VSB TECHNICAL UNIVERSITY OF OSTRAVA | FACULTY OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

MIND MAP TOOL FOR ONENOTE

NÁSTROJ PRO VYTVÁŘENÍ MYŠLENKOVÝCH MAP VE ONENOTE

TUAN VU BUI

Bachelor Thesis

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The goal of this work is to develop a plugin for efficient work with mindmaps in OneNote. The tool will allow to create a mindmap from the scratch or from the pre-selected models and shapes. The tool will also support different automatic alighment possibilities, save of the mindmap to the note in source format and/or in the image form, etc.

1. Study the similar apps and compare them.
2. Develop and architecture and design of own application.
3. Test the functionality and compare it ti the other tools if any.

References:

[1] Pfleeger, Shari Lawrence, and Joanne M. Atlee. 2009. Software Engineering: Theory and Practice: Prentice Hall, ISBN 0136061699
[2] Pressman, Roger S. 2010. Software Engineering : A Practitioner's Approach. 7th ed. NewYork: McGraw-Hill Higher Education, ISBN 9780073375977
[3] Sommerville, Ian. 2010. Software Engineering. 9th ed, International Computer Science Series. Harlow: Addison-Wesley, ISBN 978-0137035151

Extent and terms of a thesis are specified in directions for its elaboration that are opened to the public on the web sites of the faculty.

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Abstract

The goal of this work is to develop a plugin for efficient work with mind maps in OneNote for the web. The tool will allow to create a mind map from the scratch or from the pre-selected models and shapes. The tool will also support different automatic alighment possibilities, save of the mind map to the note in source format and/or in the image form, etc.

Keywords

Microsoft Office Add-in; OneNote on web; Mind Map; Office API; JavaScript; HTML; CSS

Abstraktní

Cílem této práce je vyvinout plugin pro efektivní práci s myšlenkovými mapami ve OneNotu pro web. Nástroj vám umožní vytvořit myšlenkovou mapu od začátku nebo z předem vybraných modelů a tvarů. Nástroj bude také podporovat různé možnosti automatického zarovnání, ukládání myšlenkové mapy k poznámce ve zdrojovém formátu a/nebo v podobě obrázku atd.

Klíčová slova

doplněk Microsoft Office; OneNote na webu; Myšlenková mapa; Office API; JavaScript; HTML; CSS

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Contents

List of symbols and abbreviations

COM	- Component Object Model
VBA	- Visual Basic for Applications
VSTO	- Visual Studio Tools for Office
BPMN	- Business Process Modeling Notation
ER	- Entity-relationship
UWP	- Universal Windows Platform
IS	- Information System
API	- Application Programming Interface
CSS	- Cascading Style Sheet
HTML	- Hypertext Markup Language
JSON	- JavaScript Object Notation
UML	- Unified Modeling Language
URL	- Uniform Resource Locator
W3C	- World Wide Web Consortium
XML	- Extensible Markup Language

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1 INTRODUCTION

Nowadays, when the whole world has been affected by epidemics and political wars, students cannot go to school and adults cannot go to the office. Along with that is the boredom of classical forms of learning and doing with only papers and theories. From those reasons, asynchronous learning and remote working have been implemented and considered as the vital methods in our life. However, we cannot use the old method of learning and working because it is easy to cause boredom. Therefore, mind mapping is a very suitable tool not only for teaching, learning and also for daily work (such as time management, project management, …).

Mind map is not a peculiar concept to everyone. It has appeared for a long time with many purposes such as stimulating creativity, breaking down a job or a topic to help people have the most objective and obvious understanding of the problem that has been and is being solved.

The aim of this work was to create a functional and user-friendly add-in to the OneNote app for a website where mind map creation would be streamlined.

This bachelor thesis will introduce currently available online mind mapping options that can be integrated into OneNote and other applications for mind map design. It will also provide an overview of the different technologies that will be used to create the add-on. This makes it easy to create, edit, and share mind maps in OneNote for the Web. Finally, a description of the main elements that make up the add-on and the possibilities for how to extend the add-on are presented.

2 MIND MAP

2.1 The origin of the word “mind mapping”:

The inventor who found out this term is Tony Buzan, an English author of psychologist and TV presenter who came up with the idea that notes not only need to be neatly organized, but also need to be colored and arranged in a kind of tree structure in the 1960s. Visual and written representations of ideas come together to create something that is more natural for the human brain than simple notes on paper. [1][2]

Mind map is a method of using the brain’s ability to record images. It is an easy way to remember the details, to synthesize or analysis a problem into some kinds of branching scheme.

The human brain has two hemispheres, left and right. The left hemisphere is described primarily as logical, rational, and as keeping things organized. However, the true hemisphere can be understood as intuitive and creative. Tony Buzan states that the traditional form of note-taking, including paragraphs of plain text, is difficult to remember because the brain uses only the left, logical hemisphere, while the right hemisphere is not involved at all. The traditional writing of notes from left to right and from top to bottom is not as natural for the brain as when it perceives the whole page as a whole. Buzan argues that the use of images and creativity when taking notes penetrates the brain much better because it uses both hemispheres. [3][4]

A Mind Map is a diagram which represents tasks, definitions, words and items that are linked and arranged around a central concept or topic using a non-linear graphic layout, allows users to build a visual framework around a central concept. It is used in task planning, problem solving, learning and in solving may other everyday activities.

Originally, mind maps were intended as a way to help pupils and students make notes with keywords and pictures, but overtime they have become a general format that allows you to capture any ideas or take notes in an easy-to-understand and memorize form.

2.2 The principles of mind map

A mind map is the process by which the user breaks down the original problem to be solved into many small parts to make the work simpler and easier to do. From a main topic, we will divide it into several sub-topics next to it, using blocks (circle, cube,...) that are connected by arrows in a logical way. varies depending on the creativity of each person. Each block will contain one or several keywords to describe in a general way the topic or the work to be done, be careful not to write too many words to describe a topic because it will make things complicated. complex and reduces recall. [5][6]

An example of mind map which was created:

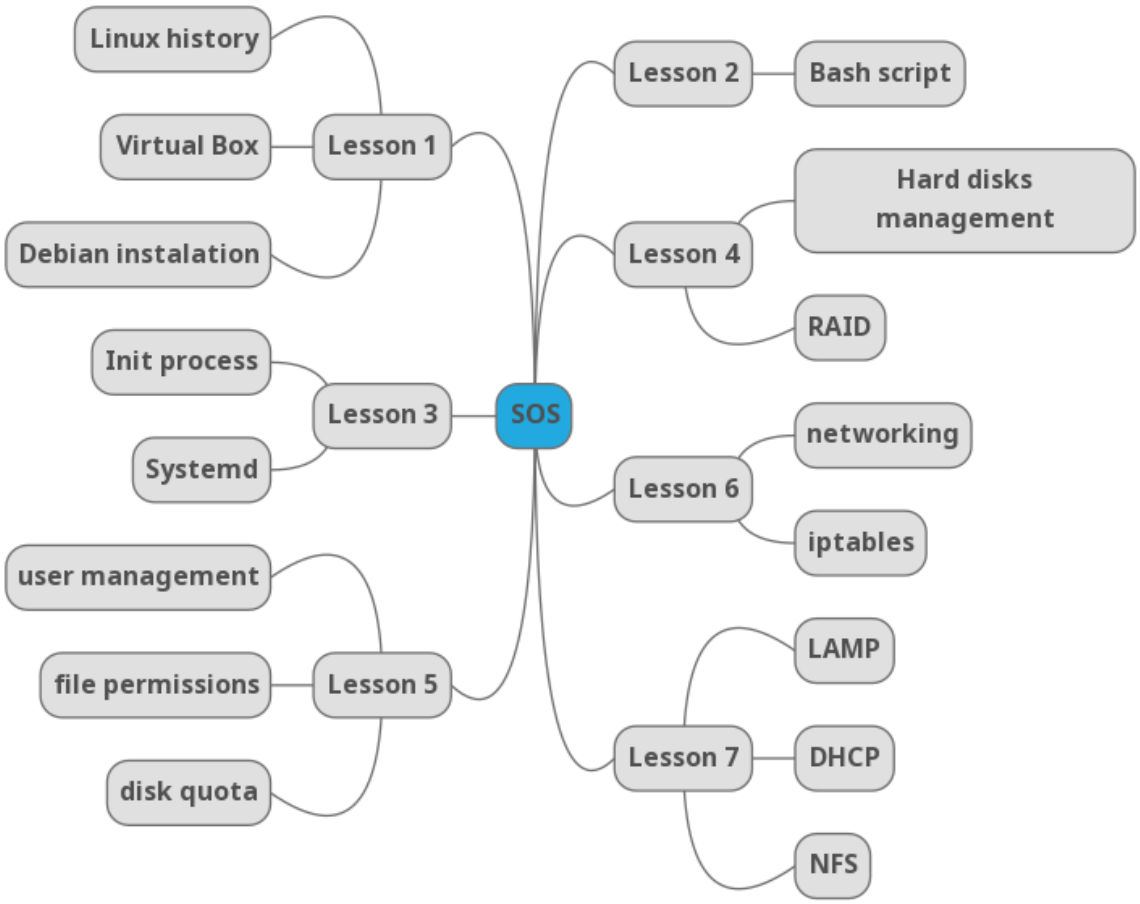

Figure 2.1: Mind map for "Administration of Operating Systems"

As we can see in the figure 2.1 above, it is an example of mind map. Mind map is not too complex to create, it depends on the creativities of each user. However, it needs to be ensured that it fully mees the connection components according to the structure of the mind map as well as the content of the topic.

There are already exists many separated tools and also add-ins for OneNote that will help users to create mind maps or export them in to this application. Let's see how they work and what is the advantages and disadvantages when users use these add-in.

2.3 Current tools to draw mind map

Nowadays, the term "mind map" is very familiar with not only pupils and lecturers but also for people from many different professions. From that reason, many application were made to make drawing mind maps more easier and convenient.

Below I will compare some existing applications in these days to me:

	Lucid chart	Visual Paradigm	MindMeister	OneMind
What are the differences?	Collaborative diagramming solution for your entire organization. Solution for visual communication. Create online flowcharts, diagrams, UML sketches, and ER models.	Create diagrams and charts online. It is a software design tool tailored for agile software projects.	- Online Mind Mapping Software. It is an online mind mapping application that allows its users to visualize, share and present their thoughts via the cloud.	- OneMind is a crossplatform extension for OneNote from Digital GemSoft Ltd.
Features	- Nothing to install - Drag and drop - Dedicated support	- Best Modeling software - Lost of diagrams to choose from - BPMN Diagrams - import existing Applications to generate diagram or generate code from our diagram -> helps us to create a good quality diagram with less effort - It supports to import diagram from other tools such as Visio	- Online Mind Map Editor - Ready for Project Management and Collaboration - Mind Map Presentations	- Allows to create a mind map and export to OneNote for Windows and macOS operating systems in the form of an image.
Functions	- Draw - Insert - Import data - Save - Adding new themes - Change color - Export	- Draw - Insert - Import data - Save - Adding new themes - Change color - Export	- Draw - Insert - Import data - Save - Adding new themes - Change color - Export	- Adding new themes - Changing their color - Inserting images (only basic functions)
Technology	- Lucidchart is an online diagram and diagram software that supports Microsoft Office Small Visio Icon Import Microsoft Office Visio and	- Visual Paradigm is a software application designed for software development teams to model business information	- MindMeister is equipped with advanced mapping features that allow users to import text from other mind maps such as	- cross - platform extension

	can work on any operating system. - Lucidchart runs on browsers that support HTML5. This means it does not require updates of a third -party software like Adobe Flash. - In 2010, Lucidchart announced they had integrated into the Google Apps Marketplace	systems and manage development processes. In addition to modeling support, this technology provides report generation and code engineering capabilities including code generation.	MindManager and FreeMind.	
Possibilities		- Interaction with OneNote is provided by an add - on that allows users to insert any previously drawn diagram into OneNote as an image after signing in. However, the downside of such an approach is that the mind maps created in this way cannot be modified in any way.		- Extension for OneNote, approach to solving the problem is a little different than other extensions or add – ons - does not support exporting a mind map to OneNote 2019 or OneNote for the web

Table 2.1: Compare some existing application [7]

