has never worried about errors of invalid data input.

After the Sky Tower is imported into the TIP database, Jason wants to view the information defined for it. He searches for this newly-created sight from a list of TIP resources. From this list, Jason is able to see all of TIP resources (sights, sight groups, topics, and facts). During the procedure to look for the resource Sky Tower resource, Jason is surprised. He found a resource named Sky City Auckland, which was imported by another administrator a week ago. He wants to confirm if this resource is consistent with the information he has defined for the Sky Tower, so he asks the system to extract its contents. Based on Jason's request, the system displays the contents of Sky City Auckland according to the information structure that is defined for it.

Through the contents that have been displayed, Jason found that the information defined for the Sky City Auckland matches the information defined for Sky Tower. However, he feels that the information defined for Sky Tower is richer; because it consists of general information about the tower and supporting images while the Sky City Auckland resource is defined with general information only. Therefore, Jason decides to remove Sky City Auckland from the TIP database. He asks the system for the removal of this resource, and the system follows Jason's request to perform the deletion.

Jason continues to access the Sky Tower from the list that holds TIP resources. He asks the system to extract and display its contents after he has found it from the list. Also, Jason starts to access the contents of searched resources for a second time to see if there is other information he can assign to this sight to enrich its contents stored in the TIP database. While reading the contents that were explored from the official website of the Sky Tower, Jason found that the Sky Tower stored in TIP has been defined with a wrong address. He is desperate to correct this error, so he immediately asks the system for the modification of the information defined for this resource. Based on Jason's request, the system displays the existing information in the data entry form. Jason then quickly deletes the original record and inserts the correct address through drag-and-drop input. For the prevention of invalid data input, he once again asks the system to check the validation of inserted information before storing it into the database.

3.2 System Requirements

As shown in the results of our analysis in Section 2.2.3, the existing administration service interfaces are problematic for the user. Each of these interfaces was created based on its administration purpose to assist the user to import collected information into appropriate entities in the database. However, the usability of these interfaces has not been taken into account. Several issues have been caused by faulty design of interfaces, such as duplicate information import, complicated import procedure and poor interface layout.

The solution to the current situation of TIP's administration service would be a new administration interface to be utilised by the user to obtain, display and store the required information. For the proposed system to operate as required, to enhance the quality of information import service, the requirements described in Section 3.2.1 (functional requirements) and Section 3.2.2 (interface requirements) need to be met.

3.2.1 Functional Requirements

The following paragraphs specify functional requirements for the proposed interface. These requirements are considered the main focus for the development of new administration interfaces. Each requirement is specified with a description and the user's action described in the scenario.

FR1: TIP Database Connection

After launching the administration service, the user is able to perform various administration activities, including the search of existing TIP resources, the access of TIP resource contents, the insertion of new TIP resources, and the modification and deletion of existing TIP resources. Each of these activities involves data retrieval from the TIP database. So that these activities can be performed smoothly, the administration service must be able to connect to TIP database server at all times so the correct TIP information contents can be retrieved as requested by the user.

Figure 3.1 presents the action flow of this requirement. As described in the scenario, Jason owns a desktop at work and the computer is connected to the TIP database server. Jason can use it to access the administration service interface as an administrator. From the interface, he can perform various administration activities:

- Searching for the Sky Tower.
- Importing the Sky Tower as a new resource.
- Accessing the information defined for the Sky Tower or Sky City Auckland.
- Removing the Sky City Auckland.
- Modifying the information defined for the Sky Tower.

When the administration service receives Jason's request to perform any of above activities, it makes a connection to the TIP database to complete the task.
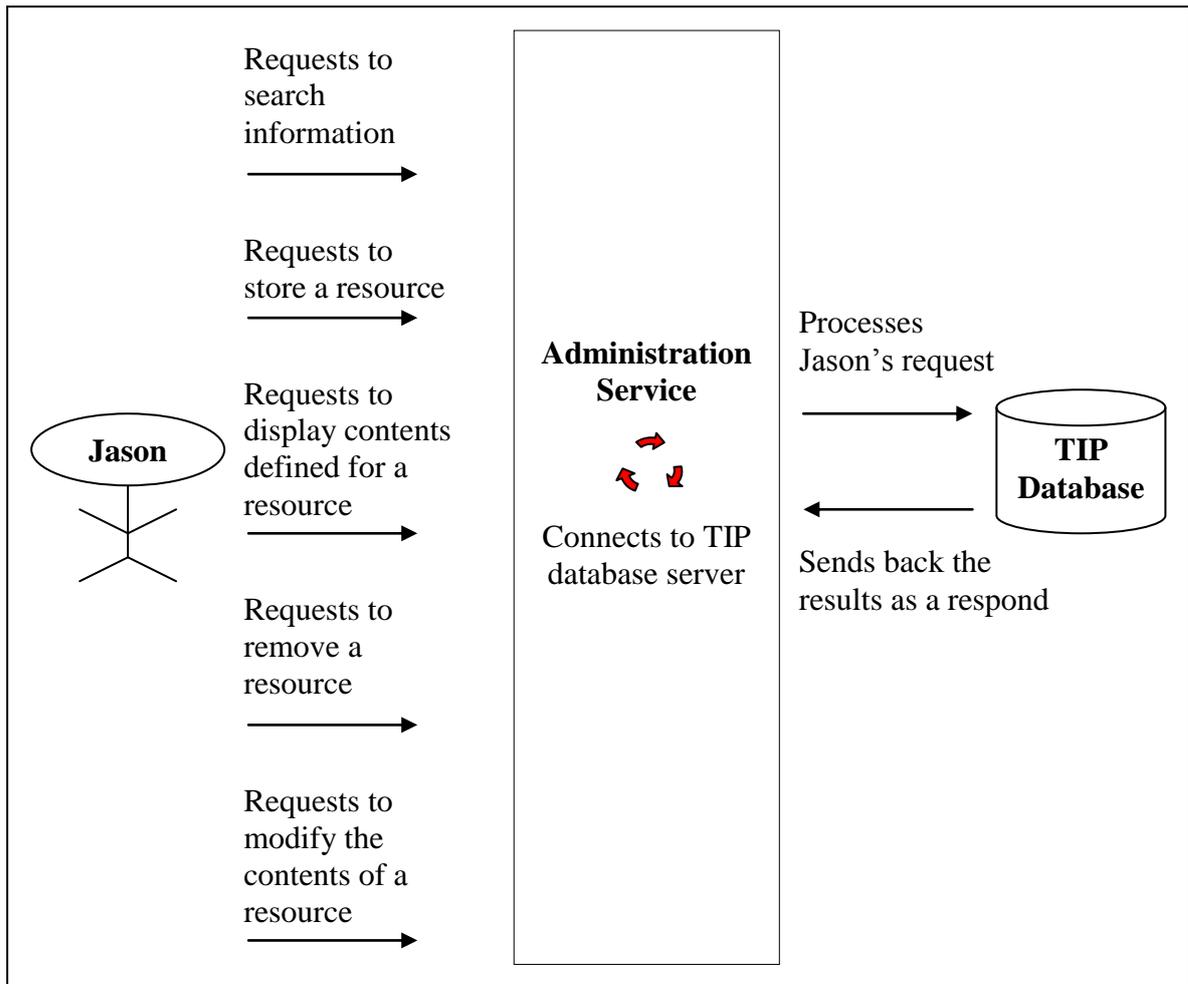
Figure 3.1: Action flow of TIP database connection.

FR2: Information Extraction and Display

The data structure of each TIP resource is composed of the resource's own properties and its relationships with other resources. In particular, the sights, sight groups, and topics can be refined using hierarchical structures. The information extraction and display function must be able to extract the contents of each resource and display the overview of the extracted contents based on the structure that is pre-defined for each resource.

In addition, the contents of external resources (i.e., the resources discovered by the search tool, IR5) may be represented in different data structures. In order to support the user in viewing the entire contents of each external resource, the display function must present external resource contents in their own structure.

Figure 3.2 describes the action flow of this requirement. After a TIP resource (e.g., Sky Tower resource) is accessed by Jason, the administration service performs the information extraction and displays the extracted contents using TIP's hierarchical structure. On the other hand, when an external resource (e.g., a resource discovered from the internet) is accessed by Jason, the administration service extracts the contents of the accessed resource and displays the contents using the resource's own data structure.
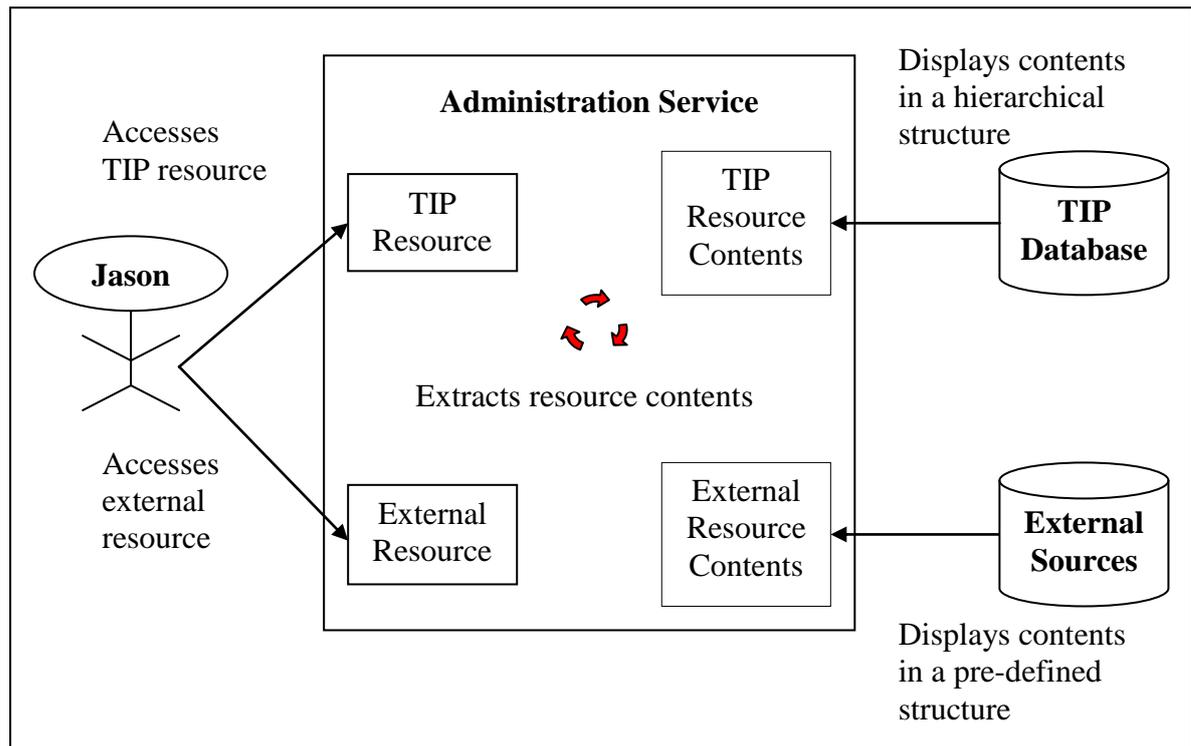
Figure 3.2: Action flow of information extraction and display.

FR3: Information Search

During the procedure of information import, sight information can be requested from either external sources or the TIP database, and various types of information can be delivered to the user, such as general information, activities, events, tours, and adventures. The information search function must make it possible to search for appropriate information from external resources and the TIP database and it must be able to discover sight related information according to the user selected search option (i.e., simple search, or other options for advanced search).

The action flow of information search is shown in **Figure 3.3**. Whenever the administration service receives a search request (e.g., search for general information

that relates to the Sky Tower from the internet) from Jason, it activates the search function to discover appropriate resources that contain information contents that match Jason's query from the TIP database or external sources.
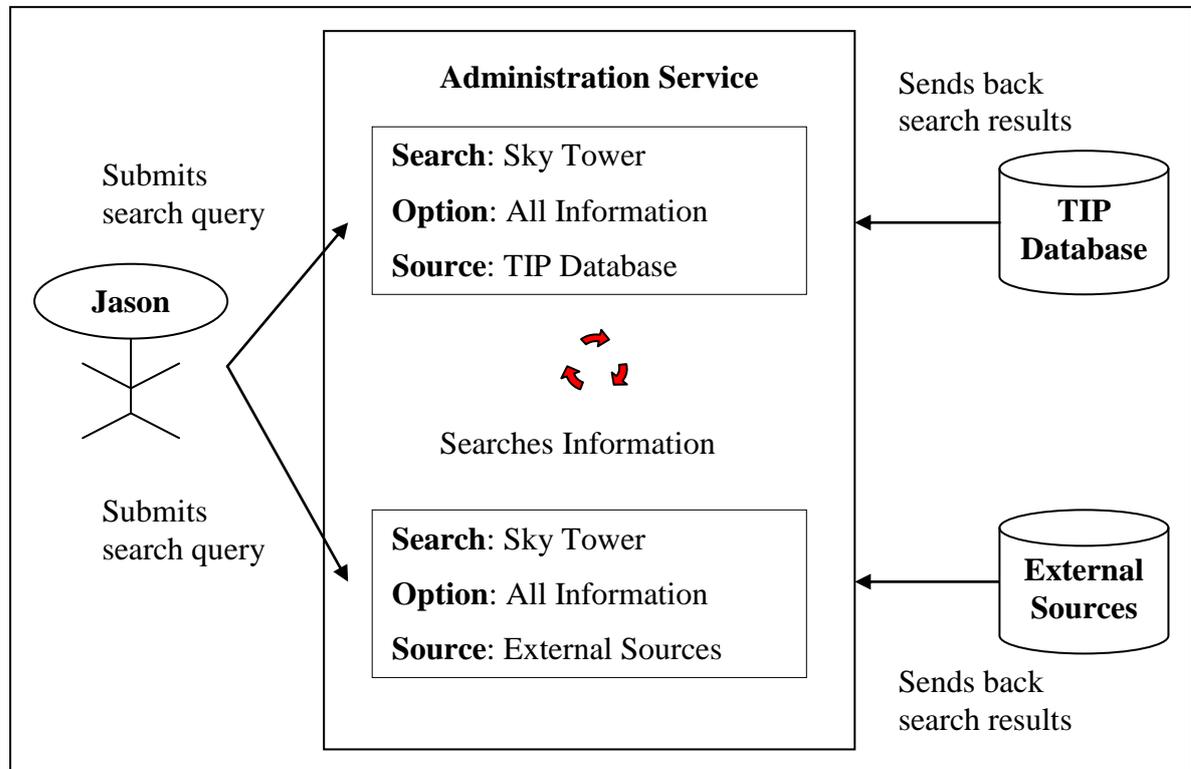
Figure 3.3: Action flow of information search.

FR4: Drag-and-Drop Information Input

Information contents that are extracted and displayed from an external resource or a TIP resource may involve a large number of texts and/or images. The administration service must allow the user to process the information input by dragging the required information contents (texts and/or images) and dropping them into the appropriate data input components, in order to avoid waste of time and input errors that might be caused while typing in a large amount of data.

Figure 3.4 presents the action flow of this drag and drop input. When TIP resource contents or external resource contents (e.g., the content of resource searched from the internet) are displayed, the administration service enables the drag-and-drop function so Jason can drag displayed contents and drop them into the input components in the data entry form.

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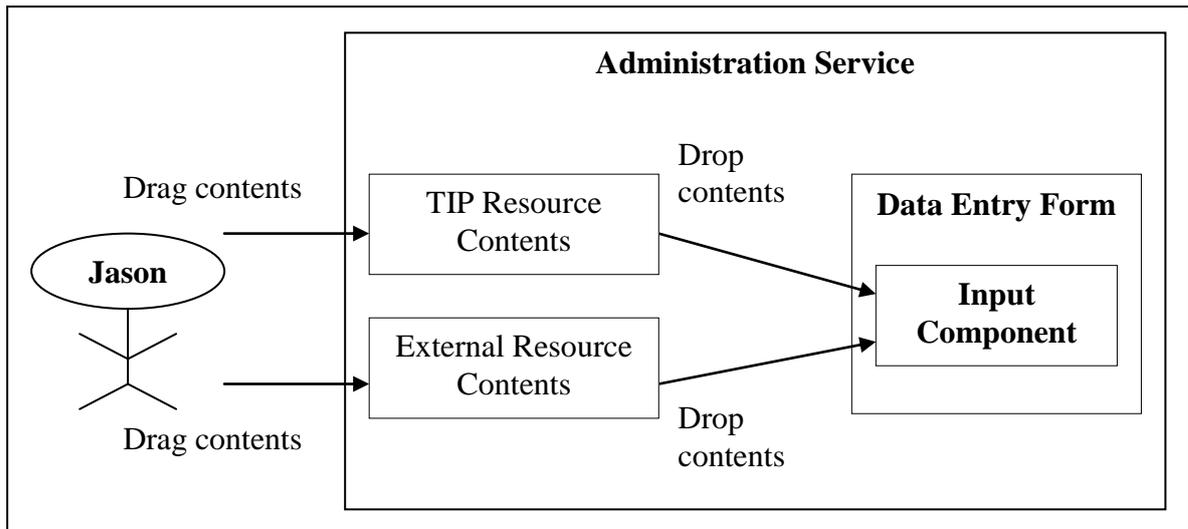
Figure 3.4: Action flow of drag and drop input.

FR5: Input Data Validation

Each attribute within each entity in the TIP database is defined as one of various data types, such as character, text, integer, float, and binary. Therefore, it is essential for the administration tool to check the data type of entered information contents before storing them into the database, to avoid input errors that might be caused during information input.

Actually, the data validation has already been developed in the current administration service. It is our intention to preserve this function in the proposed administration service.
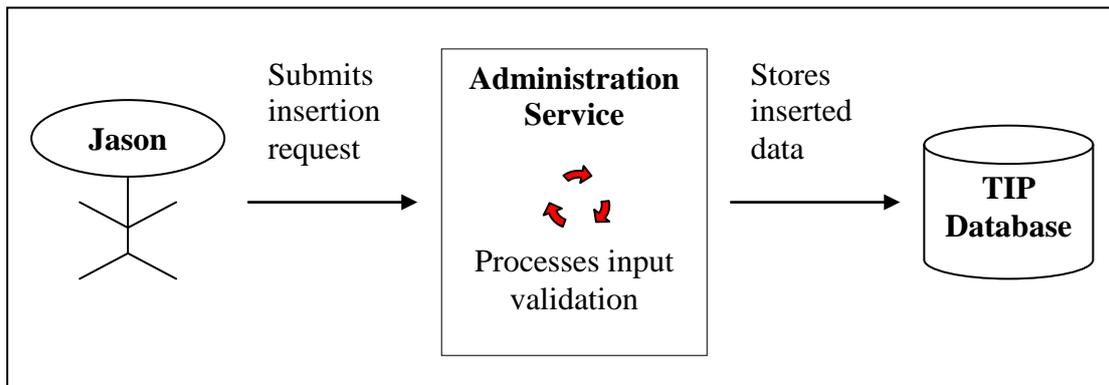
Figure 3.5: Action flow of input data validation.

Figure 3.5 shows the action flow of the data validation. Whenever the administration service receives an insertion request from Jason, it executes data validation to ensure

the validity of each entered value. On successful data validation, the administration service starts the importation of input values and stores the values into the TIP database.

3.2.2 Interface Requirements

The administration interface must be designed and developed to allow the user to input and output requested information into the interfaces manually, to enable the functional requirements that are mentioned in Section 3.2.1.

It is a common consensus that user interfaces must be responsive and user-friendly, so it is important for user interfaces not to exaggerate the complexity of graphical components, as well as not to involve complicated operational methods. If developed interfaces are difficult and frustrating to use, then they would not be beneficial to TIP's administration service. On the other hand, they might even bring up more issues with the TIP system.

IR1: Data Entry Form

The data entry form lets the user import information. It must provide appropriate interface components for the user to define properties of TIP resources (sight, sight groups, topics, and facts). In particular, it must present an appropriate layout for the user to refine sight information into hierarchical levels. Moreover, it should present sample data for each input component and work with the data validation function to transfer and store the input information into the TIP database.

IR2: TIP Resource Contents Browser

The TIP resource contents browser supports the presentation of TIP resource contents. It must have appropriate interface components available to present the properties (including texts and images) of each TIP resource. Since the sight information can be refined into levels of detail, this browser must follow this rule and display the extracted sight information using the pre-defined data model. In addition, it must provide an appropriate interface control allowing the user to request for information modification and update the contents of each TIP resource.

IR3: External Resource Contents Browser

Similar to the TIP resource contents browser, the contents of an external resource may be conducted in a unique data structure, and they require a space to bring them up to the screen after extraction. The external resource contents browser must provide different types of interface components to accommodate and display the extracted contents based on the data model defined for the resource.

IR4: TIP Resource Browser

The resources stored in the TIP database can be classified into sights, sight groups, topics, and facts. The TIP resource browser must be able to present the resources according to these aspects using an appropriate interface structure, so the user is able to see what resources are stored in the TIP database. In addition, it must support the user in performing three administration activities: (1) information access, (2) request to create a new resource, and (3) request to delete an existing resource.

IR5: Information Search Bar

The information search bar allows the user to perform both a simple and advanced search. It must have a container to hold various search options, so the user is able to request the information that relates to the selected option. Also, it must provide a choice for the user to specify whether to search information from external sources or from the TIP database.

IR6: Search Result Browser

After the user has completed the information search procedure, s/he may wish to explore several resources or documents from the TIP database or from the external sources. Therefore, the found resources must be grouped and displayed in a search result browser based on their suppliers (the TIP database or external sources); allowing the user to access them one by one, and to analyse and compare the resources that were found from different suppliers based on same query.

3.3 Use Case and UML Activity Diagrams

Based on the requirement analysis presented in the Section 3.2, the architecture of the proposed administration interface consists of the data entry form, the TIP resource

contents browser, the external resource contents browser, the TIP resource browser, the information search bar, and the search result browser.

To specify the interaction between the interface and the user on one hand, and between the interface and the TIP system on the other hand, a use-case analysis is conducted in the following paragraphs and subsections to identify and analyse the functions and services which the interface needs to provide for both the TIP system and the user. Moreover, following the use-case analysis, the description for each use case further extended through UML activity diagrams to demonstrate and explain the steps within each use case.
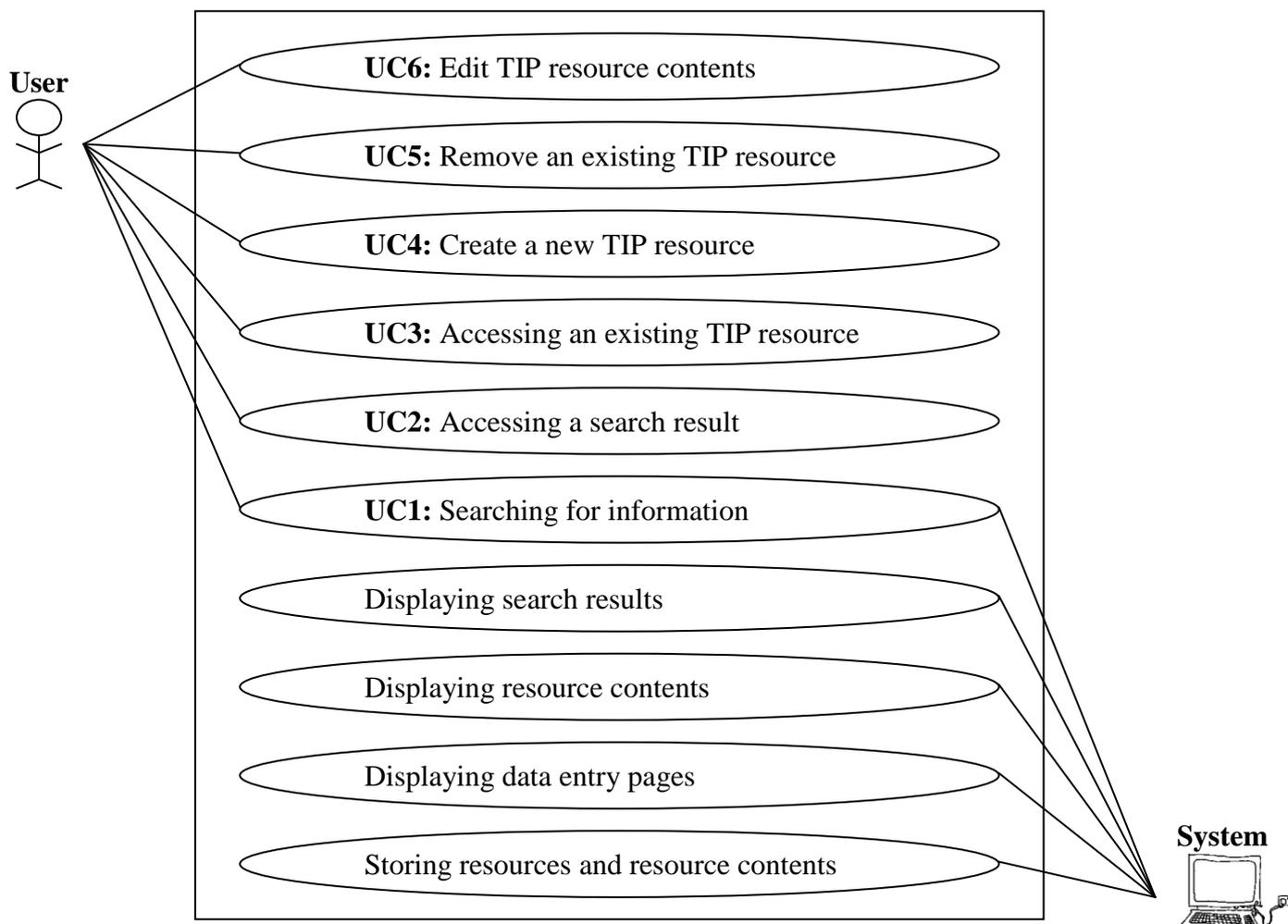
Figure 3.6: Use-Case Diagram for the administration services.

Figure 3.6 shows the use-case diagram for the administration service. The user and the system are identified as the actors of the proposed interface. The reason for having these two characters as the actors of the system is that these two characters have interactions with the resources (including TIP resources and external resources), and the administration interface.

This design defines six use cases for the user to perform various administration activities (information search, information access, information creation, and information edition or deletion) and it defines five use-cases for the system to respond to actions that the user has requested (display search results, present resource contents, provide data entry form and store to be inserted contents).

In order to provide more details for the use cases designed, the script for each use case is described in the following subsections. Since the system actions aim to respond to various administration requests, we combine the use cases for both actors together and present the analysis based on the use cases that are designed for the user. Each analysis is illustrated with a UML activity diagram.

3.3.1 Use Case 1: Searching for Information

Actors: The user and the system

Basic course:

1. System shows administration interface.

2. The user provides a search query and selects the information source (TIP database or external sources).

3. If the selected source is "TIP database", the system searches required information from the TIP database server, and displays the results in the result browser.

Alternative course:

1. If the selected source is "external sources", the system searches required information from external sources and displays the results in the result browser.
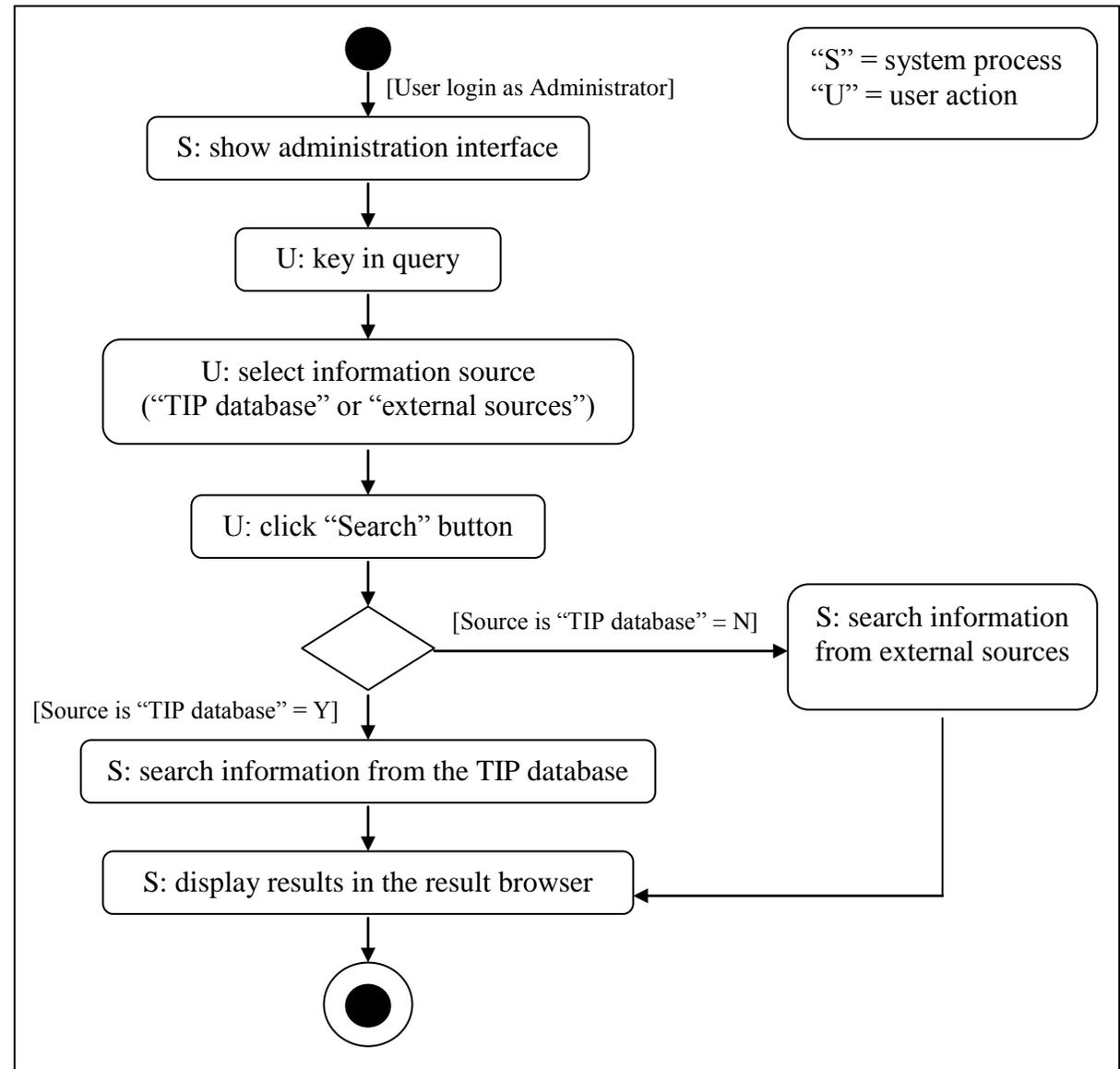
Figure 3.7: UML activity diagram for information search.

[User login as Administrator]

S: show administration interface

U: key in query

U: select information source
("TIP database" or "external sources")

U: click "Search" button

[Source is "TIP database" = N]

S: search information from external sources

[Source is "TIP database" = Y]

S: search information from the TIP database

S: display results in the result browser

"S" = system process
"U" = user action

3.3.2 Use Case 2: Accessing a Search Result

Actors: The user and the system

Pre-condition:

    1. The system has found requested resources during an information search procedure.

Basic course:

    1. The user selects a found resource from the result browser.

    2. The system extracts the information contents of the selected resource.

    3a. If the selected resource is originally from the TIP database, the system displays its information contents in the TIP resource contents browser.

Alternative course:

    3b. If the selected resource is originally from an external source, the system displays its information contents in the external resource contents browser.
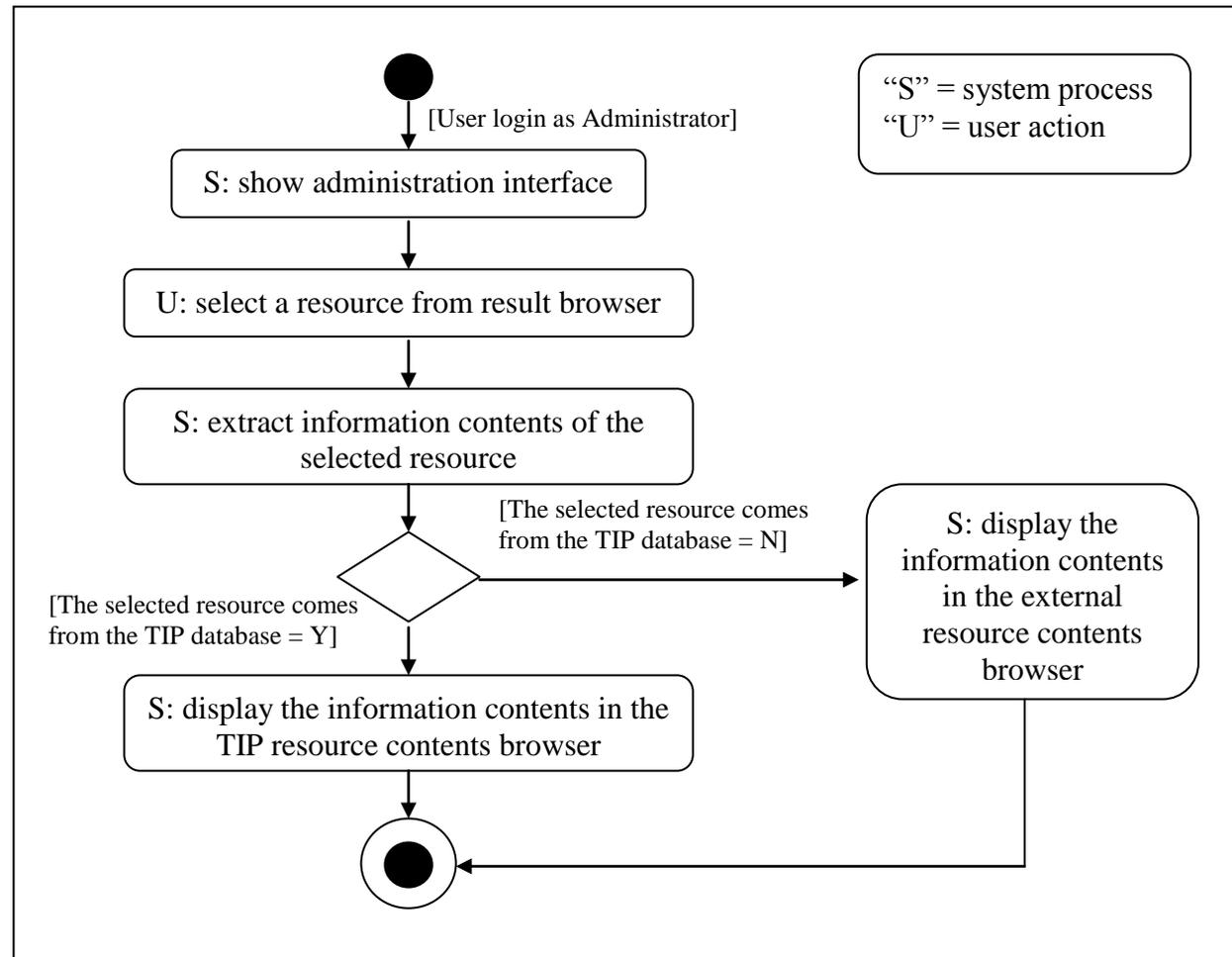
Figure 3.8: UML activity diagram for accessing found resources.

3.3.3 Use Case 3: Accessing an Existing TIP Resource

Actors: The user and the system

Pre-conditions:

1. The system has successfully stored some resources into the TIP database.
2. The stored resources are presented in the TIP resources browser.

Base course:

1. The user selects a resource from the TIP resources browser and requests to access the contents of the selected resource.
2. The system extracts the information contents of the selected resource from the TIP database.
3. The system displays the extracted information contents in the TIP resource contents browser.
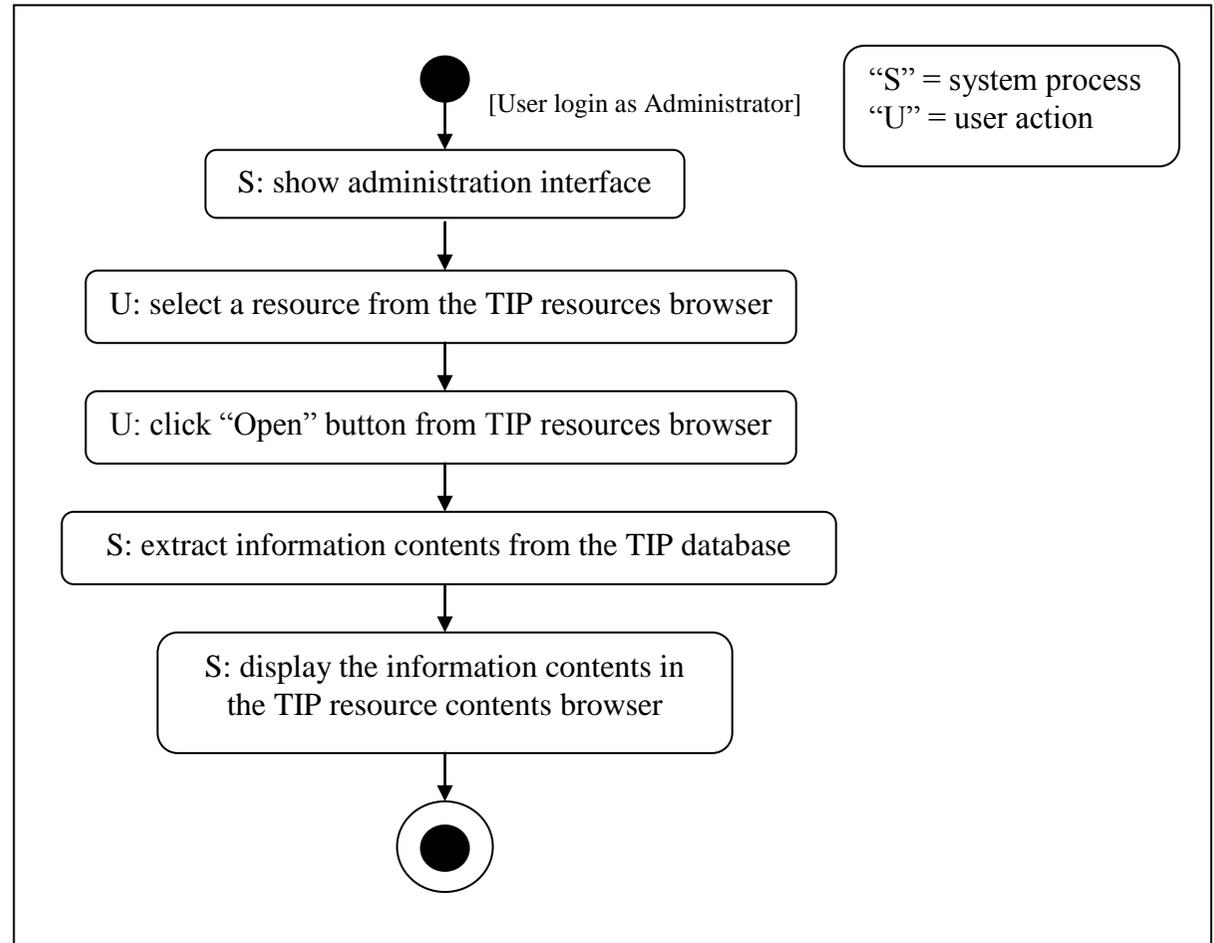
Figure 3.9: UML activity diagram for accessing existing TIP resources.

3.3.4 Use Case 4: Create a New TIP Resource

Actors: The user and the system

Pre-conditions:

1. The system has successfully extracted the information contents of the selected resources and is displaying them in the TIP resource contents browser or the external resource contents browser.

Basic course:

1. The user requests to create a new TIP resource.
2. The system presents the corresponding data entry form in blank.
3a. If the required information is provided in the TIP resource contents browser, the user drags the required information from there and drops it into the input components of the data entry form.
4. The system validates and saves the newly-created resource into the TIP database.

Alternative course:

3b. If the required information is provided in the external resource contents browser, the user drags the required information from there and drops it into the input components that are designed in data entry form.
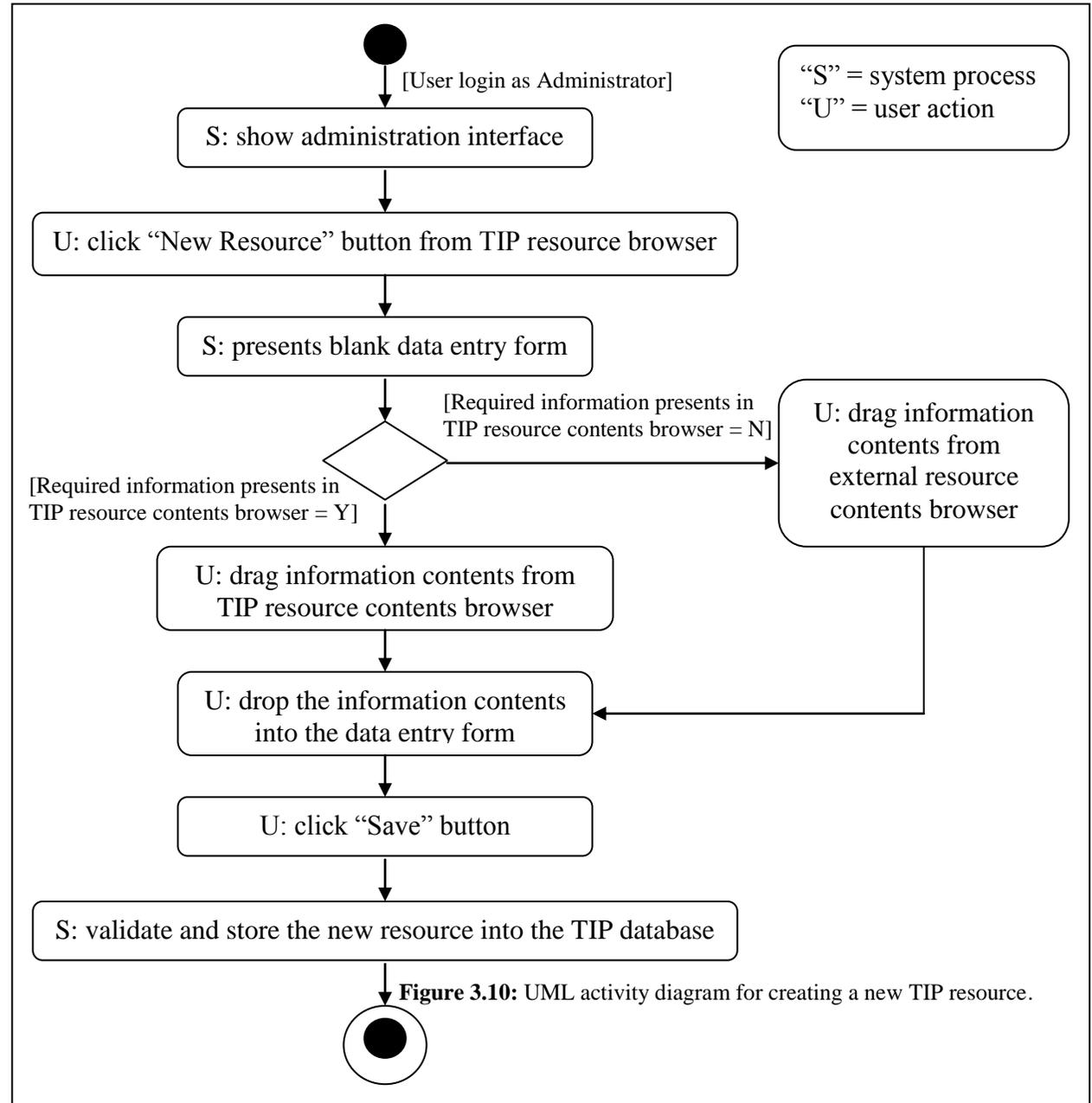
Figure 3.10: UML activity diagram for creating a new TIP resource.

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3.3.5 Use Case 5: Remove an Existing TIP Resource

Actors: The user and the system

Pre-conditions:

1. The system has successfully stored some resources into the TIP database.

2. The stored resources are presented in the TIP resource browser.

Basic course:

1. The user selects a resource from the TIP resource browser and requests to remove the selected resource.

2. The system removes the resource from the TIP database.
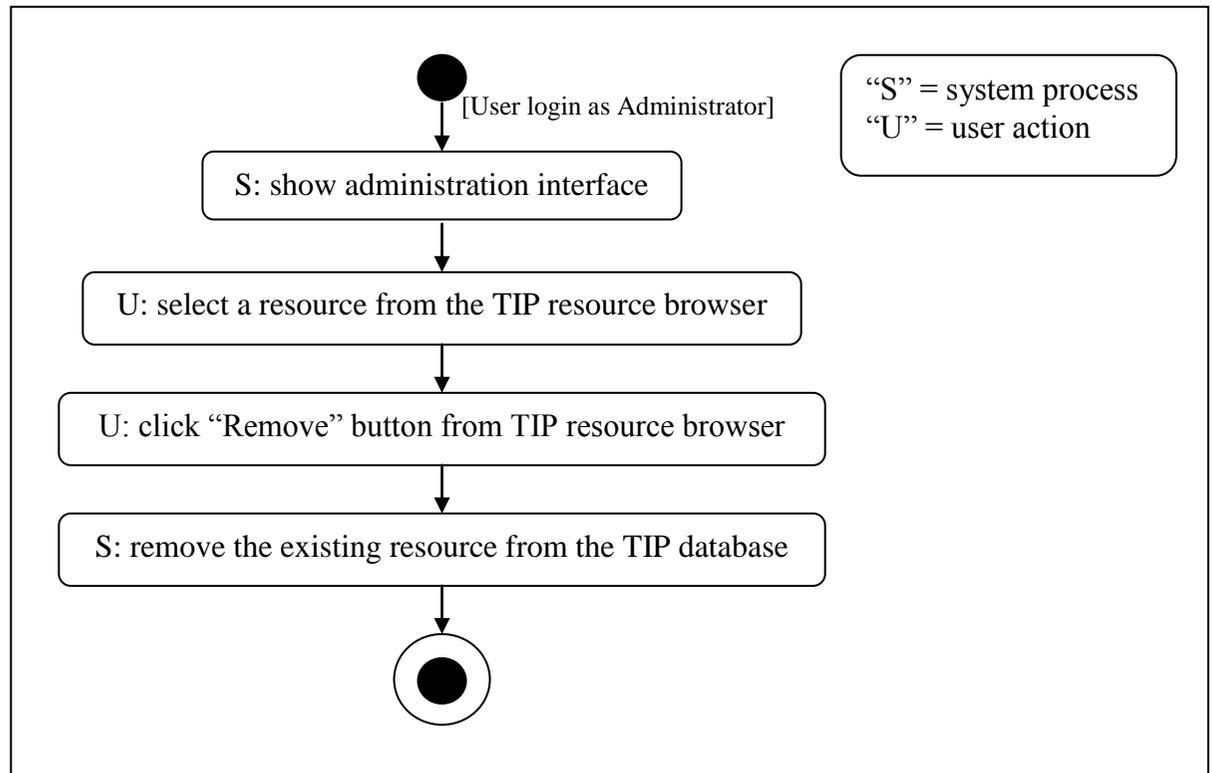
Figure 3.11: UML activity diagram for removing an existing TIP resource.

