

# ZiPlus: Digital File Compression as a Browser Extension Using Deflate Algorithm for Lyceum of the Philippines University - Cavite

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DOI: <https://doi.org/10.5281/zenodo.15761301>

Published Date: 28-June-2025

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**Abstract:** ZiPlus is a browser extension developed for Chromium-based browsers to provide users with a convenient tool for compressing and decompressing files without switching applications. This study addresses the growing need for efficient data compression due to increasing data storage demands. Using the Agile Software Development Life Cycle and the DEFLATE algorithm, the system was built and evaluated based on ISO/IEC 25010 quality standards. Ten IT experts and thirty-five subject matter users assessed its functionality, usability, and reliability. Results indicate that ZiPlus meets core software quality metrics, offering a practical and accessible solution for digital file management within academic environments.

**Keywords:** Deflate, Compression, Decompression, Browser Extension, ISO/IEC 25010.

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## I. INTRODUCTION

The rapid growth of digital data is a direct result of continuous advancements in information technology. As the volume of data generated by individuals, organizations, and institutions increases exponentially, the need for efficient storage and transmission solutions becomes more critical. One such solution is data compression—a method of reducing file sizes using encoding techniques to facilitate easier storage and faster data transfer. This process is widely applied across various file types, including text, images, videos, audio, executables, and databases (Kim, Choi, Jeong, & Song, 2019).

In computing and communications, data compression plays a vital role in optimizing performance. Techniques that minimize file size enhance storage efficiency and accelerate transfer speed, especially in environments with limited bandwidth. Studies such as Muthucamy (2018) emphasize the benefits of browser-based compression, highlighting reduced web page load times through the compression of scripts and stylesheets.

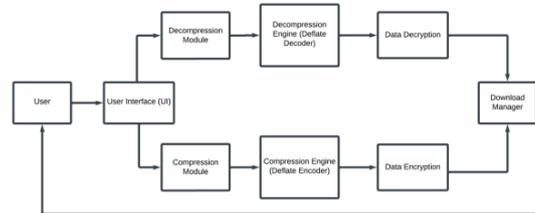
However, many existing compression tools face limitations—some only support specific file types, while others lack built-in security features. These gaps expose users to risks such as data corruption or confidentiality breaches during file transfer (Ahmet et al., 2019). To address these issues, this study introduces ZiPlus, a browser extension designed for Chromium-based platforms. It supports the compression and decompression of a wide range of files while incorporating AES encryption for data security.

ZiPlus aims to provide a user-friendly, efficient, and secure file management tool tailored for academic and institutional use, particularly benefiting students and professionals who frequently handle diverse digital resources.

## II. METHODOLOGY

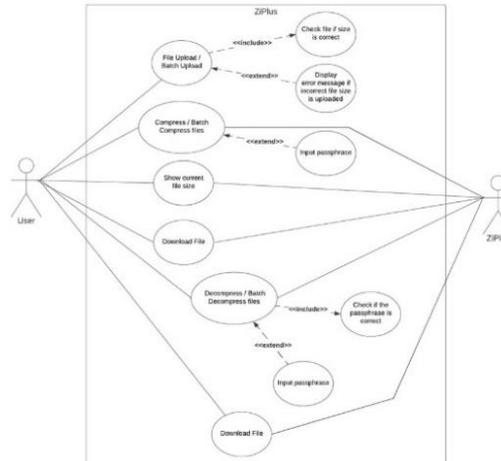
### A. Process Model

**Fig. 1: Systems Architecture of ZiPlus: Digital File Compression as a Browser Extension Using Deflate Algorithm for Lyceum of the Philippines University – Cavite**



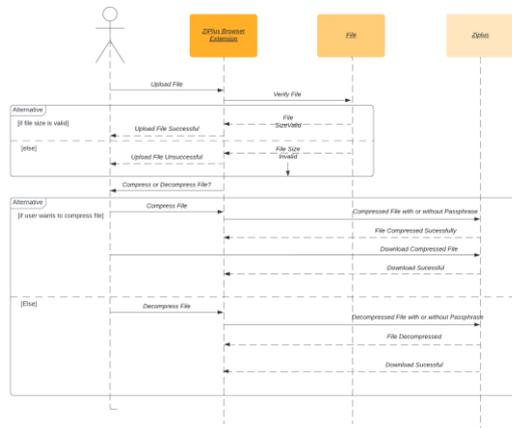
In Figure 1, it demonstrates the systems architecture of ZiPlus. It involves a sequence of components that handle initial uploaded file coming from the user through compression and decompression modules, compression and decompression engine (Deflate encoder), and data encryption, and decryption. The extension will act as the interface between the user's browser and the system. To start, the users will interact with the extension to initiate file uploads. The file will then be validated to ensure that it is a compatible file size. After successful validation, the files are processed for compression or decompression using Deflate algorithm. It will help in reducing the file size of the uploaded file or decompress the file by restoring its compressed data back to its original form. Files will go through data encryption using AES for adding another layer of security and decryption for restoring it to its original state. Furthermore, the process will be presented to the users through ZiPlus and be ready for download