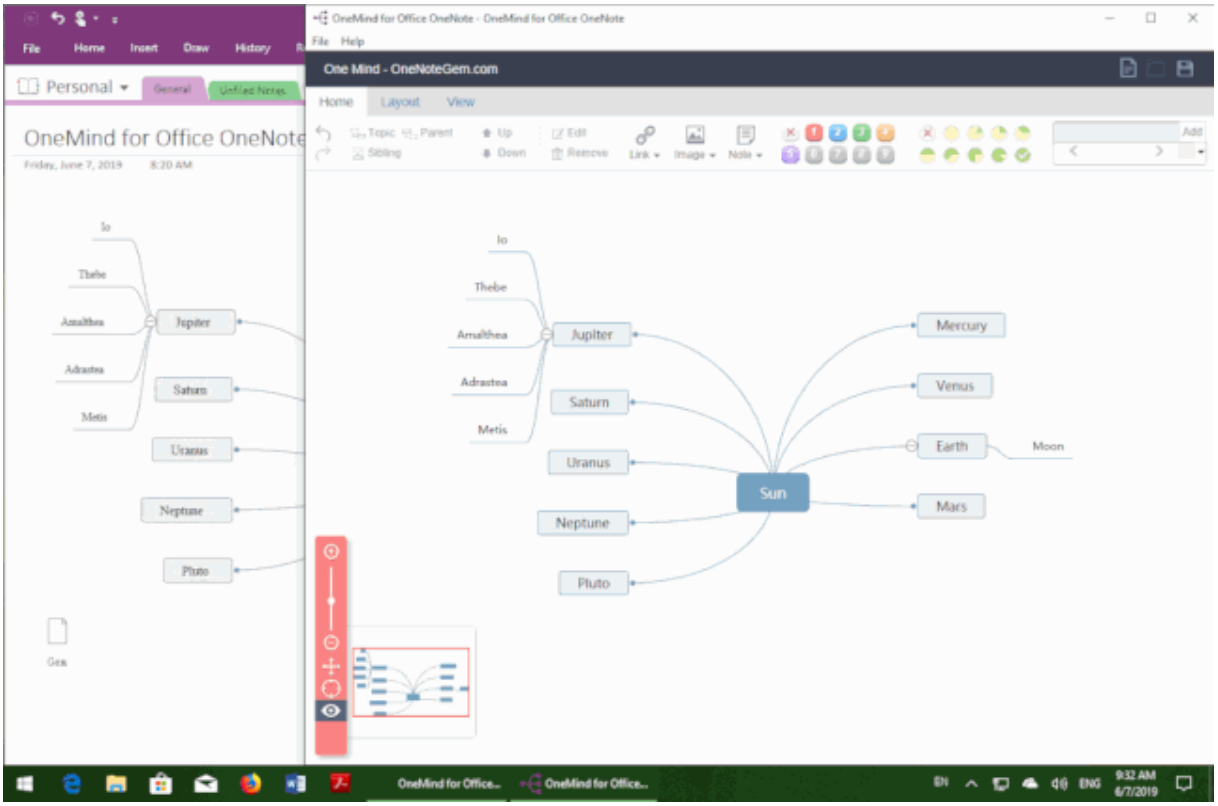

Figure 2.2: Creating a mind map using OneMind for OneNote[1]

MindMap for OneNote represents another add-on for creating and editing mind maps created by Digital GemSoft Ltd. It already brings new features directly to OneNote for Windows. With the help of this add-on, the user can create and edit a simple mind map, which is displayed in the form of native objects. Compared to the previous add-on, it includes more advanced features, such as reducing or increasing the distance between themes, moving with themes, or specifying the direction in which the next theme will be added. However, if the user wants to move the topics manually, the add-on will not know and must click on the button to redraw the mind map. Another disadvantage is that the add-on is only available for OneNote 2010, 2013 and 2016 on the Windows operating system.

[1] OneMind for OneNote - Office OneNote Gem Add-Ins

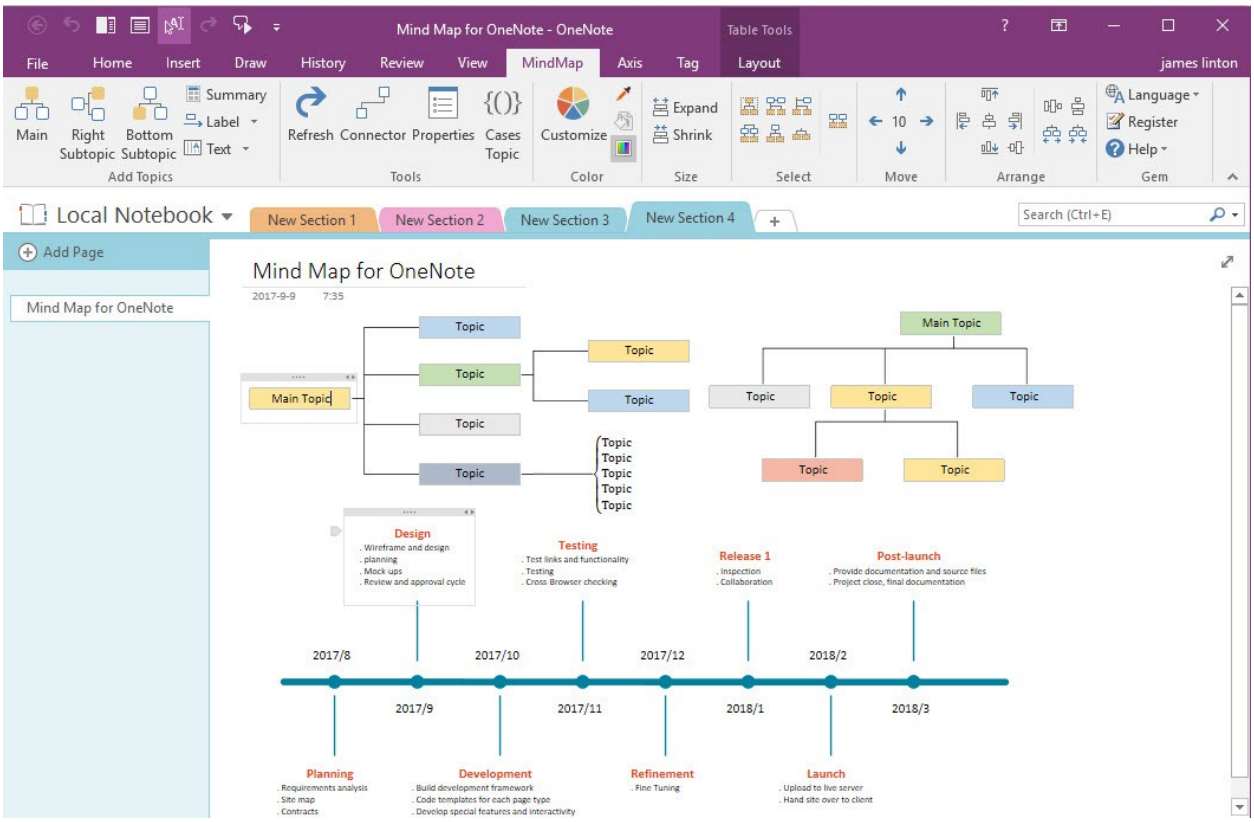

Figure 2.3: Mind Map for OneNote[2]

3 MICROSOFT ONENOTE

3.1 Microsoft OneNote

Microsoft 365 is a commercial software service package that provides cloud versions of popular Microsoft software, including: Microsoft Office suitable for office work and server software such as Exchange Server, SharePoint Server, and Lync Server. It is available for both MacOS and Windows. It includes many types of applications with different uses for individuals or students, as well as for companies and entrepreneurs.

However, the core application for this thesis is Microsoft OneNote, which will be explained now.

Microsoft OneNote is an application which is included in the Microsoft Office suite. It is a note-taking program that gathers free-form data from the notes of multi-users collaborators. In OneNote, users can create notes that can include text, pictures, tables and drawings. OneNote gathers user's transcripts, diagrams, screen clippings and audio commentaries. Moreover, it allows sharing notes between users over the Internet or a network. [8][9]

[2] Mind Map for OneNote - Office OneNote Gem Add-Ins

3.2 Future of OneNote

Based on the information that I can update, OneNote is one of the convenient applications as an electronic notebook to help users record important data, outline ideas, take notes, …

Microsoft OneNote is developed on many mobile and desktop applications, with the convenience and popularity brought by Microsoft, this application will bring users new updates from the manufacturer. Besides, programmers or any users can also develop add-ins and plug-ins to provide users with many new applications such as Mind map, …

For Windows 10 and Windows 11, OneNote will reach end-of-support on October 2025, user must update to the OneNote app.[10]

The future of OneNote is always updated with new features from Microsoft developers, and developers can also build other applications to add support for users in a convenient and complete way.

3.3 Possible extensions of OneNote:

In this part, I will introduce a little bit about the exist extensions of OneNote: [11]

Using OneNote add-in:

- Applied for OneNote 2016 or earlier
- The installation process for each OneNote add-in is different. However, the major plugins will comprise an installer file that will robotically install and configure OneNote

Adding Notes from the web with Clipper:

- Applied with all version of OneNote (including the UWP app)
- OneNote Web Clipper extension for Google Chrome should support to discovery your motivation when using the internet
- This extension allows users saving the screenshots of web pages and saving into OneNote notebooks, so users can choose data which they really want to keep and delete the redundant.

Using OneNote Macros with Onetastic:

- The Onetastic installer installs and configures automatically in OneNote 2016.
- It is multi-purpose, adding support for image editing, custom text styles, and a built-in calendar to OneNote
- The best feature of it is supporting for macros. Macro helps user to duplication their responsibilities effortlessly.

Support for Automation with Zapier and IFTTT:

- Zapier and IFTTT are the only platforms that can add automation to OneNote, from that you can create triggers, when those trigger is activated, your works will act automatically.
- Users can link other services to OneNote by using automation service
- No add-ins needed—both IFTTT and Zapier will connect to your OneNote account, making changes to your notes automatically.(example: copy your notes to other services like Evernote,…)

Improving Readability with Learning Tools:

- The Microsoft Learning Tools add-in which contains focus and knowledge mode, encompasses the core features to support you read and write easier and faster
- It helps people improve comprehension skills and also for those with dyslexia.

Over 500 new features with Gem for OneNote:

- improve your productivity, with notebook protection, section sorting, page formatting tools, shortcuts, and more (example: quickly access features to help you format your notes and export them to other programs like PowerPointl

4 PROGRAMMING LANGUAGE AND APIS

In this chapter, we will illustrate the programming languages, their construction, and libraries used to develop the add-in. Moreover, the method of creating add-in, the API of Office OneNote and the possibility of deploying add-in will be describe in this part.

4.1 Hypertext Markup Language (HTML)

Hypertext Markup Language (HTML) is the language which most websites are written. It is standard markup language used to create the content of the web page and make them functional. HTML was first created by Tim Berners-Lee, Robert Cailliau, and others starting in 1989. HTML is managed and developed by the World Wide Web Consortium (W3C). [12][13][14]

We can easily and efficiently present web pages with hypertext markup language because HTML has many formatting tags. To me, it is an easy and simple to use markup language. We can use it to design Web pages with text dynamically.

Some commonly HTML terms:

-Elements: are the designations to define the content and structure of Object in a website. Element name is enclosed by brackets.

Example: paragraphs (<p>), heading levels (from <h1> to <h6>), <a>, , , , and ,…

Tags: Tags tag is generated by elements enclosed in brackets. Between the opening and closing tags is the content of the element.

Example: …

Attributes: An attribute consists of a name and a value used to provide additional information about an element

Example: Edison System

Example of using HTML in this work:

```html
<!DOCTYPE html>
<html>

<head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="IE=Edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <title>Contoso Task Pane Add-in</title>

    <!-- Office JavaScript API -->
    <script type="text/javascript" src="https://appsforoffice.microsoft.com/lib/1.1/hosted/office.js"></script>

    <!-- For more information on Fluent UI, visit https://developer.microsoft.com/fluentui#/. -->
    <link rel="stylesheet" href="https://static2.sharepointonline.com/files/fabric/office-ui-fabric-core/9.6.1/css/fabric.min.css"/>

    <!-- Template styles -->
    <link href="taskpane.css" rel="stylesheet" type="text/css" />

</head>

<body class="ms-font-m ms-welcome ms-Fabric">

</body>

</html>
```

Figure 4.1: Example of using HTML

4.2 Cascading Style Sheet (CSS)

CSS stands for Cascading Style Sheet; it is a language used to find and reformat elements generated by markup languages (HTML). Simplify, CSS it is the web page's appearance/presentation. [15][16]

The great advantage of styling an HTML document using CSS is the separation of the content and structure of the document from its graphic form.

We can create a link between an HTML element and a style based on a number of attributes, such as the element's name, its identifier, or its class. Therefore, the rule for describing an interface consists of a selector that defines the element, the properties we want to set, and its values.

Example of using CSS in this work:

```css
html,
body {
    width: 100%;
    height: 100%;
    margin: 0;
    padding: 0;
}

ul {
    margin: 0;
    padding: 0;
}
```

Figure 4.2: Example of CSS

4.3 **JavaScript (JS)**

JavaScript is often described as an interpreted, multiplatform scripting programming language, standardized by the ECMA Script specification. It is used to declare the web page's functionality/behavior (JavaScript). It does not need to compiled and executed as another programming code like C#, Java or Python, … because it is designated as an interpreter.[17]

JavaScript's mission is to process HTML objects in the browser. It interferes with actions such as adding, removing, editing, … CSS properties and HTML tags easily. In other words, JavaScript is a client-side browser-based programming language. However, with the appearance of NodeJS, it has made it possible for JavaScript to work in the backend. Other ways to use JavaScript include using third-party APIs, developing browser-based games, displaying animations, and so on,…

In JavaScript there are 3 different ways of initializing variables with 3 different keywords corresponding to its different scope and use:

var	let	const
The scope of a *var* variable is functional scope.	The scope of a *let* variable is block scope.	The scope of a *const* variable is block scope.
It can be updated and re-declared into the scope.	It can be updated but cannot be re-declared into the scope.	It cannot be updated or re-declared into the scope.
It can be declared without initialization.	It can be declared without initialization.	It cannot be declared without initialization.
It can be accessed without initialization as its default value is "undefined".	It cannot be accessed without initialization, as it returns an error.	It cannot be accessed without initialization, as it cannot be declared without initialization.

Figure 4.3: Difference of 3 keywords[3]

The syntax of JavaScript is quite similar with Java and C#. The basic constructions of the language include the if condition, the switch decision block, the for, while and do-while loops, and the try catch error block. These basic constructions is used nearly same with C# and Java.

ES6, also known as ECMAScript 2015 has introduced JavaScript classes. JavaScript Classes are templates for JavaScript Objects which have the same common behavior. It encapsulates data that is related together so that it is stored in a single variable. The class is declared with the keyword class followed by the class name, and the constructors or functions that the class will contain can be specified in curly braces. JavaScript also allows us to use inheritance by the keyword "extends". Like another OOP programming language, the child which "extends" from the parent class will inherit all the properties and methods also include the constructor.