3.3.6 Use Case 6: Edit TIP Resource Contents

Actors: The user and the system

Pre-conditions:

1. The system has successfully extracted and displayed the information contents of the selected external resources into the external resource contents browser.

2. The system has successfully extracted and displayed the information contents that intend to be edited in the TIP resource contents browser.

Basic course:

1. The user requests to edit the displayed TIP resource contents.

2. The system fills the corresponding data entry form with existing data.

3a. If the required information is provided in the TIP resource contents browser, the user drags the required information from there and drops it into the input components designed in data entry form.

4. The system validates and saves the updated information into the TIP database

Alternative course:

3b. If the required information is provided in the external resource contents browser, the user drags the required information from there and drops it into the input components that are designed in data entry form.

Figure 3.12: UML activity diagram for editing a TIP resource.

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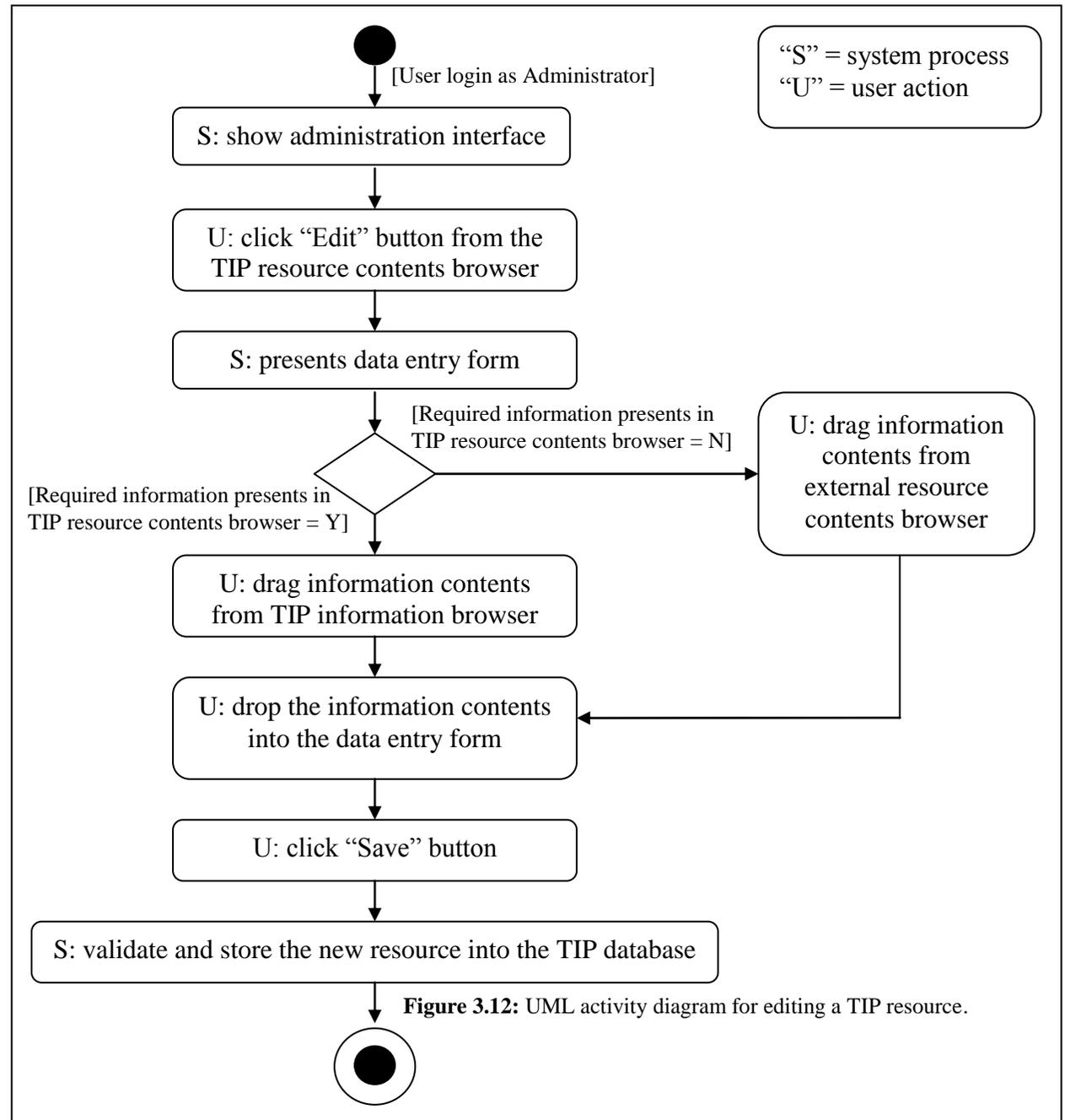
3.4 Conclusion

A requirement analysis was conducted based on a usage scenario in Section 3.1. Through the given scenario, five functional requirements (FR1 to FR5) and six interface requirements (IR1 to IR6) are identified for the new administration interface. In order to achieve these requirements, six use cases (UC1 to UC6) are introduced to specify the user's interaction with the interface. Additionally, UML activity diagrams are provided to demonstrate and explain the steps within each use case. In the following section, we introduce the new administration interface through design models that support the user in performing the activity specified in each use case.

Section 4 Design Models for the Administration Interface

According to the UML activity diagrams presented in the Section 3.3, the interactions between the user, the administration interface and the TIP system have sublimated into six use cases. These use cases are intended to be applied to actual interface designs to put emphasis on the information import for a variety of TIP resources (sights, sight groups, topics, and facts) and resource contents. In order to accomplish these tasks, a number of interfaces have been designed for the enhancement of TIP's administration service.

In this section, we introduce the design of those interfaces through informal sketches to present an overview and the activity flow of the interface layout. The designs are introduced following the overall structure of the administration service, and the corresponding interface for sights, sight groups, topics, and facts. **Table 4.1** gives an overview of the interfaces in relation to the requirements identified in Section 3.2.

The activity flow of importing information is very similar for all TIP resource categories; however, importing a sight may involve more steps than importing other resources. Therefore, in the following subsections, we put the emphasis on the overall structure of the administration service and the design for importing structure; we describe the corresponding prototypes according to their purpose, design structure, and activity sequence. Other interfaces are introduced with their purpose only.

Overall Structure of Administration Service	Corresponding Requirement
PP2: Data Entry Browser	IR1
PP3: Resource Contents Browser	IR2 and IR3
PP4: TIP Resource Browser	IR4
PP5: Information Search Tool	IR5 and IR6
Prototype Design for Sights	**Corresponding Requirement**
PP6: Resource Contents Form for Sights	IR2
PP7: Profile Entry Form for Sights	IR1
PP8: Sight Group Selection Form for Sights	IR1
PP9: Upper Sight Selection Form	IR1
PP10: Fact Value Entry Form for Sights	IR1
PP11: Sight Information Entry Form	IR1
Prototype Design for Sight Groups	**Corresponding Requirement**
PP12: Resource Contents Form for Sight Groups	IR2
PP13: Profile Entry Form for Sight Groups	IR1
PP14: Upper Sight Group Selection Form	IR1
PP15: Fact Selection Form for Sight Groups	IR1
Prototype Design for Topics	**Corresponding Requirement**
PP16: Resource Contents Form for Topics	IR2
PP17: Profile Entry Form for Topics	IR1
PP18: Upper Topic Selection Form	IR1
PP19: Fact Selection Form for Topics	IR1
Prototype Design for Facts	**Corresponding Requirement**
PP20: Resource Contents Form for Facts	IR2
PP21: Profile Entry Form for Facts	IR1
Prototype Design for External Resources	**Corresponding Requirement**
PP22: Resource Contents Form for External Resources	IR3

Table 4.1: Overview of administration interfaces with corresponding requirements.

4.1 Overall Structure of Administration service

In following, we introduce the administration components (PP2 to PP5). Each component is introduced on the basis of a sketch, relevant activity sequence and its purpose in the overall structure of the administration service (PP1).

PP1: Overall Structure

The sketch shown in **Figure 4.1** presents the main platform of the administration service. This platform is shown when the user has successfully logged in as TIP administrator. It consists of four components which have been designed to fulfil the interface requirements described in Section 3.2.2. They are:

- Data entry browser – IR1 (**Area A** in **Figure 4.1**)
- Resource contents browser – compound of IR2 and IR3 (**Area B** in **Figure 4.1**)
- TIP resources browser – IR4 (**Area C** in **Figure 4.1**)
- Information search tool – compound of IR5 and IR6 (**Area D** in **Figure 4.1**)
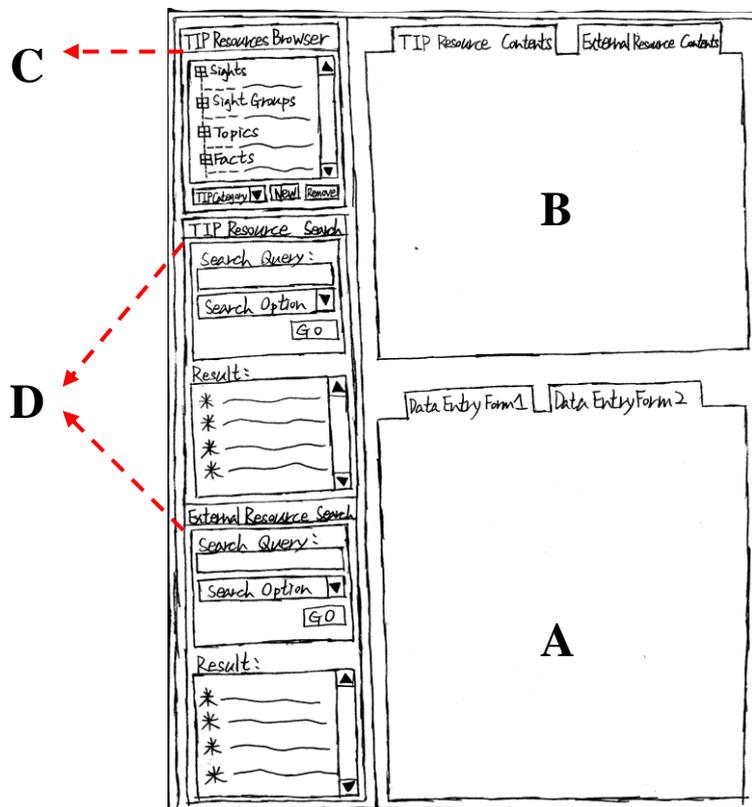
Figure 4.1: Sketch of overall structure of the administration service.

<u>PP2: Data Entry Browser</u>

The data entry browser (**Area A** in **Figure 4.1**) is designed as a tab control. Its purpose is to display the data entry forms for sights, sight groups, topics, and facts; allowing the user to carry out UC4 and UC6. The input forms presented in this browser are shown in a specific order (from left to right). The user must follow this order to define the properties of a TIP resource. This is because in order to have a resource added in the TIP database, some information is required to be stored before other information (e.g., in order to import sight information, a sight must have been created beforehand).

The following forms have been designed for the insertion or modification of TIP resource contents. They are meant to be shown in the data entry browser.

- Data entry forms for sights
    - ⇒ PP7: Profile Entry Form for Sights
    - ⇒ PP8: Sight Group Selection Form for Sights
    - ⇒ PP9: Upper Sight Selection Form
    - ⇒ PP10: Fact Value Entry Form for Sights
    - ⇒ PP11: Sight Information Entry Form
- Data entry forms for sight groups
    - ⇒ PP13: Profile Entry form for Sight Groups
    - ⇒ PP14: Upper Sight Group Selection Form
    - ⇒ PP15: Fact Selection Form for Sight Groups
- Data entry forms for topics
    - ⇒ PP17: Profile Entry Form for Topics
    - ⇒ PP18: Upper Topic Selection Form
    - ⇒ PP19: Fact Selection Form for topics
- Data entry forms for facts
    - ⇒ PP21: Profile Entry Form for Facts

PP3: Resource Contents Browser

The purpose of the resource contents browser (**Area B** in **Figure 4.1**) is to display the forms for TIP resource contents and external resource contents supporting the user in performing UC2, UC3, UC4, and UC6. The layout of this browser is also designed as a tab control, so the contents of a TIP resource and the contents of an external resource can be presented in their pre-defined data structure in separate regions.

The following forms are intended to be shown in the resource contents browser.

- PP6: Resource Contents Form for Sights
- PP12: Resource Contents Form for Sight Groups
- PP16: Resource Contents Form for Topics
- PP20: Resource Contents Form for Facts
- PP22: Resource Contents Form for External Resources

PP4: TIP Resources Browser

A sketch of the TIP resources browser is shown in **Figure 4.2**. It is the enlargement of **Area C** in the overall structure (see **Figure 4.1**). It is designed for UC3, UC4, and UC5. It aims to provide a starting point for the user to access the contents of existing TIP resources. The user can also use it to create new TIP resources according to TIP resource categories (sights, sight groups, topics, and facts), or to remove resources no longer required, from the TIP database.

Within this browser, the existing TIP resources are displayed alphabetically within four categories (sights, sight groups, topics, and facts). The user can click on each of them to request the contents of the selected resource which makes the system extract and display the resource's contents using the resource contents browser (see PP3). At the bottom of the browser, a category selection box and a "New" button are provided to create a new resource according to the selected TIP category. The user can select a category and click on the "New" button to allow the system to display an empty data entry form using the data entry browser (PP2). In addition, if a TIP resource is no longer required, the user can remove it from the TIP database by selecting the resource and clicking the "Remove" button.
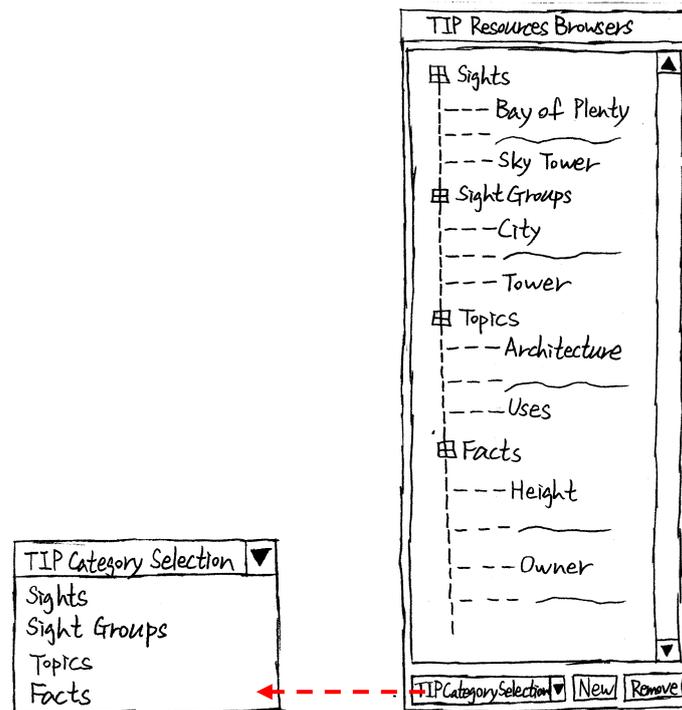
Figure 4.2: Sketch of the TIP resource browser.

PP5: Information Search Tool

Figure 4.3 shows a sketch of the information search tool. It is the enlargement of **Area D** in the overall structure (**Figure 4.1**). It has been designed in supporting UC1, and its purpose is to allow the exploration of a large number of information resources. It is designed as the combination of an entry field for the input of a search query, an option for the allowance of simple or advanced search, and a search result browser for the display of search results.

Within the sketch, the tool is partitioned into two regions: the TIP resource search tool (**Area A** in **Figure 4.3**) and the external resource search tool (**Area B** in **Figure 4.3**). The user can use each of them to trigger the information search in three steps: (1) entering the query into the textbox, (2) selecting a search mode from the combo box to attempt a simple or advanced search (e.g., select "All Options" for a simple search, or select other options for the advanced search), and (3) clicking the "Go" button to start the search. The search results are presented in the result browser. The user can access the contents of each result by clicking on each of them; the system will then extract and display the contents of the selected result using the resource contents browser (PP3).
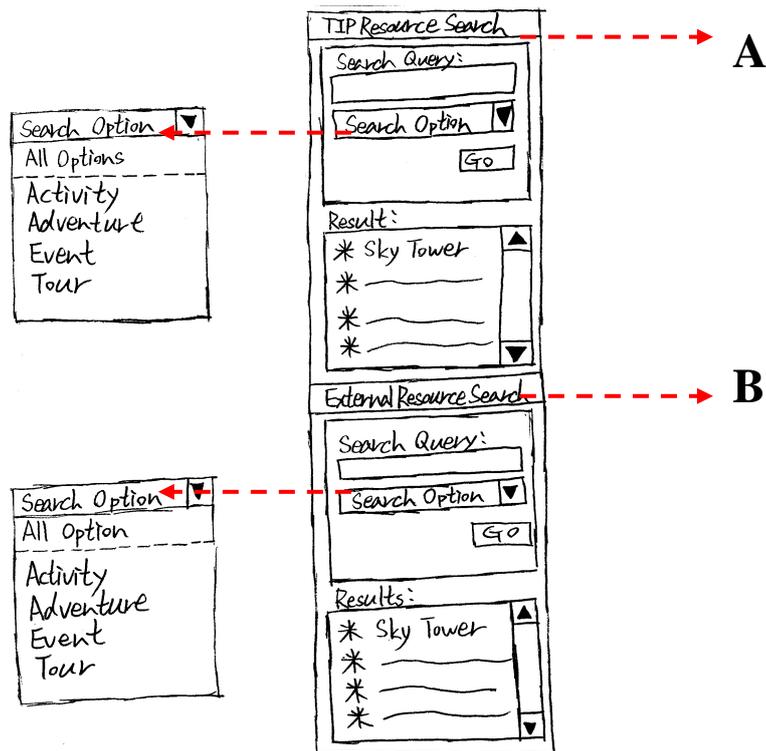
Figure 4.3: Sketch of the information search tool.

4.2 Sketch Prototypes for Sights

The following introduces the sketch prototypes for sights. PP6 has been designed for presenting the contents of an existing sight. Also, PP7 to PP11 are data entry forms for the insertion of sight resource contents. Each prototype is introduced with its purpose, corresponding sketch and relevant activity sequence.

PP6: Resource Contents Form for Sights

The design structure of the resource contents form for sights is shown in **Figure 4.4**. After a sight is selected from the TIP resources browser (PP4) or from the TIP resource search tool (see PP5), this form presents the contents extracted from the selected resource. Its purpose is to allow the user to access the detailed information defined for a sight based on five aspects: the sight's general profile, its related sight groups, its upper sights (parent sights), the sight's relevant facts and fact values, and sight-related information.

Figure 4.4: Sketch of resource contents form for sights.

Figure 4.5: Sketch of data entry browser with an input form.

The extracted resource contents of each aspect are shown using an information container and each container is named after the corresponding aspect (e.g., "Profile", "Sight Information"). At the bottom of each container, an "Edit" button is attached to let the user to edit the information by revising the values that are displayed in the corresponding container. After an "Edit" button is clicked, a series of data entry forms (PP7, PP8, PP9, PP10, and PP11) is distributed into tabs in the data entry browser (PP2) and filled with existing resource contents, and the corresponding tab will be

shown for the user to process the update. For example, if the "Edit" button of the "Sight Information" container (**Area E** in **Figure 4.4**) is clicked, the tab that hosts the Sight Information Entry Form will be brought to the foreground in data entry browser (see rectangular area in **Figure 4.5**) for the user to edit the sight information.

Moreover, the resource contents that are displayed within each container can be dragged by the user. This allows the user to use the displayed contents as source data while performing the information input.

The following paragraphs provide detailed descriptions for those five frames that are designed in **Figure 4.4**.

Area A specifies the profile description frame in the sight's resource contents form. It is designed to present general profile information of the selected sight, including the sight's name, physical location, and GPS coordinator. Also, the sight's profile image is shown at the left hand side of the profile information. This image is repeated in other resource contents forms (PP6, PP12, PP16, and PP20) to support the sight's relationship with other resources in the TIP database.

The container that holds the value of the sight's related sight groups is specified in **Area B** in **Figure 4.4**. Its purpose is to list the name of each sight group with which the selected sight is associated.

The frame that is designed for hosting the value of upper sights is shown in **Area C** in **Figure 4.4**. The purpose of this frame is to present the parents (upper sights) of the selected sight. Each value within this frame is displayed using the parents' profile images and their profile names, supporting the user in identifying the relationships between the selected sight and other sights.

The fact descriptions of the selected sight are visible in **Area D** in **Figure 4.4**. This container's purpose is to list the facts that are assigned to the selected sight. Each fact is presented with the value that this sight holds for this face.

Finally, the sight information frame is shown in **Area E** in **Figure 4.4**. The purpose of this frame is to display sight-related information of the selected sight. The sight information may contain texts and/or supporting images, and each piece of information is presented with its hierarchical position according to a topic.

PP7: Profile Entry Form for Sights

Figure 4.6 shows a sketch for the insertion of a sight profile description. Its purpose is to provide a data input environment for the profile description for a new sight, as well as to update the profile of an existing sight. This form consists of an image field and several text fields; it allows the user to define the general properties of a sight (i.e., the sight's name, its physical address and the address description, its GPS location on the map, and the sight's profile image) using drag-and-drop information input. To avoid input errors, sample data is presented under each text field to assist the user in performing the input. Action buttons are provided at the bottom of this form to support the user in storing the input values into the TIP database or cancelling the input procedure.

Figure 4.6: Sketch of profile entry form for sights.

While performing the activity to insert the contents of a sight, this form is displayed in the data entry browser (PP2) with other data entry forms designed for sights. It will be placed in the first tab in the PP2, allowing the user to create the sight in the database before defining other relevant contents (e.g., the sight's related sight groups, its upper

sights, its corresponding fact values, and sight-related information). If the values of the above aspects were defined before a sight is created, the input values would not be successfully stored in the database. This is because the system would not be able to determine which sight the values are in relation to.

PP8: Sight Group Selection Form for Sights

The sketch that is presented in **Figure 4.7** provides the design structure of the sight group selection form for a sight. This form consists of a list of available sight groups stored in the TIP database allowing the user to create the relationships between a sight and its related sight groups. Within this form, the sight groups are gathered and displayed in alphabetical order. Each of them is presented with a checkbox to enable sight group selection.

Figure 4.7: Sketch of sight group selection form for sights.

While processing the information input for a sight resource, the user can tick a checkbox to assign a sight to its related sight groups, and save the selected values using the "Save" button. In case the required sight group does not exist in the TIP database, a button, "New Sight Group", is provided at the button of this form allowing the user to activate the sight group creation dialogue (**Figure 4.8**) and create a sight group instantly.

The sight group creation dialogue mirrors the data entry browser (PP2). It holds relevant data entry forms for the insertions of sight group contents (PP13, PP14, and PP15) using a tab control, allowing the user to define the properties of a sight group. After the creation(s) of the new sight group(s), the system refreshes the values that are presented in **Figure 4.7**, and the user can then select the newly-created sight group(s) from the interface and store the selected values through the "Save" button.
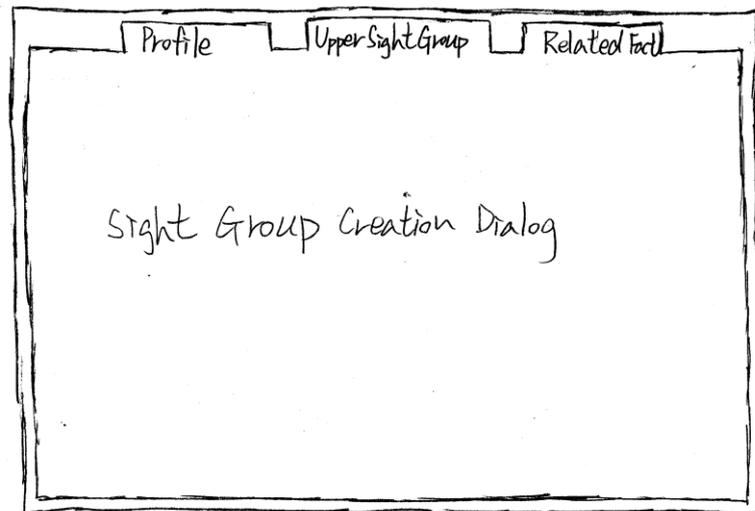
Figure 4.8: Sketch of sight group creation dialogue.

PP9: Upper Sight Selection Form

Figure 4.9 shows a sketch of the upper sight selection form. The design structure of this form is similar to that of the sight group selection form (PP8). A list of available sight names are presented in this form by alphabet. Each sight name has a checkbox for the user to select the parents (upper sights) for a sight to build up the relative network between the sights.

Similar to other data entry forms, this interface is displayed in one of the tabs in the data entry browser (PP2) when information for a sight is imported. The user can designate the parents (upper sights) for a sight by ticking off the checkbox presented at the left-hand side of each sight resource, and store the designated sights into the database through the "Save" button. However, there is a condition for processing the upper sight selection procedure: the main sight which is edited in this form must be the child of other sights. If the main sight is not related to existing sights, there would be no need to enter any value in this form.

Figure 4.9: Sketch of upper sight selection form for the sight.

PP10: Fact Value Entry Form for Sights

The sketch presented in **Figure 4.10** indicates the data entry form for specifying fact descriptions for a sight. It provides textboxes for the user to define appropriate values to those facts which are assigned to a sight. It supports the user with action buttons to extract the sight's corresponding facts from the database, as well as to store input fact values. In order to avoid input errors that might be caused during the information import, a sample data is presented under each textbox with the correct data type or the correct data format to assist the user to define fact values.

After the activation of this form, the user can click on the "Show Facts" button to extract and display the facts that are assigned to the sight. The extracted facts are inherited from the selected sight groups while processing the related sight group selection, so it is necessary for the user to process the related sight group selection before approaching this form. Once the fact values are imported, the user can then click the "Save" button to store the values into the TIP database.

Figure 4.10: Sketch of fact value entry form for sights.

PP11: Sight Information Entry Form

The sketch presented in the **Figure 4.11** indicates the design structure for defining the sight information. Its purpose is to support the user in refining sight information into levels of detail**.** This form may consist of a number of information containers (e.g., frames or boxes); however, this depends on the number of topics that have been defined for the sight. This is because each container is used for specifying the sight information according to one topic only.

Within each container, there are four components provided for the user to define the hierarchical structure of a topic that is specified to a sight. The components are a selection box for holding the topics available in the TIP database, an "Add Level" button for specifying a new level for the selected topics, a level selection box and a "Remove Level" button for deleting a level from the selected topic.

The contents within each container indicate an information input environment, allowing the user to refine sight information into hierarchical levels. The layout of each level comprises a level number for specifying the hierarchical position of input contents according to the selected topic, a text field for accommodating the sight information defined for each level, a number of image icons for hosting supporting images, and example data to indicate the data types that are allowed to be entered in the text field.

Figure 4.11: Sketch of sight information entry form.

In order to perform the insertion of sight information, the user can select the "Sight Information" tab from the data entry browser (PP2) to access this form. If the system is requested to create a new sight, by default, empty input components (i.e., image icons and text field) will be presented in level zero in an information container for the user to start the sight information input.

While inserting the sight information, the user can select a topic from the topic selection box that is designed at top left-hand corner of the information container, defining a topic to the sight. This box contains a list of topics stored in the TIP database, and they will be grouped and sorted by alphabet. If the required topic is not available in the TIP database, the user can click on the "Create a New Topic in TIP" button provided at the bottom of the browser to open the topic creation dialogue (see **Figure 4.12**) and create a new topic in TIP. After the creation of a new topic(s), the system refreshes the values listed in the topic selection box, so the newly-created topic(s) become available in the selection box for the user to continue the procedure of sight information input.

At this stage, the user is allowed to input required images and text contents into the designed input components; s/he can specify the sight information according to the selected topic through the drag-and-drop function. During this procedure, the input contents can be refined into levels of details to meet TIP's data model. This action can be performed by clicking the "Add Level" button that is provided at the bottom of each container to extend the hierarchical level of the selected topic and enable additional input components (a text field and image icons) in blank. However, if the extended level is no longer required for a topic, the user can select a level number from the level selection box and click the "Remove Level" button to remove the un-required level from the selected topic.

After the action to define the resource contents according to a selected topic, the user can add additional topics to the specified sight by clicking the "Add Topic" button provided at the bottom of this form. Whenever this button is executed, a new information container will show up with default input components, allowing the user to specify the resource contents according to a new topic. In addition, a topic selection box and a "Remove Topic" button are placed next to the "Add Topic" button and the user can use them to remove the selected topic (including the information that is assigned under this topic) when it is no longer required by the sight.

Furthermore, a series of temporary text field and image icons are shown at the left-hand side of this form. The purpose of this design is to allow the user to swap the position of two or more pieces of information contents while modifying the contents of a sight. The user can use them to hold the first piece of information, so the second piece of information can be placed in the position where the first piece of information was. After that, the user can move the first piece of information or other information contents into the position that used to hold the second piece of information to complete the information exchange procedure.

Figure 4.12 shows a sketch of the topic creation dialogue. The design structure and the purpose of this dialogue are similar to the sight group creation dialogue (**Figure 4.8**). It presents the data entry forms for the insertion of topic-related information (PP17, PP18, and PP19), and allows the user to create a topic if the required topic is not available in the TIP database during the insertion of sight information.
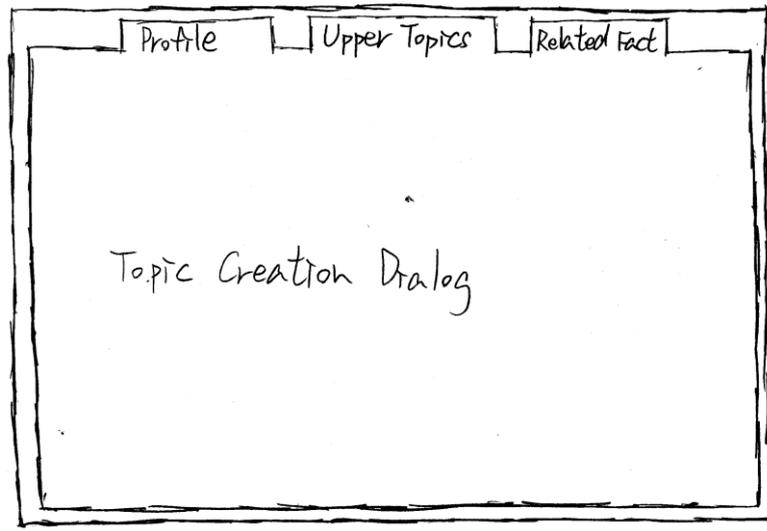
Figure 4.12: Sketch of topic creation dialogue.

4.3 Sketch Prototypes for Sight Groups

The following introduces the sketch prototypes for sight groups. PP12 has been designed for presenting the contents of an existing sight group. Also, PP13 to PP15 have been design for the insertion of sight group information. Each prototype is introduced with its purpose and corresponding sketch.

PP12: Resource Contents Form for Sight Groups

Figure 4.13 shows a sketch of the resource contents form for a sight group. The structure of this form mirrors the resource contents form for sights (PP6). It presents the resource contents of a selected sight group, as well as enabling the user to edit the information for the selected sight group. The user can access various resource contents that are defined for the selected sight group: its profile description, upper sight groups (parent sight groups), related facts, and related sights.

Within this design, information can be updated for the sight group's profile description, upper sight groups, and related facts only. The relationship between the sight group and its related sights cannot be changed from this form. The reason for this design is based on the conception of the proposed prototypes: sights groups are assumed to be the supporting elements for sights. Therefore, the relationships between

sight groups and sights can only be created or updated from the interfaces that are designed for sights.

Figure 4.13: Sketch of resource contents form for sight groups.

PP13: Profile Entry Form for Sight Groups

Figure 4.14 shows a sketch for the insertion of the sight group profile description. The design structure for this prototype mirrors the profile description input form for sight resources (PP7). Its purpose is to provide appropriate data entry settings for the user to define the identity of a sight group. S/he can use this form to specify the profile of each sight group, including its name and description. In addition, the user can use the checkbox in the interface to allow TIP users (tourists) to subscribe to updates of this sight group.

Figure 4.14: Sketch of profile entry form for sight groups.

PP14: Upper Sight Group Selection Form

The prototype design shown in **Figure 4.15** presents the upper sight group selection form for a sight group. This form mirrors the upper sight selection form (PP9). Its purpose is to display a list of sight groups available in the TIP database, allowing the user to assign a sight group to its parents (upper sight groups) and build up a relative cluster for sight groups stored in the database.

Figure 4.15: Sketch of upper sight group selection form.

PP15: Fact Selection Form for Sight Groups

Figure 4.16 shows a sketch for assigning corresponding facts to a sight group. The purpose of this form is to display a list of facts that are extracted from the TIP database, allowing the user to associate a sight group with its related facts. Within this design, the extracted facts are sorted by alphabet and each of them is presented with a checkbox. The user can tick off the checkbox that is supplied in front of each fact resource to select the related facts for a sight group.

Figure 4.16: Sketch of fact selection form for sight groups.

Figure 4.17: Sketch of fact creation dialogue.

In addition, a "New Fact" button is designed at the bottom of this form for the activation of the fact creation dialogue (**Figure 4.17**). The user is thus able to create a fact instantly if the required one does not exist in the TIP database.

After the execution of this dialogue, the profile entry form for facts is displayed in a dialogue window. The user can use this dialogue to input the profile information of a new fact and bring in the newly-created fact to the TIP database.

4.4 Sketch Prototypes for Topics

In the following, the sketch prototypes for topics (PP16 to PP19) are introduced on the basis of their purpose and relevant sketches.

PP16: Resource Contents Form for Topics

Figure 4.18 shows a sketch of the topic resource contents form. This interface mirrors the resource contents form for sights (PP6) and sight groups (PP12). Its purpose is to present the resource contents extracted from a selected topic, so the user can access the topic's profile description and its relationships with other TIP resources (e.g., the topic's related sights, its related facts, and its upper topics).

This form also provides access to editing topic information, so the user is allowed to update the resource contents that are assigned to the selected topic to enrich the topic's background information. However, since topics are assumed as supporting elements for sights, the information update can only be applied to the topic's profile description, upper topics, and related facts on this form. The relationship between the selected topic and sights can only be renewed from the sight information entry form (PP11).

Figure 4.18: Sketch of resource contents form for topics.

PP17: Profile Entry Form for Topics

Figure 4.19 presents a sketch of the dialogue to insert a topic profile. Similar to the profile description input forms designed for sights (PP7) and sight groups (PP13), this interface supplies data entry spaces for the user to declare the profile of each topic. In this form, a new topic can be defined with a topic name and topic description. The user can also modify an existing topic through this form

Figure 4.19: Sketch of profile entry form for topics.

PP18: Upper Topic Selection Form

Figure 4.20 shows the upper topic (parent topic) selection form. Similar to other upper resources selection forms (PP9 and PP14), this prototype is designed to present a list of existing topics stored in the TIP database. The user can tick off the checkbox placed in front of each topic resource to allocate a topic to its parents (upper topics) and develop a connection between the topics stored in the database.
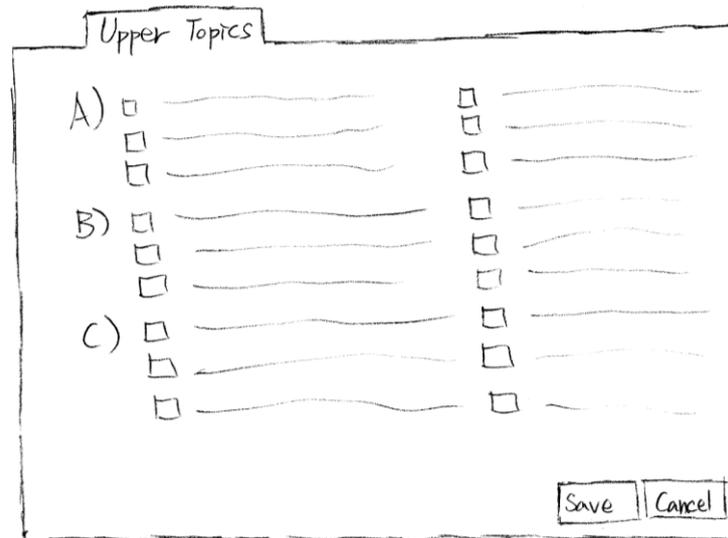
Figure 4.20: Sketch of upper topic selection form.

PP19: Fact Selection Form for Topics

The fact selection form for each topic is designed with the same purpose and structure as the fact selection form for sight groups (PP15). The user can select the corresponding facts for a topic by ticking off the checkbox provided in front of each topic name.

If the required fact is not available in the TIP database, the user can click the "New Fact" button that is supplied at the bottom of the form to enable the fact creation dialogue (**Figure 4.17**) and create a fact instantly.

4.5 Sketch Prototypes for Facts

The following introduces the sketch prototypes for facts (PP20 and PP21). Each prototype is introduced with its purpose and corresponding sketch.

PP20: Resource Contents Form for Facts

The design structure for showing the resource contents of a user-selected fact is shown in **Figure 4.21**. This form presents the information contents of a selected fact. The user is able to access the profile description assigned to the selected fact, as well as to access the fact's relationships with other TIP resources.

Figure 4.21: Sketch of resource contents form for facts.

Similar to the resource contents forms designed for other TIP resources (PP6, PP12, and PP16), the extracted resource contents are distributed into corresponding information containers. The user can click on the "Edit" button designed for each container to launch fact information edition. However, since fact resources are assumed as supporting elements for other TIP resources, the user can only request to update the profile description of the selected fact from this prototype.

PP21: Profile Entry Form for Facts

The interface model that is sketched for importing a fact's profile description is shown in **Figure 4.22**. Similar to other profile description input forms (PP7, PP13, and PP17), this model is designed to provide a data entry environment for the user to declare the profile of each fact. With this prototype, the user is able to create a new

fact with its fact name, fact description, and input data type; of course, s/he is also allowed to update the profile of an existing fact using this interface.

Figure 4.22: Sketch of profile entry form for facts.

4.6 Sketch Prototype for External Resources

The following describes the resource contents form for external resources (PP22). Because the actual layout of an external resource is designed by an external source provider and it may differ from various textual formats (e.g., plain text, HTML, or XML), we will not present its sketch in this document. However, a screenshot captured from the website of Wikipedia is used to represent the external resource contents in the following sections.

PP22: Resource Contents Form for External Resources
The resource contents form aims to be held at "External Resource" tab in the resource contents browser (PP3). Its purpose is to present the information contents provided from an external source provider.

During the information input procedure, the user can select an external resource from the information search tool (PP5) to request extraction of the contents stored in the

selected external resource. After that, the user can then access the extracted contents via the PP3 and start the information input with drag-and-drop function.

4.7 Conclusion

There are 22 sketches designed for the proposed administration service to assist the user in performing the administration activities described in use-cases (see Section 3.3). These interfaces are summarised in six categories showing in **Table 4.2**.

Sketch Category	Corresponding Sketches
Overall Structure of Administration service	PP1 to PP5
Prototype Design for Sights	PP6 to PP11
Prototype Design for Sight Groups	PP12 to PP15
Prototype Design for Topics	PP16 to PP19
Prototype Design for Facts	PP20 to PP21
Prototype Design for External Resources	PP22

Table 4.2: Summary of sketch prototypes.

With the purpose providing responsive prototypes for the proposed administration service, the design structure and the overall layout of these sketches will be evaluated through a usability test. It is certain that their purpose will not be changed in the future; nevertheless, their structures and the layouts might be changed as necessary, if issues remained.

Section 5 Design Concerns

To understand how the sketch prototypes match the requirements and whether they respond to user commands while performing the administration activities, the sketches have been reviewed via Cognitive Walkthrough [20] to go through the activity flow of each use-case. During the review, several concerns arose. These concerns are considered essential factors which impact on the ways we approach the implementation and the evaluation. Note that our focus in this section is the design concern; thus, we do not explain the sketch evaluation in a technical detail.

5.1 Concern Descriptions

The following describes identified concerns regarding the sketch prototypes and the user's interactions of performing sight information insert and information search. Each concern is briefly described with corresponding causes.

C1: Sketch Prototype Concerns

While reviewing the sketches described in Section 4, we particularly looked at the components included in overall structure of the administration service (i.e., PP1, PP2, PP3, PP4, and PP5) and the sketches of sight resource contents form (PP6) and the sight information entry form (PP11). According to the structure of these sketches or the activity flow defined for them, several issues have been identified in relation to following factors:

1) *Inconsistent Design* – some sketches have varied from the original design purpose, the defined activity sequence, or the database model.
2) *Inefficiency of Use* – some sketches can be designed in different structures to enhance the performance of administration activities.
3) *Bad Usability* – some sketches might have been designed with bad usability.

C2: Interaction Concerns – Sight Information Insert

The resources stored in the TIP database are classified into four aspects: sights, sight groups, topics, and facts. However, the import of a sight resource is considered to be

more complex than the import of other resources. In order to enhance the operation of importing a sight resource, three questions have been identified that need to be addressed:

1) How to present the contents that have been selected for various input actions?
2) How to present the source contents that have been transferred through drag-and-drop input?
3) How to refine the transferred data into levels of detail in the data entry form?

C3: Interaction Concerns – Information Search

The contents of a resource may come from a structured database or in various textual formats (e.g., plain text or XML), and the servers that store resources may be using various data models (e.g., the data model of the TIP database is a hierarchical structure). Therefore, the search tool must be able to parse the structure of different resources and identify the information from them. However, with the intention of having an integrated search assistant, the following question should be considered before implementation:

1) How to address a search query and search option when searching for sight information?
2) How does the system identify appropriate information from each resource?

Solution

There are complex issues behind each of above concerns. For example, what would be the most appropriate interface design; how would a user interact with the prototype to perform sight information insert; and how does system identify appropriate resources in response to the user's search query. In order to solve these issues, the amount of work is outside the bounds of this research due to the time constraint.

Since the issues of existing administration service emphasise the interaction of sight information insert (I1 and I7) and the layout structure of administration interface (I2, I3, I4, and I5), from now on, we narrow down the research area and address the first two concerns as the focal points of this project. In Section 5.2 and 5.3, C1 and C2 will be discussed in detail.

5.2 Sketch Prototype Concerns

In this section, we go through the concerns of sketch prototypes (known as PC in the remainder of this thesis) based on inconsistent design, inefficiency of use, and bad usability. In order to explain each concern clearly, relevant sketches will once again be presented in this section as evidence to support each concern. **Table 5.1** outlines the cause of concerns with corresponding sketches.

Cause of Concerns	Corresponding Sketch Prototypes
Inconsistent Design	PC1: Data Entry Browser (PP2)
	PC2: TIP Resource Browser (PP4)
	PC3: Sight Information Entry Form (PP11)
Inefficiency of Use	PC4: Information Search Tool (PP5)
	PC5: Resource Contents Browser (PP3)
Bad Usability	PC6: Overall Structure (PP1)
	PC7: Sight Resource Contents Form (PP6)

Table 5.1: The cause of concerns with corresponding sketch prototypes.

5.2.1 Inconsistent Design

There are inconsistencies between the three sketches (PP2, PP4, and PP11) and the design conceptions. For example, data entry browser (PP2) has varied from its design purpose, the activity sequence of TIP resource access has varied from UC3 in the TIP resource browser (PP4) and the structure required to import sight images in the sight information entry form (PP11) has varied from the database model (see Appendix I). These inconsistencies cause unsuccessful data retrieval. In other words, the information would not be successfully imported into (or exported out of) the TIP database. In the following, we describe these inconsistent sketches in detail. Each sketch is described with the corresponding inconsistency.

<u>**PC1: Data Entry Browser (PP2)**</u>

Figure 5.1 shows the sketch of data entry browser (PP2). This browser is designed as a tab control to present a series of input forms in a prioritised order (from left to right). The purpose of this design is to ensure that a resource is created before any

properties of the resource. However, there is no indicator showing the priorities of each tab, so the user can simply select each tab to perform the information insert. If the user accidentally inserts information in the wrong order, the information would not be successfully stored in the database.
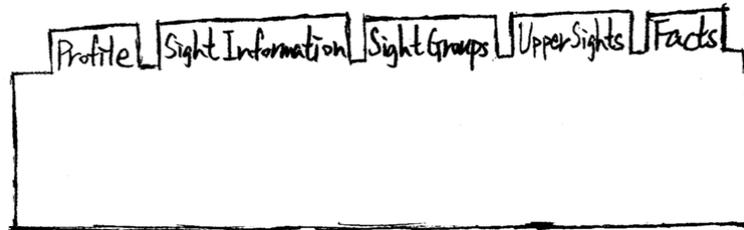
Figure 5.1: Sketch of data entry browser.

PC2: TIP Resource Browser (PP4)

According to the activity sequence designed for UC3 (see Section 3.3.3), the user can access TIP resource contents in three steps:

1) Selecting a resource from TIP resource browser.
2) Clicking the "Open" button.
3) Employing the system to extract the contents.

Similarly, through the activity sequence specified for UC5 (see Section 3.3.5), the user can remove an existing TIP resource by:

1) Selecting a resource from TIP resource browser.
2) Clicking the "Remove" button.
3) Having the system remove the resource.

However, the actual design of UC3 has deviated from this idea. Based on the sketch of the TIP resource browser (PP4) shown in **Figure 5.2** (originally introduced in Section 4.1), the user can click on a TIP resource to request the resource contents. On the other hand, s/he is able to remove an existing TIP resource by following the activity sequence of UC5. This means every time the user performs the action to remove a resource, the system would have to launch the resource contents from the database before receiving the command of resource deletion. This brings extra workload for the system and it may confuse the user while performing the administration activities.
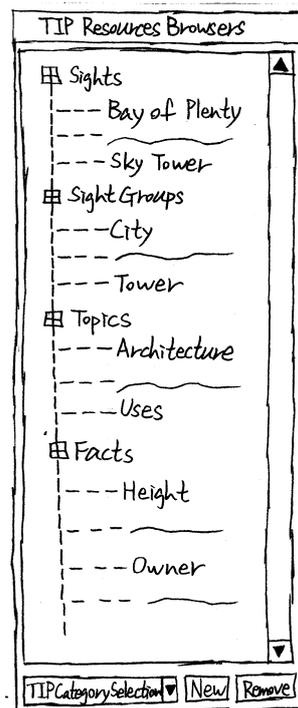
Figure 5.2: Sketch of the TIP resource browser. (originally reviewed in **Figure 4.2**)

PC3: Sight Information Entry Form (PP11)

According to the data model of the TIP database (see Appendix I), each image stored in TIP is assigned to one sight. However, the sketch of the sight information entry form (PP11) conflicts with this criterion. Based on the sketch shown in **Figure 5.3** (originally introduced in Section 4.2), the images (**Area A** in **Figure 5.3**) are inserted and stored according to a hierarchical level (**Area B** in **Figure 5.3**) of a sight. Even though the images inserted can still be retrieved in the TIP database through server-side programming, the purpose and the structure of this prototype have varied from the database design.