**Fig. 2: Use Case Diagram of ZiPlus: Digital File Compression as a Browser Extension Using Deflate Algorithm for Lyceum of the Philippines University – Cavite.**



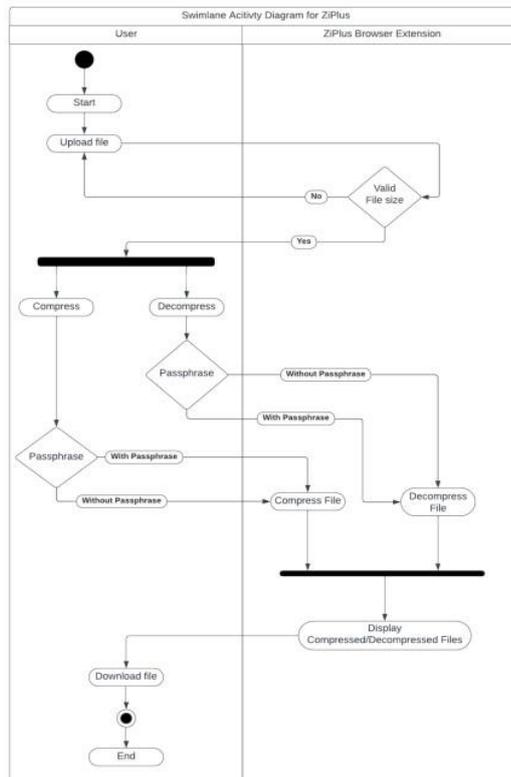
This portion of the design of the application demonstrates the expected client of the application and the capacities that are accessible for the clients to utilize. Figure 2 shows the user of the application which is the Chromium-based browser user, acting as the primary actor of ZiPlus. It shows the functions which the end-users can use for their convenient and efficient digital experience and the system to be improved or updated. The first function that primary users in ZiPlus can do is to upload files, it can be a single or batch file upload. Once the user has uploaded a file, ZiPlus will start to verify its file size whether the file uploaded has a minimum file size of 1 MB. However, if the file is not supported, it will display an error message. From the successfully uploaded file, users can now start to choose whether they want to input a passphrase or not, making the file encrypted is optional for the users. Once the user clicked the compress button and downloads it, it will then show the preview of the current file size together with its compressed file size. When it comes to decompression, the user must upload the compressed file that they have compressed using ZiPlus. If the user uploaded an encrypted file, they must put the correct passphrase to decompress it. However, if the file is not encrypted, they can just simply leave the passphrase blank and start to decompress and download the decompressed file.

**Fig. 3: Sequence Diagram of ZiPlus: Digital File Compression as a Browser Extension Using Deflate Algorithm for Lyceum of the Philippines University – Cavite**



This portion of the design of the application demonstrates the interactions between objects in ZiPlus with respect to time. It shows the control flow of the relations and how the system works with regards to the relationships of both the objects and its actor. As shown in Figure 3, there are three (3) objects namely, ZiPlus Browser Extension, File, and ZiPlus. This diagram starts with the user uploading a file in ZiPlus, once received by the system, it will start to verify the file. There will be two scenarios once the file has been verified; first, if the file size is valid. However, if the file size is not within the limit of ZiPlus, there will be a message saying file size needs to be more than 1MB. After having a successfully uploaded file, the system will now show a button to Compress/Decompress, user has an option to input a passphrase for extra security. From that, the user will be able to download the compressed file. The same process will also be done to the file if the user uploads a compressed file, the only difference is that the file will be restored to its original form.