Example of constructor which is used in this work:

[3] Difference between var, let and const keywords in JavaScript - GeeksforGeeks

```
46  class Root {
47      constructor(shape_id, text_id) {
48        //variables of the class
49        this.shape_id = shape_id;
50        this.text_id = text_id;
51        this.leftChildren = [];
52        this.rightChildren = [];
53
54        //methods of the class
55        this.contains_id = function (id) {
56          if (id == this.shape_id || id == this.text_id) {
57            return true;
58          } else {
59            return false;
60          }
61        };
62
63        this.getChild = function () {
64          return this.rightChildren.concat(this.leftChildren);
65        };
66
```

Figure 4.4: Example of creating a constructor for the class in JavaScript

4.4 Asynchronous in JavaScript

Synchronous or exactly synchronous processing is that the code will be run sequentially in a pre-written order from top to bottom, the code below only runs when the code above has finished running and returns results, and there are disagreements. The set is the code below that can run even though the code above has not been executed and return results.

Initially when I was learning and working with basic JavaScript, solving equations, doing math problems, loops, conditional structures… I thought it was synchronous, which means at a time there would only be an activity is taking place.

However, we will encounter many complex problems, such as website load time, data for example If we need to download or upload a large volume of data, if we wait for the execution of each action to proceed, it will take a lot of time, etc. Therefore, synchronous processing will be difficult to come up with a optimal solution. Thus, JavaScript has evolved to provide an asynchronous implementation to solve such problems. It means that we can control the program to behave as if it were asynchronous, but in essence, operations are still sequential, not sequential at the same time. It sounds confusing, however the problem is JavaScript has a single-threaded background, so it cannot be executed concurrently and asynchronously. In another programming language like C, C#, Java,… to execute asynchronously must use multithreading (there are many threads executing concurrently, each thread executing different tasks. different jobs). To handle an asynchronous, JavaScript has developed several ways: Callback, Promise and Async/await.[18]

Callback is a function that will be executed after another function has finished executing. In Javascript, functions are treated as objects, so it can take a function as an argument, and return a function. From that, when a parameter is passed in is any function and is called afterwards, it will be called a callback function. [19]

The callback function is specified in the argument of the asynchronous function, after which the callback function is called, in which the programmer determines what happens after the execution of the asynchronous function

Example:

```
doThesis = (thesis, callback) => {
  alert(`Starting my ${thesis} work.`);
  callback();
}
doThesis('math', () => {
  alert('Finished my thesis');
});
```

The promise approach is another innovation introduced in ECMA Script 2015 (ES6). Instead of specifying a callback function in the function call argument to be called after it is executed, the asynchronous function returns a promise which contains information about the result of an asynchronous operation. the browser promises that the function's result will be returned. With promise, we can call the then() function which contains a callback function that will be executed immediately after the asynchronous operation is completed. This function also contains information about the result of the asynchronous operation. [20]

```
//deletes all the elements in the page, there is a call by clicking on the button in the ribbon
const deleteNode = async (myNode) =>{

  await OneNote.run(async function (context) {
    var page = context.application.getActivePage();

    if (myNode == undefined) {
      myNode = await getActiveNode(context);
      if (myNode == null) {
        console.log("Terminating deleteNode function");
        return;
      }
    }

    deleteFromPage(page, myNode);
    deleteFromArr(myNode);
    deleteFromNodes(myNode);

    if (myNode instanceof Node) {
      if (myNode.direction == "left") {
        await checkGap(left_Arr );
      } else if (myNode.direction == "right") {
      await checkGap(right_Arr);
    }
  }
    return context.sync();
  }).catch(function (error) {
    console.log("Something went wrong: " + error);

    if (error instanceof OfficeExtension.Error) {
      console.log("Debug info: " + error.debugInfo);;
    }
  });
}
```

Figure 4.5: Example of using promise

In the most recent version of ES7, Async / Await has been added to make writing asynchronous code in JavaScript better, code easier to see, and easier to use. It is a JavaScript feature that helps us work with asynchronous functions in a way that is more fun and easier to understand. It is built on Promises and is compatible with all API-based Promises. [21]

```
//delete a note and node's children
async function runDelete(event) {
  await deleteNode();
  event.completed();
}
```

Figure 4.6: Example of using async/await

4.5 Used libraries and APIs

In programming, the library in programming is a place that provides us with functions and methods that can be used in many programs to help shorten reprogramming time. API stands for Application Programming Interface - application programming interface, which is the protocol that connects libraries and other applications. With access to a set of commonly used functions, APIs can exchange data between applications. The term API is closely related to libraries. Libraries often take a complex problem and put it in their code, which they convey to the programmer using an application programming interface (API). Thus, he can use the library while focusing on programming the rest of the application without worrying about the complicated problem that has already been solved by another programmer.

Nodejs is an independent development platform built on V8 JavaScript Engine – an interpreter that executes JavaScript code that makes it possible to build web applications such as video clips, forums and especially websites. Narrow-scoped society quickly and easily expands. Thus, Node.js allows users to view JavaScript not only in a language that can be executed on the client side, but also in a language that can be run on the server side. [21]

NodeJS can run on many different operating system platforms from Window to Linux, OS X, so that is also an advantage. NodeJS provides rich libraries in the form of various JavaScript Modules that simplify programming and reduce time to a minimum.

Node package manager (NPM) is a tool for creating and managing JavaScript programming libraries for Node.js. In the JavaScript community, programmers share hundreds of thousands of libraries with code that already implements a certain function. It helps new projects avoid having to rewrite basic components, programming libraries or even frameworks. Using NPM makes the work much simpler because they can help you simplify the work to be done. Currently, most libraries are available on npm, so it's relatively easier to include them by simply running a command line to download them. The package.json file is associated with each project. It contains basic information about the project, such as the Node.js version on which the project will run or the list of packages the project depends on and basic project information.[19][20]

JSON stands for JavaScript Object Notation, which is a data format that follows a certain rule that most programming languages can read today. JSON is an open standard for exchanging data on the web. The JSON format uses key-value pairs for the data to use. It supports data structures such as objects and arrays. If the user wants to convert the data to JSON, then the user only needs to call the JSON.parse() function, where their parameters will specify the data the user wants to convert. [42][43]

4.6 Office add-in platform

Office add-ins allow you to extend the functionality of Office applications with new features and new content according to your unique needs and uses using HTML, CSS, and JavaScript web technologies. Unlike add-ins for desktop applications created with VBA, COM, and VSTO, Office add-ins do not include code that runs on the user's device or in the Office client. It is for that reason that it can be used on multiple platforms such as Windows, Mac, in Internet browsers and even on iPads. [22]

Through HTML, CSS, and JavaScript to create built-in tools for OneNote, it provides three ways to extend OneNote. The first option is customizing the ribbon, which can be modified by adding new buttons or menus. These newly added elements can be displayed in an existing tab or in a newly created tab. The

next option is to insert an interactive web object inside the OneNote page. The last type of add-on is to display a pane on the right side of the screen that offers almost identical capabilities as a full-fledged website. You can use it to view a pre-made web page and interact with OneNote.

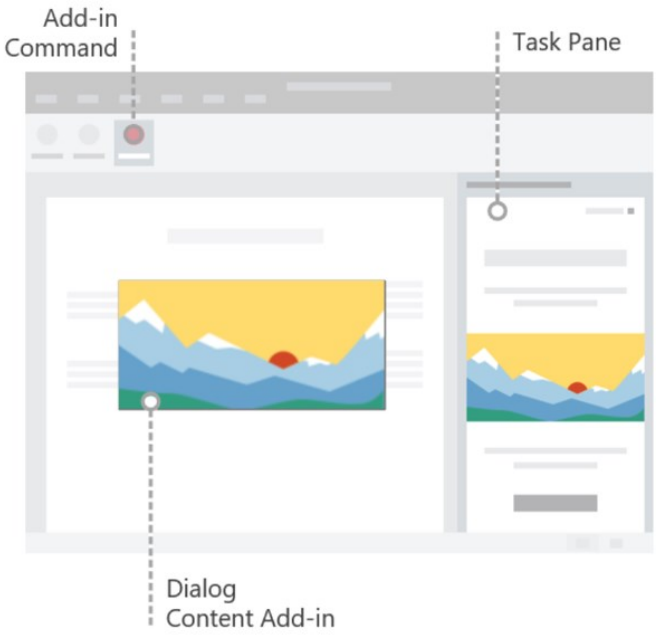

Figure 4.7: Types of Office UI elements for an add-in

Office add-in contains two basic components, an XML file and a Web application.

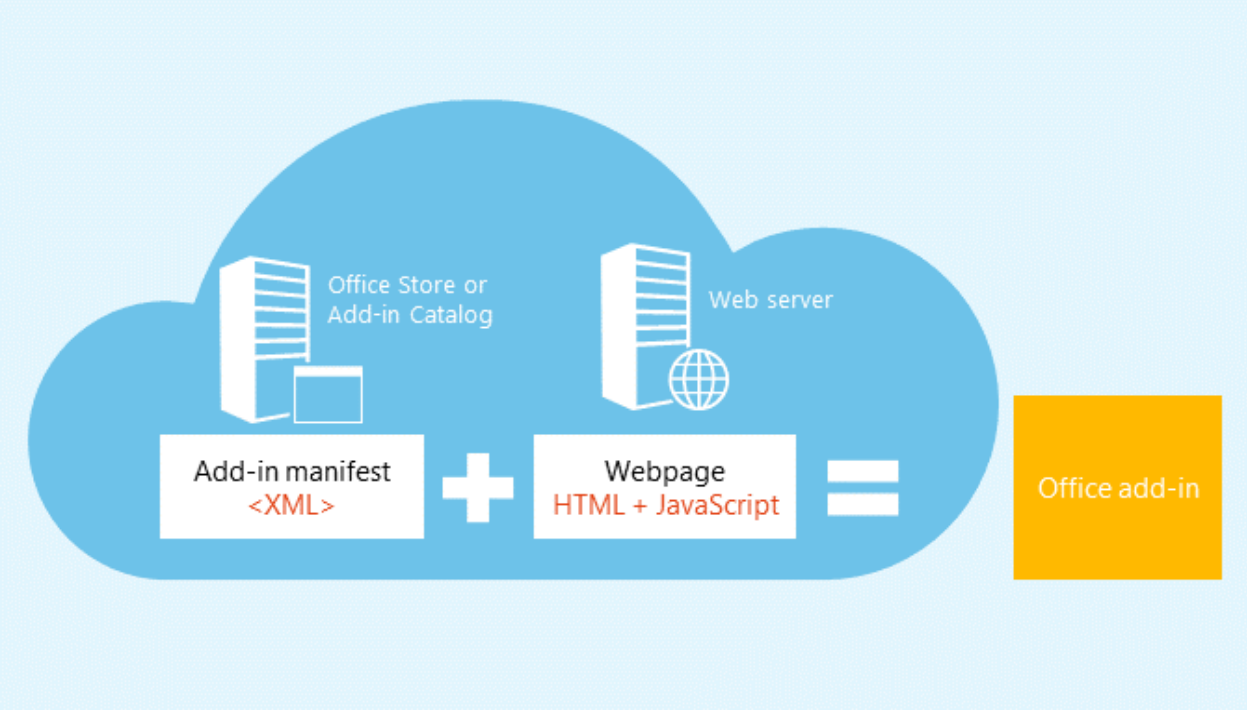

Figure 4.8: Office add-in

- The manifest file is stored on the client side and specifies, among other things, the URL of the web page that the add-on displays using the pane on the right side of the screen. The manifest.xml consists of elements that carry some information and must be in a certain order to ensure the validity of the file. Moreover, it also contains a lot of control information about the add-in, such as id of user, name, description, version, language, … It is the place where we will create the buttons along with the Icon, specify which function will be executed when the button is clicked, ...
- The web application consists of the previously mentioned technologies HTML, CSS, JavaScript and another file which are stored on the Web server and are displayed in OneNote on the Web through browser control or iframe. It can be displayed as a pane that provides more functionality and can be accessed like a classic web page.
  User can set up a structure for the web page by modifying the html file, change the appearance to complement the html by changing the css file, and all functionality of the add-on will be addressed in the source code of the web application, it means in the JavaScript code. These 3 files always complement each other to make the web app complete in terms of structure, UI and events.

```
<!-- Defining group 1 for creating a mind map-->
<Group id="CommandsGroup1">
  <!-- Name of the group -->
  <Label resid="Group1.Label"/>
  <!-- Group icon -->
  <Icon>
    <bt:Image size="16" resid="Icon.16x16"/>
    <bt:Image size="32" resid="Icon.32x32"/>
    <bt:Image size="80" resid="Icon.80x80"/>
  </Icon>

  <!-- Creating button to add a root -->
  <Control xsi:type="Button" id="CreateButton">
    <!-- Button text -->
    <Label resid="CreateButton.Label"/>
    <!-- Label of elements -->
    <Supertip>
      <Title resid="CreateButton.TitleTooltip"/>
      <Description resid="CreateButton.Tooltip"/>
    </Supertip>
    <!-- Button icon -->
    <Icon>
      <bt:Image size="16" resid="IconCreate.16x16"/>
      <bt:Image size="32" resid="IconCreate.32x32"/>
      <bt:Image size="80" resid="IconCreate.80x80"/>
    </Icon>
    <!-- Event of the button -->
    <Action xsi:type="ExecuteFunction">
      <FunctionName>create</FunctionName>
    </Action>
  </Control>
```

Figure 4.9:Example of creating a button with icon and specifying the function for button

In the fig.4.8., a button to add root is created with separate icon dedicated to it, when user clicks on button, function name "create" will be executed.

There are two APIs which can be used for Office Add-in to communicate with OneNote website. They are: Common API and OneNote JavaScript API.

- Common API:

A common API is an application interface that can be used across most Office applications. It has been supported since Office 2013. Because it was created before ES6 was introduced, this API runs on the principle of callbacks. Generic APIs are designed to complement application-specific APIs.