On the other hand, the model of the TIP database has been designed to refine the sight information (text contents) only; having PP11 developed, might confuse the user while performing the information insert. This is because the user might use it as a tool to refine the images and cause the text contents become the support of a image. Although it is arguable that some images are presenting the main story, on the current stage the TIP database model is not designed for this purpose and it is not our goal to modify the database model in this project.
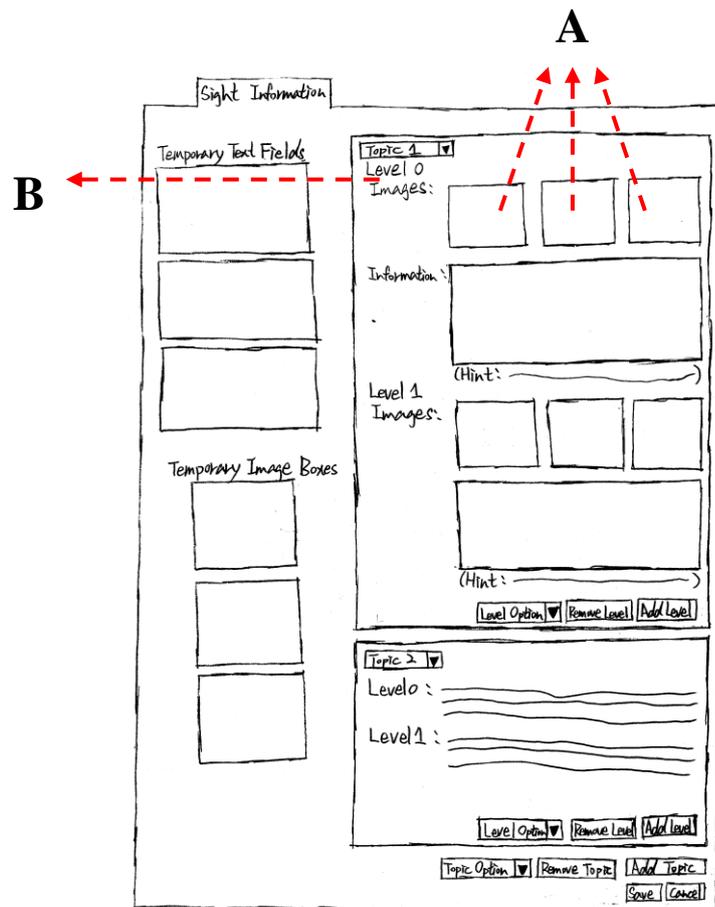
Figure 5.3: Sketch of sight information entry form. (originally reviewed in **Figure 4.11**)

5.2.2 Inefficiency of Use

The information search tool (PP5) and the resource contents browser (PP3) have been designed to support the user in searching for required information and accessing resource contents. However, some drawbacks have been identified regarding inefficiency of use in these two sketches. These drawbacks may affect the user in performing the information search, information access and information comparison. In the following, we discuss the concerns of these two sketches based on the primary thoughts of the designs and possible alternatives.

<u>PC4: Information Search Tool (PP5)</u>

Based on the sketch of information search tool (PP5) shown in **Figure 5.4** (originally reviewed in Section 4.1), its structure is partitioned in two areas; one for discovering TIP resource contents (see **Area A** in **Figure 5.4**) and one for exploring the

information from external sources (see **Area B** in **Figure 5.4**). The reason for forming this tool in two areas is because TIP resources can be categorised into four categories, but the resources from external servers might be classified in different database models. Having the search performed with separate tools, the user would be able to request the information from a preferable source (the TIP database or external sources) and the search results can be separately presented based on the search scope.
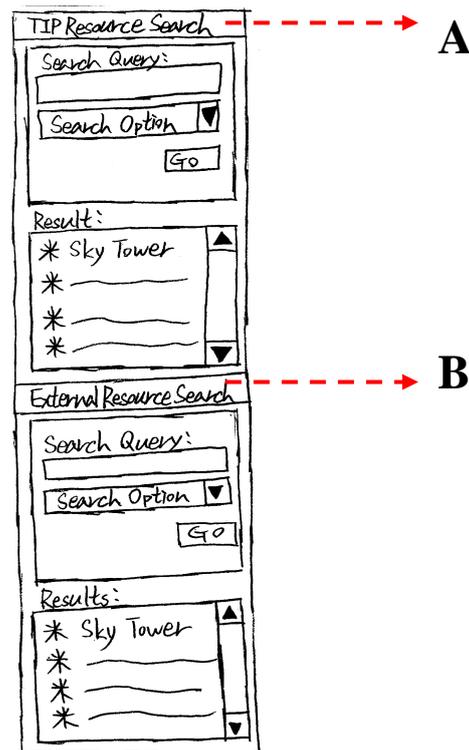
Figure 5.4: Sketch of the information search tool. (originally reviewed in **Figure 4.3**)

However, the user might like to search for information from all sources (the TIP database and external sources) at the same time. Also, s/he might like to receive the resources supplied from various sources at once. Based on this situation, the use of this design might not be efficient to support the user in searching for information. This is because, in order to receive the search results from all sources, s/he has to repeat the following activity sequence in both search areas: (1) insert search query, (2) select a search option, and (3) click on "Go" button to launch the search.

PC5: Resource Contents Browser (PP3)

The sketch of resource contents browser (PP3) is shown in **Figure 5.5**. This browser has been designed in relation to the structure of the Information Search Tool (PP5),

employing separate regions to present the contents of a TIP resource (**Area A** in **Figure 5.5**) or external resource (**Area B** in **Figure 5.5**). The reason for having the browser designed in this structure is because the contents of each resource are formatted in different structures. For example, the sight information stored in the TIP database is refined in levels of detail and the contents of an external resource can be defined in other data structures. Having separate areas to present the contents of a TIP resource and an external resource, the system would be able to display the resource contents based on the structure that is pre-defined for each resource.
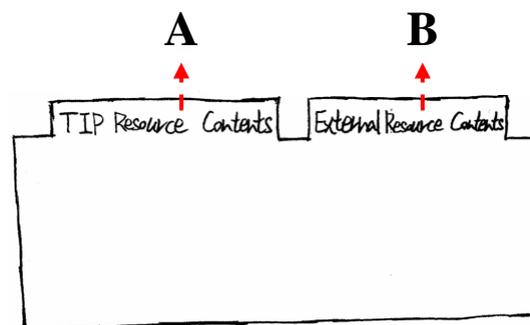
Figure 5.5: Sketch of the resource contents browser.

However, the use of this browser might be inefficient in assisting the user to perform an information comparison. This is because the browser has been designed as a tab control. In order to compare the contents of two resources (a TIP resource and an external resource), the user has to switch between the two tabs.

5.2.3 Bad Usability

The overall structure (PP1) has been designed to provide the overview of administration service and sight resource contents form (PP6) has been designed to present the sight resource contents. However, the capacity of components included in these two sketches may affect the presentation of resource contents or data entry forms. The factor of this inconsistency has been considered to be the poor usability of interface design. In the following, we discuss the structure of PP1 and PP6 based on this factor.

PC6: Overall Structure (PP1)

In the overall layout of the administration service (PP1), as shown in **Figure 5.6** (introduced in Section 4.1), the resource contents browser (**Area B** in **Figure 5.6**) and the data entry browser (**Area A** in **Figure 5.6**) have been designed in the capacity of one above another, showing the resource contents and hosting the input forms for the insertion of TIP resource properties.
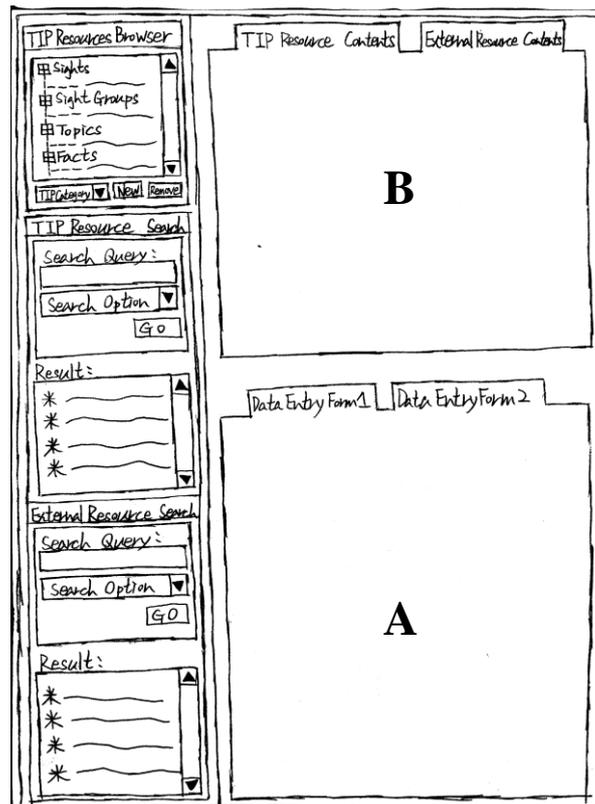
Figure 5.6: Sketch of overall structure of the administration service. (reviewed in **Figure 4.1**)

However, this design might cause an issue in presenting the resource contents and data entry forms. This is because some prototypes are required to include a large amount of information contents or interface components. For example, TIP resource contents forms (PP6, PP12, PP16, and PP20), external resource contents form (PP22), and sight information entry form (PP11). In an administration service that follows PP1, the resource contents browser and the data entry browser in this prototype might be too small to host any of these forms. Even though a scrollbar can be utilised in these browsers to support the user in accessing the contents that have been displayed, most of contents might not be seen directly on the screen.

PC7: Sight Resource Contents Form (PP6)

The sight resource contents form (PP6) has been designed for the access of sight resource contents, allowing the presentation of properties defined for a sight. However, the layout of this form (**Figure 5.7** – originally reviewed in Section 4.2) might cause the issue of data representation. This is because a sight could involve a large amount of information: the sight's profile, its relationships with other TIP resources (sight groups, facts, and upper sights) and the corresponding sight information refined in hierarchical level. With the growing of resource contents of a sight, the structure of PP6 might not be able to present all of information described in a clear overview.
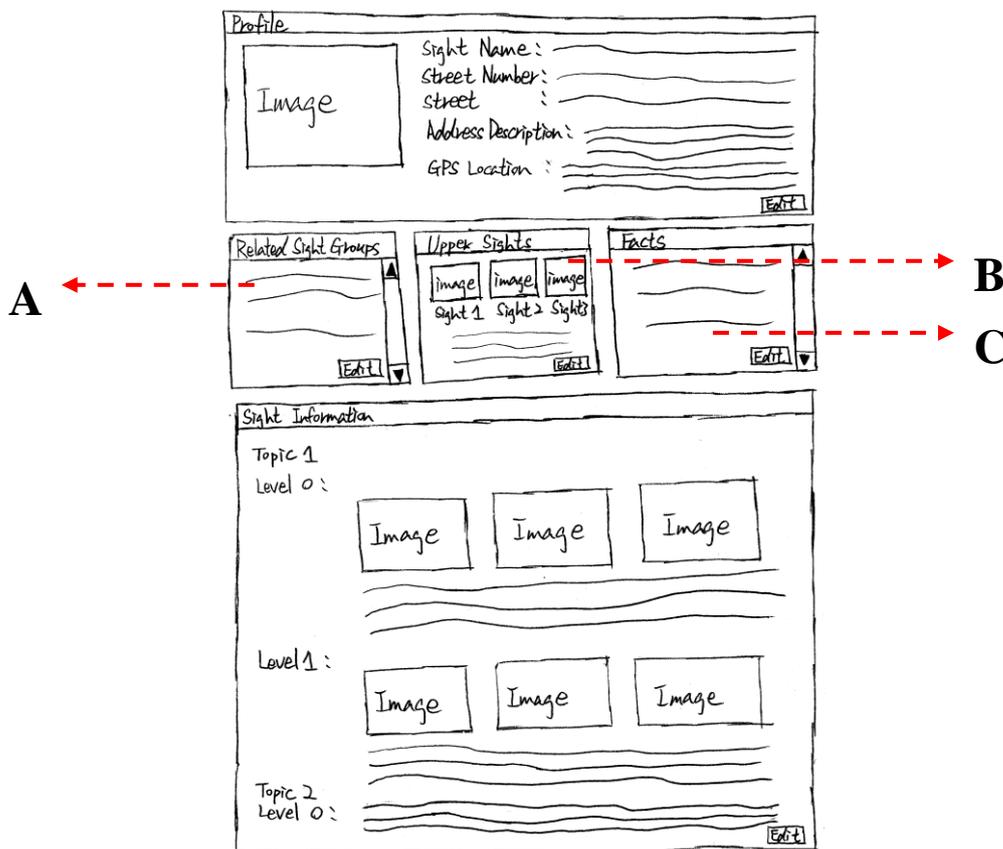
Figure 5.7: Sketch of resource contents form from sights. (reviewed in **Figure 4.4**)

In particular to the areas that present (1) related sight groups (**Area A** in **Figure 5.7**), (2) upper sights (see **Area B** in **Figure 5.7**) and (3) related facts (see **Area C** in **Figure 5.7**); while presenting a large amount of information in these areas, most of contents might be directly achieved on the screen. The user would have to use the scrollbar to view the information displayed in these areas.

5.2.4 Sketch Prototype Concern Summary

There are concerns remaining in the components included in overall structure of the administration service (i.e., PP1, PP2, PP3, PP4, and PP5) and the sketch of sight resource contents form (PP6) and the sight information entry form (PP11). The concern of these sketches can be summarised into three areas of Inconsistent Design, Inefficiency of Use and Bad Usability

In order to have effective administration service, a refinement is required for the sketches for which we identified the above issues. The refinement of each sketch is presented and described in Section 6 using the screenshot prototypes.

5.3 Interaction Concerns – Sight Information Insert

According to the requirement of TIP data structure described in Section 2.2.1, the information about a sight is categorised into various topics. Also, for each topic, the information is refined in levels of detail using hierarchical structure. However, while performing the sight information insert, additional rules are to be followed to prevent the insertion of duplicate information. The rules are:

- Each sight can have more than one topic, but each topic can only be assigned to the sight once only.
- In each topic, sight information can be distributed into a number of levels, but duplicate information cannot be involved in the same topic.
- In each topic, each level can only be defined to the topic once, and the extension of each topic intends to follow the legacy of the previous level.
- The information defined in each level in one topic can be placed in more than one topic.
- The information defined in each level under a topic can be taken off and placed into another position in the same topic or different topics.
- Two or more pieces of information defined in different topics can be swapped as necessary.

The operation to insert sight information have been analysed according to these rules and three questions have been discovered that need to be addressed:

1) How to present the contents that have been selected for various input actions?
2) How to present the source contents that have been transferred through drag-and-drop input?
3) How to refine the transferred data into levels of detail in the data entry form?

5.3.1 How to present the contents that have been selected for various input actions

The operation of sight information insert has been considered to include three actions: (1) select the required information from source contents, (2) perform drag-and-drop input to transfer the selected information from source contents to data entry form, (3) refine the transferred information into levels of detail.

However, after several input actions, the user might lose his/her direction while accessing the information showing in the source contents. This is because s/he cannot tell which information in the source contents has been selected for previous input actions. This causes duplicate information to be inserted according to the selected topic.

5.3.2 How to present the source contents that have been transferred through drag-and-drop input

As we have described in Section 3.2.1, the drag-and-drop input must allow the user to transfer the selected information from source contents to input components provided in data entry form. However, the behaviour of the selected information can vary in different drag-and-drop patterns (e.g., "copy-on-drag", "cut-on-drag", and "grey-on-drag") and this might affect the user while looking at the information showing in source contents.

5.3.3 How to refine the transferred data into levels of detail in the data entry form

Based on the rules that have been introduced at the beginning of Section 5.3, the data entry environment for inserting the sight information must provide an appropriate layout structure, allowing the user to define relevant topics for the transferred sight information and refine the information into levels of detail. In addition, this input environment must ease the user in performing the modification to swap transferred information between the topics.

5.3.4 Interaction Concern Summary

A number of rules have been defined for the insertion of sight information. The reason for having these rules is to prevent the duplicate information being inserted according to a topic. In order to follow these rules, three questions have been found according to the operation of sight information insert:

1) How to present the contents that have been selected for various input actions?
2) How to present the source contents that have been transferred through drag-and-drop input?
3) How to refine the transferred data into levels of detail in the data entry form?

To solve these questions, we present possible solutions for these questions in Section 7 to study the user's interaction for inserting sight information. Each solution represents an interaction that takes part in the operation of sight information insert.

5.3 Conclusion

From the above sections, two analyses are given for the concerns to do with sketch prototypes and the user's interaction to insert sight information. We addressed the prototype concerns with corresponding sketches and described the questions arising for the operation of sight information insert. At the end of each analysis, we decided to refine each problematic sketch using the screenshot prototype and to study the user's interaction to perform the insertion of sight information through possible interaction models.

Section 6 Screenshot Prototypes

This section describes the solutions for the concerns identified in Section 5.2 using screenshot prototypes. Firstly, we introduce the techniques that are used to create the screenshots. After that, each screenshot will be described in relation to solve the corresponding concern.

6.1 Creation of Screenshot Prototypes

The screenshot prototypes that are presented in this document are mock-ups that follow the idea of the sketches described in Section 4. They are created using the Swing components provided in NetBeans[7]. The information of the Sky Tower shown in the screenshots comes from the Sky Tower page of the Wikipedia (http://en.wikipedia.org/wiki/Sky_Tower last visited on 12/06/2008). Since the TIP system currently does not support automatic information highlighting, the highlight effect presented in screenshots showing in Section 7 is created using the drawing application Ulead PhotoImpact[8].

6.2 Solution to Sketch Prototype Concern

In this section, we go through solutions we propose for the concerns identified in Section 5.2. Each solution is presented in an interface prototype, and each prototype is described in two screenshots to present the possible refinements. Each refinement has advantages and drawbacks which we will identify and describe in the subsequent subsections. The following list outlines each solution (e.g., SP1) with a corresponding sketch prototype (e.g., PP2) described in concerns (e.g., PC1).

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[7] http://www.netbeans.org
[8] http://www.ulead.com/pi

- SP1: Data Entry Browser (PP2) – PC1

- SP2: TIP Resource Browser (PP4) – PC2

- SP3: Sight Information Entry Form (PP11) – PC3

- SP4: Information Search Tool (PP5) – PC4

- SP5: Resource Contents Browser (PP3) – PC5

- SP6: Overall Structure (PP1) – PC6

- SP7: Sight Resource Contents Form (PP6) – PC7

6.2.1 Solution to Inconsistent Design

Inconsistent sketches (PP2, PP4, and PP11) are refined into the layouts that follow the design concepts (i.e., the purpose of a prototype, the relevant activity sequence defined in a use-case, and the database model). The refinement of each sketch is presented through a screenshot. Each sketch has been refined in two alternatives for the comparison to obtain a most appropriate design. In the following, we describe the refinements of inconsistent sketches on the basis of its pros and cons.

SP1: Data Entry Browser (PP2)

As we have described in PC1 in Section 5.2.1, the data entry browser (PP2) is designed as a tab control to present the data entry forms in a specific order (from left to right). The user can thus create a resource before any properties of the resource. However, there is no indicator showing the priority of each tab in PP2. If the user accidentally inserts information in the wrong order, the inserted information would not be successfully stored in the TIP database. To compensate for this drawback, two prototypes (**Figure 6.1** and **Figure 6.2**) are designed and presented in screenshot as refinements of PP2. They are introduced in the following text.

Figure 6.1 shows a screenshot of the data entry browser. Within this design, a guideline has been attached on the top corner of the browser to indicate the priority of each tab. The user can follow the guideline to define a resource and its properties. If the user wants to modify the contents that have been inserted in an earlier input form, s/he can always click on a former tab (e.g., the "Profile" tab) to proceed with the modification.

This prototype has the advantage of presenting the entire data entry structure of a TIP resource. Through the data entry form that is presented in each tab, the user is thus able to notify what information should be inserted in order to define a TIP resource. This prevents the input of inaccurate information and it speeds up the user's interaction in performing information insert. However, because no restrictions are provided in this prototype and the user can freely access each tab to operate the insert; the contents of a resource can still be inserted in the wrong order.
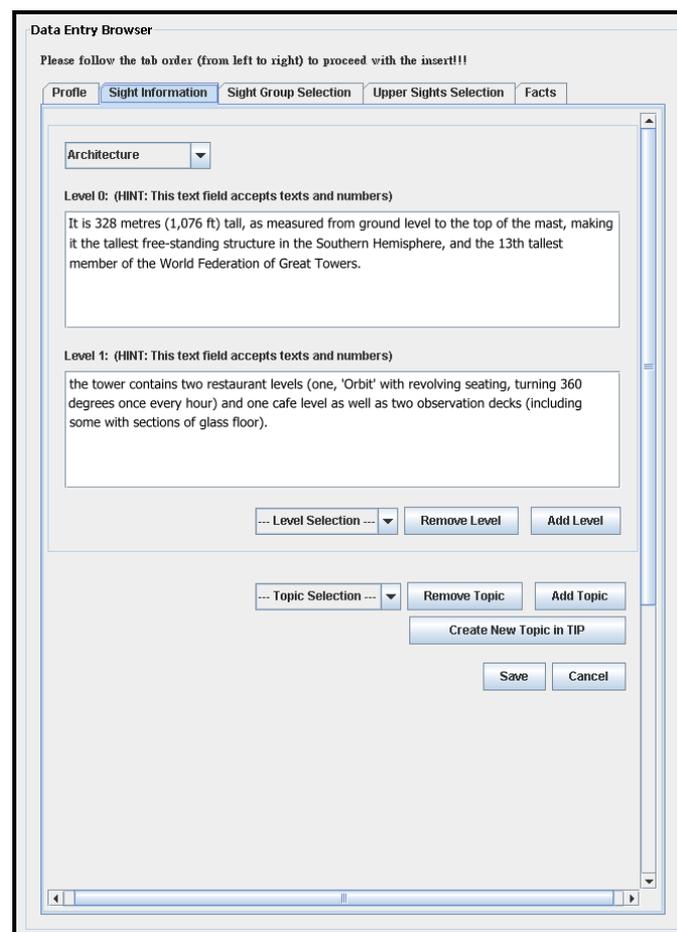
Figure 6.1: Screenshot of first refinement for the data entry browser.

An alternative refinement for PP2 is shown in **Figure 6.2**. In this design, the sequence to display each data entry form is controlled by a "Next" button. After the insertion is completed in current form, the user can click on this button to enable the display of the following form. If the user attempts to login into the following form without completing the current form, a dialogue box shown in **Figure 6.3** would show up to indicate the incomplete task. Also, to allow the modification of contents that have

been inserted in a previous data entry form, the user can select a previous form from the selection box (see **Area A** in **Figure 6.2**) and click on "Go To" button to log into the selected form and perform the update.
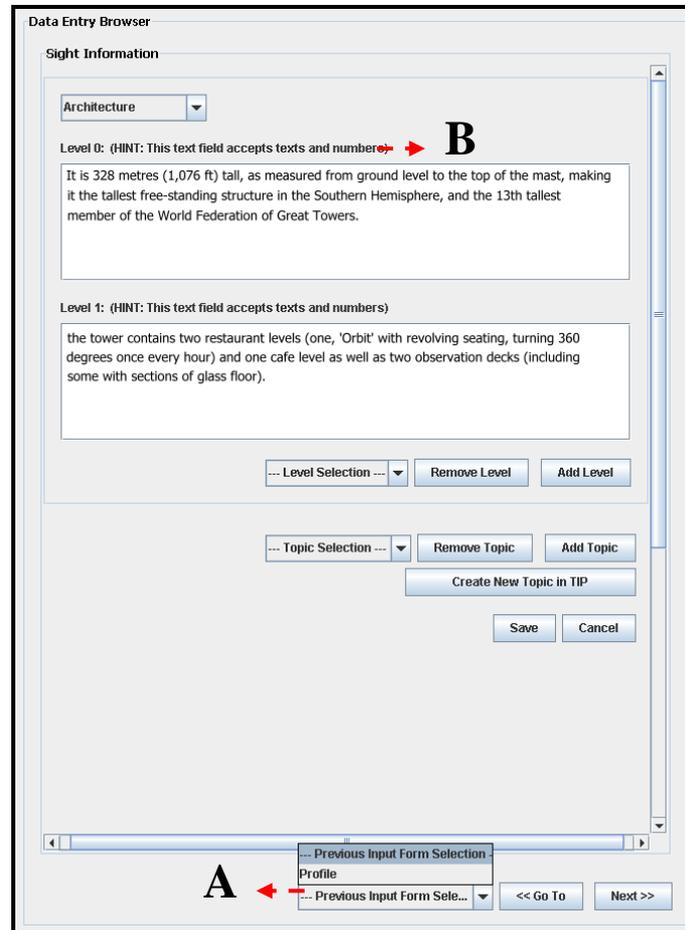
Figure 6.2: Screenshot of second refinement for the data entry browser.
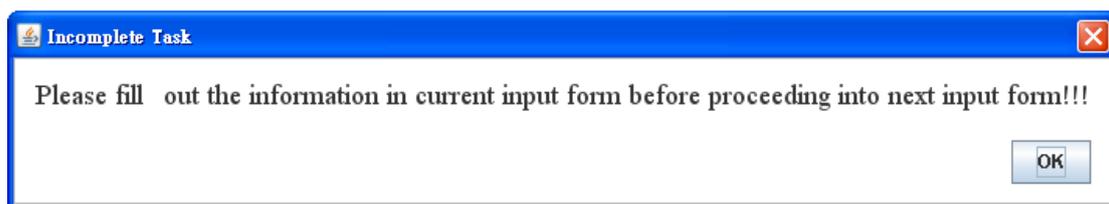
Figure 6.3: Screenshot of warning message for incomplete task.

This prototype presents the data entry form one at a time in a prioritised order. The inserted information can thus be stored into the TIP database without restriction. However, according to the structure of this prototype, the user would not be able to see the complete input structure of a TIP resource. If the user is inexperienced, s/he might be confused while performing the insert, wondering what information should be

inserted in the current input form and what may need to be inserted in the following forms.

By comparing **Figure 6.1** and **Figure 6.2**, both prototypes are designed to prevent the concern described in PC1. The former has the advantage of presenting the entire input structure of a TIP resource in tabs. The user can then access each tab to notify the information that should be inserted in order to define a TIP resource. However, there is no restriction in this prototype; the contents of a resource can thus still be inserted in the wrong order. On the other hand, **Figure 6.2** presents the data entry form one at a time; the user must complete each form and click on the "Next" button to proceed with the insertion. This enforces the user to define the contents of a TIP resource in a prioritised order and it ensures the inserted contents to be stored in the database. Even though the layout of **Figure 6.2** may not be supportive for the inexperienced user, considering each input field displayed in this browser is supported with sample data (see **Area B** in **Figure 6.2**), the user should not have trouble in performing the insert. The issue identified in the concern (PC1) may still occur in the prototype in **Figure 6.1. Figure 6.2** is judged to be the more appropriate refinement to guide the user in defining the contents of a resource.

SP2: TIP Resource Browser (PP4)

Through the sketch of the TIP resource browser (PP4), the user can access the TIP resource contents by clicking on a TIP resource and have the system extract the resource contents from the database. However, as identified in concern PC2 (see Section 5.2.1) this action flow has deviated from the activity sequence defined for accessing the TIP resource contents (UC3):

1) Selecting a resource from TIP resource the TIP resource browser.
2) Clicking the "Open" button.
3) Having the system to extract the contents.

Also, it conflicts with the sequence defined for removing a TIP resource (UC5):

1) Selecting a resource from the TIP resource browser.
2) Clicking the "Remove" button".
3) Having the system remove the resource.

Every time the user requests to remove a TIP resource, the system would first extract the contents of the selected resource before processing the resource deletion. To create

greater consistency, **Figure 6.4** and **Figure 6.5** have been designed as refinements for PP4. They are introduced as follows.

Figure 6.4 shows the first refinement for PP4. Based on this prototype, popup menus are designed to provide data retrieval functionality. The user can right-click on a category to activate the entry for new resource creation (**Area A** in **Figure 6.4**). Alternatively, the user can right-click on a resource to activate the entries for removing a TIP resource or accessing the TIP resource contents (**Area B** in **Figure 6.4**). From there, s/he can request to delete an existing TIP resource by selecting the "Remove" command. Most importantly, the user can request to access the TIP resource contents by following the activity sequence defined in UC3 (i.e., selecting the "Open" command and employing the system to display the resource contents).
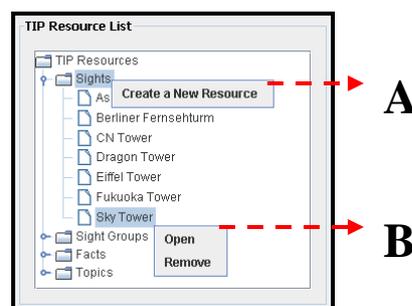
Figure 6.4: Screenshot of first refinement for the TIP resource browser.

This design remedies the concern described in PC2. The sequence of the TIP resource contents access would no longer conflict the sequence of the TIP resource deletion. In addition, this prototype provides an overview of resources stored in the TIP database according to four categories (sights, sight groups, topics, and facts). Due to this structure, the action to access the TIP resource contents can easily be performed. If the user knows which category the resource belongs to, s/he can visit the category directly and access the resource from there. On the other hand, the user can also walk through each category to check out the stored resources. However, when a large amount of resources is stored in each category, the overview of the TIP resources might not be shown clearly. Most resources cannot be directly seen from the prototype in **Figure 6.4**; the user would have to control the scrollbar to access the resources that have been stored.

The alternative refinement for PP4 is shown in **Figure 6.5**. Within this prototype, TIP resources are held in four selection boxes according to sights, sight groups, topics, and facts. Next to each box, there is a set of buttons (i.e., "Open", "Delete", and "New") supplied for the user to start off three administration activities: (1) the extraction of resource contents, (2) the deletion of an existing resource, and (3) the creation of a new resource. Each set of buttons allows the user to retrieve the resources stored in the corresponding selection box. In this prototype, the activity sequence to access the TIP resource contents is also designed to follow the principle defined in UC3. For example, the user can select a resource (e.g., Sky Tower – **Area A** in **Figure 6.5**) from the sight selection box and click on the corresponding "Open" button (**Area B** in **Figure 6.5**) to request the contents of the selected resource.
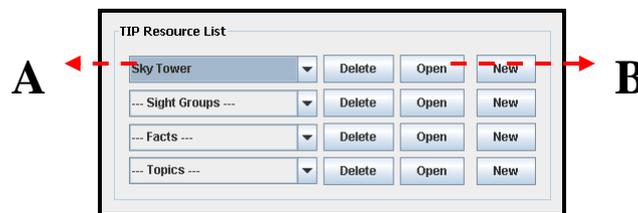
Figure 6.5: Screenshot of second refinement for the TIP resource browser.

This prototype has the advantage of being able to separate the TIP resources into four drop-downs. Through each drop-down, the user is thus able to access the overview of sights, sight groups, topics, and facts. The structure of this prototype benefits the user while accessing a large amount of resources, because s/he can be restricted in viewing and selecting resources according to only one category. However, this prototype does not assist the user in viewing the entire TIP resources at once. In order to view the resources stored in the database, the user has to access each drop-down individually.

By comparing **Figure 6.4** and **Figure 6.5**, both prototypes support the user to access the TIP resource contents using the activity sequence defined in UC3. The former allows the user to access the TIP resource contents using a popup menu, and the latter enables the performance of information access through action buttons. Moreover, both prototypes support the user in viewing resources according to four categories. **Figure 6.4** categorises the TIP resources through tree nodes (category nodes) and **Figure 6.5** separates the resources into four drop-downs. Because **Figure 6.4** is able to present the entire TIP resources after the expansion of category nodes, and the user has to

access each drop-down individually to view the resources stored in TIP using the **Figure 6.5**. **Figure 6.4** is considered to be more appropriate in support of TIP resource presentation.

SP3: Sight Information Entry Form (PP11)

In accordance with the concern described in PC3 in Section 5.2.1, the sketch of sight the information entry form (PP11) has been designed to import each image according to the hierarchical level of a sight. However, this structure has varied from the TIP database model (each image stored in TIP is assigned to one sight). It might confuse the user while inserting sight information, because s/he might use this form as a tool to refine the images and have the text contents become the support. To remedy this inconsistency, the following prototypes shown in screenshots (**Figure 6.6**, **Figure 6.7**, and **Figure 6.8**) have been designed as refinements for PP11.

Figure 6.6 shows the first refinement of PP11. In this design, the data entry for the insertion of sight-related images has been migrated to an additional input form (**Figure 6.7**). Thus, the user can perform the insertion of sight information and sight images in separate regions. Also, the inserted images can be stored in relation to a sight.

Within **Figure 6.6**, the user can define a topic for a sight by accessing the topic selection box (see **Area A** in **Figure 6.6**). After that, s/he can perform the insertion of sight information through drag-and-drop input. The user can click on the "Add Level" button to extend the hierarchical level of a topic and to request a blank input field for the extended level, or s/he can select a level from the level selection box (see **Area B** in **Figure 6.6**) and click on the "Remove Level" button to remove a level. The user can also click on the "Add Topic" button to request a new set of topic selection box and input field to define a different topic to a sight. The data entry for a new topic is placed after the former topic (see **Area C** in **Figure 6.6**).
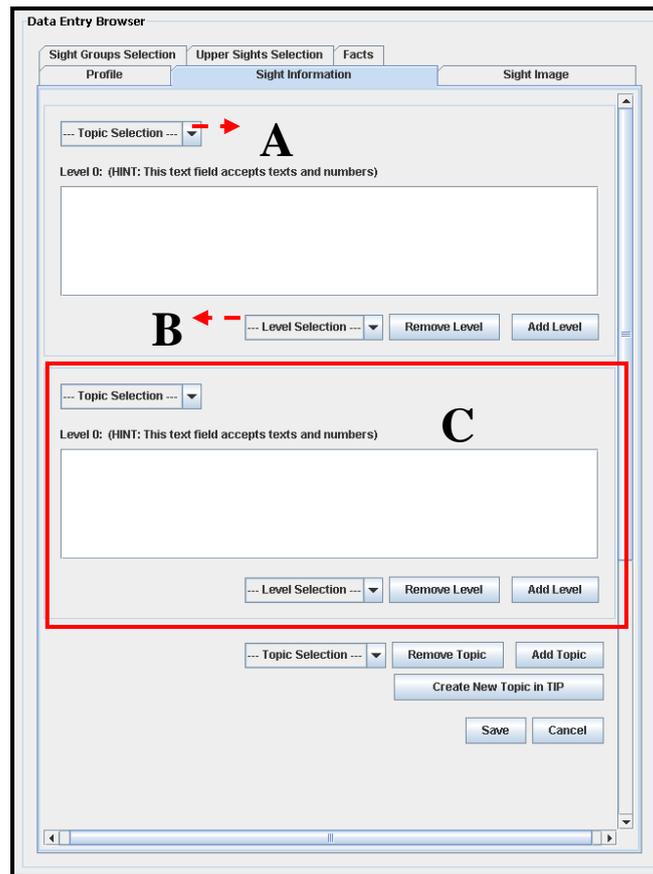
Figure 6.6: Screenshot of first refinement for the sight information entry form.

On the other hand, **Figure 6.7** provides the user with a set of buttons and selection box to insert or remove sight-related images. The user can click on the "Add Image" button to activate a blank image icon. S/he is thus able to insert an image through drag-and-drop input. The user can also select an image from the selection box and click on the "Remove Image" button to delete an un-required image.

The prototype in **Figure 6.6** and **Figure 6.7** supports the user to insert sight information and images in separate regions. Thus, the inserted images can be imported according to the TIP database model (i.e., each image is assigned to one sight). However, the layout of **Figure 6.6** may eventually become unstructured. This is because the input components are enabled after "Add Level" or "Add Topic" has been clicked. A number of topics can be defined to a sight and according to each topic the sight information can be categorised into several levels. After multiple topics have been defined in this prototype, the sight information inserted according to each topic would become difficult to visualise amongst the rest of the input components.
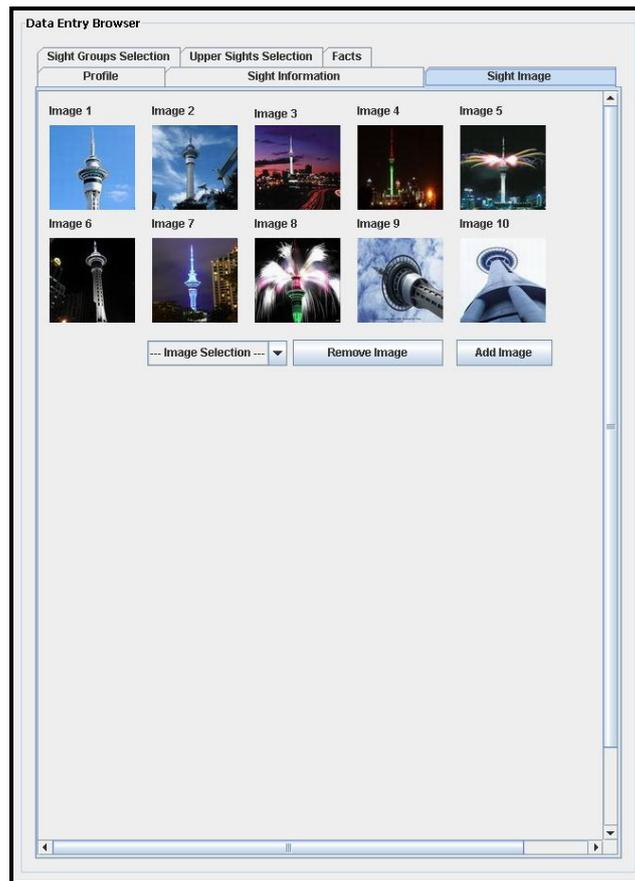
Figure 6.7: Screenshot of the sight image entry form.

Figure 6.8 shows the alternative refinement for PP11. Within this prototype, the insertion of sight information and image is also performed in separate regions (see **Area A** in **Figure 6.8** – the data entry structure for the insertion of images is the same as **Figure 6.7**, so we will not introduce it again in the following). Differently, the sight information is refined into hierarchical levels using inner tabs (topic tabs – see **Area B** in **Figure 6.8**). Each tab represents a topic defined for a sight. The user can extend the level of a topic by clicking on the "Add Level" button and have the sight information inserted through drag-and-drop input; or s/he can remove a level by selecting a level from the level selection box (see **Area C** in **Figure 6.8**) and click on the "Remove Level" button. Also, the user can select a topic from **Area D** in **Figure 6.8** and click on the "Add Topic" button to define a new topic for a sight. After that, the data entry for a newly-added topic will be presented in a new topic tab allowing the user to insert sight information. Additionally, the user can select an un-required topic from **Area E** in **Figure 6.8** and click on the "Remove Topic" button to delete an un-required topic.
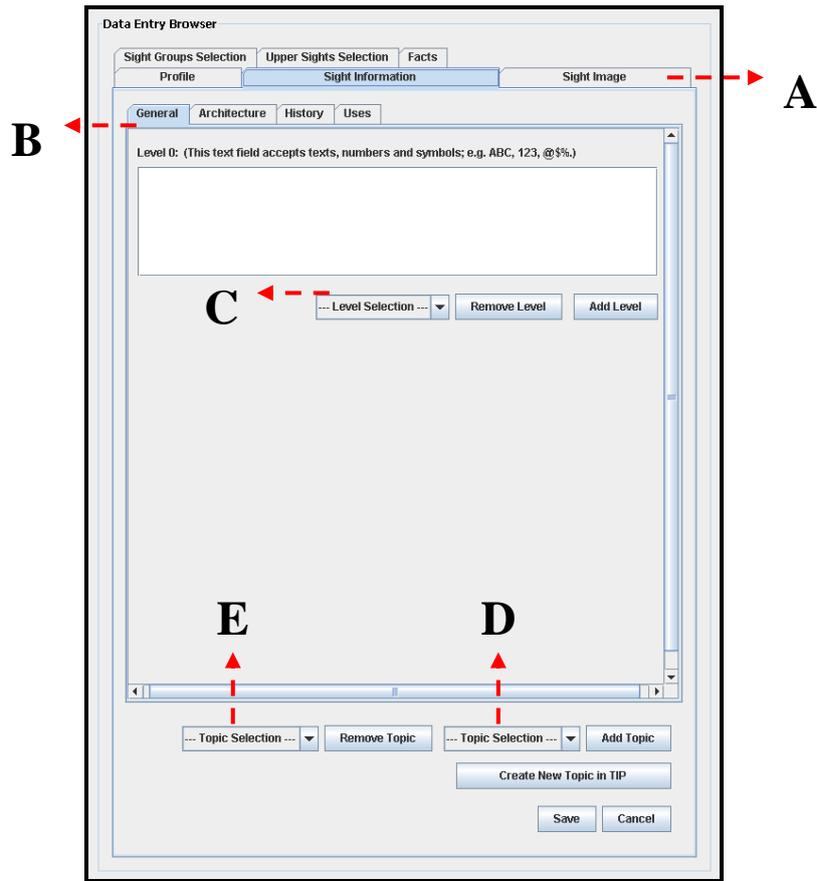
Figure 6.8: Screenshot of second refinement for the sight information entry form.

The prototype shown in **Figure 6.8** also provides separate regions to support the user in inserting sight information and images. Hence, the inserted images can be stored in accordance to the TIP database model (i.e., each image is assigned to one sight). Additionally, **Figure 6.8** has the advantage of being able to have sight information inserted in a structured layout. It clearly presents the topics that are defined for a sight and separates the data entries for each topic. The user can thus confirm the information inserted according to each topic after multiple topics are defined. However, this prototype would not support performing the information modification. Assuming the user wants to swap the information between the two topics, this prototype could not support the task. The data entries for each topic are held in separate tabs, and it is not possible for the user to swap the information between the two tabs through drag-and-drop input.

By comparing the prototypes in **Figure 6.6** and **Figure 6.8**, both prototypes provide separate regions for the insertion of sight information and images. This allows the inserted information and images to be stored according to the TIP database model. However, the structure of **Figure 6.6** brings a difficulty for the user to visualise the overview of information inserted after multiple topics are defined to a sight. Also, the design of **Figure 6.8** stops the user in performing the modification to swap inserted information between the two topics. In order to have the information insertion and modification performed properly, other designs would need to be thought of to support the sight information insert.

6.2.2 Solution to Inefficiency of Use

To address the shortcomings (inefficiency of use) that have been discovered in PP5 and PP3, these two sketches have been reflected in screenshots to compare with alternatives (i.e., the refinements of PP5 and PP3). In the following, we describe the comparison betweens the original designs and the refinements based on their advantages and drawbacks.

SP4: Information Search Tool (PP5)

As we have described in PC4 in Section 5.2.2, the sketch of the information search tool (PP5) is partitioned in two areas: (1) TIP resource search and (2) external resource search. The user can thus search for required information from a preferred source (the TIP database or external sources). Also, search results can be presented according to each source. However, the information search might be inefficiently performed in PP5, because the user has to do the same activity sequence in both search areas to receive the resources searched from all sources. In the following, PP5 has been developed in screenshot (**Figure 6.9**) to illustrate this concern. Additionally, **Figure 6.10** is developed as a refinement for PP5.

According to the prototype showing in **Figure 6.9**, through **Area A** and **Area B**, the user can discover information from the TIP database or external sources. Also, from **Area C** and **Area D**, the user is able to receive a view on the resources that are found from each search scope. However, this design proves the concern described in PC4. The use of the prototype becomes inefficient while searching the information from all

sources. The user has to take six steps to obtain the resources searched from the TIP database and external sources. This includes performing the following sequence in both search areas: (1) insert a search query, (2) select a search option, and (3) click on the "Go" button to launch the search. Additionally, the capacities of the **Area C** and **Area D** are too small in this prototype. After a large amount of resources is found, most of the resources cannot be directly seen from these two areas. The user will have to control the scrollbar to access the resources.
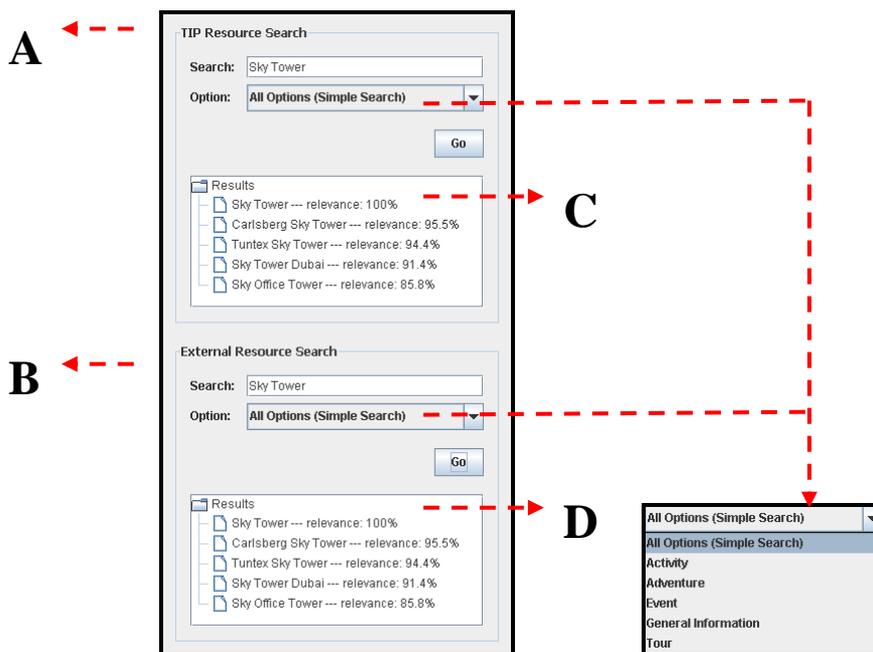
Figure 6.9: Screenshot of the information search tool.