**Fig. 4. Activity Diagram of ZiPlus: Digital File Compression as a Browser Extension Using Deflate Algorithm for Lyceum of the Philippines University – Cavite**



This portion of the design of the application demonstrates the expected client of the application and the capacities that are accessible for the clients to utilize. It demonstrates the flow of activities within ZiPlus. As shown in Figure 4, there are two (2) partitioned sections namely, User and ZiPlus Browser Extension. The swimlane on the left represents the actions performed by the user and on the right side, it represents the actions performed by ZiPlus. To start, the user will upload a file in ZiPlus and it will be validated. If it is an invalid file, the user must upload another file as it will be rejected by the system. Once the user has uploaded a valid file, they can now proceed to compress or decompress their uploaded file. If the user chose to compress the file, ZiPlus will start compressing their file. Similar with decompression, if the user chose to decompress the file, ZiPlus will bring the decompressed file back to its original format. Lastly, after the files have been processed, all the files will be displayed and will be ready for download.

**Fig. 5: Activity Diagram of ZiPlus: Digital File Compression as a Browser Extension Using Deflate Algorithm for Lyceum of the Philippines University – Cavite**

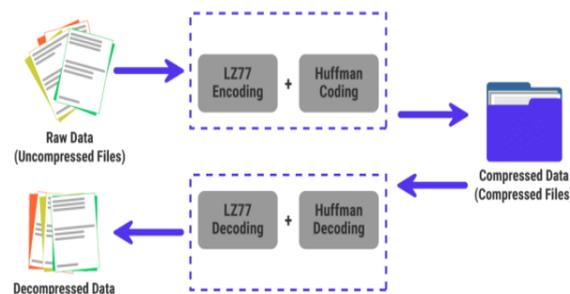
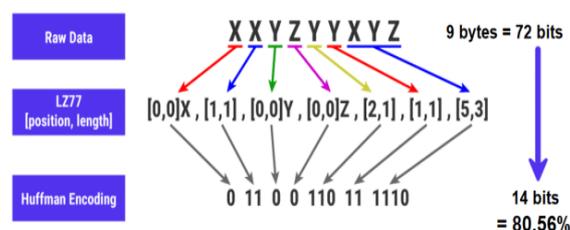


Figure 5 illustrates the sequential process of data compression and decompression within ZiPlus, using Deflate algorithm. The diagram shows the data transmission from raw data or uncompressed files that may include various formats that are only limited to images (.jpeg and .png) and documents (.pdf, .docx, .xlsx, .pptx, and .txt). The raw data will undergo a two-step compression process. LZ77 Encoding will identify the repetitive patterns within the data. Subsequently, Huffman Coding will be applied to represent the identified patterns, resulting in a more compact representation of the data. The outcome of the compression process is the generation of compressed data. These files exhibit reduced file size compared to their original size, which facilitates more efficient storage and transmission. To decompress the data, the compressed data will also go through the application of LZ77 Decoding and Huffman Decoding to restore.

**Fig. 6: Compression based on Deflate Algorithm of ZiPlus: Digital File Compression as a Browser Extension Using Deflate Algorithm for Lyceum of the Philippines University – Cavite**



In Figure 6, it demonstrates a step-by-step process of ZiPlus compression applied to a sample raw data sequence “XXYZYYXZ.” The initial raw data consists of 9 bytes which is equivalent to 72 bits. This process begins with the raw data, a sequence of characters. Below the data, the application of LZ77 Encoding is shown, revealing the positional and length indicators for each character of the given sequence. The figure then illustrates the application of Huffman Encoding to the LZ77-encoded data, assigning binary codes for each symbol based on their frequency and occurrence. From that, the process of compression is shown, a reduction from the initial 72 bits down to 14 bits. This represents a compression rate of 80.56%. This illustration shows the transformation of raw data, from LZ77 Encoding to Huffman Encoding, resulting in significant compressed data.

**B. Agile Model**

Agile methodology was chosen for the development of ZiPlus due to its flexibility and iterative approach. It allowed the proponents to do small and manageable increments along the development which helped in the continuous assessment. Its flexibility helped in accommodating changes which ensures that the system will meet the demands effectively.

**Fig. 7: Agile Model of ZiPlus: Digital File Compression as a Browser Extension Using Deflate Algorithm for Lyceum of the Philippines University – Cavite**

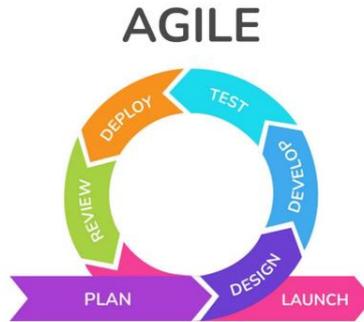


Figure 7 shows the project stages of development in the Agile Process model adapted from the article of Senna (2023).