OneNote only supports this API slightly. The generic API can only be used in OneNote to register a handler for the DocumentSelectionChanged event, which occurs every time the selected object changes on the page. Furthermore, the common API is used to call the getSelectedDataAsync, setSelectedDataAsync functions or to access the Settings object. The first two functions can be used to get or set data already in the currently active element. The Settings object stores the settings in the document. This can be used to store primitive values in a key value format. Nevertheless, It can only be used for the Content plug-in[44]

- OneNote JavaScript API:

OneNote introduced a JavaScript API for web plug-ins So users can create task pane add-ins, content, and task commands to interact with OneNote objects. This JavaScript API cannot be used by users of older Office applications. Because inside the browser container in Office is the add-in that represents the website, and also for other reasons like performance and the add-in can't communicate synchronously with Office. In addition, those communications will be based on the approach via Promise.

Use the OneNote.run() function to create a communication object between OneNote apps and add-ins because they work in other runtime environments. All the objects created in this function in the API are called proxy objects, through which we can change the properties of OneNote objects or call their functions. Any action we take on the object's proxy is added to the queue. After calling sync() on the context object, this queue is sent to the Office application and executed. This method is executed asynchronously and returns a Promise object that is consulted after it has been executed.

If the user wants to set a property, then the user needs to call the set method on the object on which the user wants to set it, the object is a proxy. And the user must specify another object which will be of the same type as the person setting or that has the property the user set. To understand the OneNote property, the user must specify another object that must load it in order for the object to be "filled" with data, by implementing the load() method, specifying in which property parameter which the user wants to download. Before reading it, the sync() method must be called to "fill" the Proxy object with data. Once executed, the Proxy object already contains enough request properties and the loaded data can be read by the user.[23]

```
// adds the Root object to the current page
const create = async() =>{
  await OneNote.run((context) = async =>{
    var page = context.application.getActivePage();

    //create image and text
    var node = addRoot(page);
    var shape_outline = node[0];
    var text_outline = node[1];

    //load id
    shape_outline.load("id,paragraphs");
    text_outline.load("id");

    return context.sync().then( () =>{
      nodes = new Root(shape_outline.id, text_outline.id);
      level.push(new Settings());
      initArr();
    });
  }).catch( (error) =>{
    console.log("Something went wrong: " + error);

    if (error instanceof OfficeExtension.Error) {
      console.log("Debug info: " + error.debugInfo);;
    }
  });
}
```

Figure 4.10: Example for OneNote JavaScript A

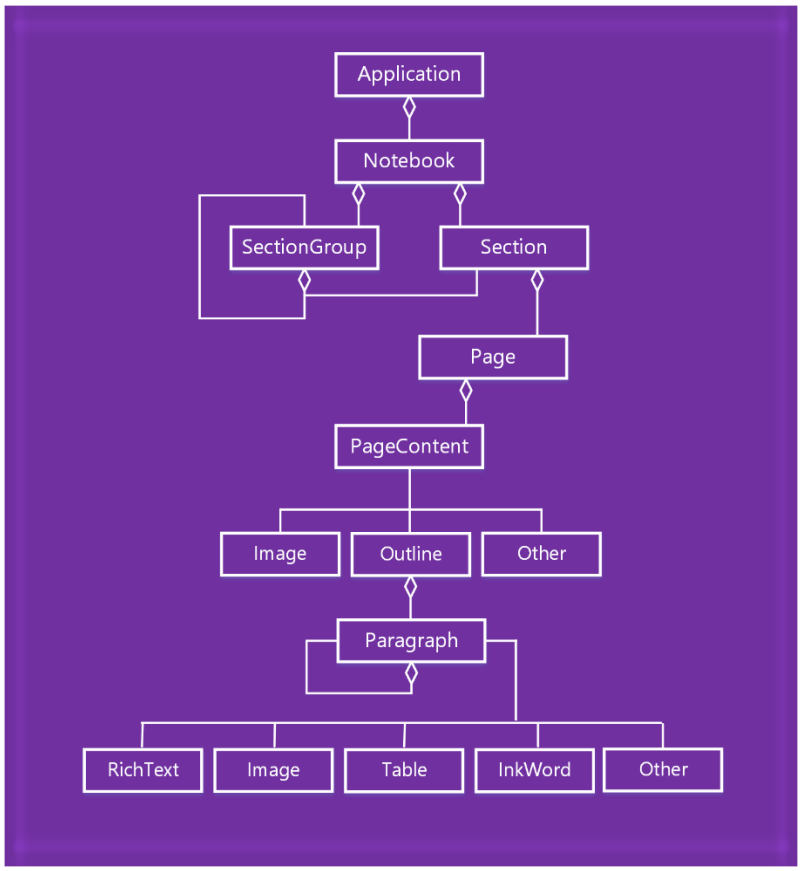

Figure 4.11: OneNote object model diagram available in the OneNote JavaScript API.[4]

[4] OneNote JavaScript API programming overview - Office Add-ins | Microsoft Docs

5 CREATE AN ADD-IN

In the previous chapter, we have already described the technologies, programming language and the principle to create a mind map.

In this part, we will analyze the functions which will be implemented in the add-in. Furthermore, the architecture and design of an add-in will be detailed to help people to understand the functions and how the plugin works easier.

5.1 Add-in Functions

5.1.1 Use case diagram and scenarios for function

The add-in will provide all necessary functions to create a mind map. Besides, it must be easy to use, not too complex and need to be user-friendly. In this use case diagram below, I have written down all functions I will implement into an extension, along with that is the user's role with the system.

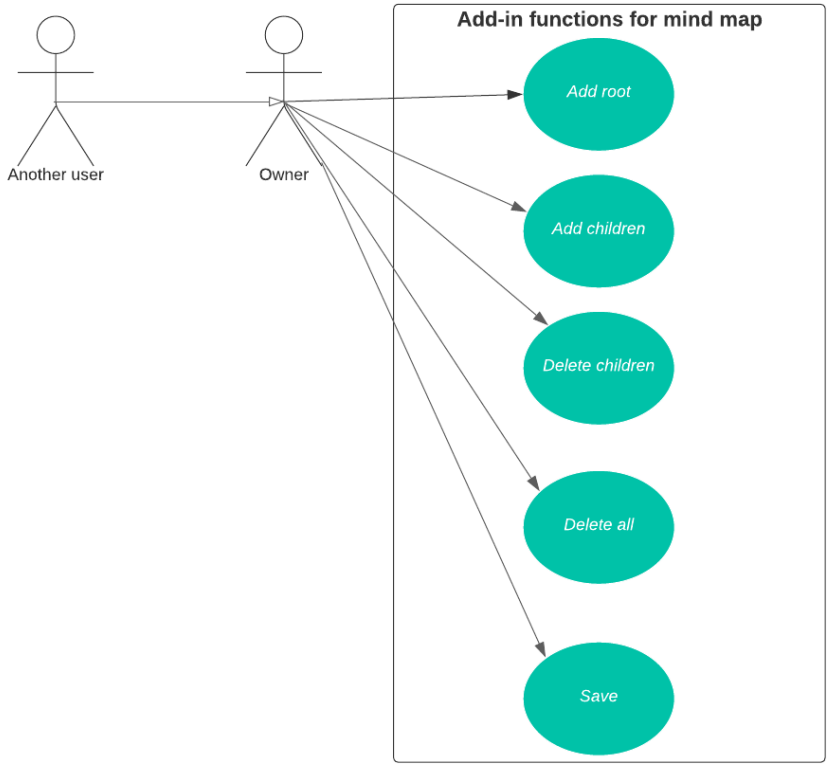

Figure 5.1: Use case diagram showing the functions of the add-in

From the use case diagram, it is easy to see that user must have a root or a implement a pre-prepared mind map to add, edit or delete the children node. [24] [25]

Name of use case	Create root
Description	The use case describes when user create a root (a new main topic)
Actors	User
Conditions	User must have an Active Page which means user must have a page already
Basic Flow: 1. User select page which wants to add root 2. User click “Add root” button. 3. Add-in reads the object structure of the mind map from the root. 4. Add-in calculates the coordinates to add root when user clicked. 5. Add-in creates HTML string for displaying shape, outline, text, … 6. OneNote displays the root for user	
Alternative Flow 1: 1.1: User did not create a page 1.2: User click on “Add Topic” button 1.3: Function will be not executed and nothing happen.	
Status of the mind map after the end of the use case	New root (topic) has been displayed on the OneNote page.

Table 5.1: The scenario for use case "create root"

Add children which means add a new topic for a root of mind map is the main function not only of the add-in but also of the another tools which is used to draw mind map. Use case scenario that is a formal description of the flow of events that occur during the execution of a use case instance. It defines the specific sequence of events between the system and the external actors.

Name of use case	Add children
Description	The use case describes when user add a new child (a new topic) is selected
Actors	User
Conditions	User must have a root (main topic) already

Basic Flow: 7. User select the root (or any children). 8. User click “Add Child Node” button. 9. Add-in reads the object structure of the mind map from the root. 10. Add-in calculates the coordinates to add topic when user clicked. 11. Add-in creates HTML string for displaying shape, outline, text, … 12. OneNote adds the new child from root for user
Alternative Flow 1: 1.1: User did not select any topic in the mind map (root or any child) 1.2: User click on “Add Topic” button 1.3: Function will be terminated.
Alternative Flow 2: 3.1: Add-in doesn’t find object which represents a structure map. 3.2: Function will be terminated.

Status of the mind map after the end of the use case	New child (topic) has been added to mind map.

Table 5.2: The scenario for use case “add children”

Deleting nodes is another basic feature that every mind map tool also have. There are 2 types of deleting that are “Delete Node” and “Delete All”. “Delete Node” is the function to delete the single node or single topic in the mind map. It means, we need to click on a node which we want to delete, then press the button, the add-in will delete a chosen node from a current mind map. “Delete All” is the function to delete everything of the mind map without clicking on any object. We just need to click the space on the screen or press on any objects of the mind map then press the button, the add-in will directly delete all the mind map. There is one thing in common between these two functions that is it can delete the entire mind map. With the “Delete Node”, if we want to delete the whole mind map, we can click on the root object then press the button because the condition for adding the new child that we must have a root (main topic) already (I have explained on the scenario of the use case “Add children”.

Name of use case	Delete children
Description	The use case describes removal of selected node.
Actors	User
Conditions	The user has mind map and wants to delete node.
Basic Flow: 1. User selects the node which user wants to delete. 2. User clicks on the “Delete node” button. 3. Add-in reads the object structure of mind map from the root. 4. Add-in reads the ID topic which user clicked on and uses to find the object which represents topic in tree structure. 5. Add-in removes the outline, text, … to the topic from OneNote page, with all of its subnodes. 6. Add-in updates the mind map.	
Alternative Flow 1:	

1.1: User select the root of a whole mind map 1.2: When user clicks on the “Delete node” button, the whole mind map will be deleted.	
Alternative Flow 1: 3.1: Add-in does not find an object which represents a thought structure maps. 3.2: Use case is closed.	
Alternative Flow 2: 4.1: Add-on detects that the user does not clicked on any part of mind map.	
Status of the mind map after the end of the use case	Node has been removed from mind map.

Table 5.3: The scenario for use case “add children”

Name of use case	Delete all
Description	The use case describes deleting all mindmap
Actors	User
Conditions	The user has created mind map and wants to delete everything .
Basic Flow: 1. User selects any node or click on the page which contains the mindmap. 2. User clicks on the “Delete all” button. 3. Add-in reads the object structure of mind map from the root. 4. Add-in removes the outline, text, … of all mind map from OneNote page 5. Add-in updates the mind map.	
Status of the mind map after the end of the use case	Mindmap has been deleted successfully

Table 5.4: The scenario for use case "Delete All"

The next and last function in add-in design for OneNote will be save.

Name of use case	Save
Description	The use case describes saving of mind map
Actors	User
Conditions	The user has already finished mind map and wants to save
Basic Flow: 1. User clicks on the “Save” button. 2. Add-in reads the object structure of mind map. 3. Add-in save mind map in xml file. 4. User receives an xml file from the OneNote page.	
Status of the mind map after the end of the use case	Node has been removed from mind map.

Table 5.5: The scenario for use case “Save”

5.1.2 Accessory design and architecture

During the design of the add-on and its subsequent development, standard software engineering procedures were followed, which aim to design quality, maintainable and easily extensible software. The methods used are described in the following publications which are suggested by supervisor Ing. Svatopluk Štolfa, Ph.D. see [16][17][18].