On the other hand, with the prototype shown in **Figure 6.10**, the user can select a source option ("All Sources", "TIP Database", or "External Sources") and have the information searched from a preferred source. The search results are presented in a browser and they are classified in two categories ("TIP Resources" and "External Resources") via separate tree nodes. This prototype advances the performance of information search. The user only takes roughly four steps to receive the information searched from all sources: (1) insert a search query, (2) select a search option, (3) select a search scope, and (4) click on the "Go" button to launch the search. Also, s/he can obtain the resources supplied from all sources at once. However, this prototype consists of a similar drawback as the **Figure 6.9**. After a large amount of resources is found, the user will have to use the scrollbar to access the resources. Thus, the user would have difficulty in visualising the classification of found resources (the TIP

database or external source). S/he might question which source a selected resource came from.
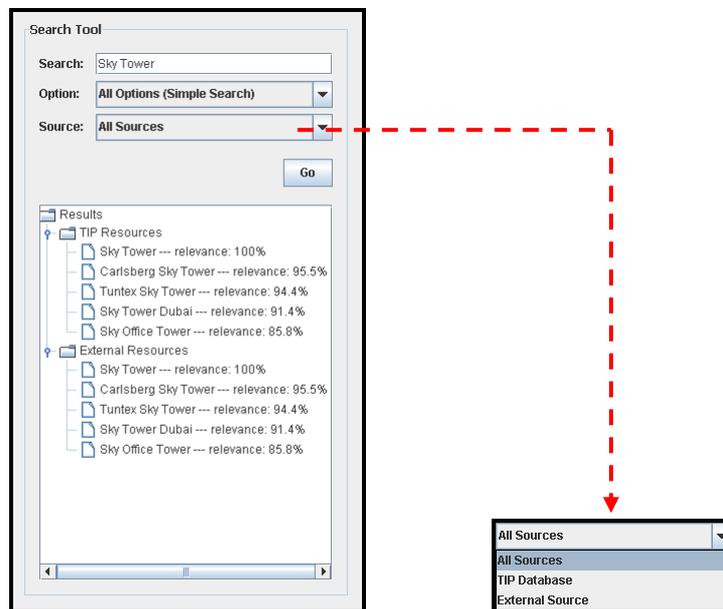
Figure 6.10: Screenshot of the refinement for the information search tool.

By comparing **Figure 6.9** and **Figure 6.10**, both prototypes allow the user to search information from a preferred source (the TIP database or external sources) and categorise the search results according to each source. Also, in both prototypes, the user will need assistance from the scrollbar to access a large amount of found resources. However, to access the resources discovered from both the TIP database and external sources, **Figure 6.10** takes the user four steps to complete the task while **Figure 6.9** takes the user six steps. This means the action to search for information can be performed through more efficient sequence in **Figure 6.10** than in **Figure 6.9**. Therefore, **Figure 6.10** has been considered to be more appropriate in support of the information search.

SP5: Resource Contents Browser (PP3)

The sketch of the resource contents browser (PP3) is designed as a tab control to separately display the TIP resource contents and external resource contents based on the data structure that is pre-defined for each resource. The user can thus access the entire contents of two resources (a TIP resource and an external resource) and reach an emphasis between them. However, as identified in concern in PC5 (see Section

5.2.2), because the user has to switch between the two tabs to read the contents of two resources, the use of PP3 might be inefficient to support the user in performing information comparison. In the following, we illustrate this concern through screenshots (**Figure 6.11a and Figure 6.11b**). Also, we introduce a refinement (**Figure 6.12**) for PP3.
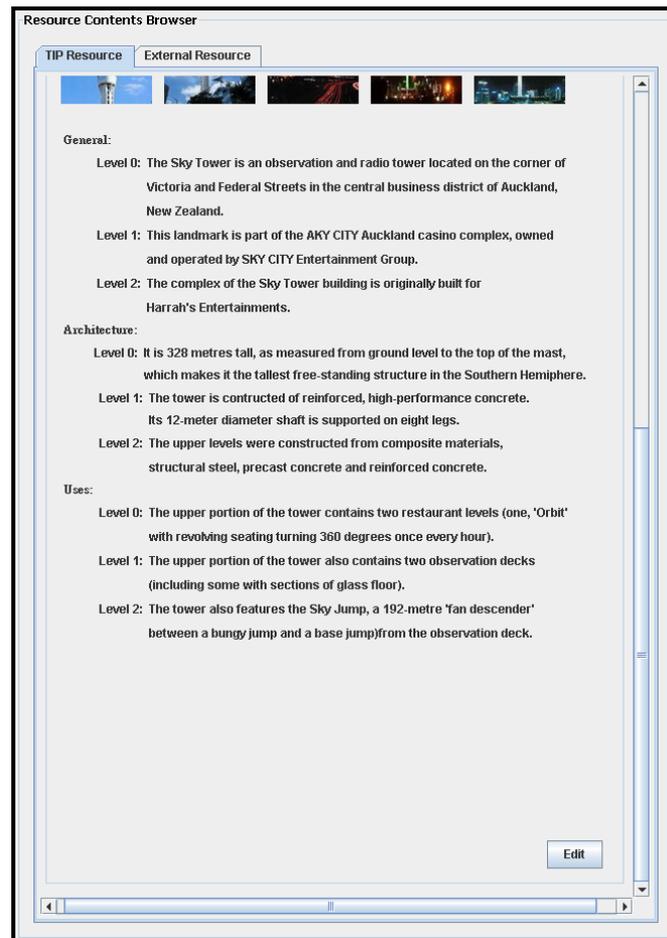
Figure 6.11a: TIP resource contents shown in resource contents browser.

The screenshot of PP3 is shown in **Figure 6.11a** and **Figure 6.11b**. This prototype confirms that the TIP resource contents and external resource contents can be separately displayed in a pre-defined data structure that is assigned to each resource. For example, the prototype in **Figure 6.11a** presents sight information stored in the TIP database in hierarchical levels. Also, in **Figure 6.11b**, the contents of an external resource (HTML document) are presented based on the data structure defined in HTML script. However, this prototype also proves the concern described in PC5. The

use of the browser is inefficient in supporting the user in performing information comparison. While comparing the contents of the two resources, the user has to switch between the two tabs to make a comparison between the contents of the two resources. This brings inconvenience for the user to perform the task. Also, the user might lose his/her direction in the procedure of comparing the contents showing in two tabs.
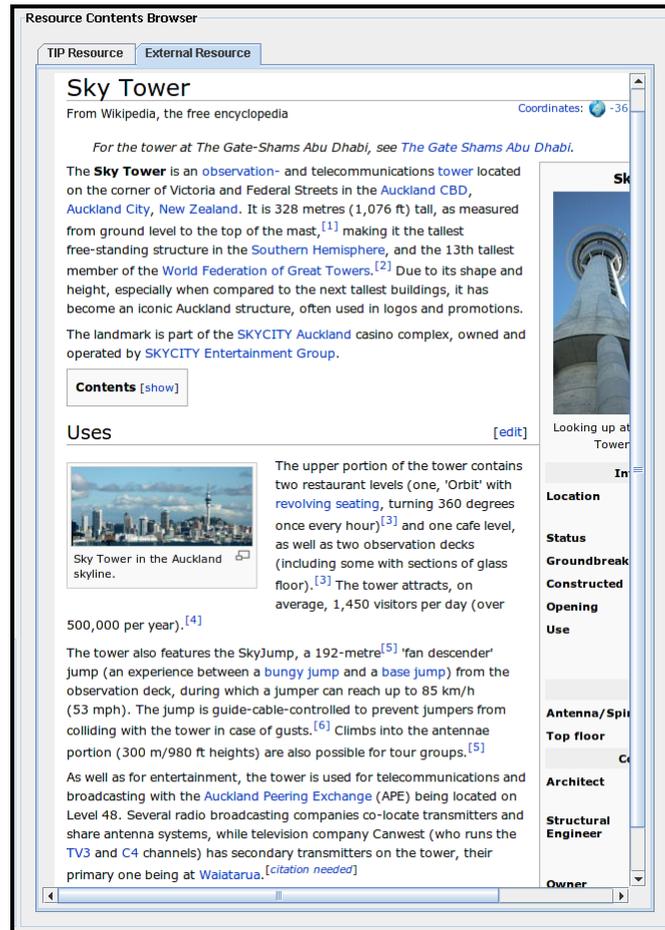
Figure 6.11b: External resource contents shown in resource contents browser.

Alternatively, **Figure 6.12** also displays the TIP resource contents and external resource contents in separate browsers. Thus, the resource contents can be displayed in a data structure that is pre-defined for each resource. Additionally, this prototype supports the user in performing information comparison by presenting the contents of two resources at the same time. Due to this structure, the user can directly access the contents of two resources from two browsers and make an emphasis between them. However, the capacity of these two browsers shows the drawback of this prototype.

Considering that they would be likely to hold a large amount of contents, based on the capacity designed, most of the contents could not be directly accessed in one view. There is a need for the scrollbar to support the user in reading the contents.
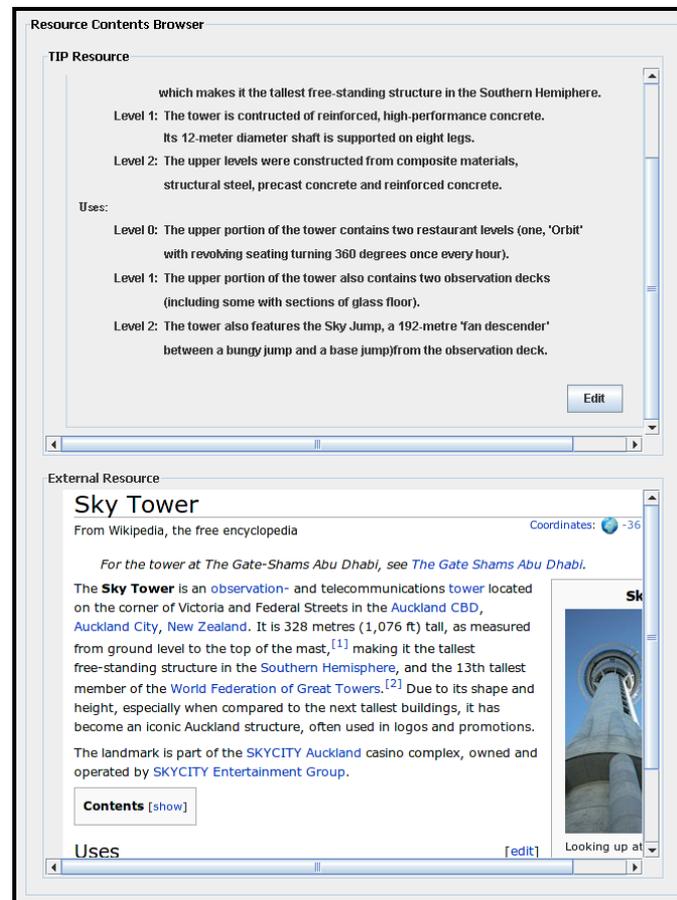
Figure 6.12: Screenshot of the refinement for the resource contents browser.

By comparing the screenshot of PP3 (**Figure 6.11a** and **Figure 6.11b**) and **Figure 6.12**, the former is more supportive in presenting the contents of one resource, but it causes inefficiency in comparing the contents of two resources. **Figure 6.12** is more efficient for information comparison, but it shows a shortcoming in presenting resource contents. In order to present resource contents in a clear overview and enhance the performance of information comparison, other designs would need to be thought of to support the presentation of resource contents.

6.2.3 Solution for Bad Usability

In this section, PP1 and PP6 have been presented in screenshot showing the evidence of bad usability design. Each screenshot has been filled in with real data to support concerns (i.e., trouble in presenting resource contents and data entry form) described in Section 5.2.3. In addition, these two prototypes have been refined into a different structure. They are described in the following based on how they have made up for the concern identified.

SP6: Overall Structure (PP1)

In accordance with the concern described in PC6 in Section 5.2.3, the resource contents browser (PP3) and data entry browser (PP2) are designed in the capacity of one above another in the sketch of overall structure of the administration service interface (PP1). The user can thus perform the insert by dragging selected contents from PP3 and dropping them into PP2. However, a resource contents form (e.g., PP6: Resource Contents Form for Sights – see Section 4.2) or data entry form (e.g., PP11: Sight Information Entry Form – see Section 4.2) may consist of a large amount of information contents or interface components. Having these forms held in browsers (PP3 and PP2) designed in PP1, most of the contents in a form might not be seen directly on the screen. A scrollbar would be required to assist the user in accessing the contents. In order to illustrate this concern, PP1 has been pictured in screenshot (**Figure 6.13**).

The structure of **Figure 6.13** confirms the concern described in PC6. Having the resource contents browser (see **Area A** in **Figure 6.13**) and data entry browser (see **Area B** in **Figure 6.13**) designed in the capacity of one above the other, most of the contents held in these two browsers cannot be accessed in one view. While analysing the resource contents showing in **Area A**, the user has to move the scrollbar up and down to access the contents that have been held in this browser. This brings the user a difficulty in visualising the entire contents of each resource. S/he may feel lost in the process of analysing the contents. Similarly, while performing the data entry in **Area B**, the user may be confused about the use of the input form that is displayed. Although there are titles showing on each tab to indicate the purpose of each data

entry form, the user can still be wondering about the information that should be entered in each form.
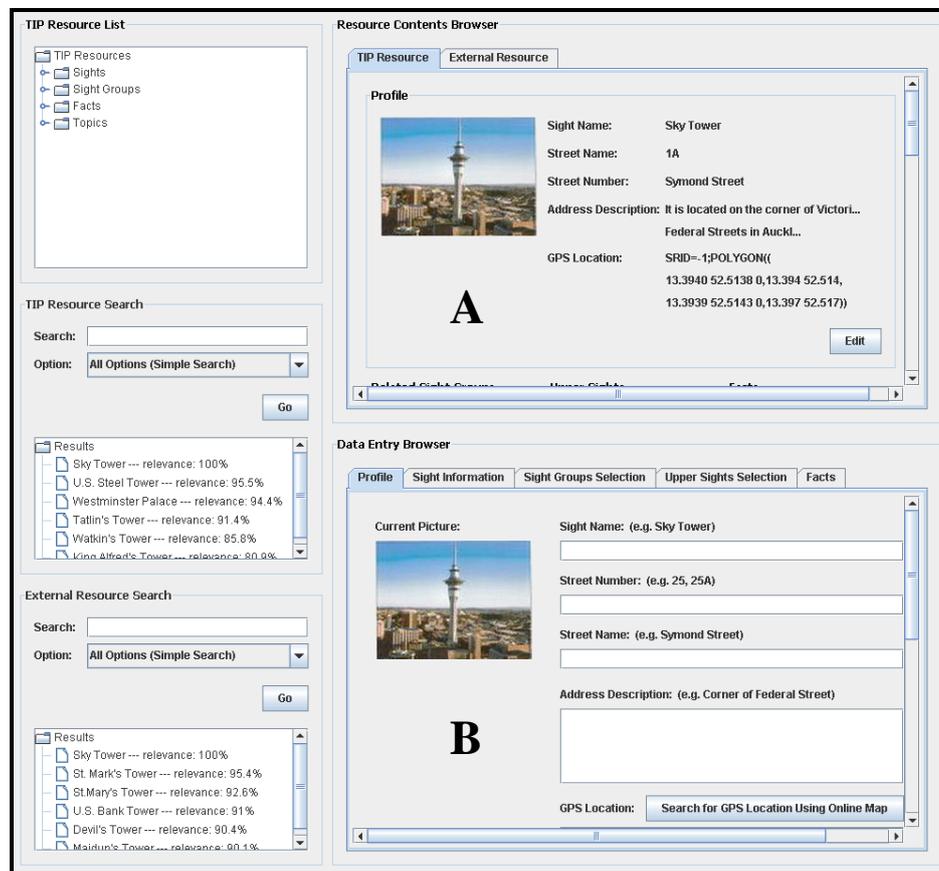
Figure 6.13: Screenshot of the overall structure of the administration service.

Figure 6.14 shows a refinement for PP1 which compensates for the drawbacks identified. According to its layout, the overall structure of the administration service interface is designed in landscape orientation. Also, the resource contents browser (see **Area A** in **Figure 6.14**) and data entry browser (see **Area B** in **Figure 6.14**) have been designed in the capacity of one next to the other. In this prototype, the resource contents and each data entry form can be presented in larger spaces. Thus, the user can more easily read the contents showing in **Area A** and s/he will be clearer about the purpose of each data entry form showing in **Area B**.

By comparing the original design (**Figure 6.13**) with the refinement (**Figure 6.14**), the latter contains the advantage of being able to present resource contents and each data entry form in a clear layout. This supports the user in analysing the contents of each resource and performing the data input, and compensates for the drawback of the

original design. Therefore, **Figure 6.14** has been considered a more appropriate structure to present overall administration service.
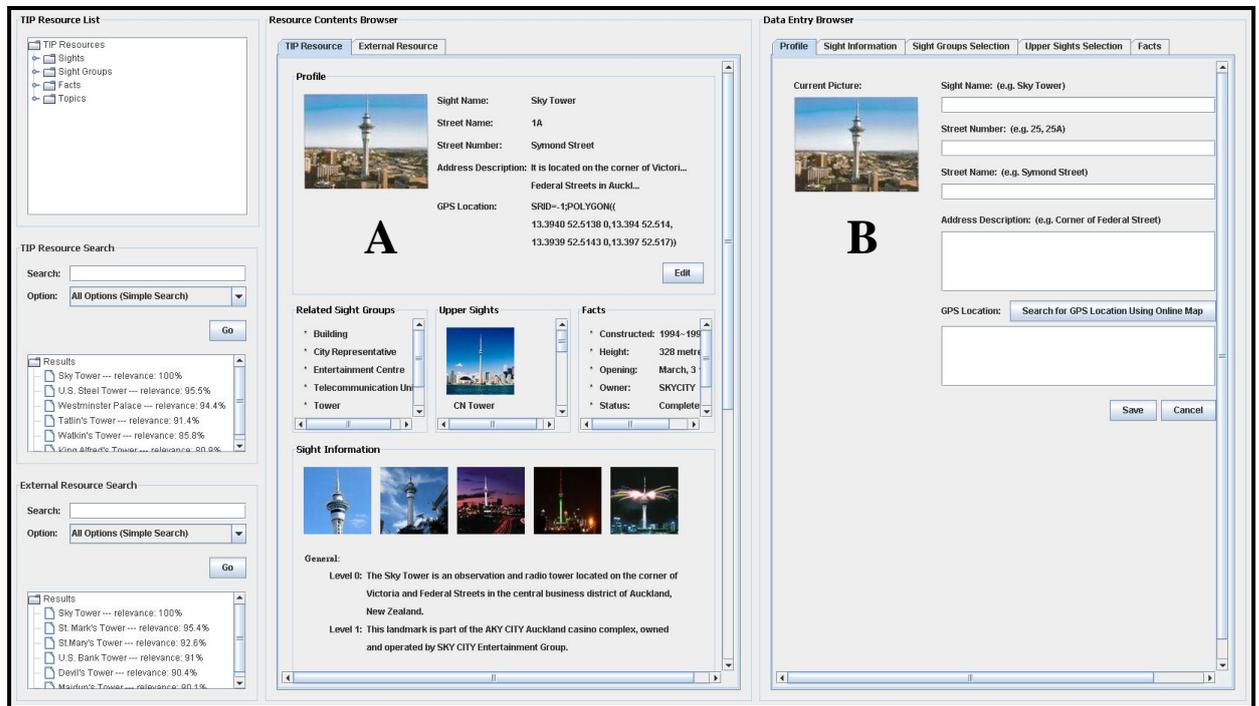
Figure 6.14: Refinement for the overall structure of the administration service.

<u>**SP7: Sight Resource Contents Form (PP6)**</u>

As we have described in PC7 in Section 5.2.3, the sketch of the sight resource contents form (PP6) is designed to support the presentation of sight resource contents. The user can thus access detailed information defined for each sight stored in the TIP database. However, a sight stored in TIP consists of various properties: the sight's profile, its relationships with other TIP resources (sight groups, upper sights, and facts), and its corresponding sight information. With the growth of information defined in these properties, most of the resource contents might not be clearly presented in PP6. The user would require assistance from the scrollbar to access the information. To illustrate this concern, PP6 has been developed in screenshot (**Figure 6.15**).

According to the areas highlighted (**Area A**, **B**, **C**, and **D**) in **Figure 6.15** most of the contents cannot be seen from a direct view. The user has to move the scrollbar up and down to view the contents displayed in these areas. This confirms the concern described in PC7. The structure of PP6 does not clearly present large amounts of

contents information for a sight. To provide compensation regarding this drawback, PP6 has been refined and shown in **Figure 6.16**.
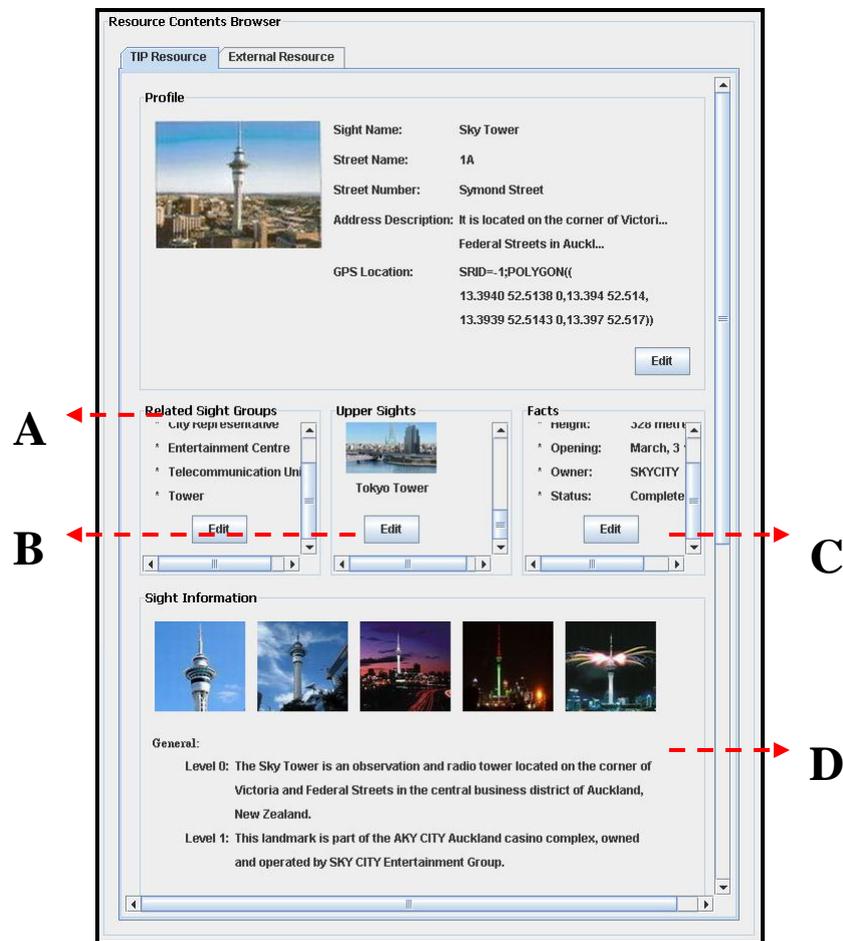
Figure 6.15: Screenshot of the sight resource contents form.

Within the prototype in **Figure 6.16**, the resource contents are hosted in inner tabs and they are presented based on the data structure of a sight. For example, the first tab from left the holds the general properties of a sight (profile, images, related sight groups, upper sights, and corresponding facts) and the subsequent tabs represent the topics defined for a sight. In order to make up for the drawback identified in **Figure 6.15**, the areas appointed in **Figure 6.15** (**Area A**, **B**, and **C**) have been enlarged and presented in the first tab in **Area A**, **B**, and **C** in **Figure 6.16**. Thus, the user can access these contents in one look. Additionally, the prototype in **Figure 6.16** presents sight information in hierarchical structure. The user can click on each tab included in **Area D** in **Figure 6.16** to access the sight information defined according to each topic (e.g., **Figure 6.17** shows the sight information defined in accordance with the topic

"General"). However, when a large amount of information is defined for each property of a sight, the user still requires assistance from the scrollbar to read the contents displayed in the newly-designed prototype (**Figure 6.16**). Because this prototype provides a large space to hold the information of each property, the user can then directly access the contents displayed.
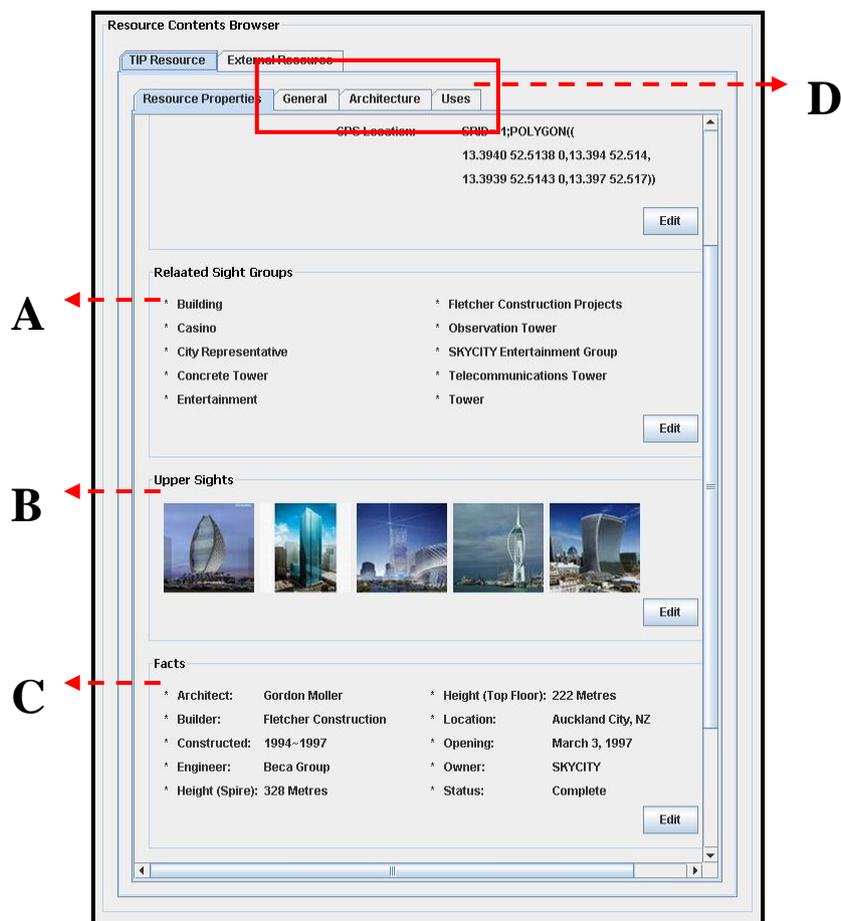
Figure 6.16: Refinement for the sight resource contents form (showing a sight's properties).

By comparing the above prototypes, **Figure 6.16** compensates for the drawback of **Figure 6.15** in that it is unable to clearly present the property information defined for a sight. It displays the information defined for each sight's properties in larger capacity. Hence, the user can directly access the display contents on the screen. Therefore, **Figure 6.16** has been considered a more appropriate prototype to support the presentation of the sight resource contents.
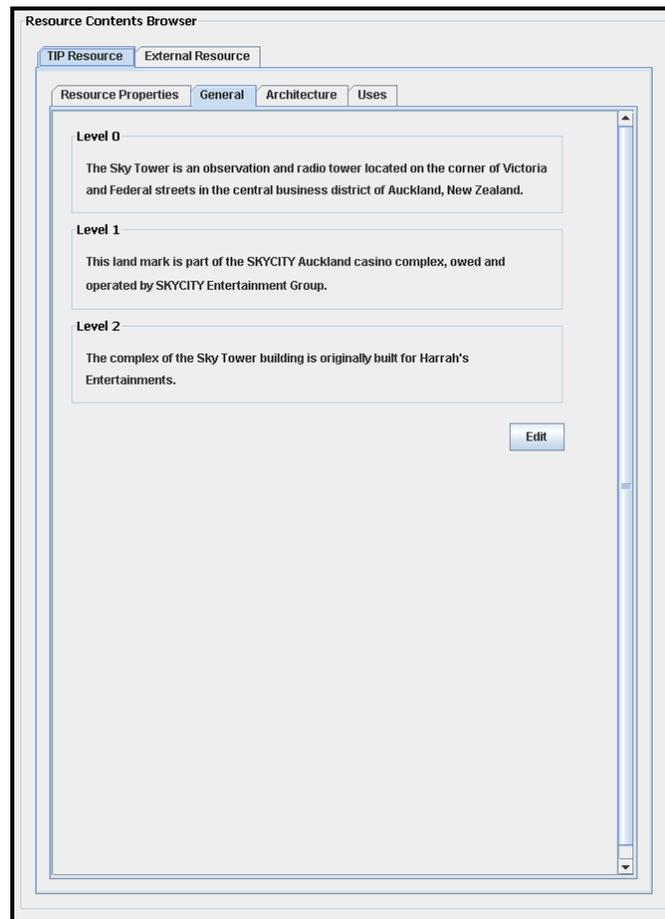
Figure 6.17: Refinement for the sight resource contents form (showing sight information).

6.3 Conclusion

In the above analysis, we proposed the solutions SP1 to SP7 to the concerns PC1 to PC7 identified in Section 5.2. Each solution presents two screenshots as possible refinements for the sketch described in each concern. Based on the pros and cons of each screenshot, a most appropriate refinement has been chosen for the prototype presented in five solutions (SP1, SP2, SP4, SP6, and SP7). Because the refinements for the prototype presented in SP3 (Sight Information Entry Form – PP11) and SP5 (Sight Resource Contents Form – PP6) still contain the drawbacks that restrict the user in performing administration activities (sight information swap or information comparison), we have decided to evaluate these refinements with test users, to study their thoughts about these screenshots and come up with other designs based on their suggestions. In addition, the screenshots presented in other solutions will also be evaluated to understand other people's opinions about these screenshots. The evaluation result for screenshot prototypes is presented in Section 8.1. Also, the

accessibility of screenshots in relation to requirements identified in Section 3.2 is evaluated in Section 8.2.

Section 7 Solutions to Interaction Concern

To solve the interaction concerns that have been described in Section 5.3, three interactions were designed to support sight information insertion:

1) Source Highlight – is a way of presenting the contents that have been selected for various input actions.

2) Drag-and-Drop Input – is a way of presenting the source contents that have been transferred through drag-and-drop input.

3) Sight Information Refinement – is a way of refining the transferred data into levels of detail in the data entry form.

In this section, we go through each interaction via screenshot prototypes and discuss the alternatives designed for these interactions based on their advantages and shortcomings. **Table 7.1** outlines each interaction with corresponding alternatives, and the subsequent sections describe each alternative in detail.

Interface interaction at left-hand side of the administration service interface: (in the Resource Contents Browser)	Interface interaction at right-hand side of the administration service interface: (in the Data Entry Browser)
Source Highlight IS1: Highlight without the Allowance of Overlaps IS2: Highlight with the Overlaps Overwritten IS3: Highlight with the Allowance of Overlaps **Drag-and-Drop Input** IS4: Copy-on-Drag IS5: Cut-on-Drag IS6: Grey-on-Drag	**Sight Information Refinement** IS7: Information Refinement in One Field IS8: Information Refinement in Multiple Fields IS9: Information Refinement in Tree View

Table 7.1: Alternatives for "Source Highlight", "Drag-and-Drop Input" and "Sight Information Refinement".

7.1 Source Highlight

The highlight operation is the prelude of the drag-and-drop information input. It is the action indicating the contents that have been selected for the drag-and-drop input. Its purpose in administration service is not just to make the required contents stand out, but also mark the background of the contents selected from a resource before each input action; and match up the contents with a corresponding topic defined for a sight. **Figure 7.1** presents a sample screenshot showing the action flow of source highlight. Based on this diagram, the action to highlight the source contents can be manipulated in the following activity sequence:

1) In data entry browser, perform the information distribution to define a topic (e.g., Architecture) for a sight (see **Area A** in **Figure 7.1**).

2) Move the mouse cursor over the specified topic and press the mouse button (right-click) to activate the colour list (**Area B** in **Figure 7.1**).

3) Select a colour (e.g., Blue) from the **Area B** to define a representative colour for the topic defined in Step 1.

4) In resource contents browser, select the required contents (**Area C** in **Figure 7.1**).

5) Move the mouse cursor over the selected contents and press the mouse button (right-click) to display the topics that are defined in the data entry browser (see **Area D** in **Figure 7.1**).

6) Select the topic that is defined in Step 1 from **Area D** to change the background colour of the selected area to blue.

7) Perform the drag-and-drop information input (i.e., dragging information highlighted in **Area C** to **Area E**.).

Based on this sequence, Steps 1 to 7 can be repeated to proceed with the highlighting of other topics and Step 5 can be repeated to associate the contents included in a highlighted area to a different topic or to deselect the highlighted contents.
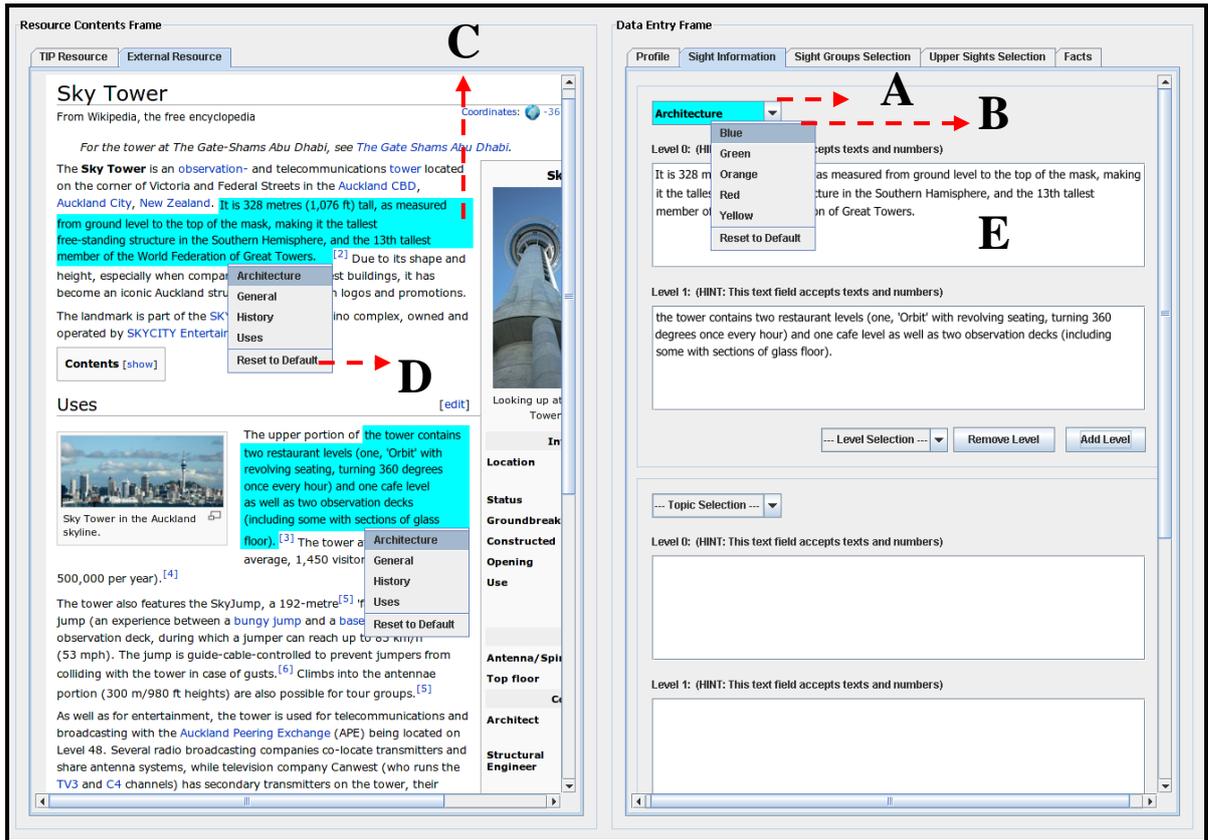
Figure 7.1: Action flow of "Source Highlight".
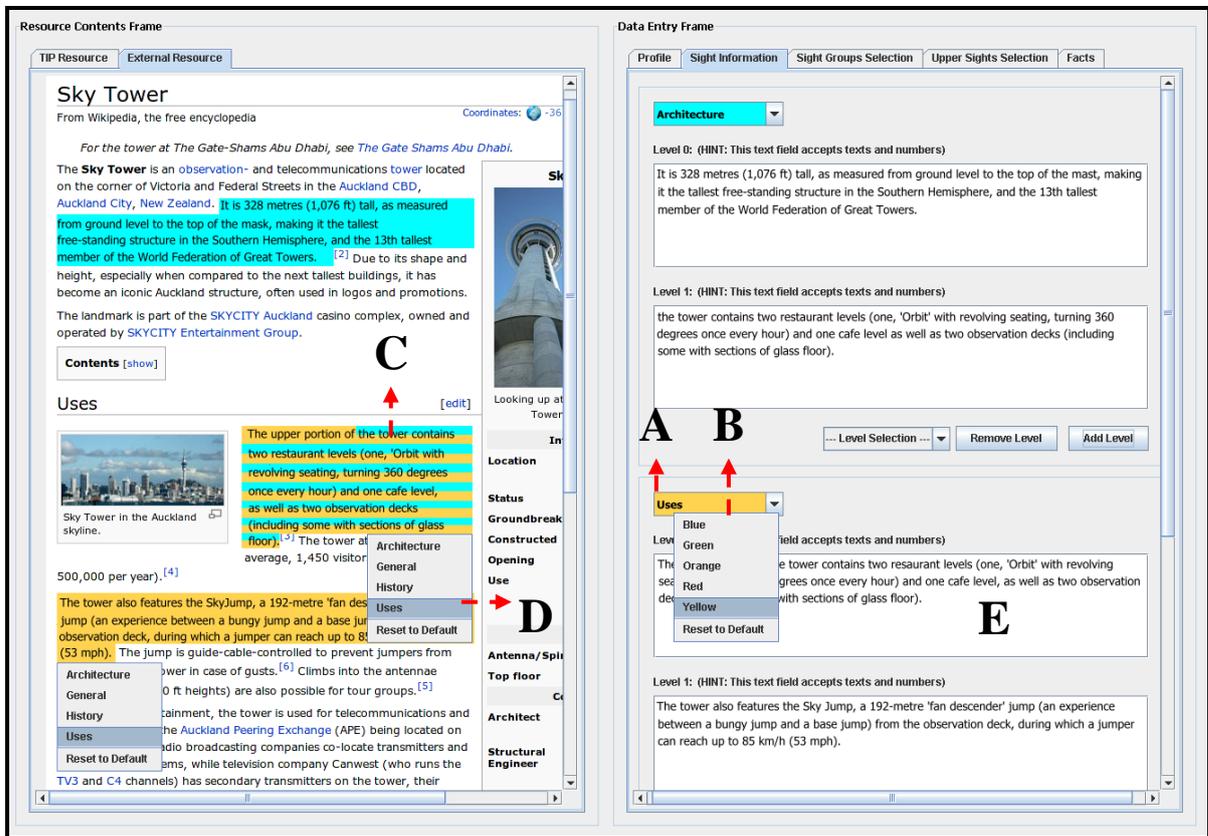
Figure 7.2: Screenshot for showing the overlap issue.

The following sequence (Step 8 to 14) is provided for the introduction of alternatives (IS1, IS2, and IS3) designed to address the overlaps issue. **Figure 7.2** presents a screenshot showing the action flow for Step 8 to 14.

8) Process the information distribution to define second topic (e.g., Uses) to a sight resource (see **Area A** in **Figure 7.2**).

9) Move the mouse cursor over the second topic and press the mouse button (right-click) to activate the colour list (see **Area B** in **Figure 7.2**).

10) Select a colour (e.g., Yellow) from the **Area B** to define a representative colour for second topic.

11) Select the required contents from the resource (**Area C** in **Figure 7.2**).

12) Move the mouse cursor over the selected contents and press the mouse button (right-click) to display the topics that are defined in the data entry browser (see **Area D** in **Figure 7.2**).

13) Select the topic that is defined in Step 8 from **Area D** to change the background colour of the highlighted area to yellow.

14) Process the drag-and-drop information input (i.e., dragging information highlighted in **Area C** to **Area E**.).

Note that the manipulation of source highlight, some contents that have been selected for the input of a topic (e.g., Architecture) may join up with unselected contents to form the requirement of another topic (e.g., Uses). Also, the selected contents themselves may be categorised into other topics. This produces an overlap between the two pieces of the information contents (see **Area C** in **Figure 7.2**). To address the issue of the overlaps, three alternatives for source highlighting have been designed: (1) "Highlight without the Allowance of Overlaps", (2) "Highlight with the Overlaps Overwritten", and (3) "Highlight with the Allowance of Overlaps".

IS1: Highlight without the Allowance of Overlaps

Figure 7.3 shows the screenshot under the condition of no overlaps allowed. By referring to the activity sequence of the highlight operation to this diagram, the overlap between the two pieces of the information contents would be marked using the representative colour of the first topic (e.g., Architecture). This means even though the yellow is chose for the emphasis of topic-two (e.g., Uses) contents in Step

13, the overlap that has been highlighted in Step 11 would still be marked in blue (see rectangular area in **Figure 7.3**).
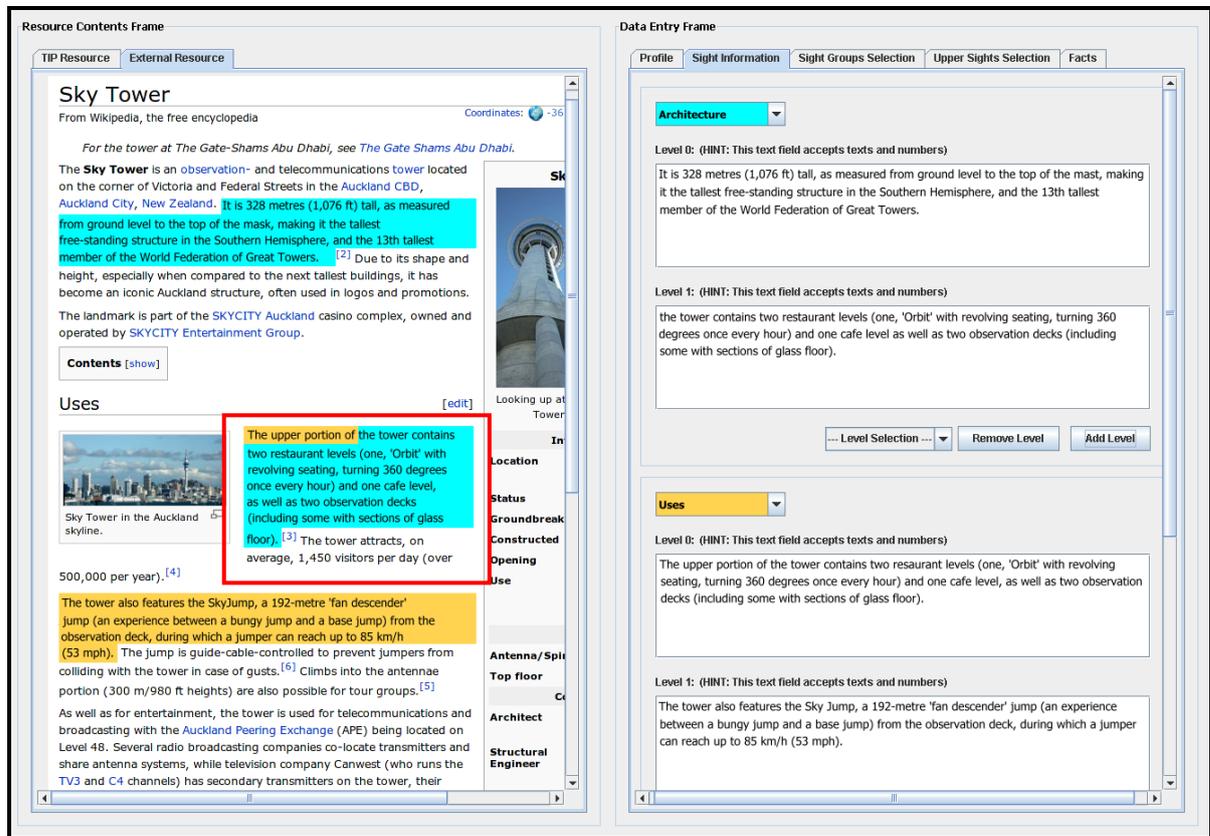
Figure 7.3: Outcome of "Highlight without the Allowance of Overlaps – IS1".

This design has the advantage of avoiding the de-selection of the texts highlighted for first topic (e.g., Architecture). However, this design restricts the display of the colour defined for topic-two in the overlap. In other words, the highlight that indicates that contents transferred according to second topic would become fragmented from the source contents.