**C. User Interface**

**Fig. 8. ZiPlus User Interface**



Figure 8 shows the user interface of the browser extension of ZiPlus once opened in any chromium-browser.

**III. RESULTS**

**A. Results of Testing**

**TABLE I: FUNCTIONAL TESTING FOR IT EXPERTS**

Test Case Scenario ID	Frequency	Pass	Fail
ZPDFC-UF	10	10	0
ZPDFC-BU	10	10	0
ZPDFC-IPC	10	10	0
ZPDFC-CP	10	10	0
ZPDFC-BCP	10	10	0
ZPDFC-DP	10	10	0
ZPDFC-BDP	10	10	0
ZPDFC-FF	10	10	0
Total	80	80	0
<b>Cumulative Percent</b>		<b>100%</b>	<b>0%</b>

Table 1 shows the result of functional testing for IT experts. A total of forty-five (45) participants were needed to gather enough data for this research. The thirty-five (35) participants shall consist of the subject matter (students), and ten (10) IT experts. The subject matter and IT experts will undergo an inclusion criterion to ensure the quality of feedback that will be acquired during the data gathering procedure. Convenience sampling techniques will be used to select the participants for this study. This method allows for the recruitment of participants who meet the inclusion criteria and are readily available and willing to participate in the study.

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**TABLE II: BROWSER COMPATIBILITY TEST FOR IT EXPERTS**

Test Case Scenario ID	Frequency	Pass	Fail
ZPDFC-GC	6	6	0
ZPDFC-OP	6	6	0
ZPDFC-ME	6	6	0
ZPDFC-BR	6	6	0
ZPDFC-VV	6	6	0
ZPDFC-CB	6	6	0
Total	36	36	0
<b>Cumulative Percent</b>		<b>100%</b>	<b>0%</b>

As shown in Table 2, all the test respondents, which are IT experts, gave ZiPlus a 100% rating for its functionality. All the test cases passed, it includes the single and multiple file upload, passphrase for encryption and decryption, single and multiple file compression, single and multiple file decompression, download, and its contact information.

### B. Results of Evaluation

**TABLE III: MEAN RESPONSE ON FUNCTIONAL SUITABILITY**

Indicators	Mean ( <i>x</i> )	Standard Deviation ( <i>sd</i> )	Verbal Interpretations ( <i>VI</i> )
Functional Completeness	3.51	0.51	Highly Acceptable
Functional Correctness	3.38	0.65	Acceptable
Functional Appropriateness	3.58	0.54	Highly Acceptable
<b>Grand Mean</b>	<b>3.49</b>	<b>0.56</b>	<b>Acceptable</b>

Table 3 shows the mean scores of the Functional Suitability of ZiPlus. There are three (3) indicators mentioned in this table such as Functional Completeness, Functional Correctness, and Functional Appropriateness. The following Verbal Interpretations (VI) apply to the mean interval: 4.00 – 3.50 for Highly Acceptable, 3.49 – 2.50 for Acceptable, 2.49 – 1.50 for Fairly Acceptable, and 1.49 – 1.00 for Poorly Acceptable. Using this VI, Functional Completeness was interpreted as “Highly Acceptable” with a mean of 3.51 and 0.51 for its standard deviation. Functional Correctness was interpreted as “Acceptable” with a mean of 3.38 and standard deviation 0.65. As for the Functional Appropriateness, it was interpreted as “Highly Acceptable” with a mean of 3.58 and standard deviation of 0.56. Overall, the grand mean on Functional Suitability is 3.49 for the mean 0.56 for the standard deviation, and lastly, its verbal interpretation is “Acceptable”.