When the add-in is running, all resources, including the web pages and images used by the add-oi, are stored on the Node.js server. The server must be enabled to use the add-on. You can run a Web server locally for many purposes, such as developing or testing plug-ins. It is run using pre-prepared scripts that are part of the sample project and can be run with the command npm run <script-name> and one of the values listed in the package.json file under the script key can used as the script name.[45][46]

```
▷ Debug
"scripts": {
  "build": "webpack --mode production",
  "build:dev": "webpack --mode development",
  "dev-server": "webpack serve --mode development",
  "lint": "office-addin-lint check",
  "lint:fix": "office-addin-lint fix",
  "prettier": "office-addin-lint prettier",
  "start": "office-addin-debugging start manifest.xml",
  "start:desktop": "office-addin-debugging start manifest.xml desktop",
  "start:web": "office-addin-debugging start manifest.xml web",
  "stop": "office-addin-debugging stop manifest.xml",
  "validate": "office-addin-manifest validate manifest.xml",
  "watch": "webpack --mode development --watch"
},
"dependencies": {
```

Figure 5.2: All scripts that can be run with the "npm run" command in package.json in project

The nodes in the mind map will be arranged in a tree hierarchy, where any number of children is based on the parent node. A similar theme was used to create an internal structure that represents the entire mind map. This consists of a single global variable into which a Root object is written after the mind map is created. It contains a field of topics that is based on the main topic of the mind map. These topics are instances of the Node class and again include an array of topics of the same type. As a result, this single global variable of type Root forms the root of the tree structure, while all other topics are of type Topic and form the remaining vertices of the tree. Such a structure is very similar to the physical distribution of topics in a mind map. From that reason, class Root and class Node is created:

The class Root will contain these properties and methods:

1. Properties:
   - shape_id: id of the shape representing the outline of the root
   - text_id: id of the object which contains the text of root
   - left_children: nodes's array of the root in the left side
   - right_children: nodes's array of the root in the right side

2. Methods:
   - contain_id: check the id of the shape_id and text_id
   - get_child: get children both sides of the node
   - add_child: add a child node on the left or right side
   - get_shift: return highest shift and lowest shift
   - getNodeAtShift: get a node at shift on the left or the right side

- getHighestDepth: return the greatest depth of the mind map
- get_text: returns a field that contains objects in the format {text id, text}, this object represents all texts in the mind map

The class Node will contain these properties and methods:

1. Properties:
   - parent: refers to a parent of a current node
   - shape_id: id of the shape representing the outline of the node
   - text_id: id of the object which contains the text of node
   - line_id: id of the image representing the line leading from the parent to the node towards this
   - direction: Indicates whether the node is to the right or left of the root
   - child: A field of nodes that are based on this node
   - shift_local: shows the vertical shift relative to the parent node
2. Methods:
   - contain_id: check the id of the shape_id and text_id
   - get_child: returns all the elements in the mind map that are below this node (in its tree structure)
   - get_child_objects: return node objects that are below this node (in its tree structure) as well as the given nood
   - add_child: create a node on the left or right side
   - get_level: return to node level (horizontal shift to root)
   - get_shift: return highest shift and lowest shift
   - get_shift_global: return global shift (vertical)
   - get_text: returns a field containing objects in the format {text id, text}, recursively called on its descendants
   - get_depth: return depth of node
   - get_max_depth: return the depth of the tree that makes up the child nodes
   - getAtLevel: return all nodes at a given level
   - get_sibling: returns node that is directly below or above the topic based on the direction parameter

At first glance, the class Node is not very different from the class Root, it has some similar properties and methods. From that reason, I thought about using inheritance in here, so class Node will inherit all from class Root. However, it does not seem feasible, because, class Node has more properties and methods, moreover, its methods are different from Root, so if you use inheritance, you will have to modify the whole thing like creating a new class. The use of inheritance has been removal for the above reason.

However, there is still an important relationship between root and child nodes, that is, root must exist in order to create more nodes to develop from it. So, when the root does not exist, or is deleted, all its child nodes disappear. It is for this reason that I will set the relationship between these two classes as composition. [26][27][30]

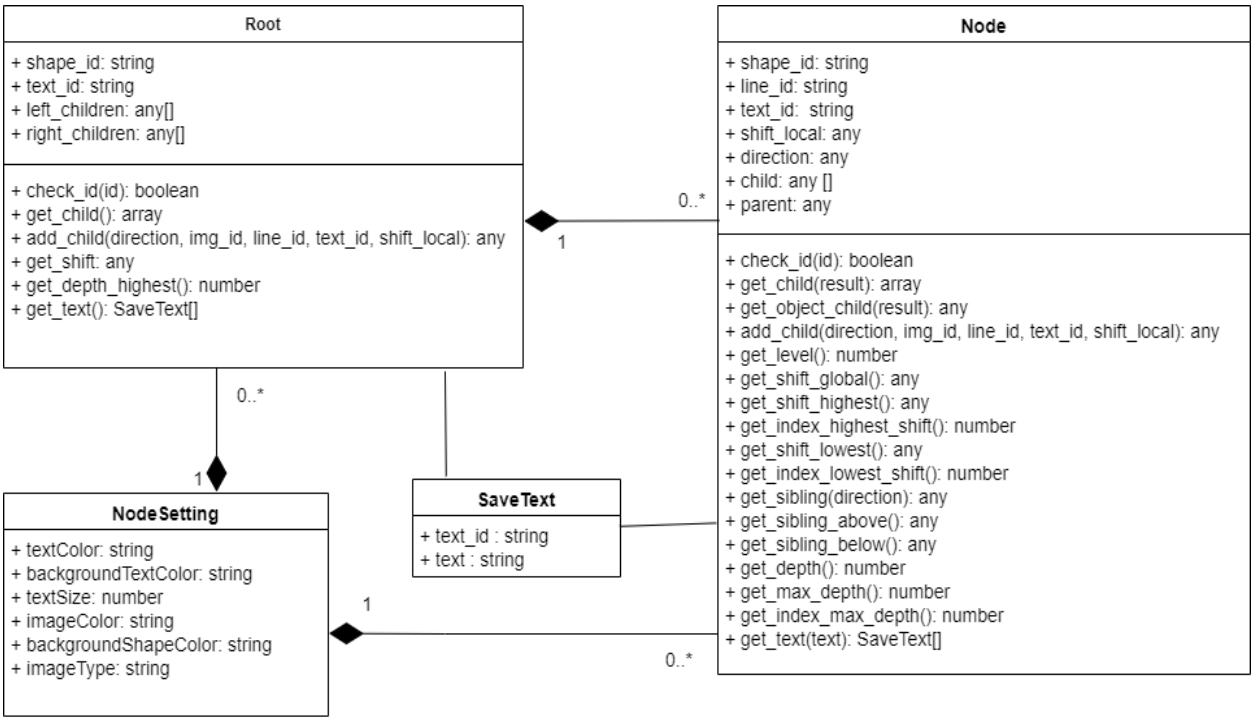

Figure 5.3: Class diagram for the add-in

Besides the composition relation between the Node and Root, we also have composition relation for the Root and the Node with a NodeSetting. In a NodeSetting class, we will pass in text and shape properties such as color, font size and type of shape which will be applied for all nodes by the setting class. If we do not declare a default setting, even our algorithm is correct, the drawing won't show up.

It is vital to state that the position is no longer open after creating a new topic so that no other topic is added here. Two global two-dimensional fields, one for each side of the mind map, are employed for this purpose. These fields are initially created four times their original size and set to zero. If one of the fields is filled, the size of the remaining fields will be doubled to allow for the insertion of more topics. When a user develops a subject, the first thing he does is see if it can be placed in the intended location. If this is the case, the id of the subject that is the parent of the newly added topic will be entered in the field's provided position, ensuring that no other topic will be inserted here. If there is no zero at the area where the new subject is to be inserted, it implies that a topic has already been created there and must be moved to make room for a new topic. This feature will be discussed later. It can be written to that position once the topic has been moved to make room for the newly added topic.

This procedure, which checks whether a topic can be added to a location, can be carried out without the usage of the global fields previously explained. It can be substituted by going through the entire structure of subjects and checking if there is a topic in the specified position at the same time. In the case of vast themes, however, this strategy is excessively time-consuming and complicated. However, it has the advantage of not requiring any explicit data to be transferred between the OneNote application and the add-on.

5.1.3 Sequence diagram

In addition to describing use cases and scenarios for each extension's functionality, we also need to determine the sequence of events of a certain group of by using a sequence diagram. It describes in detail the messages sent and received between objects and also focuses on the timing in which messages are sent and received. [28][29]

Create root is an essential first function to create a mind map. It is always done first and from there, child themes will be developed from root.

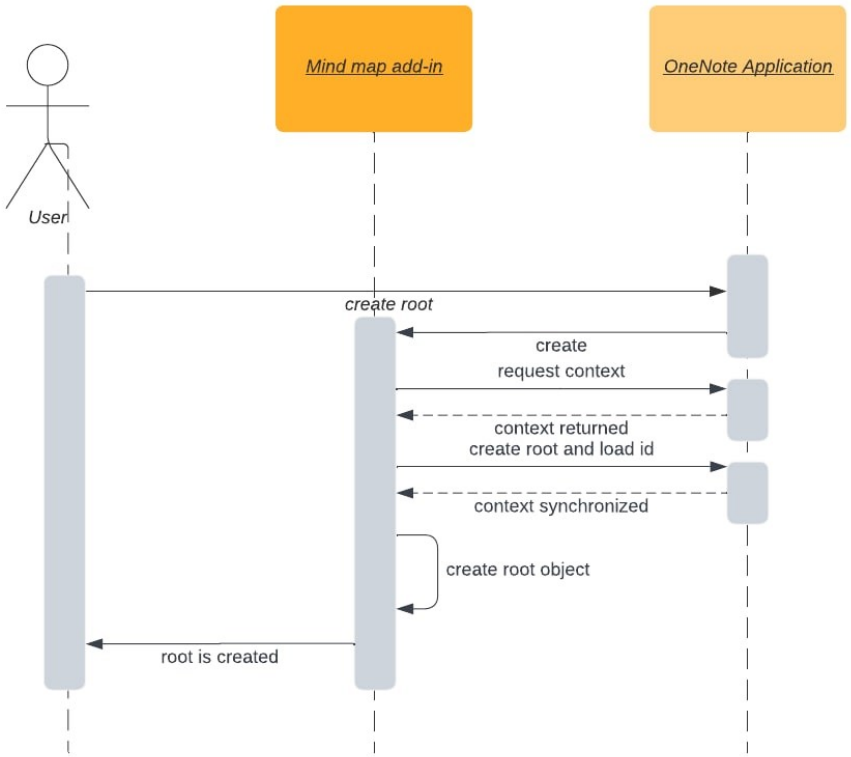

Figure 5.4: Sequence diagram for "create root" function

The next function of adding a new child node to the existing root is one of the basic functions of the plugin. It can be called by the user by clicking the "Add Child Node" button. Executing this function in the plug-in begins by searching for an active node. In the next step, we will find out the coordinates of the outline of the topic the user wants to add a new theme to and calculate from them the new coordinates to which the theme will be added. Then we need to find out if the position in the mind map has been occupied. If there is a subject in certain position, it is necessary to move it to have a free position for new node. Now that we can add a topic to a OneNote page and retrieve its id so that we can save it in a global tree structure.

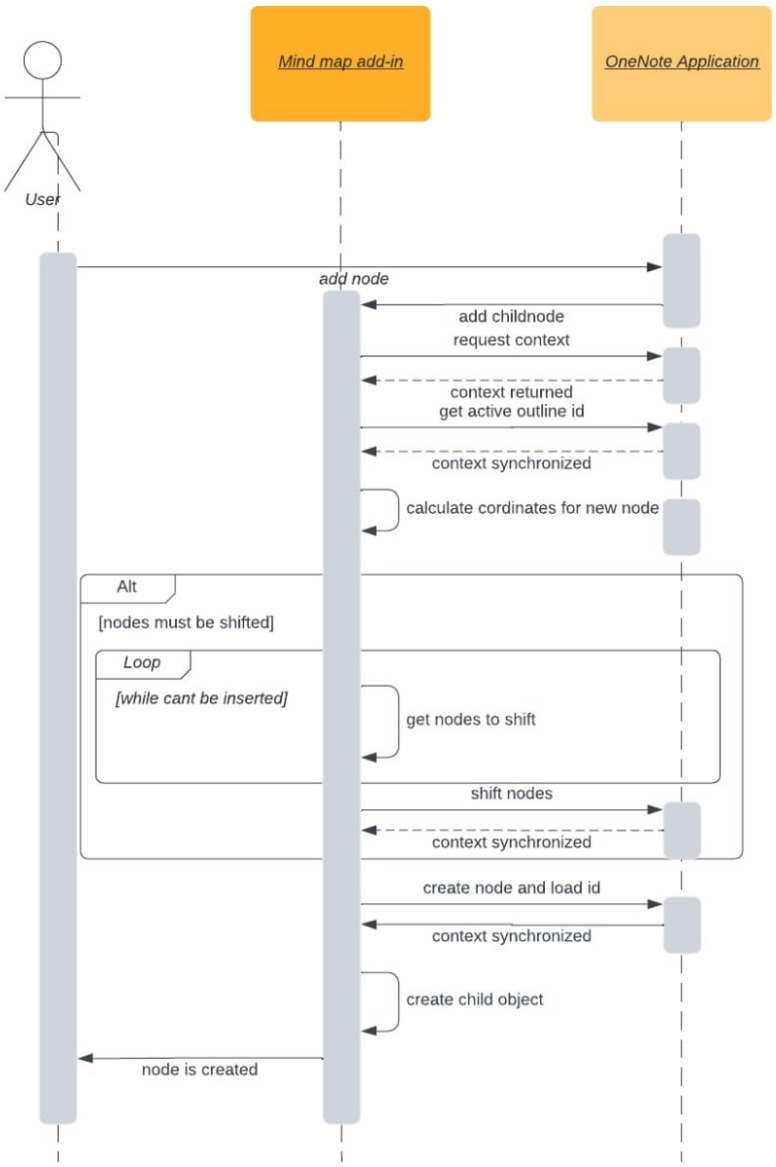

Figure 5.5: Sequence diagram for "add child node" function

The next function will be deleted node. It starts out very similar to the function of adding a new subject, by retrieving data from the image caption. Next, we need to get back the id of the active topic, i.e. the topic the user wants to delete. Based on that, we will remove the given theme along with all its child themes from the OneNote page. Then we remove the topic from the global array and the tree structure. If we have not deleted the entire mind map, we also need to fill in the blanks that may have been created by deleting the topic.