IS2: Highlight with the Overlaps Overwritten

Alternatively, the highlight operation can also be contributed towards the opposite of IS1; overwriting the overlap using the colour of the second topic. The screenshot of this alternative is presented in **Figure 7.4**. By referring to the activity sequence of the source highlight to this diagram, the overlap aims to be marked in yellow after Step13 (see rectangular area in **Figure 7.4**).
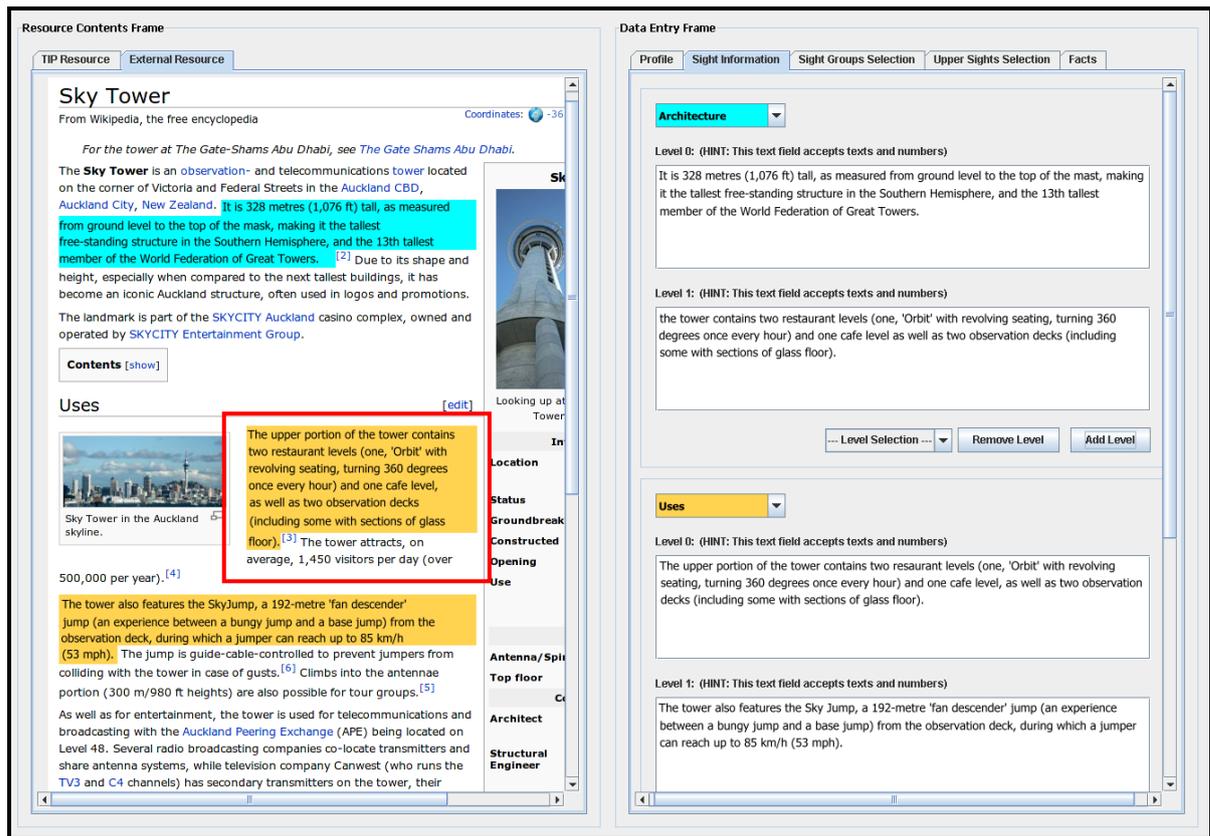
Figure 7.4: Outcome of "Highlight with Overlaps Overwritten – IS2".

Having the overlaps overwritten by the colour of the second topic (e.g., Uses) shows the texts that are highlighted according to topic-two from the resource. Nevertheless, with this design, the highlight that refers to the contents transferred according to first topic (e.g., Architecture) would be deselected from the overlap. This means the user would not be able to track down the entire topic-one contents from the resource through topic-one's representative colour.

IS3: Highlight with the Allowance of Overlaps

The third alternative of source highlight allows the overlaps. **Figure 7.5** presents the screenshot of this design. By having the activity sequence of the highlight operation referred to this diagram, the overlap would be marked in both blue and yellow after Step 13 (see rectangular area in **Figure 7.5**). Similarly, if the overlap is highlighted again to emphasise the reference of other topics, multiple colours would be marked to address this area.
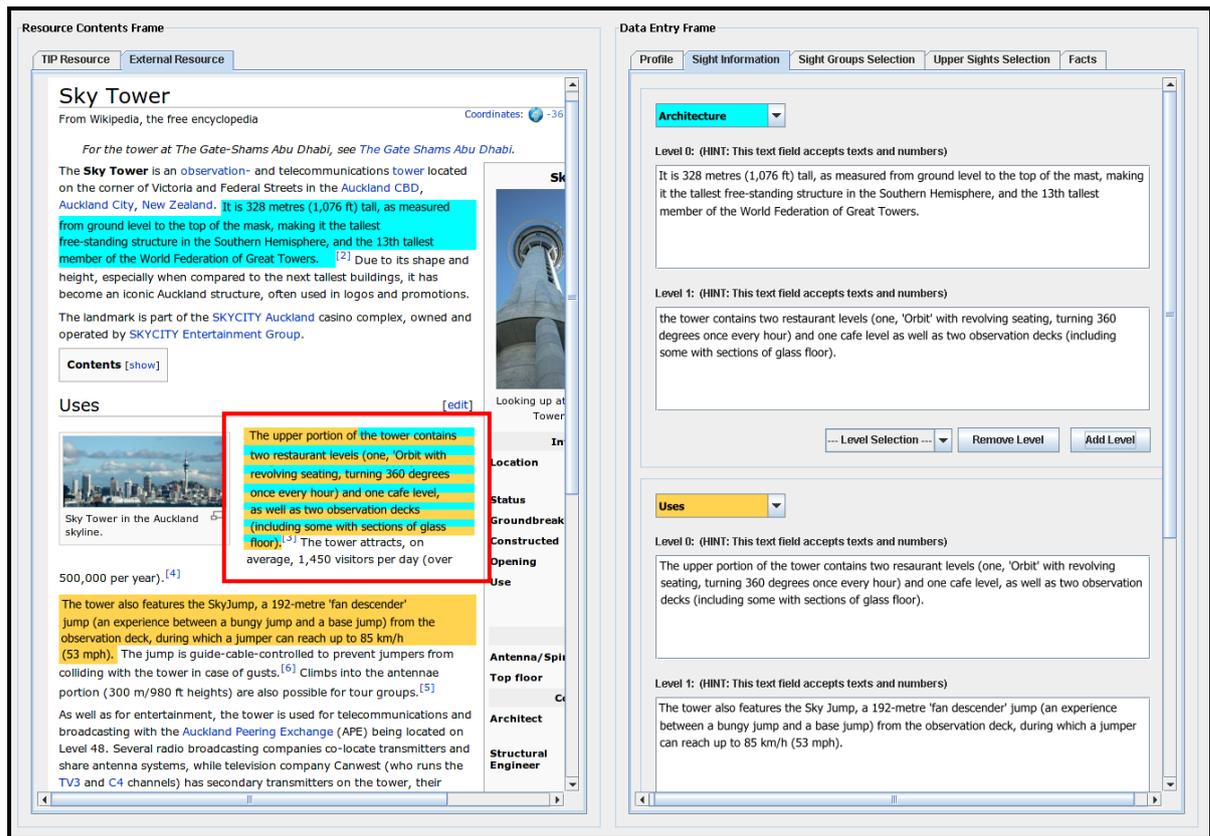
Figure 7.5: Outcome of "Highlight with the Allowance of Overlaps – IS3".

This design contrasts sharply with IS1 and IS2. It has the advantage of emphasising the texts highlighted for multiple topics, so the user is able to trace the origin of the contents transferred according to each topic. However, considering the area to display texts in a row is limited, having multiple colours highlighted on the same texts would negatively affect the visual appearance of the overlap. This may hinder the user in clearly reading the highlighted contents.

7.2 Drag-and-Drop Input

Following the source highlight, the drag-and-drop action manipulates the data transformation; transferring the contents that are highlighted from the resource to the input components provided in data entry browser through mouse motion. **Figure 7.6** demonstrates action flow of drag-and-drop input. Based on this figure, the activity sequence of drag-and-drop is generated as follows:

1) Press the mouse button (left-click) to hold on the highlighted information contents (**Area A** in **Figure 7.6**).

2) Drag the contents to a location (e.g., **Area B** in **Figure 7.6**) in the data entry browser.

3) When the contents reaches the location, release the mouse button to place them into the input component.
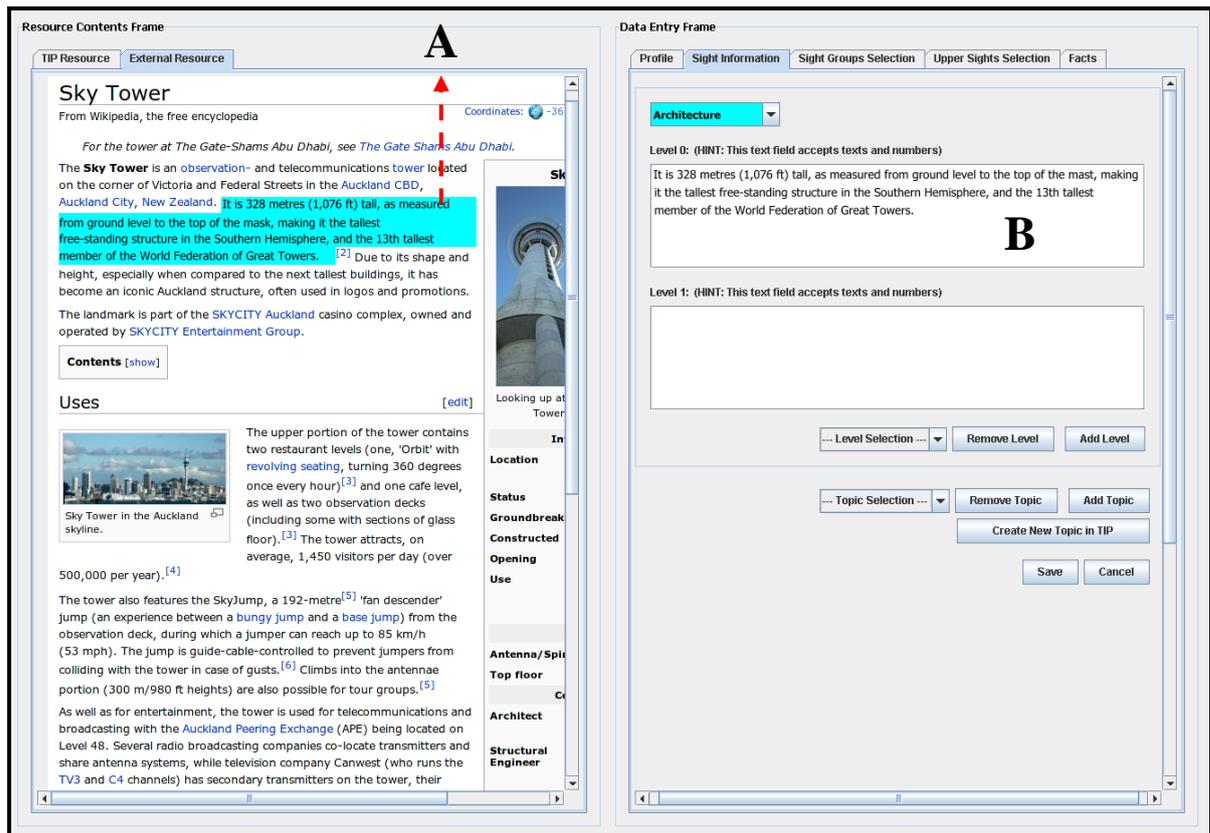
Figure 7.6: Action flow of "Drag-and-Drop Input".

However, at the end of drag-and-drop input, the behaviour of highlighted contents can vary in different drag-and-drop patterns: (1) "Copy-on-Drag", (2) "Cut-on-Drag" and (3) "Grey-on-Drag". To give a clear picture of these patterns, their descriptions are provided in the following paragraphs. Each pattern is introduced based on the activity sequence and a supporting diagram.

IS4: Copy-on-Drag

Under the condition of copy-on-drag, the drag-and-drop operation is functioning as copy-and-paste. It makes a copy of highlighted contents and places them into the data

entry form. By having the drag-and-drop activity sequence applied to this operation, the contents highlighted from the resource remains unchanged at the end of the drop action (see **Area A** in **Figure 7.6** – the outcome of this operation is same as the screenshot shown in Figure 7.6, so we are not presenting it again for this operation.)

Based on the outcome of this design, the contents highlighted from the resource can be reused for multiple topics. However, it is essential for this approach to cooperate with the highlight operation, because the reference to the transferred contents would not be shown in the copy-on-drag. The user would not be able to visually track the contents that have been transferred in each input action. This can cause the error of duplicate information input; having same information inserted to an individual topic

IS5: Cut-on-Drag

Figure 7.7 presents the screenshot of drag-and-drop input under the condition of cut-on-drag.
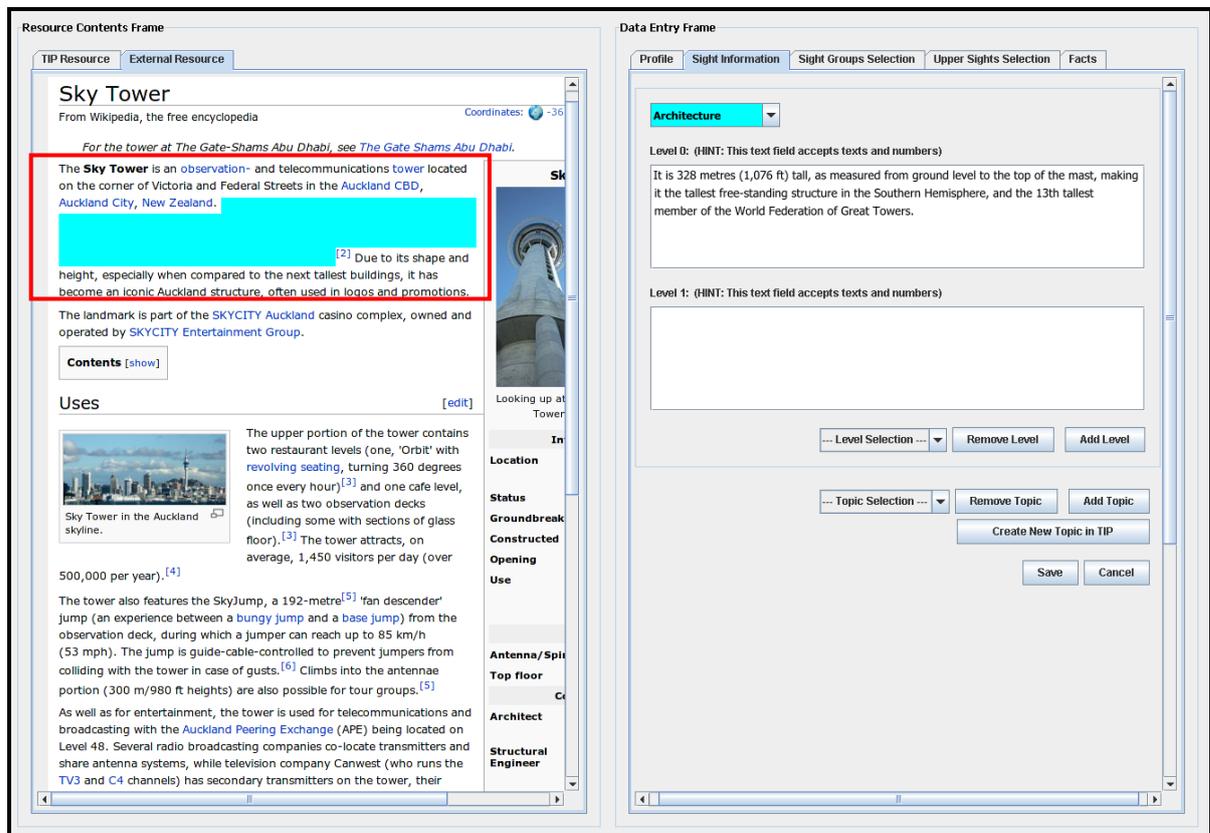
Figure 7.7: Outcome of "Cut-on-Drag – IS5".

By applying the drag-and-drop sequence to the diagram in **Figure 7.7,** the outcome of cut-and-paste data transformation would be reached. This means the contents that have been highlighted from the resource would be erased at the end of drag-and-drop operation (see rectangular area in **Figure 7.7**).

With the contribution of cut-on-drag, the contents of a resource would no longer be reusable; meaning the contents displayed in the resource contents browser can only be transferred to fulfil the input of one topic. This design can be an alternative to conduct which portions in a resource have been transferred in previous input actions, but it would not be able to show the exact transferred contents in the source contents.

I6: Grey-on-Drag

Figure 7.8 presents the screenshot of drag-and-drop input under the condition of grey-on-drag.
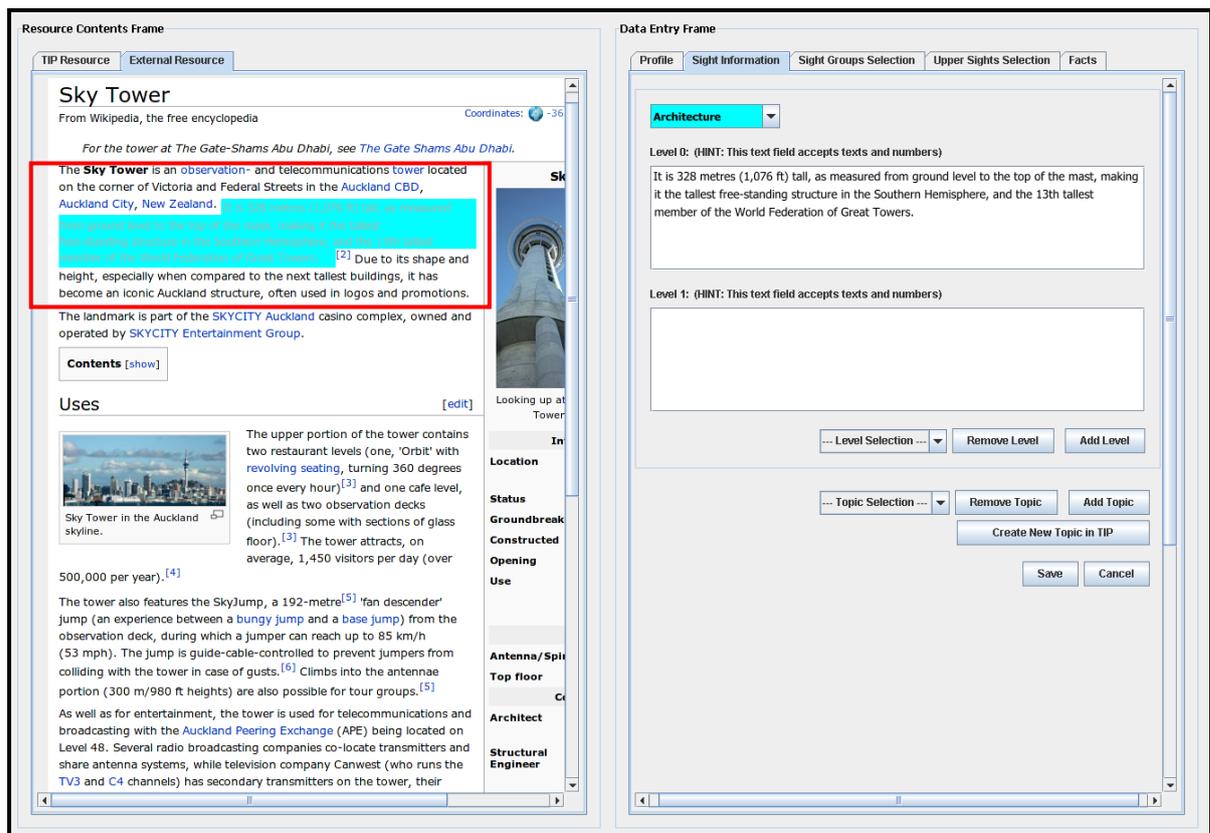
Figure 7.8: Outcome of "Grey-on-Drag – IS6".

The grey-on-drag is designed in simulation of the highlight operation; however, instead of changing the background colour of highlighted area, this operation takes effect on the highlighted contents. By applying the drag-and-drop activity sequences to this approach; at the end of drag-and-drop input, the information contents highlighted in the resource contents browser would be marked in grey (see rectangular area in **Figure 7.8**).

This design combines the advantage of IS4 and IS5. It allows the user to leave a trace on the contents that have been transferred in previous input action, as well as to reuse the transferred contents to fulfil the input of different topics. However, with this design, the user can only indicate the contents that have been transferred from a resource. It would be difficult for him/her to visually identify the transferred contents according to each topic, since all of them are marked in grey.

7.3 Sight Information Refinement

The sight information refinement is the operation contributed in the data entry browser. It is a way of categorising the sight information into various topics, as well as to refine the information into levels of detail. Unlike the nature of the previous two operations, the activity sequence of information refinement can vary depending on the structural design of the data entry browser. The following describes this operation based on three alternatives, and each alternative is propped up with a corresponding activity sequence and screenshot.

IS7: Sight Information Refinement in One Field

The first alternative of sight information refinement is to have the input contents refined in a text field. This design uses the scheme of source highlight where the inserted contents (i.e., the contents that have been transferred according to a topic defined for a sight) can be refined into levels using different colours. Each colour is chosen to emphasise the contents of one level. The screenshot that shows the action flow of this operation is presented in **Figure 7.9**, and a seven-step activity sequence is generated based on the diagram.
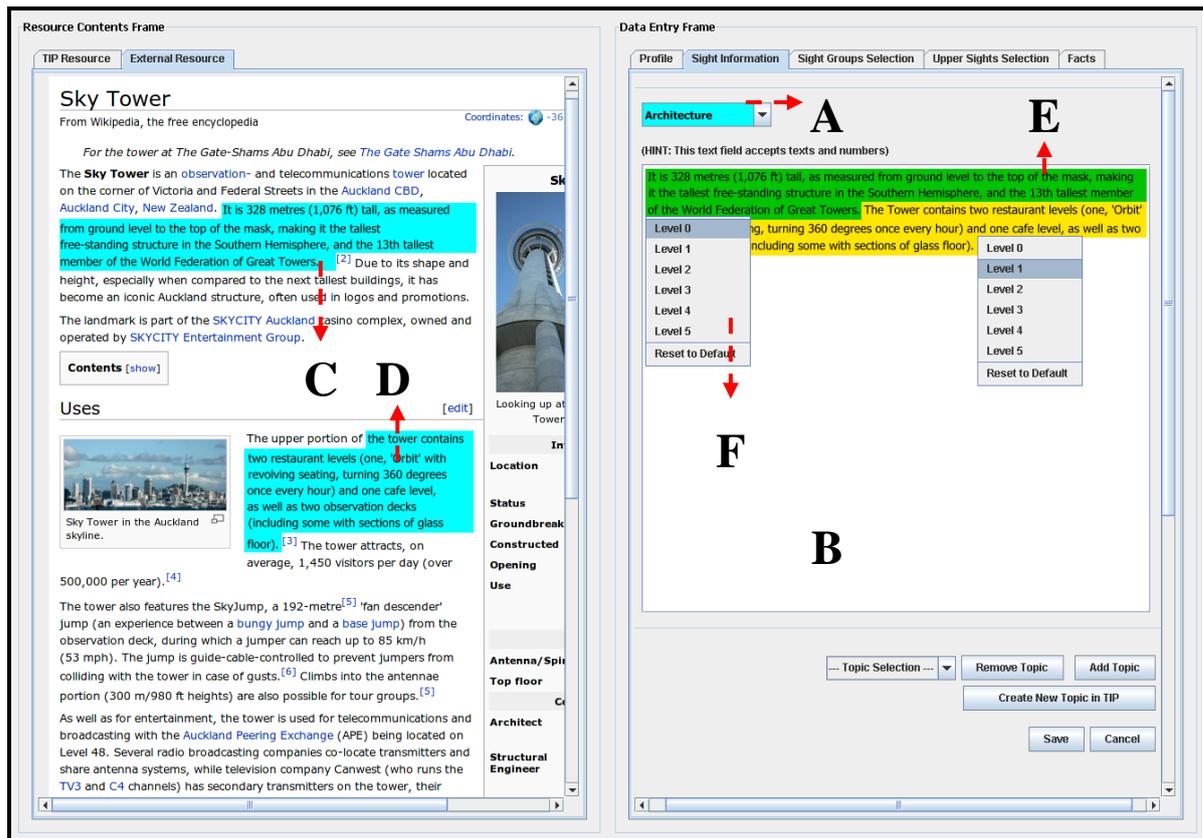
Figure 7.9: Action flow of "Information Refinement in One Field – IS7".

1) In the data entry browser, left-click on "Add Topic" button to enable input components (i.e., the topic selection box (**Area A**) and the text field (**Area B**).

2) Select a topic (e.g., Architecture) from the topic selection box (**Area A**).

3) In resource contents browser, process "Source Highlight" to highlight required contents (**Area C** and **Area D**) according to the topic defined in Step 1.

4) Perform drag-and-drop operation to input the highlighted contents into the text field that is provided in data entry browser (i.e., dragging information highlighted in **Area C** and **Area D** to **Area B**).

5) Based on the contents that have been input in the text field, highlight the contents of a level (**Area E**).

6) Move the mouse cursor over the highlighted area (**Area E**) and press the mouse button (right-click) to activate the level list (**Area F**).

7) Select a level number (e.g., Level 0) from the list (**Area F**) to specify the level of highlighted contents and change the background colour of highlighted area based on the colour that is pre-defined for the selected level.

Based on the above sequence, Steps 1 to 2 can be repeated for defining new topics to a sight; and Steps 5 to 7 can be repeated for refining input contents into various levels.

If a large amount of information contents is transferred from the resource, this design has the advantage of being able to economise on the space that is required to host the transferred contents. However, after the input action, the contents of each level can be located at any portion in the text field. Having the information refined in one field may cause difficulties for the user to identify the accent of each level.

IS8: Information Refinement in Multi-Fields

Alternatively, the contents that are transferred from a resource can also be refined through multiple text fields. Within this design, the refinement of contents inserted is manipulated by interface components (i.e., buttons and text fields), and each field provided in the data entry browser is intended to accommodate the contents of one level only. **Figure 7.10** presents the action flow of this operation. Based on this figure, a six-step activity sequence is generated as follows:

1) In the data entry browser, left-click on "Add Topic" button to enable input components (i.e., the topic selection box (**Area A**) and the text field (**Area B**) provided for the entry of level-zero contents).
2) Select a topic (e.g., Architecture) from the topic selection box (**Area A**).
3) In the resource contents browser, according to the topic defined in Step 2, perform the "Source Highlight" to highlight the required contents (e.g., contents in **Area C**) which intend to be stored in level zero.
4) Perform drag-and-drop operation to input the highlighted contents into the text field enabled in Step 1 (i.e., dragging information in **Area C** to **Area B**).
5) In the data entry browser, left-click on "Add Level" button to enable the text field (**Area D**) for level-one contents.
6) Repeat Steps 3 to 4 for the information input.

Based on the sequence designed for the alternative (IS8), Steps 1 to 2 can be repeated for defining new topics to a sight; and Step 5, 3, and 4 can be repeated for the refinement of other contents which are intended to be categorised to the topic specified in Step 2.
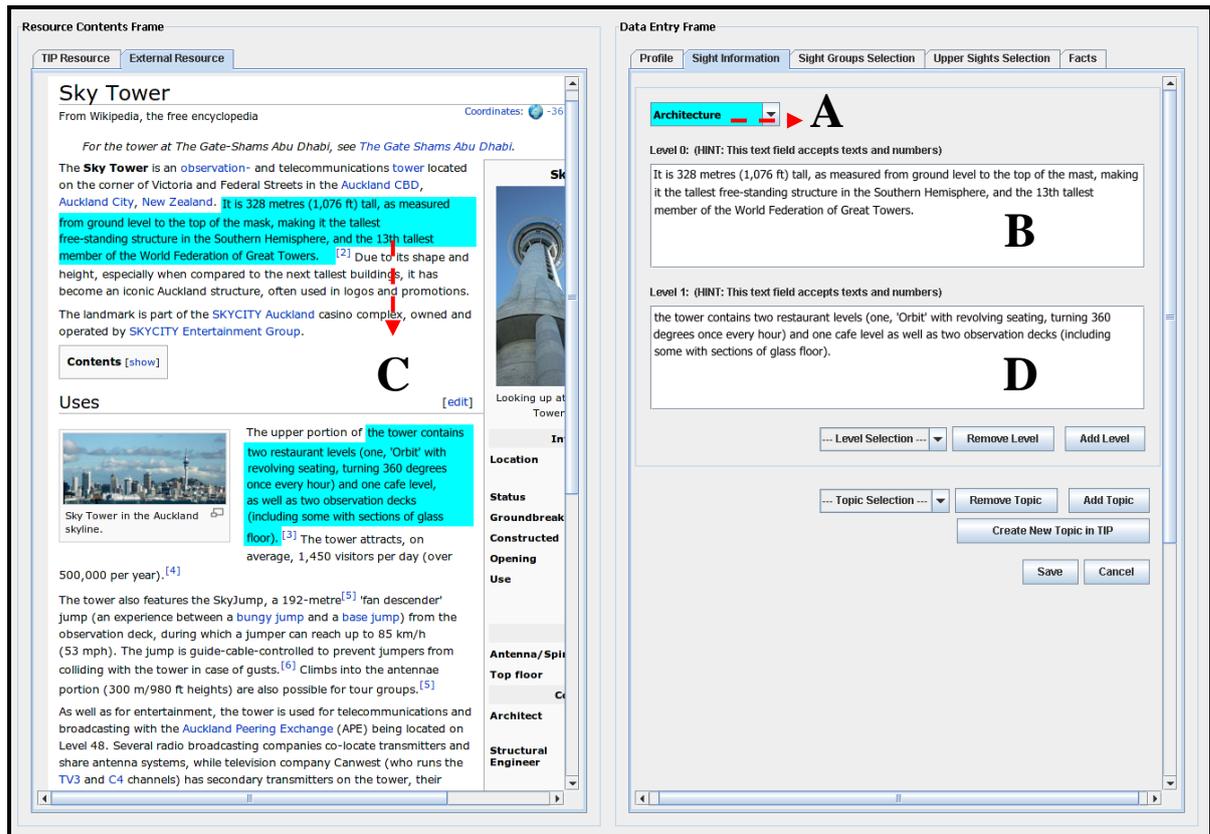
Figure 7.10: Action flow of "Information Refinement in Multiple Fields – IS8".

This design contrasts with IS7. Having the transferred contents refined in multiple text fields, the emphasis of each level can easily be identified. Nevertheless, while the scheme of a sight is growing, the size of data entry form might be restricted to host too many input components, and the overview of information transferred would be hard to track down from the data entry form.

IS9: Information Refinement in Tree View

The third alternative of information refinement is proposed to refine the contents transferred in tree view. This approach is designed in simulation of sight information structure (**Figure 2.1**) where the resource contents that have been categorised according to each topic can be separated out into levels using the child nodes that are inserted under each topic node. Of course, each topic that is defined to a sight can be clarified using a child node that is inserted under the sight. **Figure 7.11** presents the screenshot showing the action flow of this operation. Based on this figure, the activity sequence of the operation can be generated in six steps.
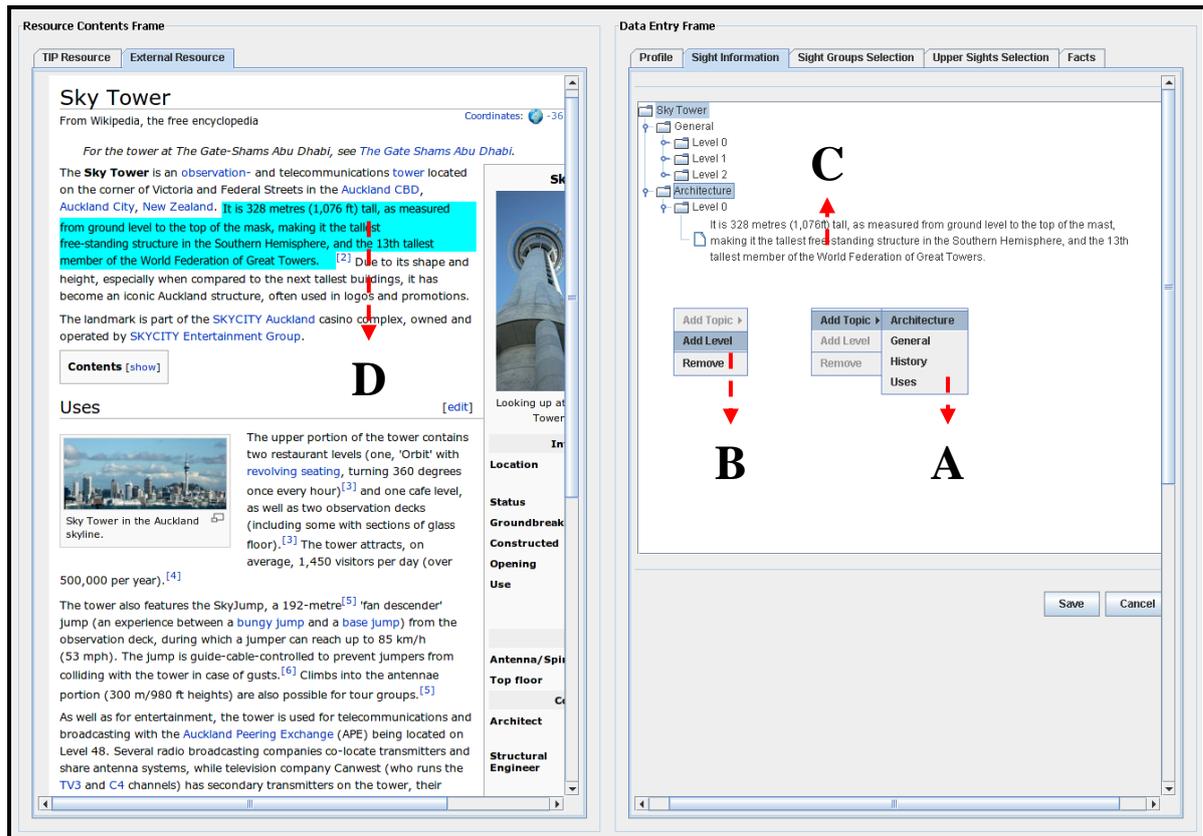
Figure 7.11: Action flow of "Information Refinement in Tree View – IS9".

1. Move the mouse cursor over the sight name and press the mouse button (right-click) to activate the action list (**Area A**).

2. In **Area A**, define a topic to the sight (e.g., Architecture).

3. Move the mouse cursor over the topic defined in Step 2 and press the mouse button (right-click) to activate the action list (**Area B**).

4. Select "Add Level" from **Area B** to reserve a hierarchical position for input contents (e.g., **Area C**).

5. In the resource contents browser, according to the topic defined in Step 2, perform "Source Highlight" to highlight the required contents (e.g., the contents in **Area D**).

6. Perform drag-and-drop operation to place the highlighted contents under the level specified in Step 4 (i.e., dragging information in **Area D** to **Area C**).

Based on the sequence designed for this alternative (IS9), Steps 1 to 2 can be repeated for defining new topics to a sight; and Steps 3 to 6 can be repeated for refining input contents into levels of detail.

Similar to the alternative (IS7), within this conception, more spaces can be conserved to accommodate a large amount of transferred contents. Moreover, this approach has the advantage of being able to show the overview of information transferred according to each topic defined in the data entry browser. However, after the import of a large amount of contents, some of transferred information will not be directly seen in the data entry browser. The user will have to control the scrollbar to view the information that has been transferred to a sight.

7.4 Conclusion

In the above analysis, we proposed the solutions IS1 to IS9 for the interaction questions identified in Section 5.3. Each solution has been introduced using an interaction model. Each interaction model represents an alternative for "Source Highlight", "Drag-and-Drop Input", or "Sight Information Refinement". To find the most appropriate alternatives from these interactions to support the insertion of sight information, the interaction models that are described in this section will be evaluated with test users to study their actions in performing sight information insert. The evaluation procedure and result for the insertion of sight information is described in Section 8.3.

Section 8 Evaluation

In this section, we describe our user evaluation of the screenshot prototypes presented in Section 6.2. We also present a quantitative evaluation of screenshot prototypes. The criterion of this evaluation was to meet the requirements identified in Section 3.2. Finally, in the quantitative evaluation, we study people's interactions in inserting sight information to find out a most appropriate interaction procedure for the sight information insert operation.

8.1 User Evaluation of Screenshot Prototypes

A user evaluation has been conducted to evaluate other people's satisfaction with the screenshot prototypes presented in each solution in Section 6.2. To find out the most appropriate prototype for each component that takes part in the administration service interface, the people involved in the evaluation need to have knowledge of TIP's existing administration service. Thus, the people who have been recruited as participants in the evaluation are guests of the ISDB group. They had been researching on the TIP system for at least five months at the time the study was performed. Note that the screenshot prototypes introduced in Section 6.2 will once again be presented in this section to support the explanation of evaluation results.

8.1.1 Prototype Evaluation Result Analysis

In the following, we describe the evaluation result for screenshot prototypes. Because the evaluation session was conducted with a group of participants (guests of the ISDB group), the participants' comments for each screenshot will be analysed in aggregate manner.

SP1: Data Entry Browser (PP2)

As we have described in PC1 in Section 5.2.1, there is no indicator showing the priority of each tab in the sketch of data entry form (PP2). In order to compensate for this concern, two prototypes were designed and presented in screenshot as refinements of PP2 in Section 6.2.1. These prototypes are shown in **Figure 8.1** and

Figure 8.2. The prototype shown in **Figure 8.1** is designed with a guideline showing the priority of each tab. It has the advantage of being able to show a complete input structure of a TIP resource; but the user can still access each tab freely, so the contents of a TIP resource can still be inserted in the wrong order. In contrast, the rptotype shown in **Figure 8.2** enforces the user to define the contents of a TIP resource in a fixed order by presenting each data entry form one at a time. The user must complete each form and click on a "Next" button to proceed with insertion. Even though **Figure 8.2** might not be ideal for an inexperienced user, it ensures the inserted contents to be stored into the database. In addition, sample data is provided in each data entry form to assist the user in performing the insert (see rectangular area in **Figure 8.2**). Therefore, our expectation was that **Figure 8.2** would be a more applicable refinement for PP2. However, a different viewpoint has been brought up during the evaluation and it is described as follows.
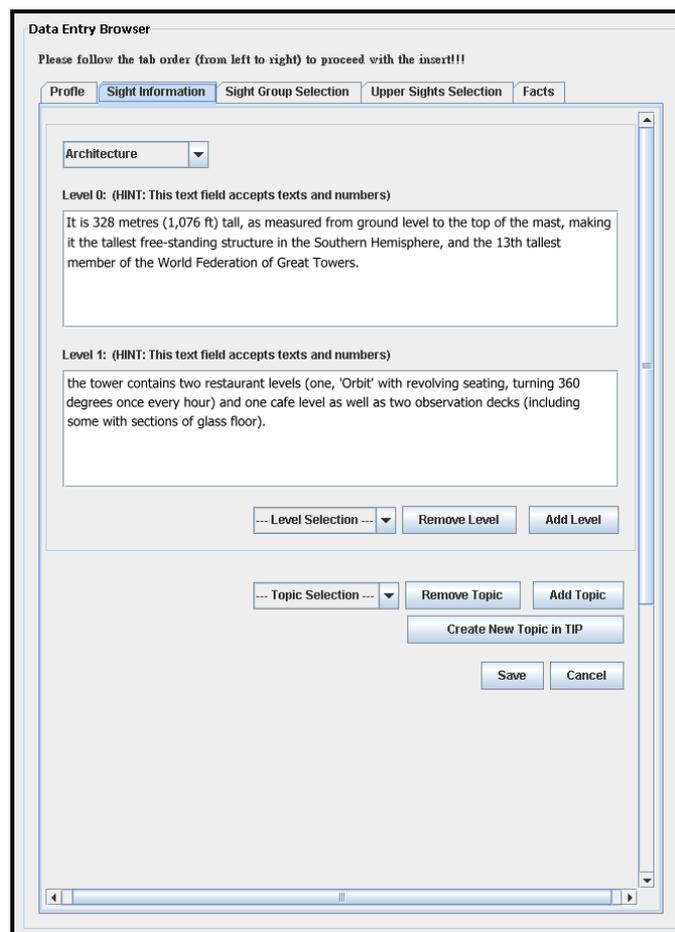
Figure 8.1: Screenshot of first refinement for the data entry browser

(originally introduced in **Figure 6.1**).
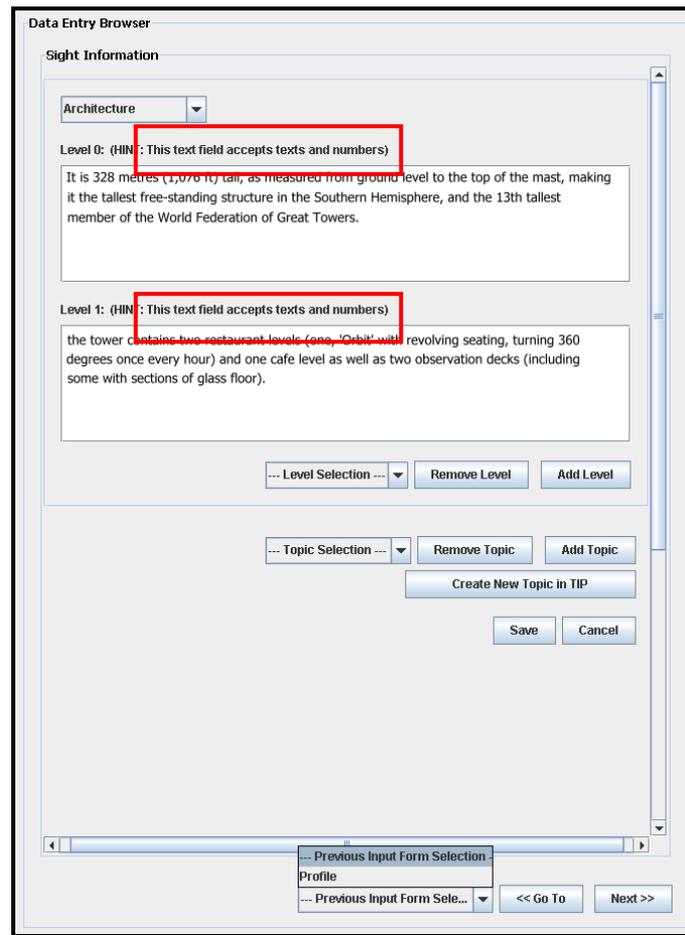
Figure 8.2: Screenshot of second refinement for the data entry browser

(originally introduced in **Figure 6.2**).

It was the participants' preferences to use the prototype shown in **Figure 8.1** for data entry. They commented that this prototype presents a clear overview of the input structure of a TIP resource. From the guideline that is provided in this prototype, they were informed about the priority of each tab. It was their consensuses that the user might accidentally access a wrong tab and thus perform the insertion in wrong order, so they suggested modifying this prototype into the structure that is presented in **Figure 8.3**.

In the prototype shown in **Figure 8.3**, **Area B** is disabled while performing the insertion in "Profile" tab (**Area A**). From there, the user can still select the tabs involved in **Area B** to check the data entry structure of a TIP resource, but s/he cannot perform any input in these tabs. When the information inserted in a former tab (e.g., the "Profile" tab) is stored into the TIP database, the system enables the following tab (e.g., the "Sight Information" tab) for the user to proceed with the insert.
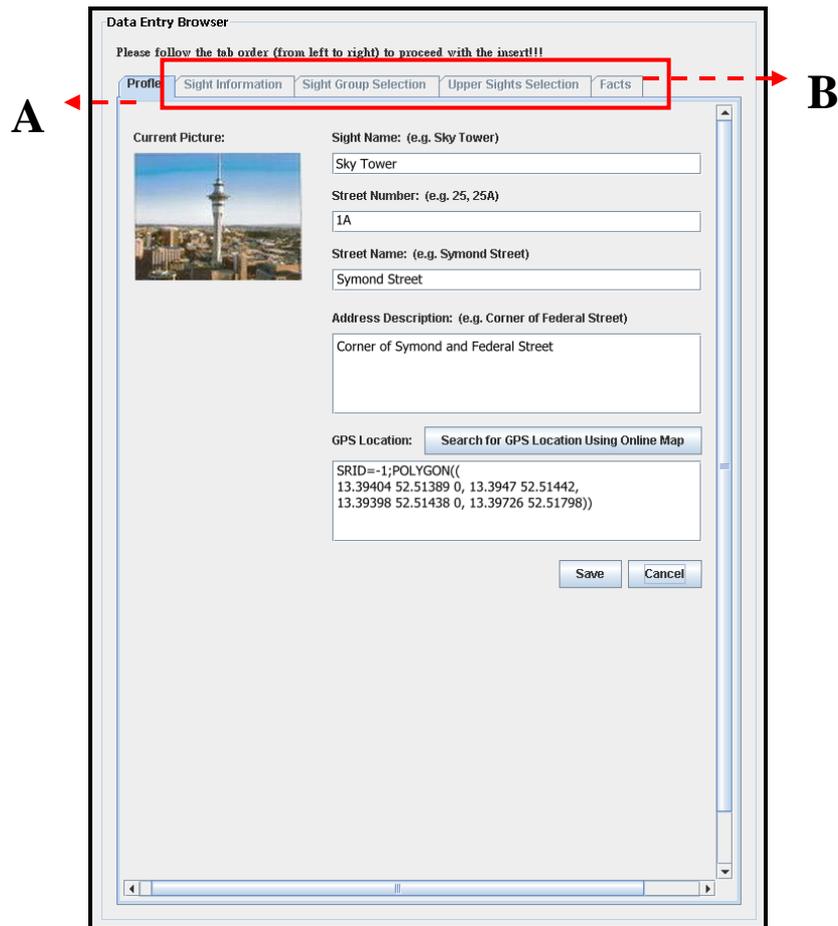
Figure 8.3: Screenshot of the refinement for the data entry browser suggested by participants.

This prototype avoids the shortcomings of **Figure 8.1**. The user is no longer able to perform the insert in each tab freely. Compared to **Figure 8.2**, both prototypes ensure the contents of a TIP resource are inserted in a fixed order. **Figure 8.3** is more flexible to use for both expert and inexperienced users. It presents a complete data entry structure of a TIP resource, so the user is informed about the information that should be inserted in order to define a TIP resource. Based on these advantages, we see the prototype shown in **Figure 8.3** to be the most appropriate refinement for the sketch of the data entry browser (PP2).

SP2: TIP Resource Browser (PP4)

According to the concern described in PC2 (see Section 5.2.1), the user can access TIP resource contents by selecting a resource from the TIP resource browser (PP4) and employing the system to extract resource contents from the database. However, this action flow differs from the activity sequence defined for accessing TIP resource contents (UC3 – Section 3.3.3). Also, it conflicts with the sequence defined for

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removing a TIP resource (UC5 – Section 3.3.5). To address this concern, two refinements were designed for PP4 (Section 6.2.1). They are presented in **Figure 8.4** and **Figure 8.5** in this section. The former uses a tree view. It includes two popup menus which provide data retrieval function: information access; TIP resource creation or removal. The user can select a resource from the browser and use the "Open" command from the menu to request the extraction of resource contents. **Figure 8.5** uses a combination of drop-down menus and buttons. The user can select a resource from a drop-down menu (e.g., **Area A** in **Figure 8.5**) and use the "Open" button that corresponds to the drop-down menu (e.g., **Area B** in **Figure 8.5**) to launch the extraction of resource contents. These two prototypes both resolve the concern described in PC2. The user can thus access the contents of a TIP resource by following the activity sequence defined in UC3. Moreover, both prototypes support the user in viewing resources according to four categories (sights, sight groups, topics, and facts). Only **Figure 8.4** also supports the user in viewing entire TIP resources in one region; therefore, this prototype is considered to be the more appropriate refinement for PP4. In support of our viewpoint, the following describes the participants' opinion about these prototypes.
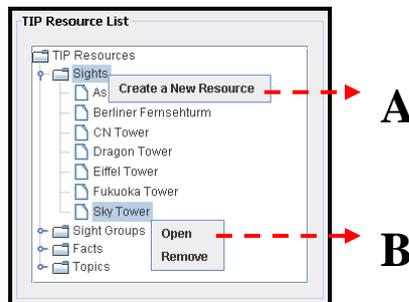
Figure 8.4: Screenshot of first refinement for the TIP resource browser
(originally introduced in **Figure 6.4**).