**TABLE IV: MEAN RESPONSE ON PERFORMANCE EFFICIENCY**

<b>Indicators</b>	<b>Mean (x)</b>	<b>Standard Deviation (sd)</b>	<b>Verbal Interpretations (VI)</b>
Time Behavior	3.49	0.51	Acceptable
Resource Utilization	3.42	0.62	Acceptable
Capacity	3.42	0.58	Acceptable
<b>Grand Mean</b>	<b>3.44</b>	<b>0.57</b>	<b>Acceptable</b>

Table 4 shows the mean scores of Performance Efficiency of ZiPlus. There are three (3) indicators mentioned in this table such as Time Behavior, Resource Utilization, and Capacity. The following Verbal Interpretations (VI) apply to the mean interval: 4.00 – 3.50 for Highly Acceptable, 3.49 – 2.50 for Acceptable, 2.49 – 1.50 for Fairly Acceptable, and 1.49 – 1.00 for Poorly Acceptable. With all the indicators under Performance Efficiency, all of them were interpreted as “Acceptable”. The mean for Time Behavior is 3.49 and its standard deviation is 0.51. As for Resource Utilization it has a mean of 3.42 and 0.62 for its standard deviation. Lastly, for the Capacity, it has a mean of 3.42 and 0.58 for its standard deviation. Overall, the grand mean for the indicators under Performance Efficiency is 3.44 with a standard deviation of 0.57, whereas its Verbal Interpretation is “Accepted”.

**TABLE V: MEAN RESPONSE ON INTERACTION CAPABILITY**

<b>Indicators</b>	<b>Mean (x)</b>	<b>Standard Deviation (sd)</b>	<b>Verbal Interpretations (VI)</b>
Appropriateness Recognizability	3.49	0.55	Acceptable
Learnability	3.62	0.53	Highly Acceptable
Operability	3.62	0.61	Highly Acceptable
User Error Protection	3.44	0.66	Acceptable
User Engagement	3.47	0.55	Acceptable
Inclusivity	3.49	0.51	Acceptable
User Assistance	3.51	0.59	Highly Acceptable
Self-descriptiveness	3.33	0.64	Acceptable
<b>Grand Mean</b>	<b>3.50</b>	<b>0.58</b>	<b>Highly Acceptable</b>

Table 5 shows the mean scores of the Interaction Capability of ZiPlus. There are eight (8) indicators mentioned in this table such as Appropriateness Recognizability, Learnability, Operability, User Error Protection, User Engagement, Inclusivity, User Assistance, and Self-descriptiveness. The following Verbal Interpretations (VI) apply to the mean interval: 4.00 – 3.50 for Highly Acceptable, 3.49 – 2.50 for Acceptable, 2.49 – 1.50 for Fairly Acceptable, and 1.49 – 1.00 for Poorly Acceptable. Out of all the eight (8) indicators, five (5) of them were interpreted as “Acceptable”, those are Appropriateness Recognizability, User Error Protection, User Engagement, Inclusivity, and Self-descriptiveness. The remaining four (4) indicators were interpreted as “Highly Acceptable”. With all these interpretations, it has been analyzed that the grand mean for these indicators is 3.50, 0.58 for its standard deviation, and “Highly Acceptable” for its VI.

**TABLE VI: MEAN RESPONSE ON RELIABILITY**

<b>Indicators</b>	<b>Mean (x)</b>	<b>Standard Deviation (sd)</b>	<b>Verbal Interpretations (VI)</b>
Faultlessness	3.36	0.57	Acceptable
Availability	3.49	0.55	Acceptable
<b>Grand Mean</b>	<b>3.43</b>	<b>0.56</b>	<b>Acceptable</b>

Table 6 shows the mean scores of the Reliability of ZiPlus. There are two (2) indicators mentioned in this table such as Faultlessness and Availability. The following Verbal Interpretations (VI) apply to the mean interval: 4.00 – 3.50 for Highly

Acceptable, 3.49 – 2.50 for Acceptable, 2.49 – 1.50 for Fairly Acceptable, and 1.49 – 1.00 for Poorly Acceptable. Both indicators were interpreted as “Acceptable”. Faultlessness has a mean of 3.36 and standard deviation of 0.57. As for Availability, it has a mean of 3.43 and standard deviation of 0.56. Overall, the grand mean for these two (2) indicators is 3.43, 0.56 for its standard deviation, and interpreted as “Acceptable”.

**TABLE VII: MEAN RESPONSE ON SECURITY**

Indicators	Mean (x)	Standard Deviation (sd)	Verbal Interpretations (VI)
Confidentiality	3.47	0.66	Acceptable
<b>Grand Mean</b>	<b>3.47</b>	<b>0.66</b>	<b>Acceptable</b>

Table 7 shows the mean scores of the Security of ZiPlus. There is only one indicator mentioned in this table which is Confidentiality. The following Verbal Interpretations (VI) apply to the mean interval: 4.00 – 3.50 for Highly Acceptable, 3.49 – 2.50 for Acceptable, 2.49 – 1.50 for Fairly Acceptable, and 1.49 – 1.00 for Poorly Acceptable. Both indicators were interpreted as “Acceptable”. Confidentiality has a mean of 3.47, standard deviation of 0.66, interpreted as “Acceptable”.