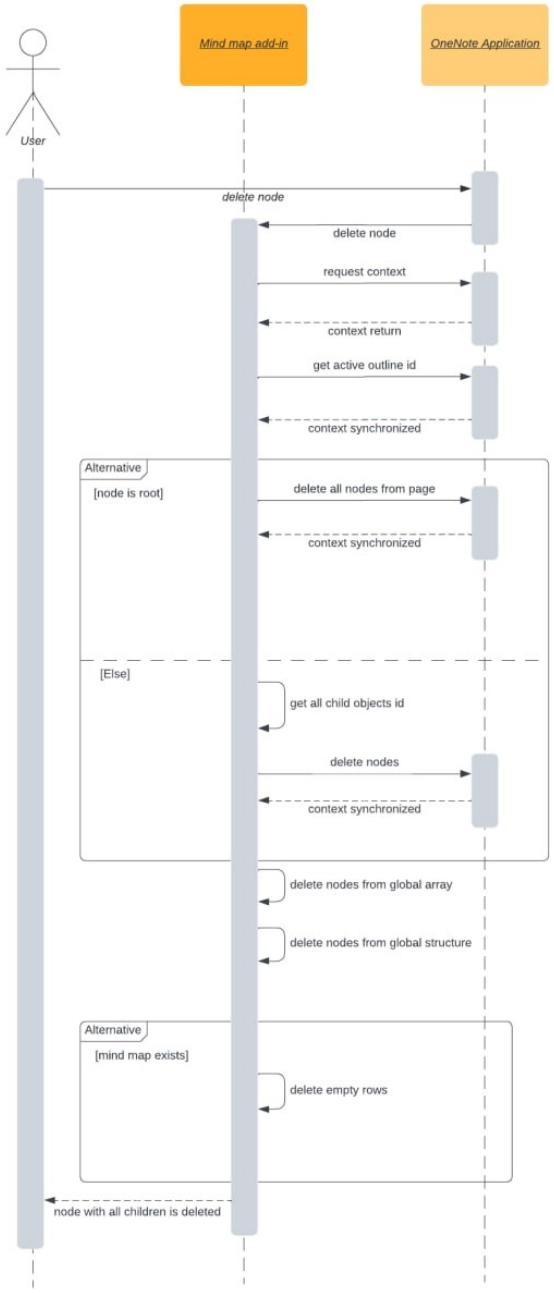

Figure 5.6: Sequence diagram for "delete node" function

The next function is deleting all. Its implementation is similar to the condition that the node selected for deletion is root in the delete node function. At that time, the entire mind map will be deleted.

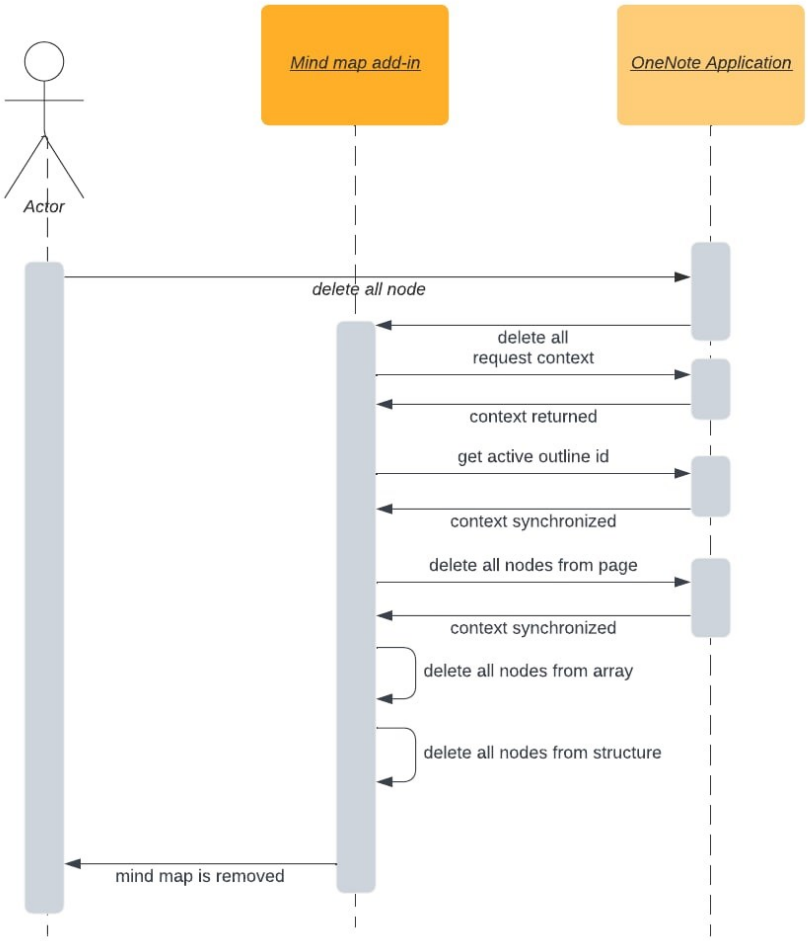

Figure 5.7: Sequence diagram for "delete all" function

The final function is save which will help user save the mind map in xml file.

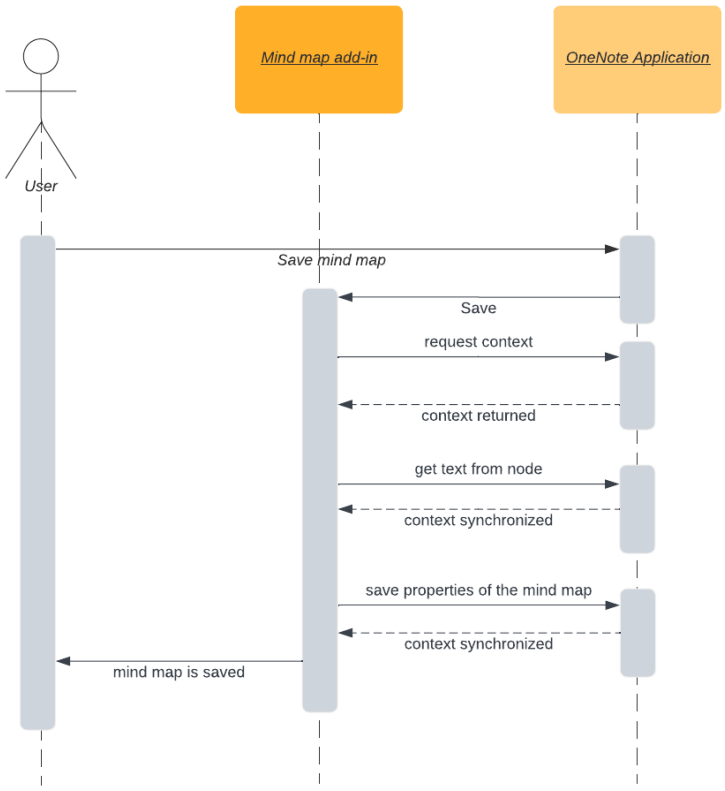

Figure 5.8: Sequence diagram for "delete all" function

The following figure shows the architecture of the add-in and the interconnection of the individual parts of which the add-on consists.[31]

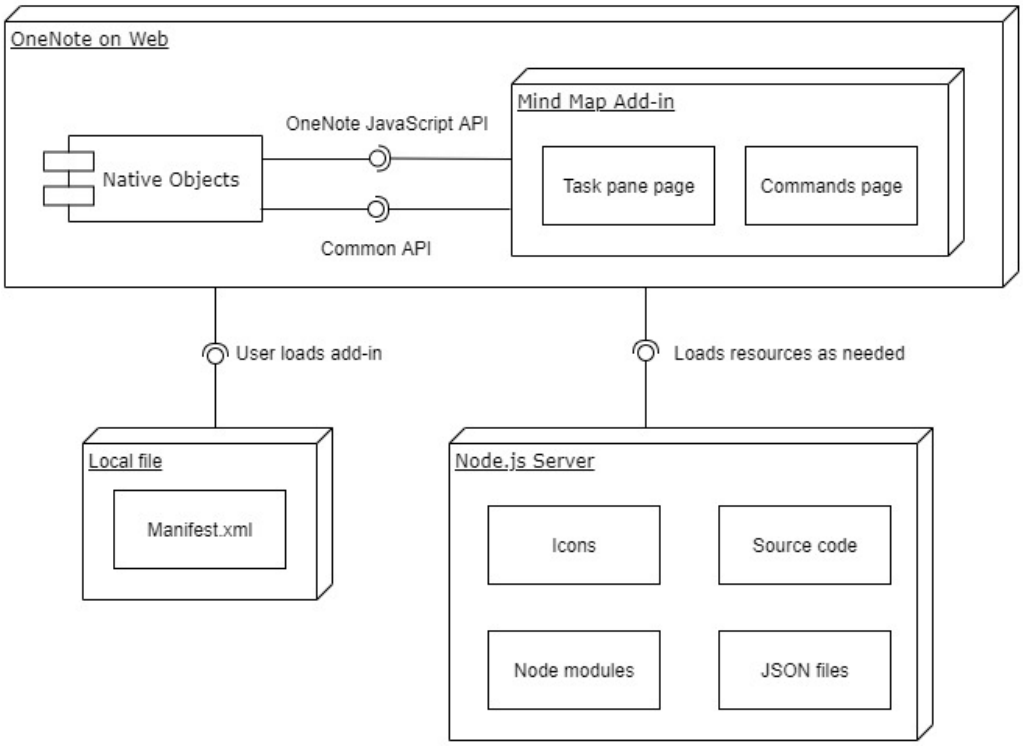

Figure 5.9: Component diagram

State diagrams are used to scale the dynamic nature of the system block. They identify different states of a consumer object during its lifetime, and these states are changed by claims. [32][33]

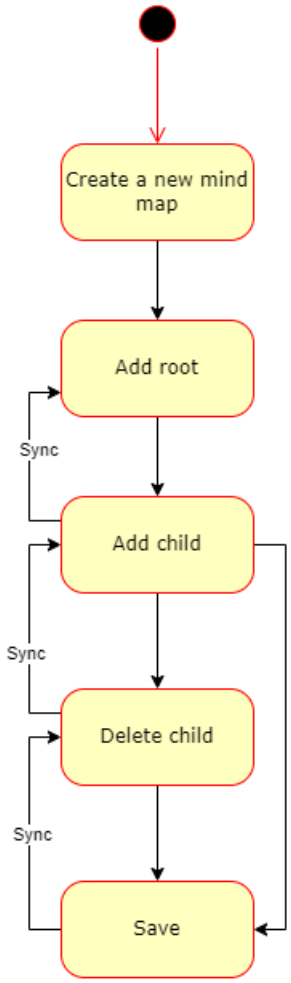

Figure 5.10: State diagram

5.2 Implementations

There are two ways to develop a function for the add-in:

- The first way is to create buttons and specify the function for it. When the user clicks the button, it will execute the specified function
- The second way is to create a button and attach a taskpane to it. That is, when the user clicks the button, the taskpane tab interface will appear, allowing the user to interact with it.

In this work, I choose the first way to implement the functionality for the add-in.

Adding a theme also includes creating objects to be added to the OneNote page. This process has already been partially described in the previous chapter. To create such an object, the x coordinates are a string describing the html element that will be added to the page. When creating the text of the topic, the <p> tag is selected as the html element, which contains the attributes that define the color and size of the text.

```
//text tag will be inserted to OneNote page
export function createText(text, textsize, textcolor, bgcolor) {
    if (bgcolor == "white" || bgcolor == "#ffffff") {
      var html = `<p style="color: ${textcolor}; font-size: ${textsize}px;">${text}</p>`;
    } else {
      var html = `<p style="background-color: ${bgcolor}; color: ${textcolor}; font-size: ${textsize}px;">${text}</p>`;
    }

    return html;
  }
```

Figure 5.11: Example of creating an html tag to insert text to OneNote page

When creating the border of a theme or a line that leads from one theme to another, the <img> tag will be used, while the tag has the width, height, and src attributes set. This way to create the outline of a topic, where the image is inserted at a certain position, has the disadvantage that it is not inserted immediately into the OneNote page and it takes some time for the image to be displayed. display, depending on the size of the image. There are three types of images that can be displayed for a theme: ellipse, rectangle, and rhombus. If the global shapeType variable is initialized and passed to the NodeSetting class property as ellipse, the ellipse will be displayed. Same for other conditions.

```
//create a shape to insert on the page
const createShape = (width, height, bgcolor, imgcolor, shapeType) =>{
  var canvas = createCanvas(width, height, shapeThickness , bgcolor, imgcolor);
  var context = canvas.getContext("2d");

  if (shapeType == "ellipse") {
    context.ellipse(width / 2, height / 2, width / 2 - 4 , height / 2 - 4 , 0, 2 * Math.PI, false);
  }
  if (shapeType == "rectangle") {
    context.rect(0 + shapeThickness , 0 + shapeThickness , width - shapeThickness  * 2, height - shapeThickness  * 2);
  }
  if (shapeType == "rhombus") {
    context.moveTo(0 + shapeThickness , height / 2 + 1);
    context.beginPath();
    context.lineTo(width / 2, height - shapeThickness );
    context.lineTo(width - shapeThickness , height / 2);
    context.lineTo(width / 2, 0 + shapeThickness );
    context.lineTo(0 + shapeThickness , height / 2 + 1);
    context.closePath();
  }

  context.stroke();

  var img = canvas.toDataURL("image/png");
  var html = `<img width="${width}" height="${height}" src="${img}"/>`;

  return html;
}
```

Figure 5.12: Example of creating an html tag to insert image to OneNote page

By creating a canvas frame in canvas.js, it is easily for drawing a shape on the canvas: [40][41]

```
export const createCanvas = (width, height, shapeThickness , bgcolor, imgcolor) =>{
    var canvas = document.createElement("canvas");

    canvas.width = width;
    canvas.height = height;
    var context = canvas.getContext("2d");
    context.lineWidth = shapeThickness ;
    context.fillStyle = bgcolor;
    context.strokeStyle = imgcolor;

    return canvas;
  }
```