Figure 8.5: Screenshot of second refinement for the TIP resource browser
(originally introduced in **Figure 6.5**).

It was the participants' comments that the structure in **Figure 8.4** is richer than the one in **Figure 8.5**. They commented that **Figure 8.4** displays all resources in one browser, which allows the user to access the entire TIP resource at once. Unlike **Figure 8.5**, the user would not need to switch between the drop-downs to look for a required TIP resource in the prototype shown in **Figure 8.4**. It was our concern that after a large number of resources has been stored in each category; the user would have to scroll to access them. Otherwise, s/he might not be able to see which category the displayed resources belong to. Based on this issue, the participants addressed that; having the resources presented in the prototype shown in **Figure 8.4** would speed up the user's action to access a required resource. This is because all of resources are presented in one browser. Also, they felt that it was reasonable to have a scrollbar to help viewing the resources in this prototype.

Based on our opinion and the participants' viewpoint, the prototype shown in **Figure 8.4** and **Figure 8.5** have been designed to (1) prevent the concern described in PC2 and (2) support the user in viewing resources according to each category. The former prototype has the additional advantage of presenting an overview of the resources stored in the TIP database. Therefore, it is our conclusion that the prototype in **Figure 8.4** should be used when presenting TIP resources.

SP3: Sight Information Entry Form (PP11)

In accordance with the concern stated in PC3 (see Section 5.2.1), the sketch of the sight information entry form (PP11) has been designed to import sight-related images according to the hierarchical level of a sight. This design varies from the TIP database model where each sight image stored in TIP is assigned to one sight. To address this inconsistency, two prototypes were designed as refinements for PP11 in Section 6.2.1. They are presented in **Figure 8.6** and **Figure 8.7**. These prototypes hold the input forms to insert sight information and images in two separate tabs. Thus, information and images can be inserted for a sight. However, in **Figure 8.6**, the components for defining topics and sight information are enabled in a column after the "Add Level" or "Add Topic" button is clicked. Thus, inserted information would lay amongst the rest of components. After a number of topics have been defined for a sight, this may make it difficult for the user to identify information inserted according to one topic.

Also, in **Figure 8.7**, the data entries for each topic are separated in tabs. This prevents the user from swapping the information between the two topics while modifying the existing information. Even though these prototypes need to support the user in both sight information insertion and modification, these prototypes have not been designed to support in sight information insert. This viewpoint was supported by the participants during the evaluation. In the following, we discuss their opinion about these prototypes.
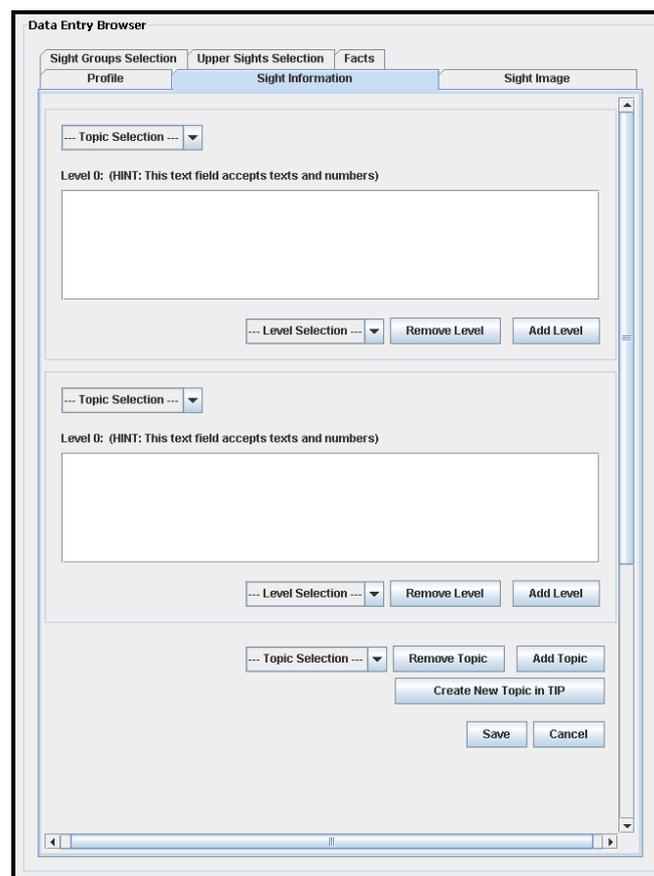
Figure 8.6: Screenshot of first refinement for the sight information entry form
(originally introduced in **Figure 6.6**).

According to the participants' comments, the user may feel lost while inserting and modifying information using **Figure 8.6**. The reason they provided was that the prototype will be filled with input fields after two or more topics have been defined for a sight. Thus, it is difficult for the user to identify information that has been inserted according to each topic. Also, when swapping information between two topics, it is difficult to perform the activity through drag-and-drop input. For example, while dragging information from the bottom of the input form shown in **Figure 8.6** to

the top of the form, it would be a long way to move the information to its new location. This causes an inconvenience for the user. On the other hand, the participants commented that **Figure 8.7** provides a structured layout for sight information insert. From the tabs shown in the rectangular area, the user can easily reach the topics that have been defined for a sight and the sight information that has been inserted to each topic. However, it was their consensus that this prototype does not support the action to swap information between the two topics. Based on this drawback, it was their suggestions to change the input method and use traditional copy-and-paste to complete the task.
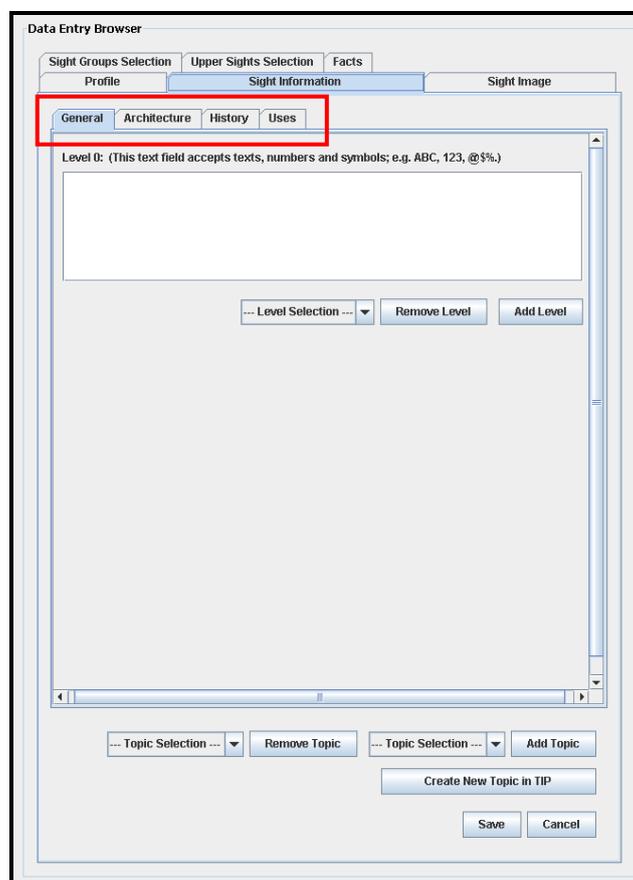
Figure 8.7: Screenshot of second refinement for the sight information entry form
(originally introduced in **Figure 6.8**).

In comparison of our viewpoint and the participants' thoughts, it is a consensus that both prototypes are not well qualified to support sight information insertion or modification. **Figure 8.6** has the shortcoming of being providing an unstructured layout after multiple topics are defined for a sight. **Figure 8.7** prevents the user from using drag-and-drop input to swap information between two topics. Even though the

participants suggested having traditional copy-and-paste in support of swapping information, there are concerns involved in the performance of sight information insert (see Section 5.3 for interaction concerns for sight information input). In order to enhance this performance, we analysed the user's interaction and discussed various methods for the insertion of sight information. The results are reported in Section 7. Also, the user's interaction to insert sight information is evaluated in Section 8.3.

SP4: Information Search Tool (PP5)

As we have described in PC4 in Section 5.2.2, information search might be inefficiently performed using our initial sketch of the information search tool (PP5). This is because the user has to repeat the search action in two search areas (TIP resource search and external resource search) to receive resources searched from the TIP database and external sources. To illustrate this concern, in Section 6.2.2, we developed a screenshot prototype of PP5 to obtain a clear picture of this prototype. Additionally, a refinement for PP5 was also developed in that section. These two prototypes are presented in **Figure 8.8** and **Figure 8.9**. Both prototypes support the user to search information from a particular source (TIP database or external sources) and categorise the search results according to each source. Also, in both prototypes, the user will have to scroll to access a large amount of found resources. Because **Figure 8.9** requires four steps to receive search results supplied from all sources while **Figure 8.8** requires six steps to complete this task, we considered that **Figure 8.9** would be more appropriate in support of information search. A similar viewpoint arose by the participants during the evaluation.

It was the participants' opinion that the structure of **Figure 8.9** is better than **Figure 8.8**, because it allows the user to search for information from all sources (TIP database and external sources) in one interface. Also, it provides a clear overview of the search results from each source. They commented that although the search results are also presented classified as TIP resource versus external resource in **Figure 8.8**, the size of the result browsers are too small for holding search results in this prototype (see **Area A** and **Area B** in **Figure 8.8**). Thus, the user would find it difficult to view search results in this prototype when there is a large number of found resources. It was our concern that **Figure 8.9** can also limit the user in accessing the classification of search results when a large amount of resources is displayed in this prototype. The

participants addressed that **Figure 8.9** provides a bigger browser to present search results. Thus, the user can visually access more results from this browser than the browsers provided in **Figure 8.8**. Also, the user can always follow the tree level (see rectangular area in **Figure 8.9**) to identify the source of a search results.
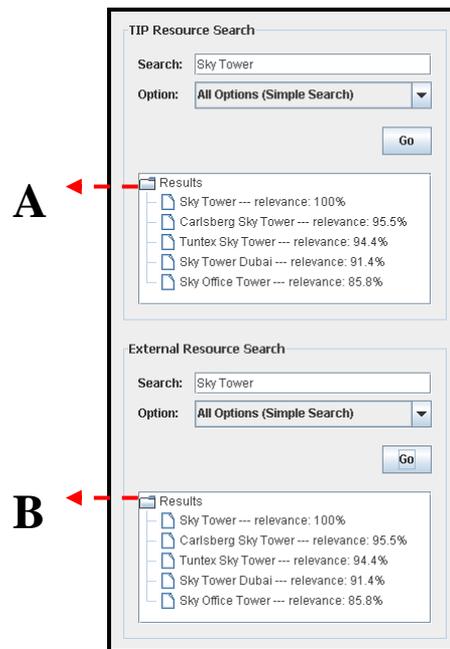
Figure 8.8: Screenshot of the information search tool (originally introduced in **Figure 6.9**).
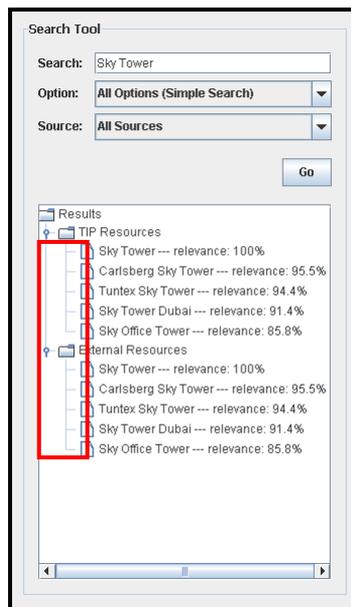
Figure 8.9: Screenshot of the refinement for the information search tool
(originally introduced in **Figure 6.10**).

Based on our opinion and the participants' viewpoint, both **Figure 8.8** and **Figure 8.9** assist the user in searching information and accessing search results according to the TIP database or external sources. **Figure 8.9** provides additional advantages: (1) being able to have information search performed through a more efficient sequence and (2) allowing the user to access search results from only one browser. Although it may affect the user in accessing the classification of results after a large amount of resources are found, the same issue can also be seen in **Figure 8.8** and the capacity of the result browser in **Figure 8.9** is appropriate for holding search results. Therefore, **Figure 8.9** would be the most suitable way to support the information search.

SP5: Resource Contents Browser (PP3)

According to the concern described in PC5 (see Section 5.2.2), the use of the resource contents browser (PP3) might be inefficient in supporting the user to search for information. To illustrate this concern, we developed a screenshot prototype based on PP3 to present a clear overview of this prototype in Section 6.2.2. An alternative refinement was also developed in Section 6.2.2. These two prototypes are shown in **Figure 8.10** and **Figure 8.11** in this section. Based on these prototypes, **Figure 8.10** confirms the concern stated in PC5. The user has to switch between the two tabs to compare the contents of two resources; however, it provides a bigger browser to support the user in viewing resource contents. On the other hand, **Figure 8.11** assists the user in comparing the contents of two resources by showing two sets of contents on the screen simultaneously; however, most contents cannot be directly accessed in one view. The user has to use the scrollbar to access the displayed contents. Because these prototypes do no support the user in viewing resource contents or comparing displayed information, thus we considered to invent other design for presenting resource contents. However, our participants introduced a different viewpoint during the evaluation, which is described as follows.

The participants showed a consensus that both **Figure 8.10** and **Figure 8.11** are not qualified to support the presentation of resource contents. They commented that both prototypes cause inefficiency for the action to compare resource contents, and **Figure 8.11** contains an additional deficiency in presenting resource contents. According to their comments, the structure of **Figure 8.10** is like a web browser. Most of the contents can be presented on the screen. Even though some contents at the bottom of

the form are hidden, the user can always use the scrollbar to navigate through the contents. However, the participants pointed out that it is a drawback not to be able to access two sets of contents concurrently in this prototype because concurrent access would be useful in comparing two resources. This is because information comparison is performing by switching between the two tabs and the user may thus lose his/her way in the process of viewing the contents. On the other hand, it was the participants' opinion that the structure provided by **Figure 8.11** is worse than that provided by **Figure 8.10**. Having resource contents displayed in **Figure 8.11**, the user is even more in danger of losing his/her direction in the procedure of comparing displayed contents. This is because the capacities of two browsers are too small in this prototype. Most contents are hidden in these browsers. While comparing the contents shown on the screen in two browsers, the user would have a difficulty in identifying correspondences of information.
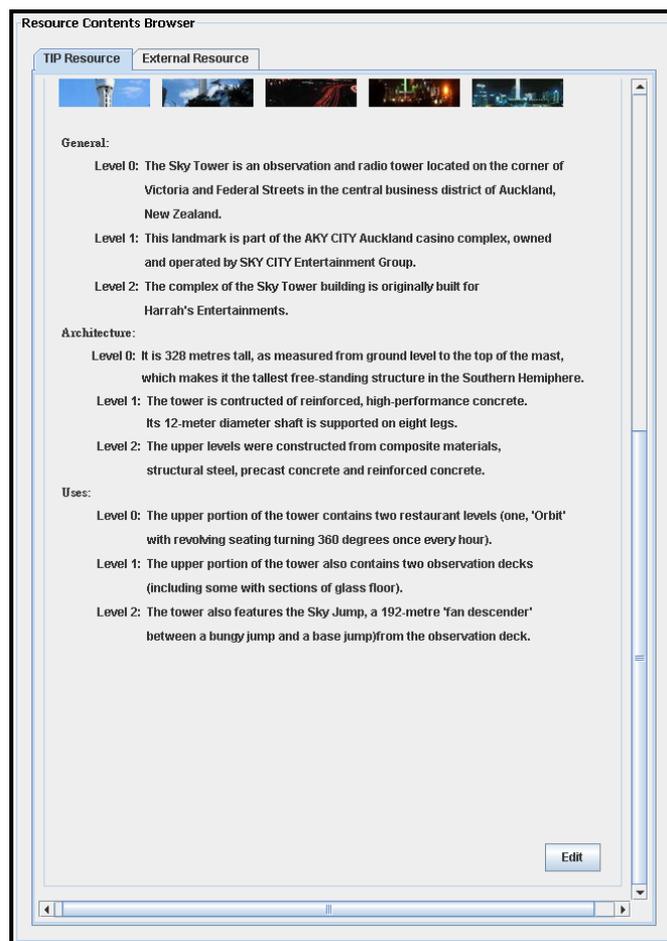
Figure 8.10: Screenshot of the TIP resource contents shown in resource contents browser (originally introduced in **Figure 6.11**).
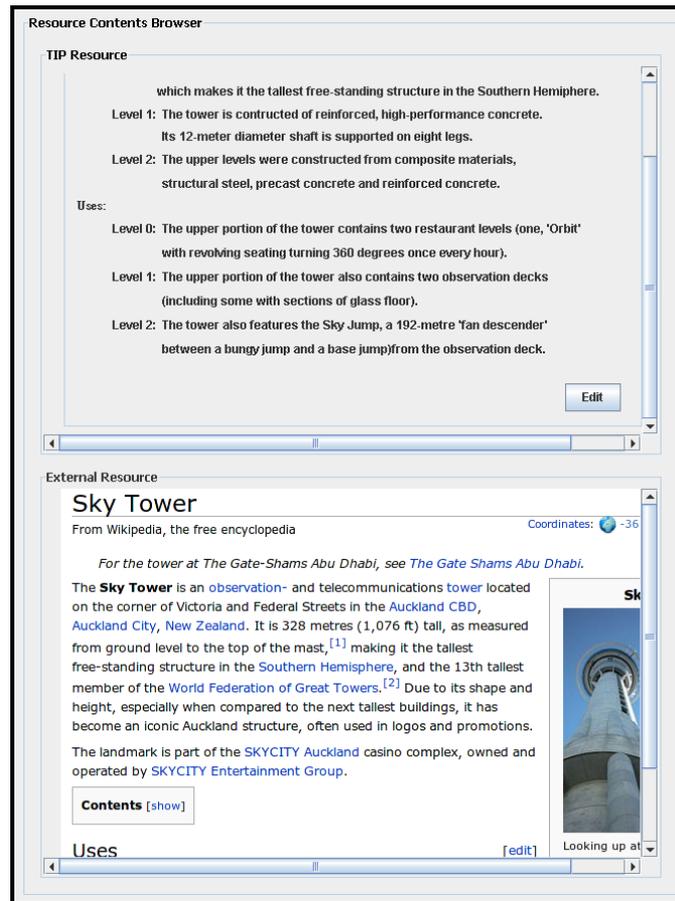
Figure 8.11: Refinement for the resource contents browser (originally introduced in **Figure 6.12**).

We consider that both **Figure 8.10** and **Figure 8.11** have drawbacks in presenting resource contents and in supporting the action to compare information. The participants suggested having PP3 refined into a prototype as shown in **Figure 8.12**. In this prototype, **Area A** and **Area B** are designed to support the presentation of TIP resource contents and external resource contents. From there, the contents of each resource can be displayed in their own structure. Also, they can be shown on the screen simultaneously. This structure enhances the performance of information comparison. The user can thus access the contents of two resources at the same time and compare them. However, the overall structure of the administration support (PP1) consists of four components: data entry browser (PP2), resource contents browser (PP3), TIP resource browser (PP4), and information search tool (PP5). In order to have **Figure 8.12** built in for PP3, the overall structure of the administration support would need changing. This is because the area of the overall structure would become oversized on the screen. In other words, the screen size of a typical desktop monitor

(e.g., a 19-inch monitor) would be too small to show the overall administration service structure.
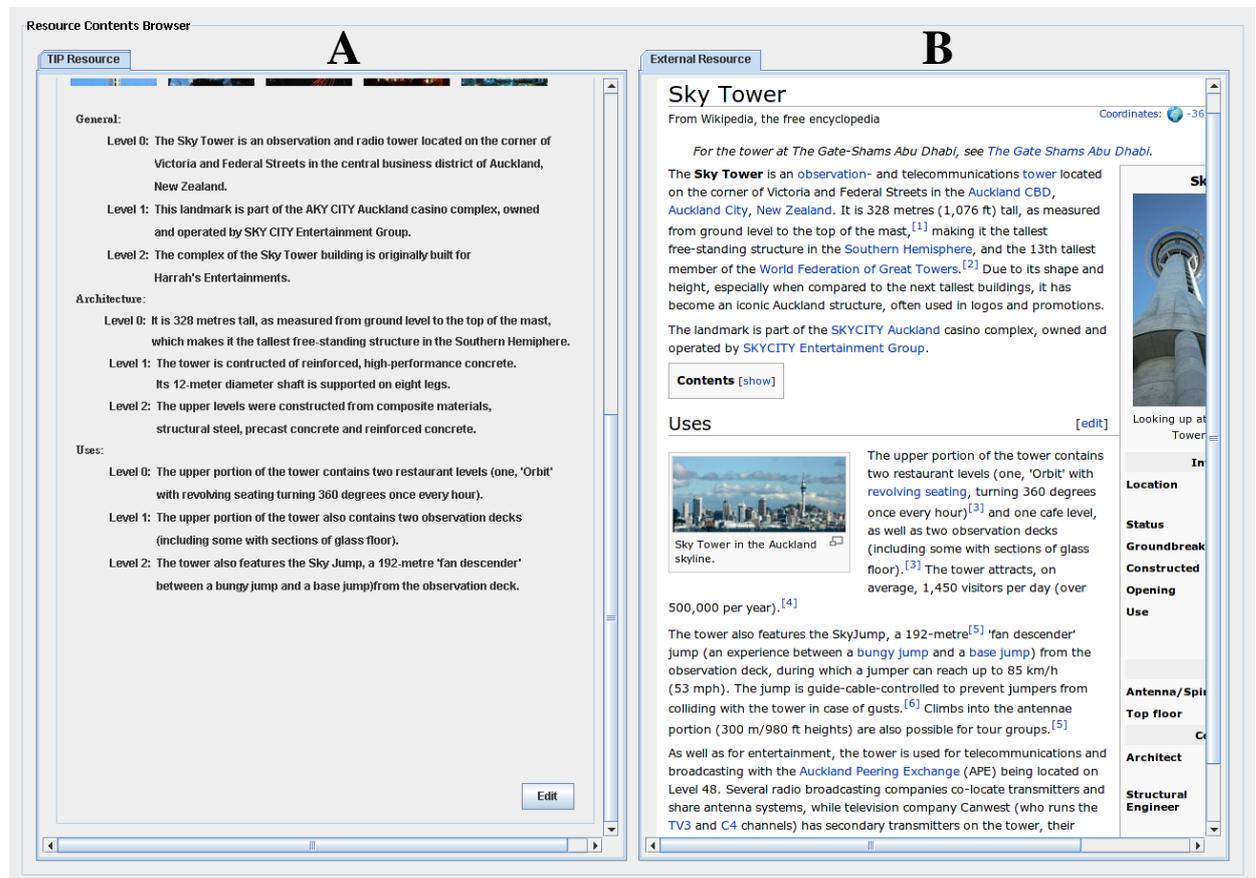
Figure 8.12: Refinement for the resource contents browser (participants' suggestion).

By comparing the above three prototypes, both **Figure 8.10** and **Figure 8.11** have the drawbacks of not being suitable for information comparison and/or presenting a clear overview of resource contents. On the other hand, **Figure 8.12** clearly presents the contents of a TIP resource and an external resource concurrently, and is well suited for information comparison. Therefore, this prototype has been considered to be the most appropriate refinement to support the presentation of resource contents. However, while combining this prototype with other administration components, the overall capacity of the administration service interface would need to be redefined. Otherwise, the overall structure of the administration service will become oversized on a typical desktop screen. Because the area of **Figure 8.12** is oversized, we will use **Figure 8.10** in the remainder of this document when explaining other prototypes.

SP6: Overall Structure (PP1)

In accordance to the concern described in PC6 in Section 5.2.3, the resource contents browser and data entry browser are designed to be shown on top of each other in the sketch of overall administration support structure (PP1). Having the resource contents and data entry form held in this structure, most of the contents or interface components might be obscured by the browsers that hold the resource contents and data entry forms. To illustrate this concern, PP1 was shown in screenshot in Section 6.2.3. This screenshot is presented again in **Figure 8.13** in this section. It confirms that the browsers (**Area A** and **Area B**) shown in this prototype are too small for holding a large amount of information contents or interface components. This causes usability problems. S/he has to move the scrollbar frequently while accessing resource contents or performing information input. Alternatively, the resource contents browser (**Area A**) and the data entry browser (**Area B**) are designed to be shown next to each other in **Figure 8.14** (originally developed in Section 6.2.3). Thus, most of the contents shown in those two browsers can be clearly presented. This supports the user in accessing resource contents and performing information input. Therefore, we consider the prototype shown in **Figure 8.14** to have a more appropriate structure to present the administration support. This viewpoint was supported by our participants during the evaluation, as described in the following paragraph.

It was the participants' comments that most of the contents are obscured by in the browsers supplied in **Figure 8.13**. The user would have trouble in viewing resource contents and performing information insert. Also, they pointed out an additional drawback regarding the resource contents browser (**Area A** in **Figure 8.13**) and its support of information comparison. Having the resource contents presented in this browser makes it difficult for the user to compare the two resources. This is because the size of the browser is too small to hold a large amount of resource contents. Even though a scrollbar can be used for navigating through the contents, the user would have difficulty in analysing the resource contents. On the other hand, the participants provided positive feedback for **Figure 8.14**. They commented that the structure of **Figure 8.14** is very similar to the prototype shown in **Figure 8.12**. Most contents held in the browsers can be shown on the screen. This enhances the user's performance in accessing resource contents and performing information insert. Thus, s/he can easily achieve the desired information from **Area A** (in **Figure 8.14**) and understand the

purpose of each input form shown in **Area B** (in **Figure 8.14**). In addition, having the browsers shown next to each other would improve the user's action to perform information insert. The participants felt that the drag-and-drop input can be performed more easily along the horizontal axis, because dragging along the vertical axis was more difficult.
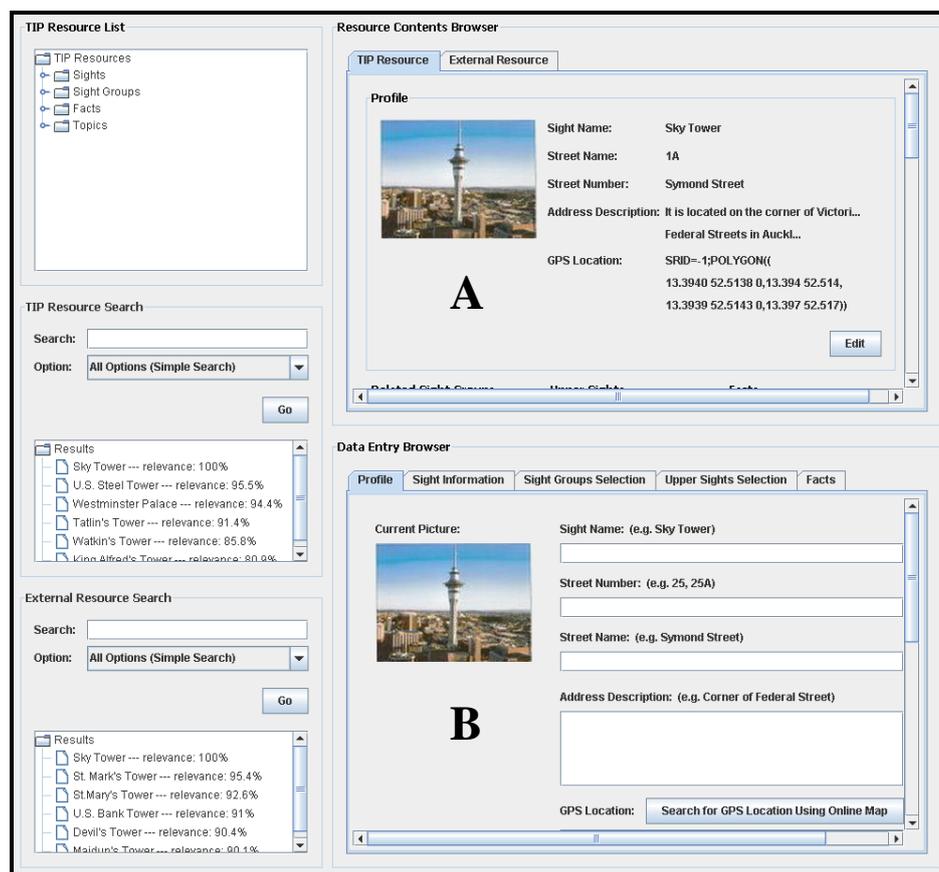
Figure 8.13: Screenshot of the overall structure of the administration service
(originally introduced in **Figure 6.13**).

According to our opinion and the participants' viewpoints, **Figure 8.14** has the advantage of providing a clear overview of the resource contents and each data entry form; this enhances the user's performance in accessing resource contents and performing information insert. These advantages make up for the drawback of **Figure 8.13** – namely, not presenting resource contents and data entry forms in a clear layout. Therefore, **Figure 8.14** would be the most appropriate structure to present the administration service.
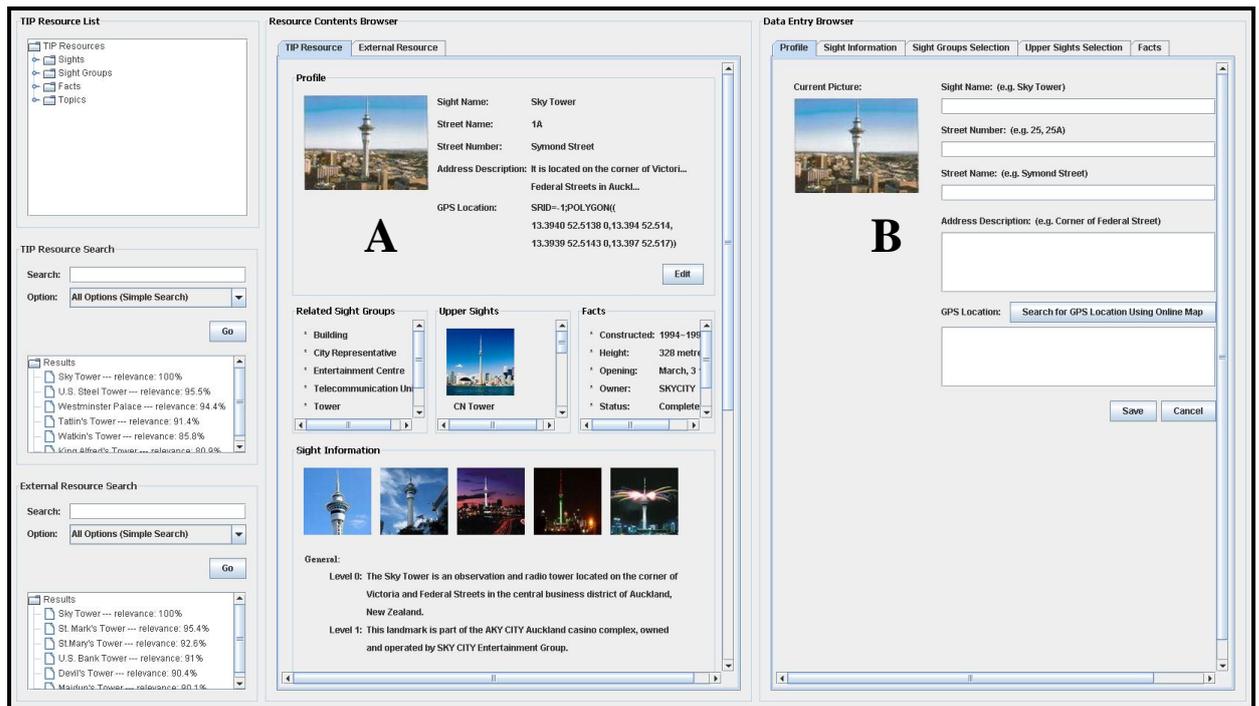
Figure 8.14: Refinement for the overall structure of the administration service
(originally introduced in **Figure 6.14**).

SP7: Sight Resource Contents Form (PP6)

We described in PC7 (see Section 5.2.3) that the structure of the sight resource contents form (PP6) implies that most of the resource contents held in browsers designed in PP6 might not be directly visible on the screen. To illustrate this concern, we developed a screenshot prototype of PP6 in Section 6.2.3. This screenshot is again presented in **Figure 8.15** in this section. In this prototype, most of the contents are hidden in the browsers. Particularly in the highlighted areas (**Area A**, **B**, **C**, and **D**), the contents are partly present. This confirms the concern for PP6. Hence, the user would have difficulty to reach the entire contents defined for each sight's property. On the other hand, **Figure 8.16** (originally developed in Section 6.2.3) makes up for the drawback of **Figure 8.15** by separately displaying the contents of a sight through inner tabs. The areas highlighted in **Figure 8.15** (**Area A**, **B**, and **C**) have been replaced with bigger spaces in the first tab in **Figure 8.16**, allowing the contents to be clearly presented in these areas. Also, the subsequent tabs (rectangular area) in **Figure 8.16** represent the topics defined for a sight and the information that is held in these tabs is presented according to its hierarchical level. Even though some contents would still be hidden in the browser in **Figure 8.16**, these contents are categorised in corresponding properties in each tab; thus, the user is able to access them directly.

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Therefore, **Figure 8.16** has been considered the more appropriate structure to present sight resource contents. As a support to our viewpoint, the following describes the participants' opinion about these prototypes.
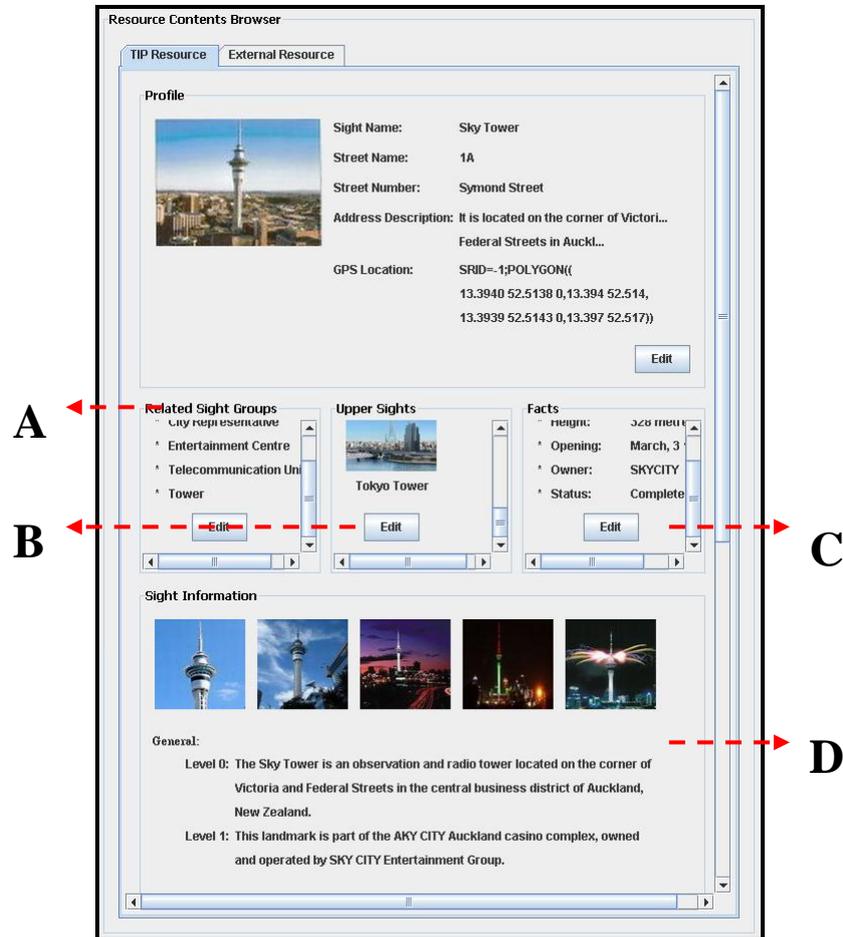
Figure 8.15: Screenshot of the sight resource contents form (originally introduced **in Figure 6.15**).

The participants commented that **Figure 8.16** provides a better overview of the contents defined for a sight than **Figure 8.15**. In the latter, the user may find it difficult to identify the contents defined for each property, because most of contents are hidden in the browsers. Even though scrollbars are supplied to assist the user in navigating through the contents, it is difficult to read the contents that are presented. In particular in **Area A**, **B**, and **C** in **Figure 8.15**, the user can hardly access the entire contents held in these areas in one look. Moreover, sight information is presented in a column at the bottom of the form. Due to this structure, the user cannot reach the information defined according to each topic. Even though each piece of information is labelled with its level and topic, the user would still have trouble to classify them

visually. This is because the font sizes chosen for each topic and information are very similar. The participants gave positive feedback about the structure of **Figure 8.16**. It was their opinion that this prototype is designed in a more structured layout.

Because the contents defined for each property and the sight information assigned for each topic are clearly presented in tabs, the user can directly access them. It was our concern that the contents shown at the bottom of the browser may still be hidden on the screen; however, the participants felt comfortable to browse them using the scrollbar.
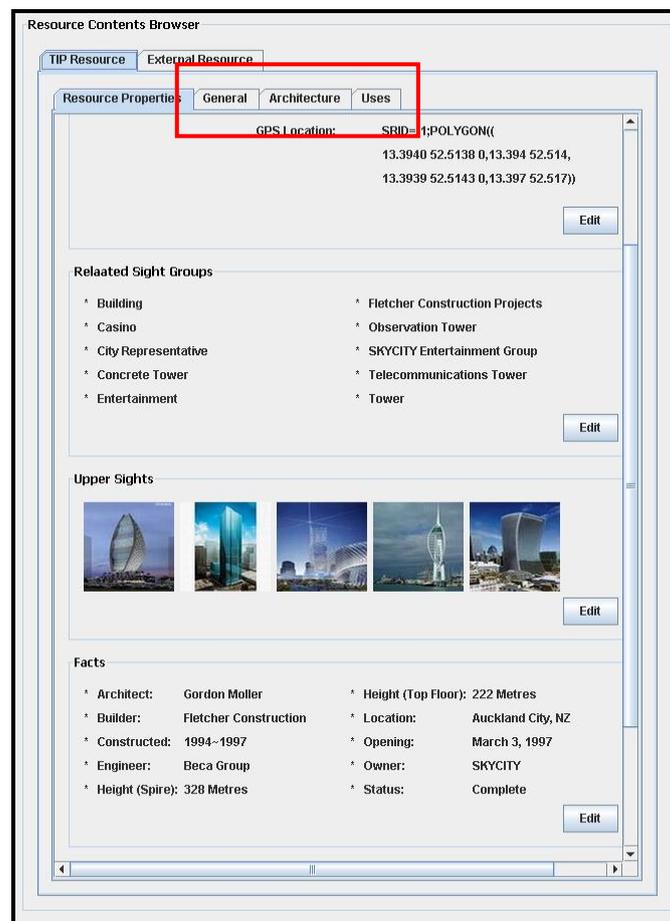
Figure 8.16: Screenshot of the refinement of the sight resource contents form
(originally introduced in **Figure 6.16**).

By comparing our viewpoint and the participants' thoughts, **Figure 8.15** has the drawback of hiding contents in the browsers. On the other hand, **Figure 8.16** has the advantage of presenting a clear overview of the contents defined for each property and the sight information assigned for each topic. Therefore **Figure 8.16** would be the most appropriate structure to present sight resource contents.

8.1.2 Prototype Evaluation Conclusion

In the previous section, we evaluated the screenshots of our prototype solutions described in Section 6.2 to study other people's satisfaction with these prototypes. Based on the results, we have chosen appropriate refinements for the prototypes presented in six of the solutions (SP1, SP2, SP4, SP5, SP6 and SP7). This includes refinements which were suggested by the participants during the evaluation (for SP1 and SP5). In addition, the evaluation result in Section 8.3 shows that the tree view structure (IS9) supports the user in performing information insert and information swap. Also, it clearly presents the topics defined for a sight and the sight information inserted for each topic. Thus, the prototype designed for IS9 is considered the most appropriate refinement of SP3. In order to find out whether these prototypes meet the system requirements identified in Section 3.2, we evaluated their usability. The results of our evaluation are presented in the following section.

8.2 Qualitative Evaluation

In this section, we present our evaluation of our prototype according to the requirements introduced in Section 3.2. The goal of this evaluation is to confirm that the implemented prototypes satisfy the user's needs in relation to the six use cases specified in Section 3.3. To show that the implemented prototypes support the user in performing each use case, this evaluation refers back to the scenario described in Section 3.1. We show how Jason (the administrator of the TIP database) performs the activities that were listed in our requirements.

8.2.1 Qualitative Evaluation using Scenario

The accessibility of the implemented prototypes was analysed as follows.

One week after the establishment of the Sky Tower, Jason tries to collect information about this landmark and import it into the TIP database. He logs into the TIP system as an administrator to access the administration service interface (**Figure 8.17**). From there, Jason can

- search for sight information and to access search results using the information search tool (**Area A**);

- access resources stored in the TIP database using the TIP resource browser (**Area B**);

- read the contents of a TIP resource or an external resource using the resource contents browser (**Area C**) and

- to perform the information insert or modification through the data entry browser (**Area D**).
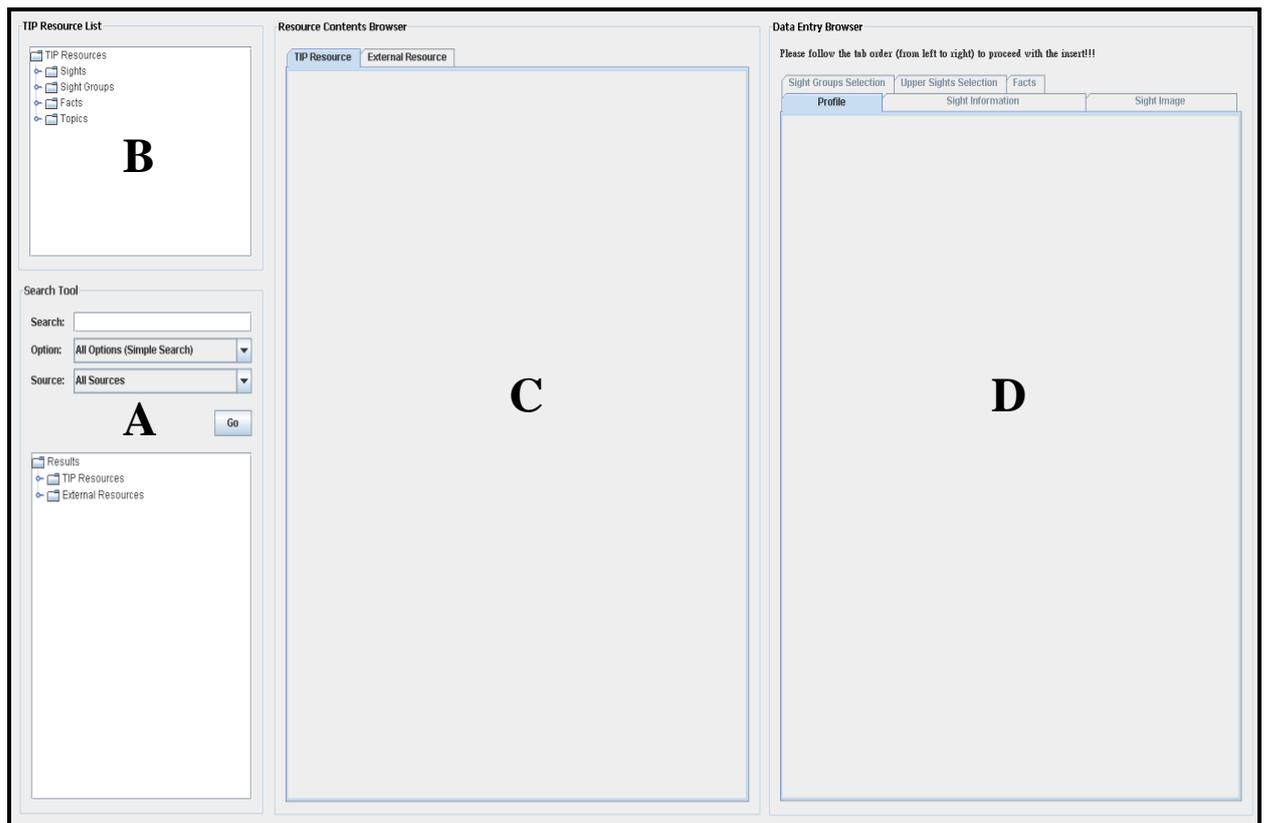
Figure 8.17: Structure of the overall structure of the administration service interface.

Jason prefers to get as much information as he can about the Sky Tower before inserting the sight information, so he uses the information search tool (**Figure 8.18** – the enlargement of **Area A** in **Figure 8.17**) to search for the information that relates to the Sky Tower from the Internet. The search tool provides Jason with a number of search options as the choices of simple and advanced search. Also, it supplies three alternatives which Jason can use to search for information from the TIP database and/or from external sources. The search results are classified as TIP resources or external resources and they can be viewed through the result browser (see rectangular area in **Figure 8.18**). Jason chooses "Sky Tower" as the search query, "General

Information" as the search option and "External Sources" as the search scope. He asks the system to perform the search using the "Go" button. Based on Jason's request, the search results are categorised as external resources and they are presented in the result browser.
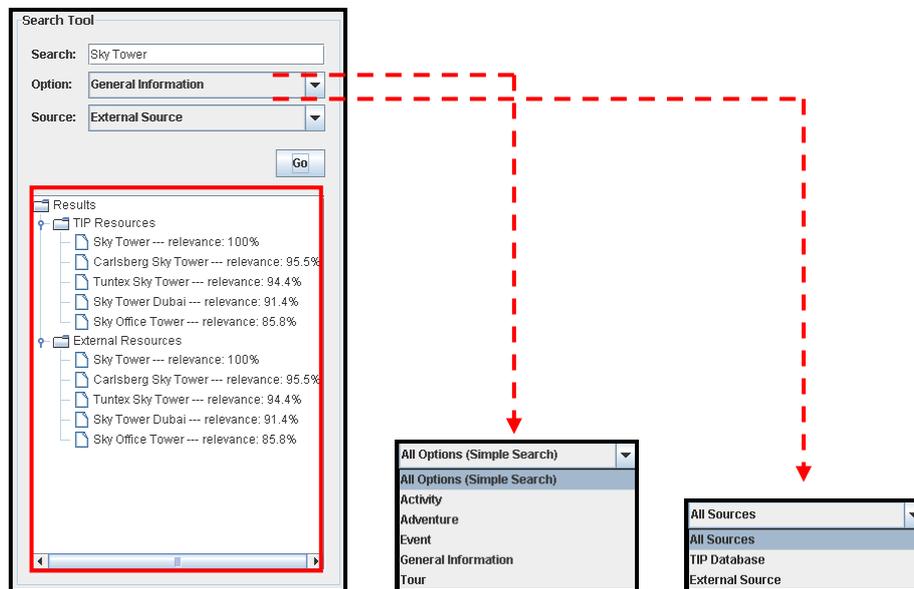
Figure 8.18: Screenshot of the information search tool (originally introduced in **Figure 6.10**)

Jason would like to view the contents of each result using the resource contents browser (**Figure 8.19 –** the enlargement of **Area C** in **Figure 8.17**). This browser displays TIP resource contents and external resource contents in separate areas (see rectangular area in **Figure 8.19**). Thus, the contents of each resource can be presented in their own data structure. Jason selects a resource and asks the system to extract and display its contents. Since the selected result is an HTML document retrieved from the Internet, its contents are displayed in the "External Resource" area based on the data structure defined in its HTML markup.

Jason is satisfied with the search results after viewing their contents. Before he requests to start the insertion, he asks the system to check the TIP database to see if other administrators have already imported information about the Sky Tower. In the information search tool (**Figure 8.18**), he chooses "Sky Tower" as the search query, "All Options" as the search option and "TIP database" as the search scope. When the system provides a negative feedback, Jason accessed the TIP resource browser (**Figure 8.20 –** the enlargement of **Area B** in **Figure 8.17**) to request creation of a

new resource. In this browser, TIP resources are categorised in sights, sight groups, topics, and facts. Through right-clicking on each category, a popup menu is activated to supply the entry for new resource creation (**Area A** in **Figure 8.20**). Also, by right-clicking on each resource, a menu is shown that supplies data retrieval functionalities (**Area B** in **Figure 8.20**): "Open" for TIP resource contents extraction and "Remove" for TIP resource deletion.
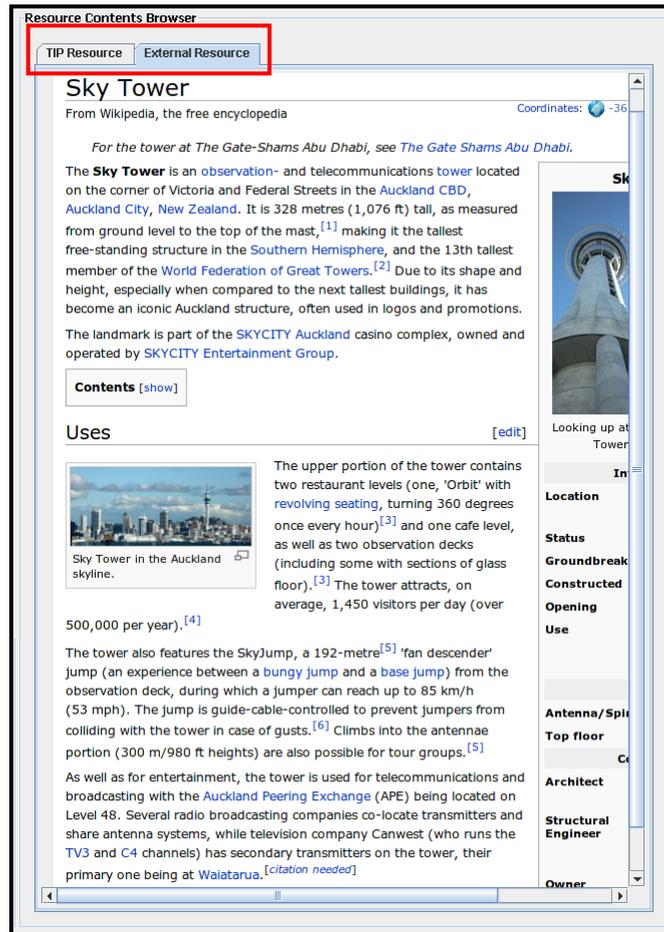
Figure 8.19: External resource contents shown in the resource contents browser (originally introduced in **Figure 6.11b**).
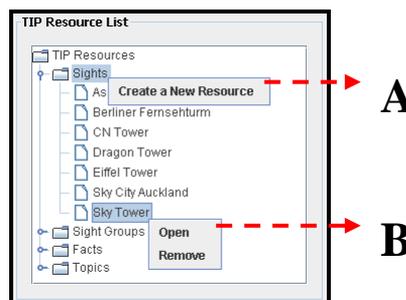
Figure 8.20: Screenshot of the TIP resource browser (originally introduced in **Figure 6.4**).
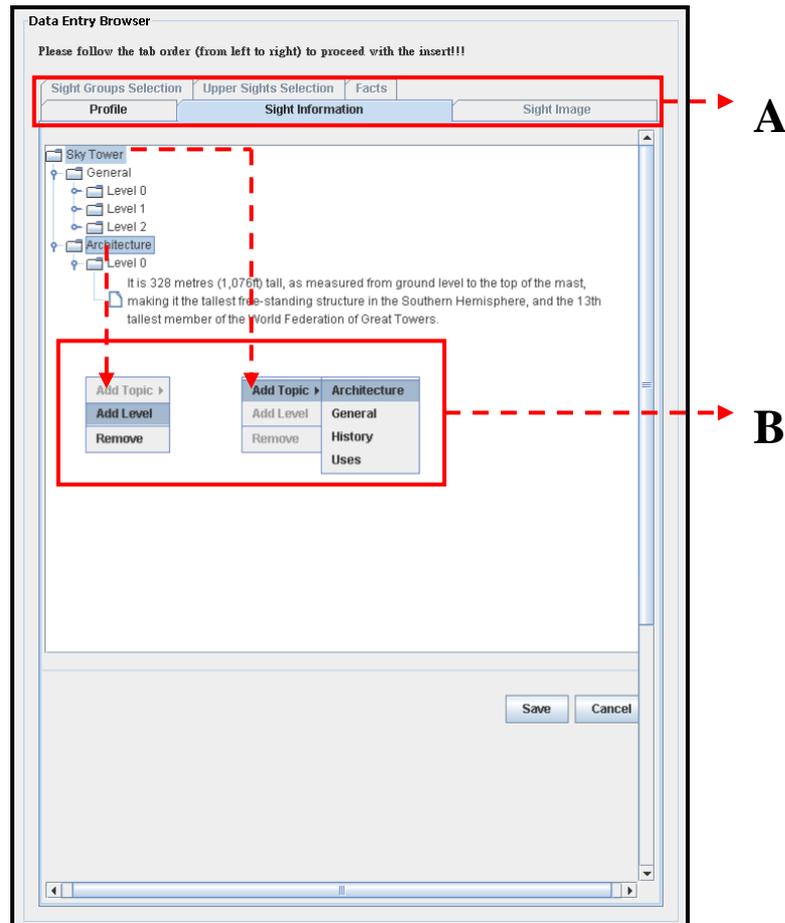
Figure 8.21: Screenshot of the sight information entry form (originally introduced in **Figure 7.11**).
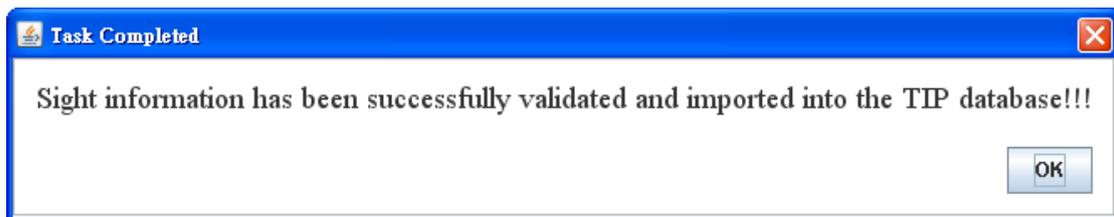
Figure 8.22: Dialogue showing the information has been successfully stored.

From the entry shown in **Area A** in **Figure 8.20**, Jason asks the system to present data entry forms for the insertion of sight resource contents using the data entry browser (**Figure 8.21** – the enlargement of **Area D** in **Figure 8.17**). This browser provides separate areas to hold the data entry forms for a sight, sight group, topic, or fact. Through the displayed input forms, the contents of each TIP resource can be imported into the database according to the data structure defined for each resource. As in **Area A** shown in **Figure 8.21**, the data entry forms for the insertion of sight resource contents are separated into tabs. By accessing each tab, the properties of a sight (a

sight's profile, sight information, related sight group, upper sights, facts, and images) can be defined. Jason completes the insertion of the profile of the Sky Tower and opens the sight information entry form. He wants to define sight information of the Sky Tower using the contents displayed in **Figure 8.19**, but he does not want to have any duplicate information inserted for this sight. Therefore, he is very carful in analysing the displayed contents. When he has reached desired information during the procedure of analysing the contents, he starts to define the hierarchical structure (i.e., topics and levels) for the Sky Tower through popup menus (**Area B** in **Figure 8.21**) and insert the information into the data entry form via drag-and-drop input. At the end of the insertion, Jason clicks on the "Save" button to ask the system to validate the inserted information and to store the information into the database. **Figure 8.22** illustrates the message box showing the information has been successfully validated and imported into the TIP database.

Figure 8.23: Screenshot of the sight resource contents form (originally introduced in **Figure 6.16**)
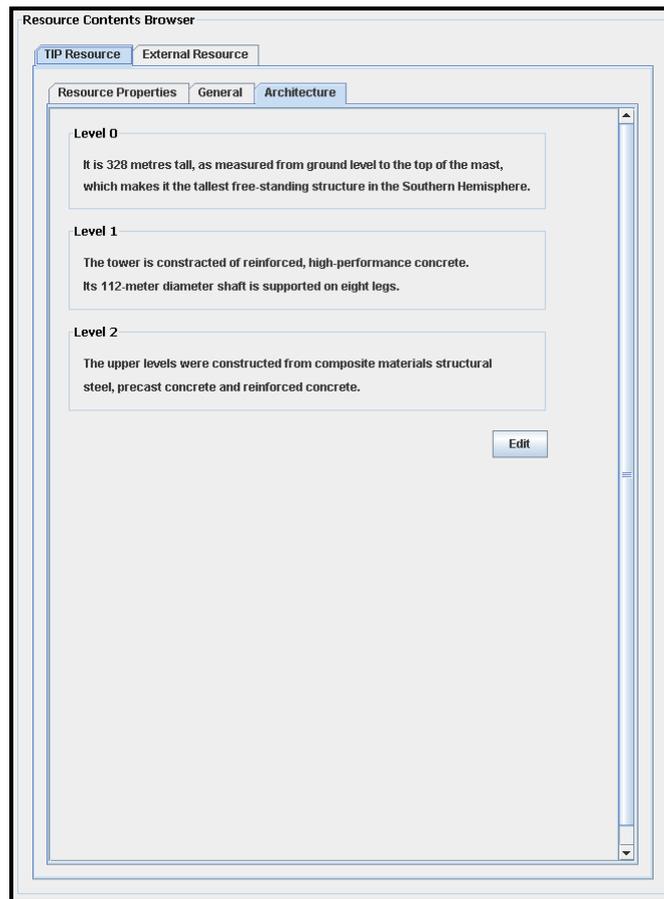
Figure 8.24: Screenshot of the sight resource contents form (showing sight information) (originally introduced in **Figure 6.17**).

After the Sky Tower is imported into the TIP database, Jason wants to view the information defined for it, so he accesses the TIP resource browser (**Figure 8.20**) to search for this newly-created sight. During the procedure to look for the Sky Tower, he is surprised to see a resource named Sky City Auckland that has been imported by another administrator a week ago. He wants to check whether this resource consists of the same information as what he has defined for the Sky Tower, so he asks the system to extract and display its contents through the "Open" command shown in **Area B** in **Figure 8.20**. Since "Sky City Auckland" is a sight stored in the TIP database, its contents are displayed in the "TIP Resource" area in the resource contents browser (**Figure 8.23 and Figure 8.24**) based on its hierarchical structure. For example, the "Resource Properties" tab (**Area A** in **Figure 8.23**) presents the general properties of the Sky City Auckland. In this tab, the information defined for each property (i.e., profile, related sight group, upper sights, and related facts) is gathered through boarder frame. Jason is thus able to access the identity defined for the Sky City

Auckland and this sight's relationships with other TIP resources. Jason can also access the subsequent tabs (**Area B** in **Figure 8.23**) to read the sight information defined for Sky City Auckland according to each topic. Like in the prototype shown in **Figure 8.24**, the sight information defined for each topic (e.g., Architecture) is presented in hierarchical levels.

Looking at the contents that are displayed, Jason discovers that the information defined for the Sky City Auckland mirrors the information he has defined for Sky Tower. However, he feels that the information defined for Sky Tower is richer. Therefore, Jason decides to remove the "Sky City Auckland" sight from the TIP database. In the TIP resource browser (**Figure 8.20**), he right-clicks on "Sky City Auckland" to activate the menu shown in **Area B**. With the "Remove" command, he asks the system to remove this resource. **Figure 8.25** illustrates the message box showing that the resource has been successfully removed from the TIP database.
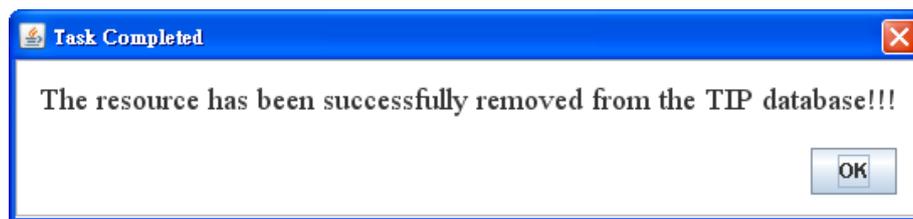
Figure 8.25: Dialogue showing a resource has been successfully removed.

Jason then continues to access the "Sky Tower" sight from the TIP resource browser (**Figure 8.20**). After he has found it from the browser, he asks the system to extract and display its contents in the "TIP Resource" area of the resource contents browser (**Figure 8.26**). Also, Jason accesses the contents shown in **Figure 8.19** for a second time to see if there is other information that he can assign to this sight to enrich its contents stored in the TIP database. While reading the contents shown in **Figure 8.19**, Jason finds that "Sky Tower" sight stored in the TIP database has been defined with a wrong address (**Area A** in **Figure 8.26**). To correct this error, he asks the system for the modification of the profile defined for the Sky Tower by accessing the "Edit" button supplied at the bottom of the "Profile" frame (**Area B** in **Figure 8.26**). Following Jason's request, the profile defined for the Sky Tower is displayed in corresponding data entry form (**Figure 8.27**). From there, Jason deletes the original

record and inserts the correct address via drag-and-drop input. He then uses the "Save" button to store the update. As a confirmation, **Figure 8.22** is presented after the successful import.
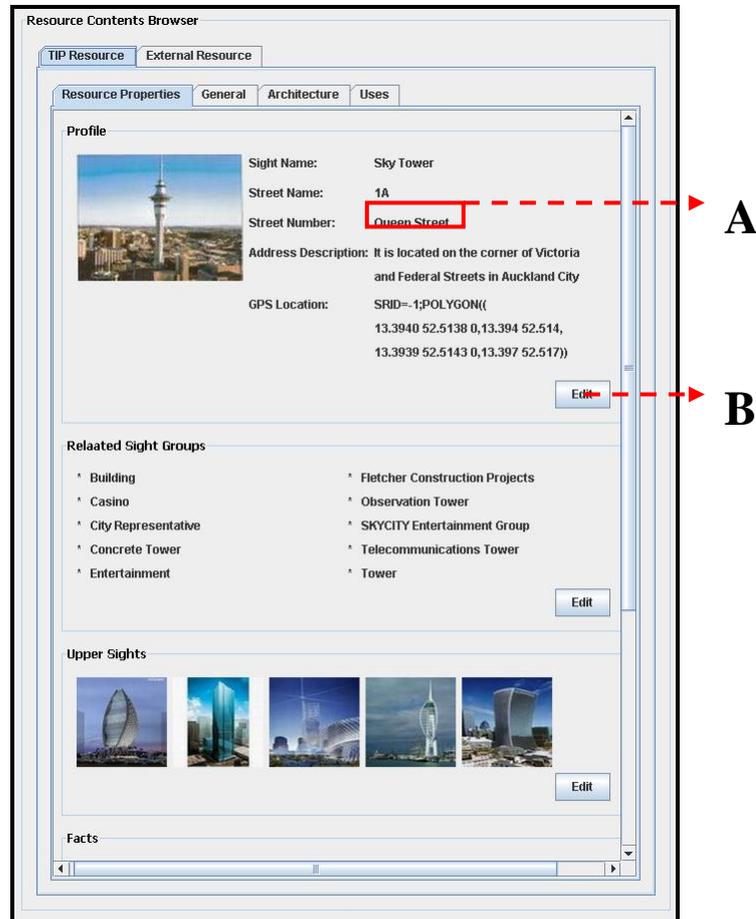
Figure 8.26: Screenshot of the sight resource contents form (originally introduced in **Figure 6.16**)

Figure 8.27: Screenshot of the profile entry form for sights.

8.2.2 Qualitative Evaluation Conclusion

In accordance with the scenario described in the previous section, the implemented prototypes can be used to perform the six use-cases described in Section 3.3:

- UC1: Searching for information
- UC2: Accessing a search result
- UC3: Accessing an existing TIP resource
- UC4: Create a new resource
- UC5: Remove an existing TIP resource
- UC6: Edit existing TIP resource contents

Through the information search tool (**Figure 8.18**), the user can search for appropriate information (UC1) from the TIP database and/or external sources using simple or advanced search. Also, s/he can access the search results (UC2) from the result browser (rectangular area in **Figure 8.18**) and ask the system to present the contents

of each result in their own data structure in the "External Resource" area of the resource contents browser (**Figure 8.19**). Alternatively, the user can access TIP resources (UC3) from the TIP resource browser (**Figure 8.20**). By right-clicking on a resource, an action menu will be shown (**Area B** in **Figure 8.20**). Through the action to select the "Open" command from this menu, the contents of the selected TIP resource will be displayed in their hierarchical structure in the "TIP Resource" area of the resource contents browser (**Figure 8.23**). Besides, the user can select the "Remove" command from the menu to remove a selected TIP resource (UC5).

The user can also right-click on a category (sights, sight groups, topics, or facts) displayed in TIP resource browser (**Figure 8.20**) to activate the entry of new resource creation (**Area A** in **Figure 8.20**). S/he can thus request the creation of a new resource (UC4), and the system presents a blank data entry form using the data entry browser (**Figure 8.21**). From there, the user can define the contents of a resource through drag-and-drop insert and store the inserted information in the TIP database. In order perform the modification of information defined for a TIP resource (UC6), the user can click on an "Edit" button that is provided for a TIP resource property displayed in the resource contents browser (**Area B** in **Figure 8.26**). The system will then display the existing information using the corresponding data entry form in the data entry browser (**Figure 8.27**). From there, the user can modify the contents of a TIP resource using the drag-and-drop input and store the update into the TIP database.

The use cases were originally designed to fulfil the requirements specified in Section 3.2. Our evaluation shows that our prototypes can be used to perform the use cases defined in Section 3.3; therefore, our evaluation confirms that the implemented prototypes successfully fulfil the requirements.

8.3 Quantitative Evaluation

As we have described in Section 5.3, there are three questions identified for the operation of sight information import. They are:

1) How to present the contents that have been selected for various input actions.

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2) How to present the source contents that have been transferred through drag-and-drop input.

3) How to refine the transferred data into levels of detail in the data entry form.

We developed three alternative solutions for each of these concerns. They are outlined in the **Table 8.1** (see Section 7 for details of these solutions).

Interface interaction at left-hand side of the administration service interface: (in Resource Contents Browser)	Interface interaction at right-hand side of the administration service interface: (in Data Entry Browser)
<u>Source Highlight</u> IS1: Highlight without the Allowance of Overlaps IS2: Highlight with the Overlaps Overwritten IS3: Highlight with the Allowance of Overlaps **<u>Drag-and-Drop Input</u>** IS4: Copy-on-Drag IS5: Cut-on-Drag IS6: Grey-on-Drag	**<u>Sight Information Refinement</u>** IS7: Information Refinement in One Field IS8: Information Refinement in Multiple Fields IS9: Information Refinement in Tree View

Table 8.1: Alternatives for "Source Highlight", "Drag-and-Drop Input" and "Sight Information Refinement" (originally introduced in **Table 7.1**).

In this section, we describe a user evaluation that we carried out to evaluate the user's action in performing sight information insert based on three situations:

1) Inserting sight information according to one topic.

2) Inserting sight information according to two topics.

3) Swapping inserted sight information between two topics.

The goal of this evaluation is to discover which alternative from **Table 8.1** the user would choose for completing each task, as well as to find the most appropriate alternative in "Source Highlight", "Drag-and-Drop Input", and "Sight Information Refinement" to support the operation of sight information insert. Additionally, we

aimed to find out an effective activity sequence (meaning the activity sequence that causes less error in performing each task) for inserting or swapping sight information. The time that the user required to complete each task was also measured in this experiment.

8.3.1 Evaluation Plan

Participants

During the evaluation period, the participants needed to learn about the following information before evaluating the given task:

- The TIP database structure for storing sight information.
- The alternatives designed for "Source Highlight", "Drag-and-Drop Input", and "Sight Information Refinement".
- The prototypes developed for inserting sight information.

This information gave them the ability to determine how they should complete each task. The timeframe for each section of the evaluation was limited; this created a need for the participants to have some knowledge of the TIP system. Without basic knowledge of TIP the participants would have struggled to complete the evaluation in the set time. Therefore, the people recruited for this evaluation are identical to the participants of the prototype evaluation.

Methodology

Each participant participated in an individual session. The session started with a tutorial allowing the participant to get to know the TIP database structure for storing sight information, the interactions included in the sight information insert operation (i.e., the concerns described in Section 5.3 and the solution of each concern presented in **Table 8.1**), and the prototypes involved in this evaluation.

During the evaluation, each participant was asked to solve three tasks through scenarios of use. Each task might require the participant to insert or swap sight information using the alternatives shown in **Table 8.1**. The alternatives that were selected by each participant to complete each task were recorded. Also, each participant was asked to communicate his/her thought processes verbally while they worked, allowing us to take notes of his/her decision in selecting each alternative and

comments in using the selected alternative. Besides, the activity sequence that each participant performed to complete each task was also noted down. Thus, we can compare it with the sequence described in Section 7 to find out the most effective activity sequence for inserting or swapping sight information. In order to measure how long each participant required to complete each task using the alternatives provided in **Table 8.1**, the time that a participant took to perform each task was also recorded.

At the end of the evaluation, an open discussion was held to understand each participant's experience in solving the tasks and his/her overall impression of the proposed prototype.

8.3.2 Test Cases

The following describes the tasks that were given during the evaluation. Each task is described with its goal and relevant assumptions. The test data of each task can be found in Appendix II.

Task 1: Inserting Sight Information According to One Topic

In this task, each participant was asked to act as an administrator of the TIP database who wants to insert sight information about the Sky Tower. The assumption was that two pieces of information that relate to the topic Architecture have been found on the Wikipedia website. It was each participant's task to refine the emphasised information into levels of detail and store it into the TIP database.

The goal of this task was to find out which alternative each participant would use to insert sight information according to one topic only. In particular, here we looked at whether or not a participant performed the "Source Highlight". This is because the alternatives of "Source Highlight" (IS1, IS2, and IS3) were designed to address an overlap in source contents. Since there is no overlap involved in this task, it is unnecessary to address any alternatives for "Source Highlight" in the result. Therefore, we will only describe whether each participant performed a highlight operation. In addition, we look at each participant's decision in selecting the

information refinement model and study his/her behaviour to refine sight information according to the specified topic

Task 2: Inserting Sight Information According to Two Topics

Similar to Task 1, each participant was asked to act as an administrator of the TIP database to insert sight information about the Sky Tower. The assumption was that four pieces of information had been found on the Wikipedia website, including:

- Two pieces of information that relate to the topic Architecture.
- Two pieces of information that relate to the topic Uses.

Each participant needed to refine them into hierarchical levels and store them into the TIP database.

In this task, we also look at each participant's decision in using the alternatives to insert sight information. Because this task required each participant to present an overlap, we particularly focus on his/her interaction in performing "Source Highlight". In addition, each participant's choice in selecting the information refinement model and his/her action to insert sight information is studied.

Additionally, we assume that the alternative of "Drag-and-Drop Input" which has been chosen for the insertion of topic-one (e.g., Architecture) information would also be the chosen method to support in inserting topic-two (e.g., Uses) information. This is to prevent overlaps from being presented in unreasonable structure. For example, if the sentence "*The Sky Tower is the tallest building in New Zealand*" has been inserted to the topic Architecture through IS4 and "*Sky Tower is the tallest building*" has been inserted to the topic Uses through IS5, the presentation of this sentence will become like "*The   in New Zealand*" in the source contents. This would not make sense to each participant while comparing the information inserted for Architecture to the original contents. Also, it would confuse the participant while assigning sight information for other topics.

Task 3: Swapping Sight Information Between the Two Topics

We assume that four pieces of information have been presented in an overlap or outside the overlap in the web page of the Wikipedia. Also, they have been inserted

for the Sky Tower according to the topic Architecture and Uses. It is each participant's task to swap the inserted information between these two topics.

The goal of this task is to focus on each participant's interaction in changing the representative colour in the source contents and the position of information inserted in the data entry form. We also look at the user's decision in choosing the information refinement model to find out an appropriate data entry environment for rearranging the hierarchical position of the sight information defined for a sight.

In additional, we assume that the contents of the Wikipedia page had been extracted from an external resource store in the TIP server. This was to prevent the participants from being confused while performing the task, because it would be unreasonable to present the information in highlight if the Wikipedia page has just been retrieved from the website.

8.3.3 Evaluation Results and Analysis

In this section, we analyse the evaluation results of the above three tasks based on each participant's interaction in performing "Source Highlight", "Drag-and-Drop Input" and "Information Refinement". Each participant's preferred activity sequence and the time required to complete each task are also be discussed.

Participants' Choice in "Source highlight", "Drag-and-Drop" and "Information Refinement"

Table 8.2 shows which alternatives of "Source Highlight", "Drag-and-Drop Input", and "Information Refinement" the participants selected to complete each task. Because the two sets of results and comments given by the two participants are so similar, the evaluation result of each task are analysed in one joint format.

	Results – Participant 1	**Results – Participant 2**
Task 1	**Decision of Source Highlight:** Participant 1 decided to perform a highlight operation in this task. **Selection of Drag-and-Drop Input:** *IS4:* Copy-on-Drag **Selection of Information Refinement:** *IS8:* Information Refinement in Multiple Fields	**Decision of Source Highlight:** Participant 2 decided to perform a highlight operation in this task. **Selection of Drag-and-Drop Input:** *IS4:* Copy-on-Drag **Selection of Information Refinement:** *IS8:* Information Refinement in Multiple Fields
Task 2	**Selection of Source Highlight:** *IS3:* Highlight with the Allowance of Overlaps **Selection of Drag-and-Drop Input:** *IS4:* Copy-on-Drag **Selection of Information Refinement:** *IS9:* Information Refinement in Tree View	**Selection of Source Highlight:** *IS3:* Highlight with the Allowance of Overlaps **Selection of Drag-and-Drop Input:** IS6: Grey-on-Drag (additional suggestion for addressing the overlaps) IS4: Copy –on-Drag (for normal insert procedure) **Selection of Information Refinement:** *IS9:* Information Refinement in Tree View
Task 3	**Selection of Information Refinement:** *IS9:* Information Refinement in Tree View	**Selection of Information Refinement:** *IS9:* Information Refinement in Tree View

Table 8.2: Participants' choice in "Source Highlight", "Drag-and-Drop Input" and "Sight Information Refinement" during the evaluation.

Task 1: Both participants decided to perform highlight operations on the contents that they selected for input. Their explanation for performing this operation were that through the highlight operation, the information selected for each input could be easily identified in the source contents. As administrators of the TIP database, they were able to see which part of the source contents had been transferred to the topic defined in the data entry form.

It was both participants' decision to transfer sight information from the source contents into the data entry browser using the "Copy-on-Drag" technique (IS4). They explained that after each input action, the texts that they selected for input remained unchanged in the source contents when they used IS4. Thus, they were still able to read the entire text included in the source contents after the insert. Even though the text that was selected for each input can still be shown in the source contents after a "Grey-on-Drag" (IS6) has been performed, both participants chose not to use this method for inserting sight information. They remarked that using IS6 to insert sight information, the text that is selected in the source contents will be greyed out after each insert. Hence, they were having difficulty in viewing it. Also, both participants decided not to perform sight information insert using "Cut-on-Drag" (IS5). This was because the selected text disappears from source contents after each insert, which caused difficulties in reading the source contents for further input actions.

It was both participants' choice to refine the sight information using multiple fields (IS8). Their comments were that when refining sight information according to only one topic, it is easier to see the overview of the information transferred through multiple fields. They commented that the structure of multiple-fields refinement clearly presents the hierarchical levels that have been specified for a topic and the information that have been transferred to each level. It was our proposal in the discussion that a similar result can be performed by the tree view structure (IS9). Both participants commented that IS9 would be better for inserting sight information according to multiple topics (see the following analysis for the Task 2 result for more details).

Task 2: While performing the information insert according to two topics, it was both participants' decision to allow the display of overlaps (IS3). They commented that this

method clearly highlights the information selected for various input actions from the source contents. They were able to use the highlighted information as a reference to find out the data that have been transferred to each topic. It was our concern described for IS3 (see Section 7.1) that the visual appearance of an overlap may be negatively affected when it fills up with multiple colours. Regarding this concern, both participants remarked that although our concern may be true, this method provides a structure to clarify the information that have been selected for various input actions and it allowed them to notify the information transferred according to each topic. Additionally, Participant 2 suggested using a different "Grey-on-Drag" method to light up overlaps: turning the texts that are not included in any overlap into grey after the information included in an overlap has been inserted into the data entry browser. Thus, the texts included in overlaps will become more obvious in the source contents. However, this participant pointed out a drawback of this method, which is that those texts which are outside the overlaps will then become difficult to read.

In the normal information insert procedure, it was both participants' decision to use "Copy-on-Drag" (IS4) to insert sight information, because the texts selected in the source contents remain unchanged after each insert. They were thus able to access entire texts from the source contents and continue further input actions. Similar to the evaluation result for Task 1, both participants chose not to use "Cut-on-Drag" (IS5) to insert sight information. They commented that using the alternative (IS5) for inserting information, the texts that are selected in the source content cannot be shown after each input. Thus, they had difficulties in comparing different parts of information presented in the source contents and accessing desired information for the other input actions.

When refining sight information according to two topics, both participants decided to use the tree view (IS9). They commented that using the single fields or multiple fields for refining sight information according to two or more topics would make it difficult to visualise the hierarchical structure defined for each topic and the information transferred to each level. This was a drawback that we identified for IS9 in Section 7.3. After a large amount of sight information has been inserted into the data entry browser, the information shown in the browser would be hidden. Hence, the user would have to use the scrollbar to navigate the inserted information. Regarding this

concern, both participants remarked that even though our concern was true, the IS9 still provides a better overview (compared to the single field (IS7) and multiple fields (IS8) structure), showing the information transferred according to multiple topics. They could thus directly reach the hierarchical structure defined for a sight while performing the insert and see what information had been inserted according to each topic.

Task 3: In this task, both participants interacted with tree view structure (IS9) to rearrange the hierarchical position of information transferred between two topics. They commented that IS9 clearly presents the topics that have been defined for a sight and the information that has been transferred according to each topic. Therefore, it is easier to compare information at different hierarchical levels and to swap information inserted for two topics or two levels of the same topic using this data entry model.

Conclusion: To summarise our observation and both participants' comments in this study, the highlight operation has the advantage of indicating the information that is selected for each input action. In particular, "Highlight with Allowance of Overlaps" (IS3) supports the participants in addressing the information that is assigned to multiple topics in source contents. Also, "Copy-on-Drag" (IS4) supports the participants in inserting sight information without changing the appearance of source contents. By comparing the participants' comments for choosing an information refinement model, the multiple fields structure (IS8) better supports insertion of sight information according to a single topic, and the tree view structure (IS9) supports insertion of sight information according to multiple topics and swap of information. Because each sight stored in the TIP database is likely to consist of multiple topics, IS9 is considered to be the more appropriate data entry model for sight information refinement. Based on the above description, IS3, IS4, and IS9 are the most applicable alternatives to support in the operation of sight information insert.

Comparison of Activity Sequence for Inserting Sight Information (Task 1 and Task 2)

Table 8.3 compares the activity sequence of information insert introduced in Section 7, which Participant 1 followed, and the sequence that Participant 2 performed during the evaluation.

	Originally designed activity sequence (Participant 1's performance)	**Participant 2's performance in evaluation**
Step 1	Define a topic in the data entry browser.	Define a topic in the data entry browser.
Step 2	Move the mouse cursor over the specified topic and right-click to activate the colour list.	Move the mouse cursor over the specified topic and right-click to activate the colour list.
Step 3	Select a colour from the list to define a representative colour for the topic defined in Step 1.	Select a colour from the list to define a representative colour for the topic defined in Step 1.
Step 4	Select the required information in the resource contents browser.	Select the required information in the resource contents browser.
Step 5	Move the mouse cursor over the selected information and right-click to display the topics that have been defined in the data entry browser.	Perform drag-and-drop information input.
Step 6	Select the topic that was defined in Step 1 to change the background colour of the selected area to the colour defined in Step 3.	Move the mouse cursor over the selected information and right-click to display the topics that have been defined in the data entry browser.
Step 7	Perform drag-and-drop information input.	Select the topic that was defined in Step 1 to change the background colour of the selected area to the colour defined in Step 3.

Table 8.3: Comparison of activity sequence that participants performed for inserting sight information.

From **Table 8.3**, we can see a difference in performing the task starting from Step 5. It was our original design to highlight the selected information prior to data transfer. This sequence is designed as a generalisation of typical drag-and-drop behaviour, in which the information is first highlighted before the transfer. However, since our "Source Highlight" technique is different from the general highlight operation, it was Participant 2's decision to have the selected information transferred into the data entry form before interacting with "Source Highlight". This participant commented that since "Source Highlight" identifies the information selected according to each topic in the source contents, it is not appropriate to assign the selected information to any topic before it has actually been transferred.

On the other hand, the activity sequence that Participant 1 performed to insert sight information is the same as the sequence described in Section 7. This participant commented that after performing Steps 1 through 3 to define a topic, they could then repeat Steps 4 through 7 to assign sight information to the defined topic. Thus, each piece of information could be explicitly assigned to a topic defined in the data entry browser.

Based on the above description, Participant 2 shown a different activity sequence for inserting sight information. However, the "Source Highlight" is originally designed to mark the background of the information selected from the source contents before each input action (see Section 7.1). In order to insert sight information using the sequence that Participant 2 performed, the design purpose would need to be changed for "Source Highlight". Besides, according to Participant 1's comment, we can only assume that the activity sequence that we have designed for information insert is effective for some people. To improve its effectiveness, more evaluations will need to be performed with other people.

Comparison of Activity Sequence for Swapping Information (Task 3)

Table 8.4 compares the original activity sequence of information swap (see Section 7.1 for more detail) with the sequence that both participants performed during the evaluation.

	Original Activity Sequence	**User's Performance in Evaluation**
Step 1	In the resource contents browser, move the mouse cursor over the highlighted area and right-click to display the topics that have been defined in the data entry browser.	In the resource contents browser, move the mouse cursor over the highlighted area and right-click to display the topics that have been defined in the data entry browser.
Step 2	Select a different topic to change the background colour of the highlighted area.	Select a different topic to change the background colour of the highlighted area.
Step 3	In the data entry browser, use drag-and-drop to swap the information between the topics.	Having the system to change the position of information transferred according to the topic selected in Step 2.

Table 8.4: Comparison of activity sequence that participants performed for swapping sight information

In the original activity sequence, it was the administrator's task to change the background colour of highlighted information in the source contents and to change the hierarchical position of the information transferred in the data entry form. However, a different opinion was brought up by our participants during the evaluation.

It was both participants' consensus to manually associate the highlighted information with a new topic in the source contents and to have the system automatically transfer the information from one topic to another in the data entry form. Their comments about this performance were that since the source contents and the information showing in the data entry form are both extracted from the TIP database, it is unnecessary for the administrator to manually swap the information. It would be more effective to have the system perform this action. They also commented that swapping the information manually using the drag-and-drop might introduce errors. For instance, when the administrator tries to swap two pieces of information that are placed at opposite ends of the data entry browser (i.e., top and bottom of the browser),

it would be a long distance to move the information from one end to another. If the administrator accidentally releases the mouse button during the action, the information might be inserted into an incorrect location.

Based on the comments from both participants, the activity sequence that we have designed for the information swap seems ineffective. However, this result was produced by only two people's comments; its correctness will need to be investigated through more evaluations. Besides, the activity sequence that both participants performed to swap information involved the automatic information transfer. Currently, this function is not supported by the TIP system. In order to perform it, a component would need to be developed for TIP that links information that is highlighted in the source contents to the corresponding information inserted in the data entry browser. Thus, after the administrator performed the action to change the background colour of a piece of highlighted information in the source contents, the system could then automatically move the corresponding information inserted in the data entry browser into the newly-defined hierarchical position.

In addition, while evaluating the test user's interaction for swapping information, it was also a goal to see the user's action to swap the information included in overlaps. However, it is our main purpose of quantitative evaluation is to discover an appropriate method in "Source Highlight" for addressing the overlap issue. Therefore, we consider it is not appropriate to test the user's action to swap information included in the overlap. Thus, we have explored this in detail.

Comparison of Time Required

Table 8.5 shows the estimated time that a participant would take to complete each task, and the actual time required for both participants to complete the tasks.

	Estimated Time	**Participant 1**	**Participant 2**
Task 1	10 minutes	10 minutes	12 minutes
Task 2	15 minutes	8 minutes	8 minutes
Task 3	7 minutes	5 minutes	4 minutes

Table 8.5: Comparison of the time that participants required to complete each task.

It was our expectation that the participant would spend more time to think about which method in "Source Highlight", "Drag-and-Drop Input" and "Information Refinement" they should use and about which method would produce a better outcome in order to complete each task. However, from the numbers shown in table, the time required for both participants to complete Task 2 and Task 3 was less than our estimation. The main factor that caused the time to be reduced could be that the participants had become more familiar with the system. Based on our observation, both participants showed an increase in speed when performing Task 2 and 3, compared to Task1. They could quickly show us the method they picked to complete each action and explain the reason for using the chosen method. Thus, we assume that the more familiar the participants became with the system, the less time they required in performing the tasks. Also, we observed results that it is possible to complete each task within the estimated time.

8.3.4 Quantitative Evaluation Conclusion

In this section, we described the user study that we performed to discover which alternatives for "Source Highlight", "Drag-and-Drop Input" and "Sight Information Refinement" the user would use in completing the following three tasks, as well as to find out the most appropriate alternatives to support the operation of sight information insert.

1) Inserting sight information according to one topic.
2) Inserting sight information according to two topics.
3) Swap inserted sight information between the two topics.

In additional, we aimed to identify an effective activity sequence (meaning the activity sequence that causes the smallest number of errors in performing each task) for inserting sight information or for swapping inserted information. Also, we looked at the time that the user required to complete each task.

The evaluation result shows that the "Highlight with Allowance of Overlaps" alternative (IS3) best supports the user in indicating the information that is assigned to each topic in the source contents; the "Copy-on-Drag" alternative (IS4) best supports the user in inserting sight information without changing the appearance of the source

contents; and the "Information Refinement in Tree View" alternative (IS9) best supports the user in inserting sight information in accordance with multiple topics and in swapping information. Thus, these three alternatives are the most appropriate methods to support the sight information insert operation.

Regarding the activity sequence of sight information insert, Participant 1 used the originally designed sequence to complete the task (Task 1 and Task 2) and Participant 2 performed these tasks using a different sequence. Also, both participants employed automatic information transfer to swap sight information (Task 3). They felt that it would be more effective to have the system perform this action. Considering that these two activity sequences were studied using only two people, it is difficult to judge their effectiveness. Hence, more evaluations need to be performed with other people.

Finally, the time required for both participants to complete Task 2 and Task 3 was less than our estimates. We assume that the factor which caused the time to be reduced could be that the participants were getting more familiar with the system. On the other hand, the overall result in **Table 8.5** shows that it is possible to complete each task within estimated time.

8.4 Conclusion

In this section, we evaluated the screenshot prototypes and the interaction models in regards to the insertion of sight information.

For testing other people's satisfaction with the screenshot prototypes created in this project, we carried out seven analyses which cover the prototype solutions described in Section 6.2. Each analysis contains possible designs for the prototype involved in each solution, and each design was presented in screenshot. Based on the advantages and drawbacks of each design, the most appropriate screenshot was identified for each solution.

For evaluating the accessibility of the system requirements described in Section 3.2, we carried out a qualitative evaluation to find out if the prototypes chosen in the first

evaluation can be used to perform the use cases defined in Section 3.3. The evaluation result shows that each use case can be well performed using the developed prototypes. This confirms that our prototypes successfully fulfil the requirements.

For evaluating the interaction models introduced in Section 7, we carried out a quantitative evaluation studying other people's behaviour using the designed model to perform sight information insert and information swap. The result shows that the following three models are most appropriate in performing sight information insert:

- "Highlight with Allowance of Overlaps" (IS3)
- "Copy-on-Drag" (IS4)
- "Information Refinement in Tree View" (IS9)

Also, while examining the effectiveness of the activity sequence for inserting sight information and swapping inserted information, a different sequence was suggested by our participants for these operations. They felt that the sequence they performed to complete each task was more effective than our designs. Because our designs were tested by only two people, it is difficult to judge their effectiveness. Therefore, more evaluation will need to be performed with other people to obtain a more accurate result. Finally, based on the time our participants required to perform the given task, it is possible to complete each task within the estimated time.

Section 9 Related Approach and Future Work

As described in the thesis, the proposed administration service supports the user in performing sight information insert through drag-and-drop input (FR4). Comparing this information transfer technique with the existing data input manner in TIP (keyboard typing), the time to insert a large amount of sight information can thus be reduced. However, it is pointed out in [21] that the drag-and-drop input is also slow in transferring a large amount of information. Therefore, [21] introduces the Entity Quick Click to enhance the traditional information transfer operations (copy-and-paste and drag-and-drop).

In this section, we study the Entity Quick Click and analyse the information transfer operation supported by this approach. After that, we will compare its information transfer operation with our sight information insert operation based on the technique of information highlight and transfer. We will then describe a newly-designed sight information insert operation, which conducts the information highlight and transfer techniques supported by the Entity Quick Click. At the end of this section, we will introduce possible future works for TIP's administration service.

9.1 Entity Quick Click

Entity Quick Click [21] is an information extraction and transformation approach for the enhancement of traditional data input methods (keyboard typing) and information transfer operations (copy-and-paste and drag-and-drop). It supports the user in transferring entity phrases (e.g., person names, city names, company names, phone numbers, and street addresses) from a source document to a receiving application through a mouse click. It is designed and developed based on two assumptions:

- The user copies entity phrases that are recognised by the computer system.
- The receiving application knows where to insert the copied phrases.

The phrases included in a source document are extracted by an entity extractor. Apart from this, the extracted phrases are automatically highlighted by the system after they are displayed on the screen. The user can move the mouse cursor over a highlighted

phrase and click at the phrase to activate the transfer, sending the phrase to the receiving application. Alternatively, the user can manually select a phrase (including vocabularies that are not discovered by the extractor and/or the vocabularies that are found), press the shift key to enable the Entity Quick Click and highlight the selected phrase, and click on the phrase to launch the transfer.

However, there are situations where the user does not want to copy the computer recognised phrases, or the application that receives the transferred phrase does not know where the copied phrases should be inserted. Hence, the Entity Quick Click also supports the user in transferring information through copy-and-paste and drag-and-drop operations. After the phrases are extracted and shown, the user can copy or cut the extracted phrases in the operating system buffer and paste them into the receiving application. In addition, the user can manually select a phrase and transfer the selected phrase using the drag-and-drop operation.

9.2 Comparison of Information Highlight and Transfer Techniques

In this section, we compare the operations for inserting sight information into TIP (see Section 7) with the operation for copying entity phrases using the Entity Quick Click based on the technique of information highlight and transfer.

	Information Highlight Manner	Information Transfer Manner	Information Transfer Environment
TIP Administration Service	• Manual Highlighting	• Manual Transfer	• Graphical User Interface
Entity Quick Click	• Automatic Highlighting • Manual Highlighting	• Automatic Transfer • Manual Transfer	• Graphical User Interface

Table 9.1: Analysis of the information highlight and transfer techniques supported by TIP's administration service and Entity Quick Click.

Table 9.1 presents the information highlight and transfer techniques supported by both approaches.

It is common for both approaches, in supporting the user in manual highlighting, to indicate the information that is selected for each transfer action. Differently, the highlighting is enabled through a popup menu in TIP's administration service while this feature is activated in the Entity Quick Click by holding down the Shift key. In addition, the Entity Quick Click also emphasises automatic highlighting. After the phrases are extracted from a source document by the entity extractor, this approach automatically highlights the extracted phrases to engage the user's attention to important phrases.

Also, the information transfer can be performed manually in a graphical user interface in both approaches. Hence, the transferred information can be placed into a user-specified location. In TIP's administration service, the user can transfer the information selected from the resource contents browser into a component provided in the data entry browser using the drag-and-drop operation. On the other hand, the Entity Quick Click can be activated to transfer the information displayed in a word processing software to a receiving application through the drag-and-drop and copy-and-paste. Additionally, this approach allows automatic information transfer. The Entity Quick Click assumes that the receiving application knows where to insert the transferred information. The user can thus click on a system-discovered phrase or a manually selected phrase and transfer it to a location that is known by the receiving application.

From the above study, we conclude that both the TIP's administration service and the Entity Quick Click support the user in indicating the information that is selected for each transfer action using the manual highlighting. They also assist the user in transferring information manually in a graphical user interface. The Entity Quick Click supports additional features: automatic information highlight and automatic information transfer. To perform the former, an entity extractor is developed to extract and highlight phrases included in the source document. Thus, the user can follow the highlights to achieve important phrases. However, such an extractor does not exist in the TIP system and it is not our goal to develop this component to interpret and

highlight the information extracted from a TIP resource or from external resources (including the information stored in an external database or in various textual formats: plain text or XML) in this project. On the other hand, in order to perform automatic information transfer, the user can click on a phrase identified in the source document and transfer it to a receiving application.