Figure 5.13: Example of creating a Canvas

The process of drawing an arrow connecting two subjects is very similar to drawing an outline of a subject. The only problem is finding the coordinates. we have to calculate the first and last coordinates of the arrow first. The next step is to calculate the coordinates where the two lines representing the arrowheads will be drawn. First, using the previously calculated coordinates, we calculate the angle at which the main line will be created. To do this, we use the Math.atan2 function, which returns the angle in radians between the x-axis and the line representing the direction of the arrow. With this angle we add or subtract the value π / 6 depending on the arrow with which we calculate the coordinates. That is, the lines forming the arrowhead will make an angle of 30° with the main line of the arrow. If we want a larger angle between them, we will have to use, for example, a value of π / 4 instead of a value of π / 6. However, we must convert the angle calculated this way to coordinates so we know where to draw the lines. We do this with Math.cos for the x coordinate and Math.sin for the Y coordinate. We multiply these values by the length of the line representing the tip and subtract them from the point's target coordinates.[36][37][38][39]

```
function calcShapeAndArrowCoords(direction, shift, width, height) {
  let shiftx = 1;
  let shifty = 1;

  let x1 = direction == "right" ? 0 : width;
  let y1 = shift < 0 ? height : 0;
  let x2 = direction == "right" ? width : 0;
  let y2 = shift < 0 ? 0 : height;

  let dx = x2 - x1;
  let dy = y2 - y1;
  let angle = Math.atan2(dy, dx);
  let arrowlength = 4;
  let arrow1x = x2 - arrowlength * Math.cos(angle - Math.PI / 6);
  let arrow1y = y2 - arrowlength * Math.sin(angle - Math.PI / 6);
  let arrow2x = x2 - arrowlength * Math.cos(angle + Math.PI / 6);
  let arrow2y = y2 - arrowlength * Math.sin(angle + Math.PI / 6);

  //line shouldn't be too close to edge, it needs some space for its stroke size and anti-aliasing
  while (x1 < 1 || x2 < 1 || arrow1x < 1 || arrow2x < 1) {
    x1++;
    x2++;
    arrow1x++;
    arrow2x++;
    shiftx++;
  }

  while (y1 < 1 || y2 < 1 || arrow1y < 1 || arrow2y < 1) {
    y1++;
    y2++;
    arrow1y++;
    arrow2y++;
    shifty++;
  }
```

Figure 5.14: Calculate shape and arrow coordinate

After calculating coordinates for arrow and shape function will return values related to that coordinate and we will use it to draw arrow using following function:

```
  return {
    imgX1: x1,
    imgX2: x2,
    imgY1: y1,
    imgY2: y2,
    arrowX1: arrow1x,
    arrowX2: arrow2x,
    arrowY1: arrow1y,
    arrowY2: arrow2y,
    shiftX: shiftx,
    shiftY: shifty,
  };
}
```

Figure 5.15: Coordinates returned after performing calculations to draw arrows and shape

We use this function to draw an arrow which connecting this node to another node:

```
export const drawArrow = (context, coords) =>{
    context.strokeStyle = "black";

    context.beginPath();
    context.moveTo(coords.imgX1, coords.imgY1);
    context.lineTo(coords.imgX2, coords.imgY2);
    context.lineTo(coords.arrowX1, coords.arrowY1);
    context.moveTo(coords.imgX2, coords.imgY2);
    context.lineTo(coords.arrowX2, coords.arrowY2);
    context.stroke();
}
```

Figure 5.16: Function to draw arrow

6 TEST FUNCTIONS AND COMPARE IT WITH ANOTHER TOOL.

6.1 Test functions and compare

To use an extension for OneNote on the website, first user must need to run the source code with “npm run dev-server” command then insert a manifest.xml file of an add-in. By clicking on the tab Insert on the tab bar, use will see the “Office Add-ins” button like this:

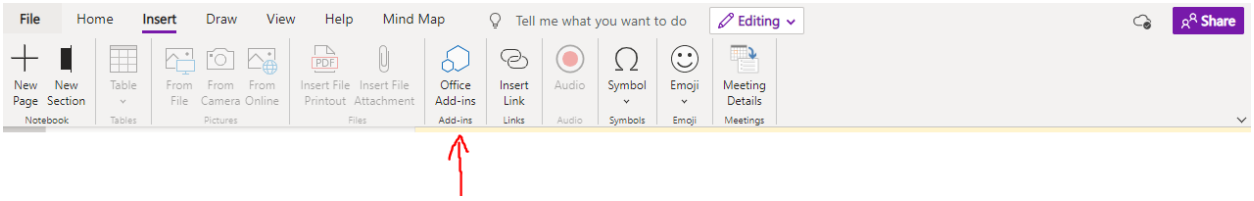

Figure 6.1: Click to Office Add-ins

Click on that button, user will see the interface to upload the add-in:

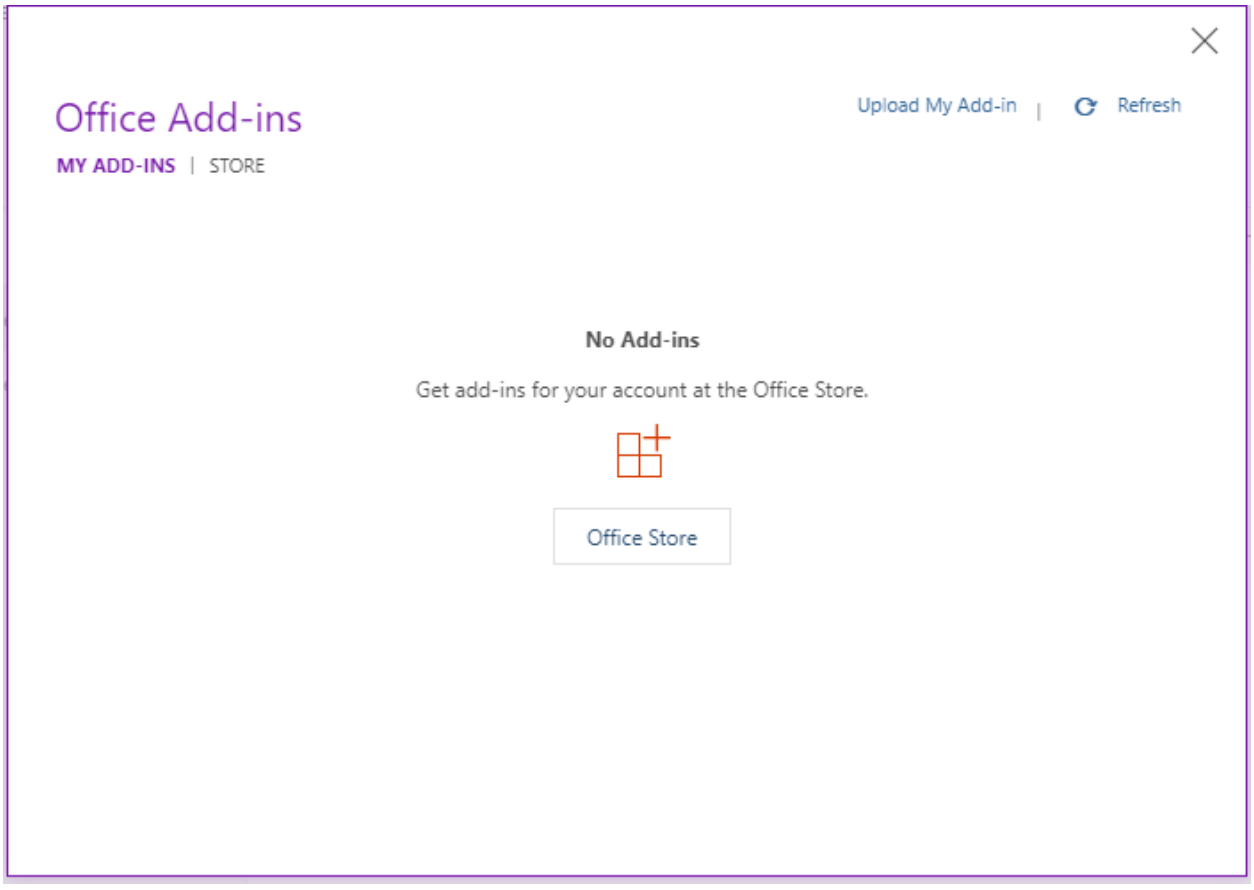

Figure 6.2: Click to Upload My Add-in

Choose “Upload My Add-in” in the top right corner, user will see like this:

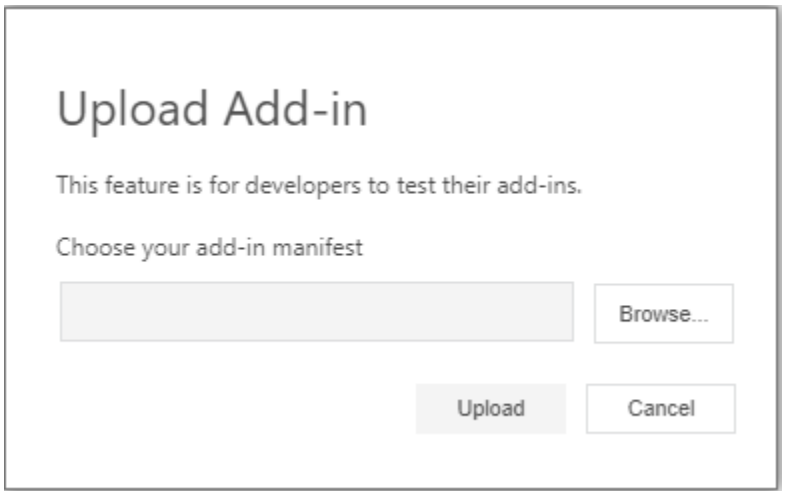

Figure 6.3: Click to Browse

Click on browser and find the root directory of the add-in, then upload the manifest.xml file.

After insert the manifest.xml file to the OneNote on the website you will have a Mind Map tab on the tab bar:

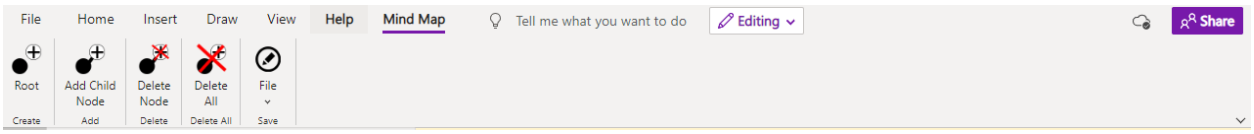

Figure 6.4: Mind Map tab

In the Mind map tab, which supplies by the extension, there are 5 buttons with 5 features which was described in the previous chapter.

When click on the button “Root”, user will see the root (the main topic) for the mind map is created in the middle of the page.

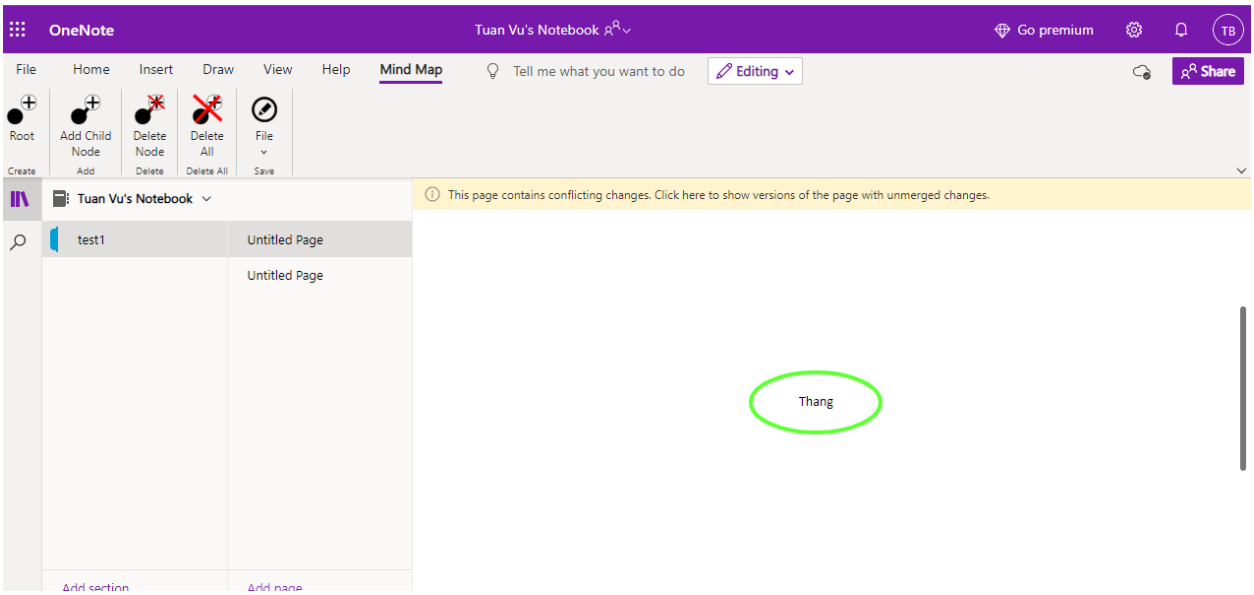

Figure 6.5: Create Root

To create a child node from the root, user must click on the root, then press the “Add Child Node” button. Children nodes will be added in the order of right first and left after.