Based on this approach, we suggest enhancing the operation of sight information inserts using the automatic transfer technique. This enhancement is described in the next section.

9.3 Automatic Sight Information Transfer

In the following, we describe the enhancement of a sight information insert operation. The enhanced operation consists of manual and automatic information highlight, and automatic information transfer. Our goal here is to introduce the enhanced operation based on a different information transfer procedure. Thus, it is not our focus to design a component that automatically interprets and highlights the information extracted from each resource, match up the transferred information with the corresponding information included in source contents, or determine the duplicate information insert. Since the TIP system does not exist as a component that performs these tasks, the enhanced operation is designed based on five assumptions:

- Each topic stored in the TIP database is assigned with a corresponding colour.
- The TIP system consists of an ability to determine and highlight the extracted information using a colour assigned to a corresponding topic stored in the database.
- The TIP system knows the explicit location to hold the transferred sight information in the data entry browser.
- The TIP system knows which portion in the source contents the transferred information comes from.
- The TIP system consists of an ability to detect duplicate information.

In accordance with the result of quantitative evaluation (Section 8.3): (1) having overlaps highlighted in source contents, the information that is relevant to multiple topics can be explicitly indicated; (2) having the copying method to transfer sight information, source of transferred information can still be clearly presented in the source contents; and (3) having the tree view to refine transferred sight information, the topics that are defined for a sight and the information that is transferred according to each topic can be clearly presented. Therefore, three additional assumptions are identified as follows:

- Overlaps are presented in source contents to address the information that is related to multiple topics (IS3).
- Sight information is transferred through the copying technique (IS4).
- The sight information refinement is performed using the tree view (IS9).
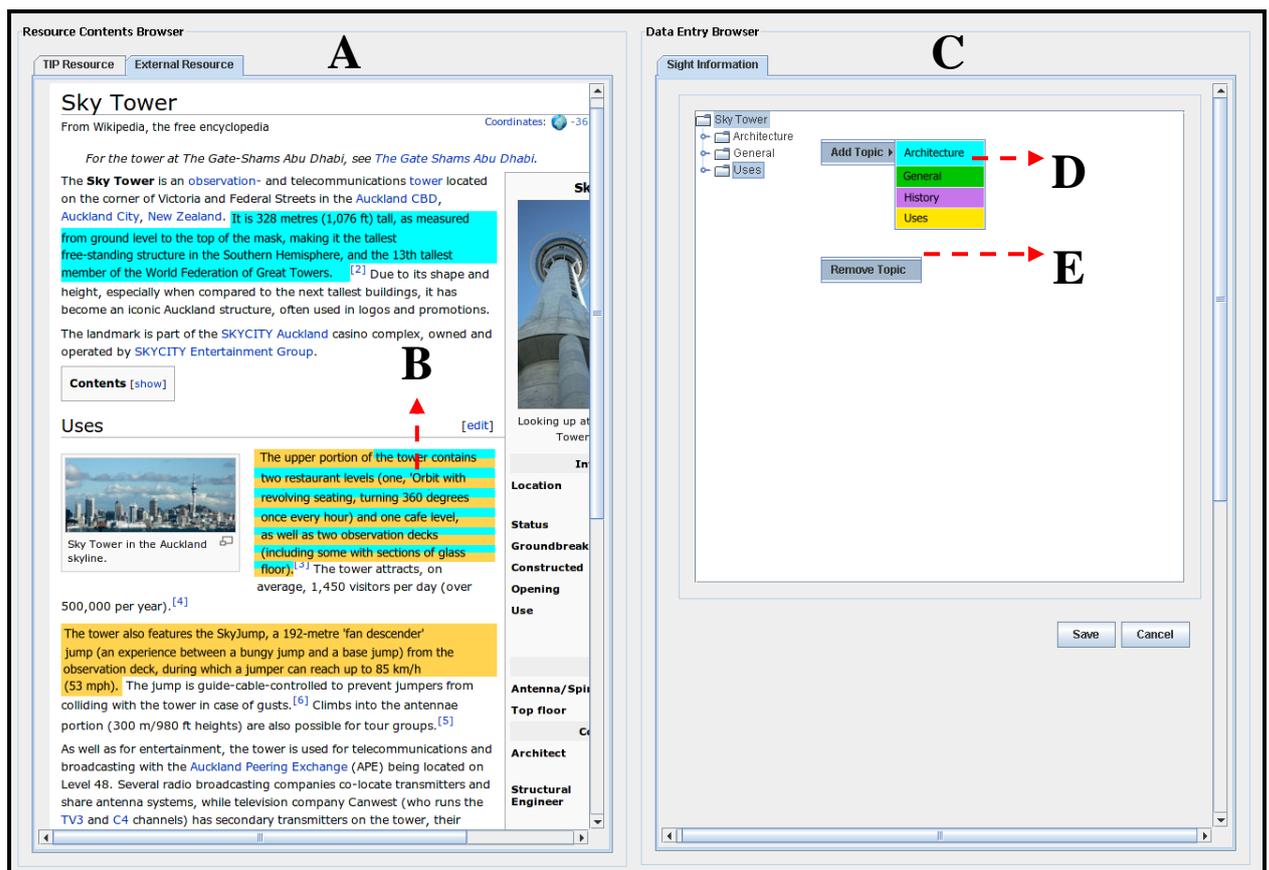
Figure 9.1: Sight information insert environment for automatic sight information transfer.

Figure 9.1 presents a sample screenshot of the newly-designed sight information insert environment. In this design, we assume that the TIP system can be functioned to interpret the information extracted from each resource. Thus, the extracted information can be refined in accordance to relevant topics stored in the TIP database, and each piece of refined information can be automatically highlighted in a colour that is assigned to a corresponding topic (e.g., the highlighted information shown in source contents − **Area A**). The highlights may include overlaps (**Area B**) to indicate the information that is related to multiple topics. On the other hand, after the sight information entry form (**Area C**) is presented, the user can move the mouse cursor over the sight name and right-click on it to activate a popup menu (**Area D**). By selecting "Add Topic" from this menu, a list of topics stored in the TIP database will be displayed. From there, the user can select a topic to assign the selected topic to the sight. In addition, the background of each topic displayed at **Area D** is highlighted in the representative colour of the topic. Thus, the user can follow the colour to match up the information highlighted in the resource contents browser with relevant topics. Alternatively, the user can select a topic and right-click on it to activate the popup for topic deletion (**Area E**). Through the action to select "Remove Topic", s/he can delete the selected topic.

Figure 9.2 presents a sample screenshot showing the action flow of the newly-designed operation. Assuming the user has defined three topics ("Architecture", "General" and "Uses") for the sight Sky Tower in the data entry browser. Also, the information presented in **Area A** (representing the information highlighted for the topic "Architecture"), **Area B** (representing the information highlighted for the topic "Uses"), and **Area C** (representing the information related to both topics − the overlap) is automatically highlighted by the system. The user can therefore left-click on each highlight to activate the transfer and send the information to a hierarchical level defined for the corresponding topic. If an overlap is clicked, the information included will be sent to relevant topics defined in the data entry browser. Also, if the user tries to click on the same piece of information twice to transfer duplicate information into a topic defined in the data entry browser, a message box (**Figure 9.3**) will be shown to warn the user about the duplicate information insert and stop the process inserting the clicked information for the second time.
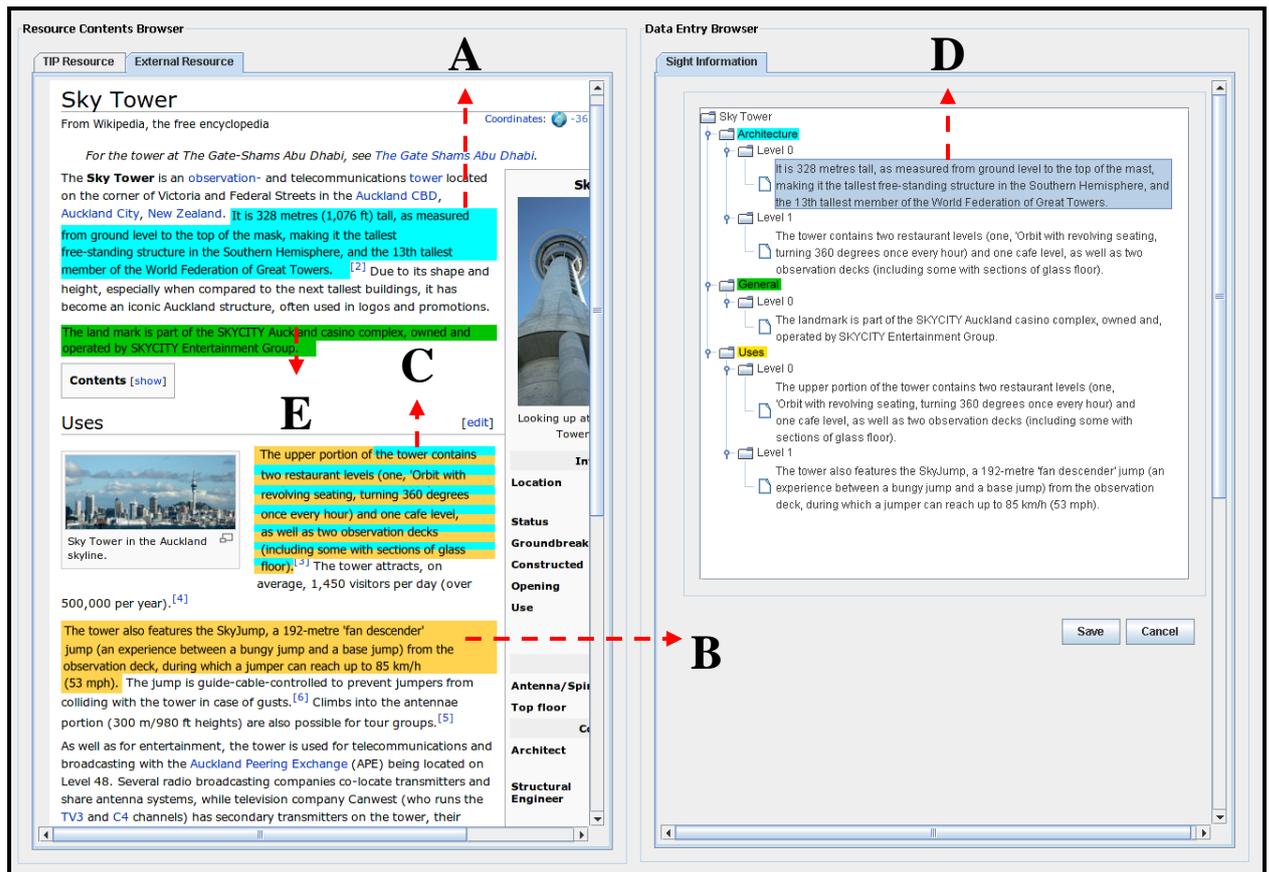
Figure 9.2: Action flow of automatic sight information transfer.
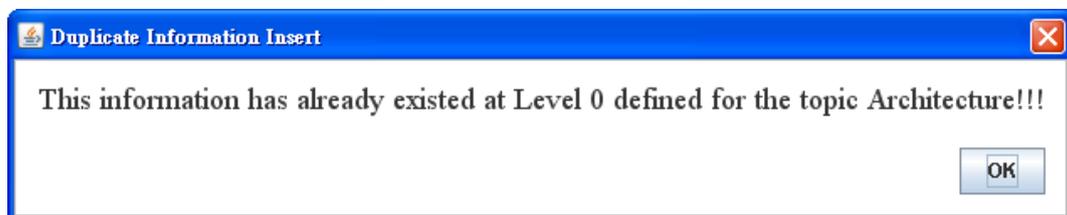
Figure 9.3: Screenshot of warning message for the insertion of duplicate information.

In the data entry browser, the hierarchical level defined for each topic is determined by the sequence to insert each piece of information. For instance, if the user first clicks on **Area A** then clicks on **Area C**, the information highlighted in **Area A** will be transferred into Level 0 defined for the topic "Architecture", and the information included in **Area C** will be transferred into Level 1 defined for the topic "Architecture" and Level 0 defined for the topic "Uses".

When the user wants to swap the information between the two topics or the two levels in the same topic, s/he can select a piece of information in the data entry browser

(e.g., **Area D**) and right-click on it to activate a menu (**Figure 9.4**). Through the entry "Swap Information to …" provided in this menu, the user can access the overview of hierarchical structure defined for the sight. From there, the user can choose a hierarchical position to swap the information included in **Area D** with the information held in the chosen position. If this action involves swapping information between the two topics, the system will automatically change the colour of the highlight of swapped information in the resource contents browser. Also, the user can remove a piece of un-required information by choosing "Remove Information" supplied in **Figure 9.4**. The system will then follow the user's request to remove the selected information from the data entry browser and de-highlight the corresponding texts located in the resource contents browser.

Figure 9.4: Popup menu for swapping or removing information inserted in the data entry browser.

Alternatively, the user can right-click on a highlight in the resource contents browser (e.g., **Area A**) to activate a menu (**Figure 9.5**) showing topics that are defined in the data entry browser. From the menu, the user can select a different topic to change the colour that is highlighted in **Area A**. After that, if the information contained in **Area A** has not been transferred before, the system will automatically transfer it into a hierarchical level defined for the selected topic. Otherwise, in the data entry browser, the automatic transfer will be activated to move this information from the original host to the newly-defined position. This action can also be performed on the overlap. For instance, after right-clicking on **Area C**, a popup menu (**Figure 9.6**) will be launched. From the menu, the user can select "Architecture → General" to transfer the information in **Area C** that is originally highlighted for the topic "Architecture" into a hierarchical level defined for the topic "General". If this information is previously transferred, the system will automatically move it from the topic "Architecture" to "General" in the data entry form. Of course, **Area C** will be filled in with the representative colours of the topic "General" and "Uses" after this performance.
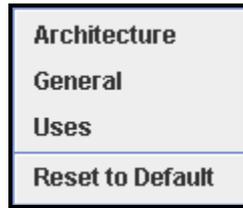
Figure 9.5: Popup menu for assigning highlighted information to a relevant topic, or de-selecting the highlighted information (for information outside the overlaps).
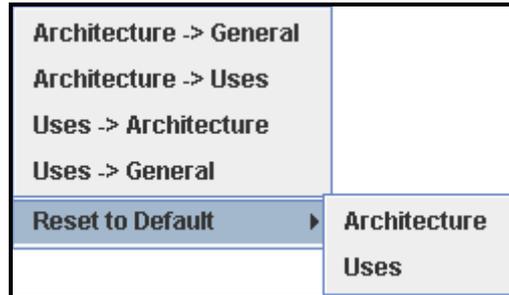
Figure 9.6: Popup menu for assigning highlighted information to a relevant topic, or de-selecting the highlighted information (for information included in overlaps).

Furthermore, the user can perform manual highlighting to assign the information that is not discovered by the system to a corresponding topic and transfer it to the data entry browser. In order to perform this action, the user can manually select a piece of information (e.g., **Area E**) and right-click on it to activate the menu showing in **Figure 9.5**. Thus, the user can choose a topic (e.g., General) to highlight the selected information using the representative colour of the chosen topic. At the same time, the system will automatically transfer the information into a hierarchical level defined for the chosen topic in the data entry browser. Additionally, the manually highlighted information can include partial information that has previously been highlighted. Hence, an overlap will be produced to this newly-highlighted area.

On the other hand, if the user does not like the information that is highlighted by the system, s/he can always right-click on a piece of highlighted information to activate the menu showing in **Figure 9.5** and select "Reset to Default" to de-highlight the information. This action also works on overlaps. The user can right-click on an overlap to activate the menu showing in **Figure 9.6** and select "Reset to Default". Thus, a list of topics to which the information included in the overlap is relevant will be presented. The user can select a topic to rub out the representative colour of the

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selected topic from the overlap. Also, when the user performs the action to de-highlight information, if the de-highlighted information has been transferred into the data entry browser previously, the system will automatically remove it from the data entry browser.

9.4 Future Work

From the above description, the newly-designed sight information insert operation supports the user in performing manual and automatic information highlighting, and automatic information transfer. The information that is extracted from a resource is refined and highlighted in accordance to relevant topics stored in the TIP database. The user can left-click on each highlight (including overlaps or non-overlaps) and transfer the information included in it to a hierarchical level defined for a topic. Through **Figure 9.4**, the user can swap the information placed in two hierarchical positions. Alternatively, the user can transfer the highlighted information into topics defined in the data entry browser or move the transferred information from one topic to another using the **Figure 9.5** or **9.3d**. Additionally, the user can manually highlight the information presented in source contents and allow the system to transfer the highlighted information into the data entry browser. Also, s/he can de-highlight the information presented in the source contents to remove the information included in the de-highlighted area from the data entry browser.

We present this new design to demonstrate a different information transfer technique that can be utilised to enhance the operation of sight information inserts. Future work on this design is to evaluate its usability with audiences, and compare its performance with the evaluation result shown in Section 8.3 or related approaches that have been researched by other research groups. Additionally, a component that performs automatic information interpretation and extraction should also be designed and developed in the near future to support the newly-designed sight information insert operation in identifying sight-related information included in the source contents and transferring identified information to a system-known location in the data entry browser.

Finally, based on the concern (C3) addressed in Section 5.1, the information search tool must have the function to parse the structure of different resources (including TIP and external resources) and identify appropriate information from them. In order to achieve this feature, two studies should be completed before the implementation:

- *How to address a search query and search option when searching for sight information* – a study to discover the user's aptitude in addressing a search query and search option in order to search for sight information from the TIP database or external sources.
- *How does the system identify appropriate information from each resource* – a study to discover an appropriate search strategy to identify the information that matches the user's search query and option from TIP and external resources.

Due to the limited timeframe of this project, it is not our goal to study the user's aptitude in performing the search or the information search strategy. However, in order to have an integrated search assistant to support the user in performing information search, they are considered as on-going tasks for TIP's administration service.

Section 10 Summary

In this section, we summarise the work that we accomplished in this project.

Overview of the Existing and the Proposed Administration Service
The original goal of our project, as described in Section 1, is the information import into the TIP system via a graphical user interface. We aimed to design and develop an administration working panel that supports the administrator in identifying and extracting the appropriate sight information from various resources, as well as in transferring and storing extracted information into the TIP database.

We started off with an analysis (Section 2) to clarify the issues of the existing administration interfaces (I1 to I7). Because of these issues, it is time consuming for the administrator to perform administration activities. Most importantly, the sight information imported according to each topic and sight is filled with repetition.

Based on the issues identified, we came out with an idea to develop a new administration interfaces. In Section 3, we clarify the requirements for the new interfaces through a user scenario. From there, five functional requirements (FR1 to FR5) and six interface requirements (IR1 to IR6) are clarified for the new administration interface. Also, six use cases (UC1 to UC6) were conducted to fulfil these requirements.

In Section 4, 22 prototypes (PP1 to PP22) were designed in sketches for the proposed administration service. The purpose of these prototypes is to support the administrator in performing administration activities described in the use cases, to present the contents of each resource in their own data structure, and to store the inserted information in accordance with TIP's database structure.

Concerns and Solutions with Prototype and Interaction Design
Before the implementation of designed prototypes, in Section 5, we walked through each sketch according to the activity sequence defined in the use cases to understand

whether the prototypes match the requirements. During the review, we identified concerns from the prototype designs and the administrator's interaction to insert sight information and to search desired information. We particularly focused on the concern of seven sketches and described each prototype concern in accordance with three factors:

- Inconsistent Design (PP2, PP4 and PP11)
- Inefficiency of Use (PP5 and PP3)
- Bad Usability (PP1 and PP6)

These concerns were considered to affect the administrator in performing his/her activities. Thus, we decided to refine each problematic sketch according to the corresponding concern. Additionally, we analysed the operation to insert sight information according to the rules that have been defined for the insertion of sight information. From this analysis, we derived the following three questions as concerns for the operation:

- How to present the contents that have been selected for various input action?
- How to present the source contents that have been transferred through drag-and-drop input?
- How to refine the transferred data into levels of detail in the data entry form?

In Section 6, we went through proposed solutions for the concerns identified with the sketch prototypes. Each solution consisted of two screenshots as possible refinements for one sketch. Based on the pros and cons of each screenshot, we identified an appropriate prototype for five solutions (SP1, SP2, SP4, SP6, and SP7) based on our (the developer's) satisfaction. To solve the questions raised about the insertion of sight information, possible solutions for these questions were presented in Section 7. Each solution represents an interaction model that takes part in the insertion of sight information and consisted of three alternatives. The solutions are:

- Source Highlight (IS1 ~ IS3)
- Drag-and-Drop Input (IS4 ~ IS6)
- Sight Information Refinement (IS7 ~ IS9)

Through the user study described in Section 8.1, an appropriate prototype was discovered in six solutions (SP1, SP2, SP4, SP5, SP6 and SP7) based on other

people's satisfaction. There was a concern for the sight information entry form (PP11) that could not be solved in SP3. Thus, we decided to find out the appropriate refinement for this sketch through the interaction evaluation described in Section 8.3. Note that the evaluation result from Section 8.3 shows that the prototype using a tree view structure (IS9) was considered the most appropriate sight information insert model. Additionally, the result from the qualitative evaluation (Section 8.2) shows that the activity defined for each use case can be performed well using the prototypes chosen from the user evaluation (Section 8.1). The use cases were originally designed to illustrate the system requirements defined in Section 3; therefore, this evaluation proves that the prototypes developed successfully fulfil the requirements.

To find out the most appropriate alternative for each solution that would best support the administrator in inserting sight information, test user's interaction flow to insert and swap sight information was studied in quantitative evaluation (Section 8.3). Based on the evaluation result, the following alternatives were considered most applicable to support the insertion of sight information.

- *IS3: Highlight with Allowance of Overlaps* – supports the administrator in discovering information inserted to multiple topics in source contents.
- *IS4: Copy-on-Drag* – supports the administrator in inserting sight information without changing the appearance of source contents.
- *IS9: Information Refinement in Tree View* – supports the administrator in inserting sight information and swapping inserted information between two topics.

In addition, while evaluating the effectiveness of the activity sequence for inserting sight information and swapping inserting information, a different sequence was suggested by our participants for these operations. However, to use their design to insert sight information, the purpose of the designed model that was identified in Section 7 would need to be changed. Also, by taking their suggestion on swapping inserted sight information using an automatic information transfer technique, a function that identifies the information that is highlighted in the source contents with the corresponding information inserted in the data entry browser would need to be provided by TIP. Because we tested our designs with only two users, it is difficult to

judge whether they are effective. Therefore, we found that there is a need to evaluate our design with more users to validate our results.

Future Works

In Section 9, we studied a related approach, Entity Quick Click. This approach supports the user in transferring entity phrases from source documents to a receiving application through automatic information highlighting and transferring techniques. In addition, it also supports traditional "copy-and-paste" and "drag-and-drop" operation. Based on the information extraction and transfer techniques introduced by this approach, we enhanced the operation of sight information insert. The enhancement supports the administrator in inserting sight information through manual and automatic information highlight and through automatic information transfer. In order to find out whether this design is appropriate in supporting sight information insert, its usability and performance needs to be evaluated in the future.

Another area for future work is a component that automatically interprets and extracts information in documents from external sources.

Further future work can investigate the questions that are identified in Section 5.1 for the operation of information search.

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Appendix A: TIP Database ER Diagram

Figure A.1: TIP Database ER Diagram. (This image is taken from [19].)

Appendix B: Test Data for Quantitative Evaluation

<u>**Instruction for Task 1:**</u>

Task 1: Insert Sight Information According to a Topic	
Goal:	The sight information contents that are selected according to the chosen topic are inserted in an effective activity sequence.
Assumptions:	- A Sight is chosen. **(Sky Tower)** - A topic is chosen **(Architecture)**. - The sight information that is selected according to the chosen topic is known. **(see sample screenshots)** - The representative colour of the chosen topic is known. **(Architecture – blue)**
Steps:	1. Select a data entry form. **(single field, multiple fields, or tree view)** 2. Add a topic according to the sight. - Assign a topic. - Decide whether to perform "Highlight Operation" **<u>Single Field Data Entry</u>** 3. Perform sight information selection according to the chosen topic. 4. Perform "Highlight Operation" **(depending on your decision in step 2)** 5. Perform "Drag-and-Drop" input. - Decide which input method you like to use. 6. Refine the inserted information into levels of detail. **<u>Multiple Fields/Tree View Data Entry</u>** 7. Refine the source contents to select level-0 contents according to the chosen topic. 8. Perform "Highlight Operation" **(depending on your decision in step 2)** 9. Perform "Drag-and-Drop" input. 10. Add a level according to the chosen topic. 11. Repeat step 7 ~ 10 to define level-1 contents according to the chosen topic.
Time for expert:	10 minutes

Instructions for user:	You are an administrator of the TIP database. Your job is to import and update the sight-related information in the TIP database. Today, you are trying to collect and import sight information that is related to the Sky Tower. You have started searching through the internet, and you have found some useful information from the Wikipedia website. You have interpreted the contents displayed in the webpage and emphasised two pieces of information that relate to the architecture of the tower. You want to refine the emphasised information into levels of detail and store them into the TIP database.

Table B.1: Instruction for Task 1 (Quantitative Evaluation).

Source Contents for Task 1

Figure B.1: Source contents for Task 1 (Quantitative Evaluation).

The User's Choices of the "Sight Information Refinement" Model

Note that these models apply to both Task 1 and Task 2.

Choice 1: Information Refinement in Single Field (IS7)

Figure B.2: Data entry model for "Information Refinement in Single Field – IS7" (Task 1 and Task 2).

Choice 2: Information Refinement in Multiple Fields (IS8)

Figure B.3: Data entry model for "Information Refinement in Multiple Fields – IS8"

(Task 1 and Task 2).

Choice 3: Information Refinement in Tree View (IS9)
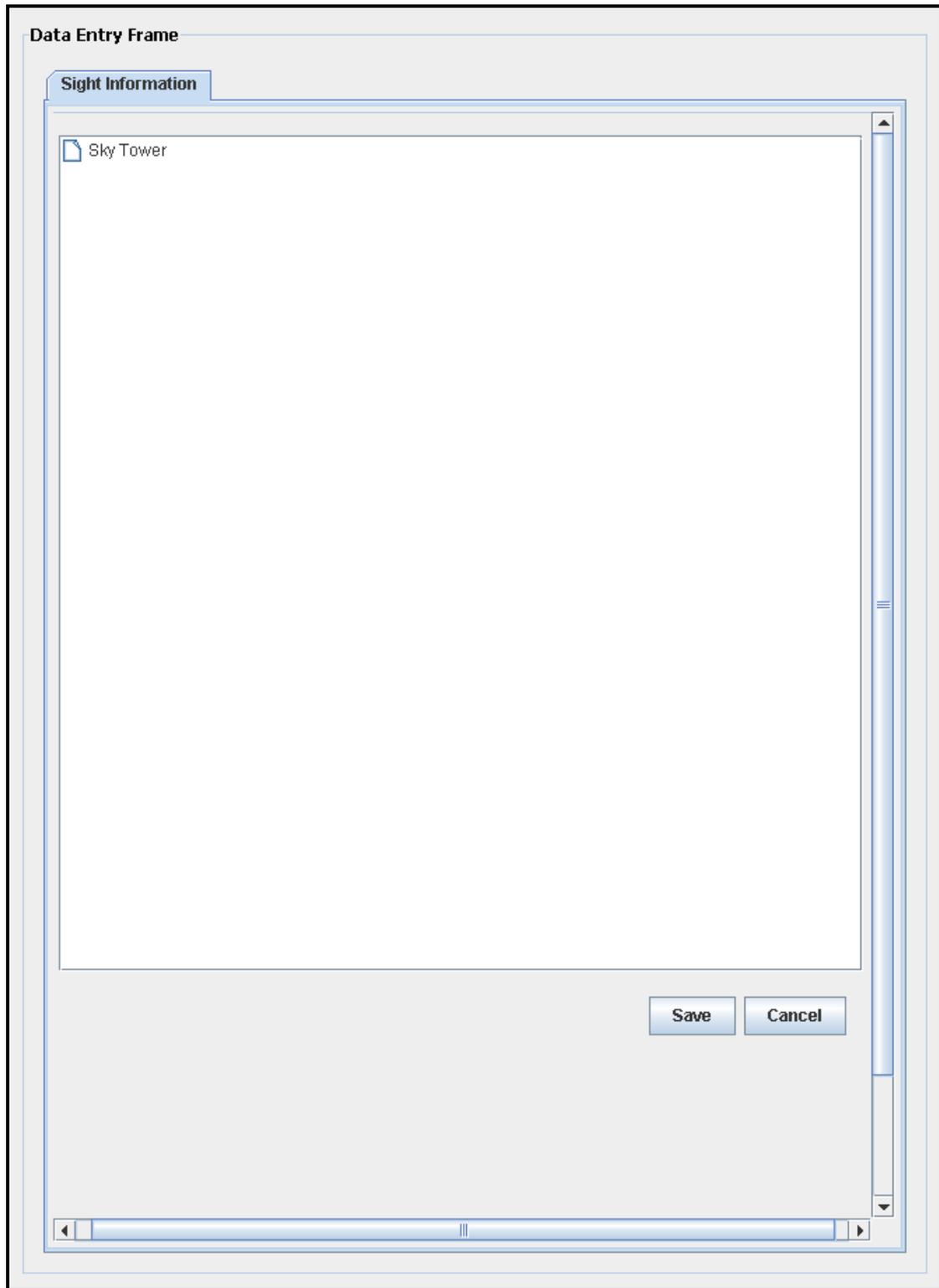
Figure B.4: Data entry model for "Information Refinement in Tree View – IS9" " (Task 1 and Task 2).

The following presents test data using in Task 1.

The User's Choices of "Source Highlight" – Task 1

Topic (with highlight):

Architecture

Topic (without highlight):

Architecture

Sight Information for "Architecture" – Level 0:

The Sky Tower is an observation- and telecommunications tower located on the corner of Victoria and Federal Streets in the Auckland CBD, Auckland City, New Zealand. **It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers.[2]** Due to its shape and height, especially when compared to the next tallest buildings, it has become an iconic Auckland structure, often used in logos and promotions.

Sight Information for "Architecture" – Level 1:

The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).[3] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[4]

The User's Choices of "Drag-and-Drop Input" – Task 1

Copy-on-Drag – IS4 (Architecture – Level 0):

The Sky Tower is an observation- and telecommunications tower located on the corner of Victoria and Federal Streets in the Auckland CBD, Auckland City, New Zealand. **It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers.[2]** Due to its shape and height, especially when compared to the next tallest buildings, it has become an iconic Auckland structure, often used in logos and promotions.

Copy-on-Drag – IS4 (Architecture – Level 1):

The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).[3] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[4]

Cut-on-Drag – IS5 (Architecture – Level 0):

The Sky Tower is an observation- and telecommunications tower located on the corner of Victoria and Federal Streets in the Auckland CBD, Auckland City, New Zealand.

[2] Due to its shape and height, especially when compared to the next tallest buildings, it has become an iconic Auckland structure, often used in logos and promotions.

Cut-on-Drag – IS5 (Architecture – Level 1):

> [3] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[4]

Grey-on-Drag – IS6 (Architecture – Level 0):

> The Sky Tower is an observation- and telecommunications tower located on the corner of Victoria and Federal Streets in the Auckland CBD, Auckland City, New Zealand. It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers.[2] Due to its shape and height, especially when compared to the next tallest buildings, it has become an iconic Auckland structure, often used in logos and promotions.

Grey-on-Drag – IS6 (Architecture – Level 1):

> The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).[3] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[4]

Input Data (Single Field) – Task 1

Architecture:

It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers. The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).

Input Data (Multiple Field / Tree View) – Task 1

Architecture – Level 0:

It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers.

Architecture – Level 1:

The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).

Instruction for Task 2:

Task 2: Insert Sight Information According to Two Topics	
Goal:	The sight information contents that are selected according to the chosen topics are inserted in an effective activity sequence.
Assumptions:	- A Sight is chosen. **(Sky Tower)** - Two topics are chosen. **(Architecture, Uses)** - The sight information contents that are selected according to the chosen topics are known. **(see sample screenshots)** - The representative colours of the chosen topics are known. **(Architecture – blue, Uses – yellow)**
Steps:	1. Select a data entry form. **(single field, multiple fields, or tree view)** 2. Add first topic according to the sight. - Assign a topic - Assign a representative colour. **Single Field Data Entry** 3. Perform sight information selection according to the chosen topic 4. Perform "Highlight Operation". - Decide which highlight method you like to use. 5. Perform "Drag-and-Drop" input. - Decide which input method you like to use. 6. Refine the inserted information into levels of detail. 7. Repeat step 2 ~ 6 to add a second topic and its corresponding sight information according to the sight. **Multiple Fields/Tree View Data Entry** 8. Refine the source contents to select level-0 contents according to the chosen topic 9. Perform "Highlight Operation". - Decide which highlight method you like to use. 10. Perform "Drag-and-Drop" input. - Decide which input method you like to use. 11. Add a level according to the chosen topic. 12. Repeat step 8 ~ 10 to define level-1 contents according to the chosen topic. 13. Repeat step 2, 8 ~12 to add a second topic and its corresponding sight information according to the sight.
Time for expert:	15 minutes

Instructions for user:	You are an administrator of the TIP database. You are trying to collect and import sight information that relates to the Sky Tower. You have searched through the internet and found appropriate information from the Wikipedia website. You have interpreted the contents displayed in the webpage and emphasised four pieces of information, including:
	- Two pieces of information that relate to the architecture of the tower. - Two pieces of information that relate to the use of the tower.
	You want to refine the emphasised information into levels of detail and store them into the TIP database according to two topics. However, while performing the action to highlight the contents according to two topics, an overlap would be produced between the two pieces of information. Therefore, you also want to find a way to address or ignore the overlap.

Table B.2: Instruction for Task 2 (Quantitative Evaluation).

Source Contents for Task 2

Figure B.5: Source contents for Task 2 (Quantitative Evaluation).

The following presents test data using in Task 2.

The User's Choices of "Source Highlight" – Task 2

Topic (with highlight):

Architecture

Uses

Sight Information for "Architecture" – Level 0:

The Sky Tower is an observation- and telecommunications tower located on the corner of Victoria and Federal Streets in the Auckland CBD, Auckland City, New Zealand. **It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers.**[2] Due to its shape and height, especially when compared to the next tallest buildings, it has become an iconic Auckland structure, often used in logos and promotions.

Sight Information for "Architecture" – Level 1:

The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).[3] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[4]

Sight Information for "Uses" – Level 0:

(Highlight without the Allowance of Overlaps – IS1)

The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).[3] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[4]

Sight Information for "Uses" – Level 0:

(Highlight with Overlaps Overwritten – IS2)

> The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).[3] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[4]

Sight Information for "Uses" – Level 0:

(Highlight with the Allowance of Overlaps – IS3)

> The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).[3] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[4]

Sight Information for "Uses" – Level 1:

> The tower also features the SkyJump, a 192-metre[5] 'fan descender' jump (an experience between a bungy jump and a base jump) from the observation deck, during which a jumper can reach up to 85 km/h (53 mph). The jump is guide-cable-controlled to prevent jumpers from colliding with the tower in case of gusts.[6] Climbs into the antennae portion (300 m/980 ft heights) are also possible for tour groups.[5]

The User's Choices of "Drag-and-Drop Input" – Task 2

Copy-on-Drag – IS4 (Architecture – Level 0):

The Sky Tower is an observation- and telecommunications tower located on the corner of Victoria and Federal Streets in the Auckland CBD, Auckland City, New Zealand. **It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers.[2]** Due to its shape and height, especially when compared to the next tallest buildings, it has become an iconic Auckland structure, often used in logos and promotions.

Copy-on-Drag – IS4 (Architecture – Level 1):

The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).[3] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[4]

Copy-on-Drag – IS4 (Uses – Level 0):

The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).[3] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[4]

Copy-on-Drag – IS4 (Uses – Level 1):

The tower also features the SkyJump, a 192-metre[5] 'fan descender' jump (an experience between a bungy jump and a base jump) from the observation deck, during which a jumper can reach up to 85 km/h (53 mph). The jump is guide-cable-controlled to prevent jumpers from colliding with the tower in case of gusts.[6] Climbs into the antennae portion (300 m/980 ft heights) are also possible for tour groups.[5]

Cut-on-Drag – IS5 (Architecture – Level 0):

The Sky Tower is an observation- and telecommunications tower located on the corner of Victoria and Federal Streets in the Auckland CBD, Auckland City, New Zealand.

[2] Due to its shape and height, especially when compared to the next tallest buildings, it has become an iconic Auckland structure, often used in logos and promotions.

Cut-on-Drag – IS5 (Architecture – Level 1):

[3] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[4]

Cut-on-Drag – IS5 (Uses – Level 0):

[3] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[4]

Cut-on-Drag – IS5 (Uses – Level 1):

The jump is guide-cable-controlled to prevent jumpers from colliding with the tower in case of gusts.[6] Climbs into the antennae portion (300 m/980 ft heights) are also possible for tour groups.[5]

Grey-on-Drag – IS6 (Architecture – Level 0):

The Sky Tower is an observation- and telecommunications tower located on the corner of Victoria and Federal Streets in the Auckland CBD, Auckland City, New Zealand. It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers.[2] Due to its shape and height, especially when compared to the next tallest buildings, it has become an iconic Auckland structure, often used in logos and promotions.

Grey-on-Drag – IS6 (Architecture – Level 1):

The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).[3] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[4]

Grey-on-Drag – IS6 (Uses – Level 0):

The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).[3] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[4]

Grey-on-Drag – IS6 (Uses – Level 1):

The tower also features the SkyJump, a 192-metre[5] 'fan descender' jump (an experience between a bungy jump and a base jump) from the observation deck, during which a jumper can reach up to 85 km/h (53 mph). The jump is guide-cable-controlled to prevent jumpers from colliding with the tower in case of gusts.[6] Climbs into the antennae portion (300 m/980 ft heights) are also possible for tour groups.[5]

Input Data (Single Field) – Task 2

Architecture:

It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers. The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).

Uses:

The tower also features the SkyJump, a 192-metre[5] 'fan descender' jump (an experience between a bungy jump and a base jump) from the observation deck, during which a jumper can reach up to 85 km/h (53 mph). It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).

Input Data (Multiple Field / Tree View) – Task 2

Architecture – Level 0:

It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers.

Architecture – Level 1:

The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).

Uses – Level 0:

It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).

Uses – Level 1:

The tower also features the SkyJump, a 192-metre[5] 'fan descender' jump (an experience between a bungy jump and a base jump) from the observation deck, during which a jumper can reach up to 85 km/h (53 mph).

Instruction for Task 3:

Task 3: Swap the Inserted Information Between Two Topics	
Goal:	The sight information contents that are selected according to two topics are swapped in an effective activity sequence.
Assumptions:	- A Sight is chosen. **(Sky Tower)** - Two topics are chosen. **(Architecture, Uses)** - The method of Drag-and-Drop is chosen. **(Copy-on-Drag)** - The sight information contents that are selected according to the chosen topics are known. **(see sample screenshots)** - The representative colours of the chosen topics are known. **(Architecture – blue, Uses – yellow)** - The selected sight information contents are highlighted according to chosen colours, and the highlighted contents involve overlaps. **(see sample screenshots)**
Steps:	1. Select a data entry form. **(single field, multiple fields, or tree view)** 2. Swap the inserted information between the two topics (including overlap) - Move level-1 contents in Architecture to level 0 in Uses, and move level-0 contents in Uses to level 1 in Architecture. (This may involve changing the colour from source contents or changing the position of input information) 3. Swap the inserted information between the two topics (excluding overlap) - Move level-0 contents in Architecture to level 1 in Uses, and move level-1 contents in Uses to level 0 in Architecture. (This may involve changing the colour from source contents or changing the position of input information).
Time for expert:	15 minutes

Instructions for user:	You are an administrator of the TIP database. Last night, you had an argument with the waiter while you were dinning in the restaurant in Sky Tower, and you lost 500 dollars while playing in the Sky City casino. Therefore, you like to vent your anger on the contents of Sky Tower stored in the TIP database.
	You have requested to display the Wikipedia page that relates to Sky Tower and the information of Sky Tower stored in the TIP database. You want to swap the information that is inserted according to two topics; including the information that is involved in an overlap and the information that is outside the overlap. So the information of Sky Tower stored in the TIP database can become a terrible mess.

Table B.3: Instruction for Task 3 (Quantitative Evaluation).

Source Contents for Task

Resource Contents Frame

External Resource

Sky Tower

The Sky Tower is an observation- and telecommunications tower located on the corner of Victoria and Federal Streets in the Auckland CBD, Auckland City, New Zealand. It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers.[2] Due to its shape and height, especially when compared to the next tallest buildings, it has become an iconic Auckland structure, often used in logos and promotions.

The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).[3] The tower attracts, on average, 1,450 visitors per day (over 500,000 per year).[4]

The tower also features the SkyJump, a 192-metre[5] 'fan descender' jump (an experience between a bungy jump and a base jump) from the observation deck, during which a jumper can reach up to 85 km/h (53 mph). The jump is guide-cable-controlled to prevent jumpers from colliding with the tower in case of gusts.[6] Climbs into the antennae portion (300 m/980 ft heights) are also possible for tour groups.[5]

Figure B.6: Source contents for Task 3 (Quantitative Evaluation).

The User's Choices of the "Sight Information Refinement" Model – Task 3

Choice 1: Information Refinement in Single Field (IS7)

Figure B.7: Data entry model for "Information Refinement in Single Field – IS7"

(Task 3 – for "Architecture").

Figure B.8: Data entry model for "Information Refinement in Single Field – IS7"

(Task 3 – for "Uses").

Choice 2: Information Refinement in Multiple Fields (IS8)

Figure B.9: Data entry model for "Information Refinement in Multiple Fields – IS8" (Task 3 – for "Architecture").

Figure B.10: Data entry model for "Information Refinement in Multiple Fields – IS8" (Task 3 – for "Uses").

Choice 3: Information Refinement in Tree View (IS9)

Figure B.11: Data entry model for "Information Refinement in Tree View – IS9" (Task 3).

The following presents test data using in Task 3.

The User's Choices of "Source Highlight" – Task 3

Topic (with highlight):

Architecture

Uses

After swapping the information defined for Level 1 of "Architecture" with the information defined for Level 0 of "Uses"

The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).[3] The tower attracts, on average, 1,450

After swapping the information defined for Level 0 of "Architecture" with the information defined for Level 1 of "Uses"

The Sky Tower is an observation- and telecommunications tower located on the corner of Victoria and Federal Streets in the Auckland CBD, Auckland City, New Zealand. **It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers.**[2] Due to its shape and height, especially when compared to the next tallest buildings, it has become an iconic Auckland structure, often used in logos and promotions.

The tower also features the SkyJump, a 192-metre[5] 'fan descender' jump (an experience between a bungy jump and a base jump) from the observation deck, during which a jumper can reach up to 85 km/h (53 mph). The jump is guide-cable-controlled to prevent jumpers from colliding with the tower in case of gusts.[6] Climbs into the antennae portion (300 m/980 ft heights) are also possible for tour groups.[5]

Input Data (Single Field) – Task 3

(After swapping the information defined for Level 1 of "Architecture" with the information defined for Level 0 of "Uses")

Architecture:

> It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).

Uses:

> The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor). The tower also features the SkyJump, a 192-metre[5] 'fan descender' jump (an experience between a bungy jump and a base jump) from the observation deck, during which a jumper can reach up to 85 km/h (53 mph).

(After swapping the information defined for Level 0 of "Architecture" with the information defined for Level 1 of "Uses")

Architecture:

> The tower also features the SkyJump, a 192-metre[5] 'fan descender' jump (an experience between a bungy jump and a base jump) from the observation deck, during which a jumper can reach up to 85 km/h (53 mph). It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).

Uses:

The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor). It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers.

Input Data (Multiple Fields / Tree View) – Task 3

(After swapping the information defined for Level 1 of "Architecture" with the information defined for Level 0 of "Uses")

Architecture – Level 0:

It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers.

Architecture – Level 1:

It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).

Uses – Level 0:

The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).

Uses – Level 1:

> The tower also features the SkyJump, a 192-metre[5] 'fan descender' jump (an experience between a bungy jump and a base jump) from the observation deck, during which a jumper can reach up to 85 km/h (53 mph).

(After swapping the information defined for Level 0 of "Architecture" with the information defined for Level 1 of "Uses")

Architecture – Level 0:

> The tower also features the SkyJump, a 192-metre[5] 'fan descender' jump (an experience between a bungy jump and a base jump) from the observation deck, during which a jumper can reach up to 85 km/h (53 mph).

Architecture – Level 1:

> It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).

Uses – Level 0:

> The tower is constructed of reinforced and high-performance concrete, and it upper levels were constructed from composite materials and structural steel. It contains two restaurant levels (one, 'Orbit' with revolving seating, turning 360 degrees once every hour)[3] and one cafe level, as well as two observation decks (including some with sections of glass floor).

Uses – Level 1:

> It is 328 metres (1,076 ft) tall, as measured from ground level to the top of the mast,[1] making it the tallest free-standing structure in the Southern Hemisphere, and the 12th tallest member of the World Federation of Great Towers.
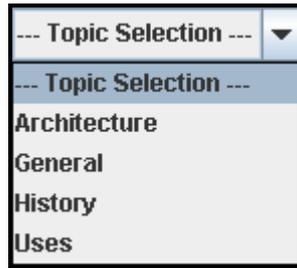
Figure B.12: Topic selection box in data entry form.

**Figure B.13:** Popup menu for colour selection in data entry form.

Figure B.14: Popup menu for colour selection in resource contents browser.


**Figure B.15:** Popup menu for swapping information included in overlaps.
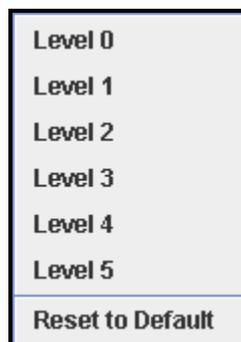
Figure B.16: Popup menu for information refinement in single field (IS7).

**Figure B.17:** Popup menu for addition a new topic in tree view (IS9).
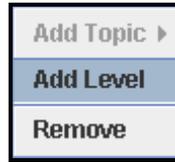
Figure B.18: Popup menu for addition a new level in tree view (IS9).