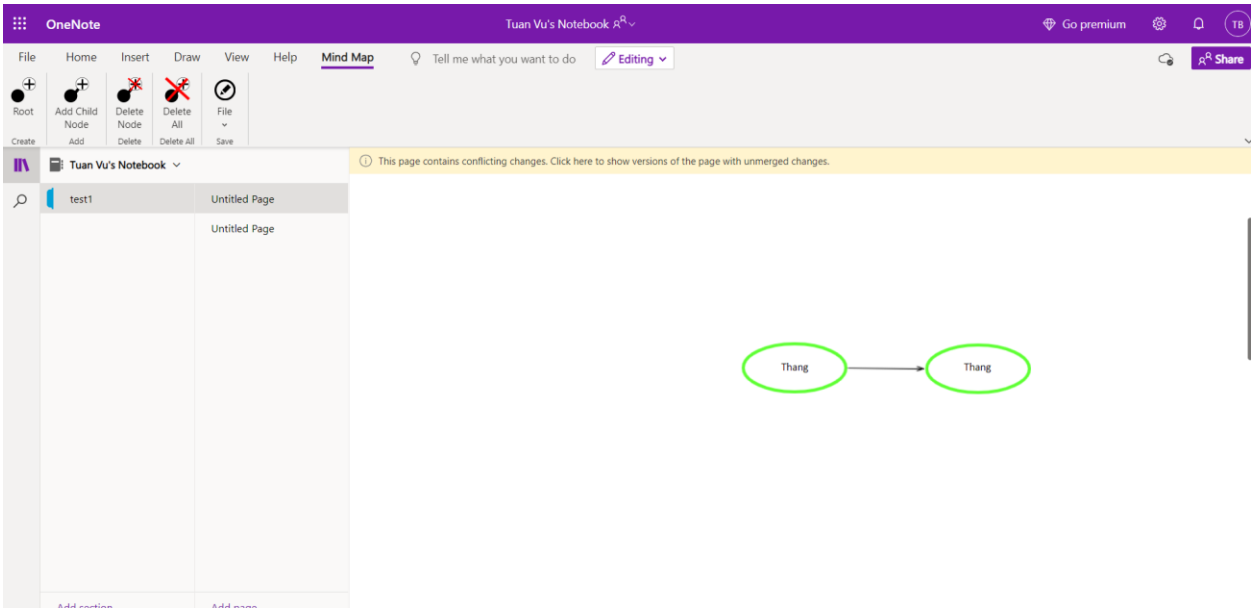

Figure 6.6: Create Left node

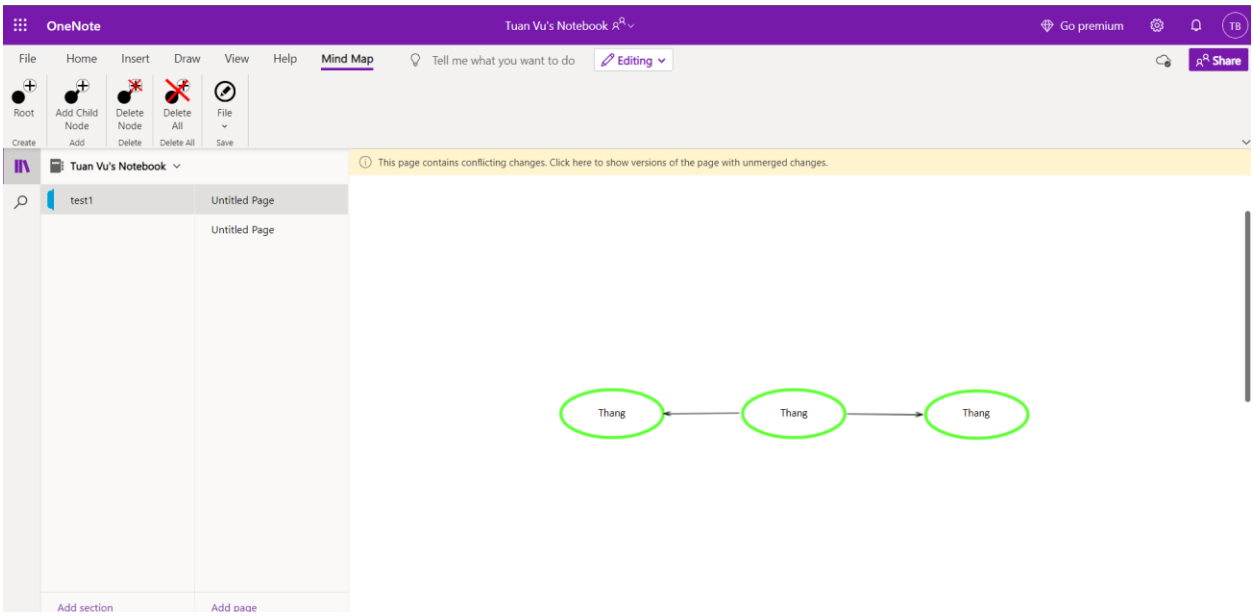

Figure 6.7: Create Right node

By choosing the node, then press the Add button, it is easily to create children nodes for the mind map.

If user want to delete any node, just click on it and press the Delete node button:

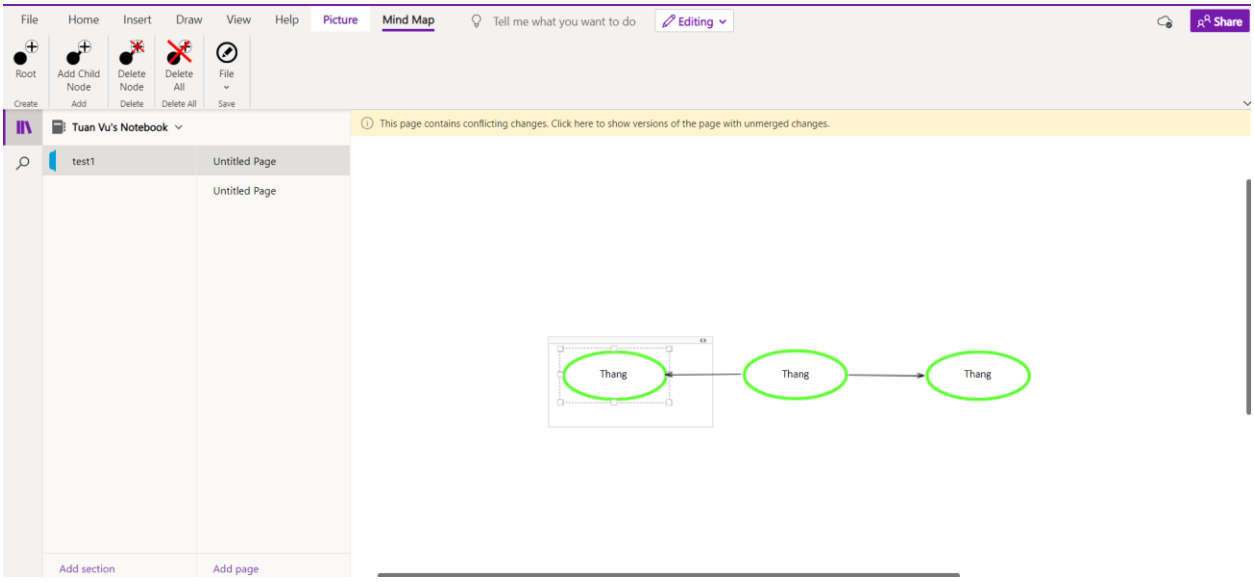

Figure 6.8: Click to Right node for deleting

After choosing a node and click on the "Delete Node" button, that node will be removed from the page. The result will be liked this picture:

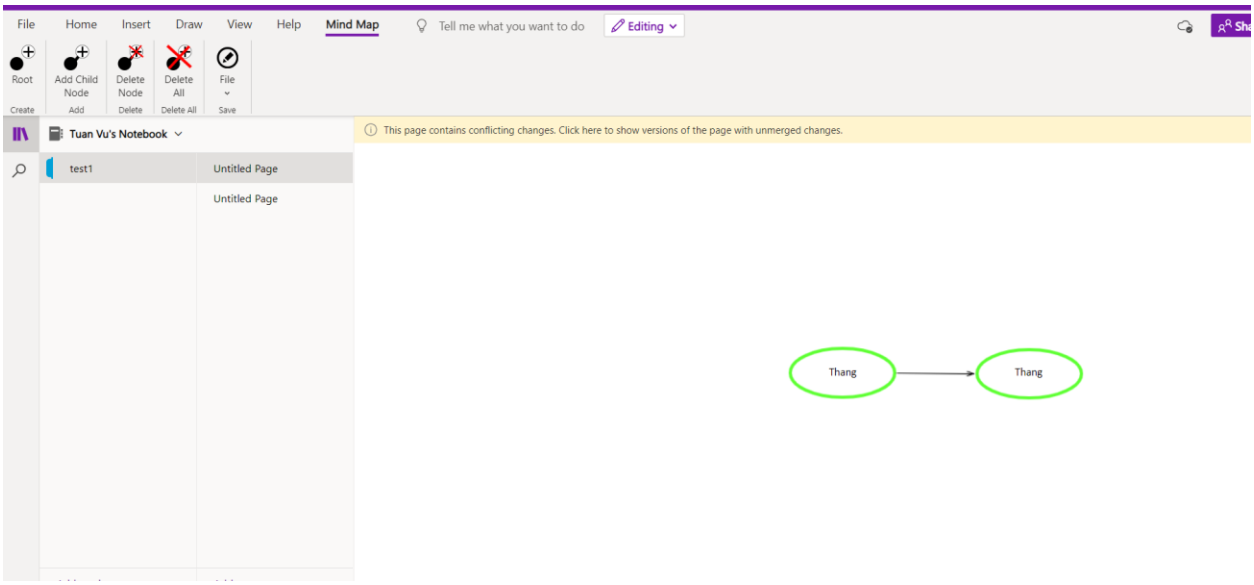

Figure 6.9: Click to Delete Node

To save the mind map, user choose the "File" button then choose "Save as file", the add-in will save the mind map in the xml file, then automatically download to your computer.

The last function is delete all, which means delete every objects existed on the page, user just need to click on the page or any node, then press the "Delete All" button, the page will no longer contain any objects, looks like a new page and will allow the user to create another mind map.

We can see that it is easily for user to use this extension to create a mind map. However, If compared with other software that supports drawing mind maps, this extension is still lacking and needs to be added a

lot. The speed of this extension is also a big obstacle that makes users dislike this add-in. Moreover, if you compare the features that the software provides, this add-in only supllies a basic function is for drawing mind maps, while other applications bring a lot of features such as inserting images. , insert icons,...(like mindmup.com). Along with that, the mindmup.com website also helps users self-align shapes and text, something this add-in has yet to do.

In the next section, I will present solutions that can be used to improve this extension

6.2 Add-in Extension options in future

The add-in currently in a state where it offers a number of basic functions together with an intuitive and friendly user interface. It can be used to draw a diverse mind map, the themes of which can have different shapes by changing the properties for class Settings. However, like virtually any software, the OneNote Mind Mapping Add-in has plenty of room for various enhancements that make it even easier to create mind maps, or add new features that contribute to an even better user experience.

The first feature that a user would be able to appreciate is editing. The add-in currently only allows user to draw a mind map with a setting constructor class which was defined in the code, if you want to change any properties for the mind map, user must change the properties for the constructor in the class Setting. That's a minus and my dissatisfaction about this extension. In future, any user can enhance this edit feature for the add-in. The edit function can work by following way, when user selects edit button added to ribbon of extension tab, the taskpane tab will appear in right side of the screen, in taskpane will contain properties that user have changeable for the topics in the mind map. By clicking on a topic, the add-in will read the properties of that theme, then allow the user to change the properties (such as font size, color, ...) by selecting in the taskpane tab select a topic (1 node) that the user wants to change, then new values will be passed to replace the old properties.

The second feature that users can improve is to save the mind map as an image. It will be more optimal if users can save it as an image for easier sharing with everyone, as well as can store it anywhere and use it for reports. The mind map export function can be launched with a button located in the ribbon next to the existing buttons. When the user wants to download an image, we can use what is already implemented. The outlines of the topics and the arrows connecting them are drawn on the canvas, the difference is that we will not be drawing just one subject or arrow, but the entire mind map, which must be supplemented with texts of individual topics. This way the user can draw the entire mind map on the canvas and then export it as an image. However, it is not easy to get the coordinates of both mind maps and draw them on canvas.

The final feature that could be updated for the add-in is the ability to create drawings and text in the same pane, from which users can easily drag and drop and move themes. Currently, the add-in initializes the drawing and text on two different frames, so when the user wants to move the node, they need to move it twice. In addition, the ability to create multiple mind maps on the same page. Currently, the add-in only allows creating one mind map per page. If the user double-clicks the "Root" button, there will be 2 main themes created in the same location and overlapped, but the user can only execute functions from the created theme newest.

7 CONCLUSION

The aim of this work is to create a user-friendly and functional add-on to the OneNote application, which will streamline the creation of mind maps. Mind maps are a suitable tool for effective recording of mental processes and are proven in planning various activities of work and everyday life.

The work described and explained mind maps, their functionality and meaning. The aim was to introduce the reader to the issue of the Microsoft Office suite, which includes a key application for this bachelor's thesis, namely Microsoft OneNote. In addition, three existing add-ons have been specified that can be used to create mind maps. Two of these add-ins can only be used to import a mind map in the form of an image that needs to be drawn in an external program outside of OneNote. The third add-on already allows you to create mind maps natively in OneNote, but is only available for OneNote versions 2010, 2013, and 2016. All of these add-ons are chargeable.

After a while of research, I have developed an add-in for Office OneNote. It allows users to create mind maps easily and conveniently for daily work. A simple, effective and time-saving tool for creating and editing complex mind maps was developed for the work. The output of the work are the source codes forming a functional ,and practically usable application, which is in the form of an add-on for Microsoft OneNote and whose mind map can be modified by multiple users.

In the process of making the project due to time constraints and practical conditions, I know my project has many shortcomings, but it can be edited and improved in functions to make this extension more complete.

One thing I noticed when working on this topic is that, very few people seem to care about creating an add-in for software on OneNote in particular and Office applications in general. During the writing process, I researched on the Internet and also consulted with friends in the Czech Republic and in my country, Vietnam, but no one knew about this topic, or in other words, they not too concerned about this issue. The original reason for choosing this topic is because I think it uses api, I wanted to learn about apis and how they work. Because I think it will help to research and use the api of the crypto wallets that I am learning.

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