**TABLE VIII: MEAN RESPONSE ON MAINTAINABILITY**

Indicators	Mean (x)	Standard Deviation (sd)	Verbal Interpretations (VI)
Modularity	3.36	0.57	Acceptable
Analyzability	3.49	0.55	Acceptable
Modifiability	3.38	0.58	Acceptable
Testability	3.51	0.55	Highly Acceptable
<b>Grand Mean</b>	<b>3.44</b>	<b>0.56</b>	<b>Acceptable</b>

Table 8 shows the mean scores of the Maintainability of ZiPlus. There are four (4) indicators mentioned in this table such as Modularity, Analyzability, Modifiability, and Testability. The following Verbal Interpretations (VI) apply to the mean interval: 4.00 – 3.50 for Highly Acceptable, 3.49 – 2.50 for Acceptable, 2.49 – 1.50 for Fairly Acceptable, and 1.49 – 1.00 for Poorly Acceptable. Both indicators were interpreted as “Acceptable”. Faultlessness has a mean of 3.36 and standard deviation of 0.57. As for Availability, it has a mean of 3.43 and standard deviation of 0.56. Overall, the grand mean for these two (2) indicators is 3.43, 0.56 for its standard deviation, and interpreted as “Acceptable”. With these four (4) indicators, only Testability had a Verbal Interpretation of “Highly Acceptable”. The other three (3) indicators were interpreted as “Acceptable”. Modularity has a mean of 3.36 and 0.57 for its standard deviation. As for Analyzability, it has 3.49 as its mean and 0.55 for its standard deviation. In addition, Modifiability garnered 3.38 for its mean and a standard deviation of .058. Lastly, Testability has a mean of 3.51 and a standard deviation of 0.55. Overall, it has a grand mean of 3.44 and 0.56 for its standard deviation. Its grand mean for VI is also “Acceptable”.

**TABLE IX: MEAN RESPONSE ON FLEXIBILITY**

Indicators	Mean (x)	Standard Deviation (sd)	Verbal Interpretations (VI)
Adaptability	3.47	0.55	Acceptable
Scalability	3.33	0.60	Acceptable
Installability	3.53	0.63	Highly Acceptable
<b>Grand Mean</b>	<b>3.44</b>	<b>0.59</b>	<b>Acceptable</b>

Table 9 shows the mean scores of the Flexibility of ZiPlus. There are three (3) indicators mentioned in this table such as Adaptability, Scalability, and Installability. The following Verbal Interpretations (VI) apply to the mean interval: 4.00 – 3.50 for Highly Acceptable, 3.49 – 2.50 for Acceptable, 2.49 – 1.50 for Fairly Acceptable, and 1.49 – 1.00 for Poorly

Acceptable. Among the three (3) indicators, only one (1) of them was interpreted as “Highly Acceptable” which is the Installability. It has a mean of 3.53 and standard deviation of 0.63. Both Adaptability and Scalability were interpreted as “Acceptable”. Adaptability has a mean of 3.47 and a standard deviation of 0.55. As for Scalability, it has a mean of 3.33 and a standard deviation of 0.60. Overall, the grand mean for these indicators is 3.44 and 0.59 for the standard deviation. Its grand mean for VI is “Acceptable”.

**TABLE X: EVALUATION RESULT OF ZIPLUS**

<b>Criteria</b>	<b>Mean (x)</b>	<b>Verbal Interpretations (VI)</b>	<b>Rank</b>
Functional Suitability	3.49	<i>Acceptable</i>	2
Performance Efficiency	3.44	<i>Acceptable</i>	4
Interaction Capability	3.50	<i>Highly Acceptable</i>	1
Reliability	3.43	<i>Acceptable</i>	7
Security	3.47	<i>Acceptable</i>	3
Maintainability	3.44	<i>Acceptable</i>	5
Flexibility	3.44	<i>Acceptable</i>	6
<b>Grand Mean</b>	<b>3.46</b>	<b><i>Acceptable</i></b>	

Table 10 demonstrates the quality characteristics based on ISO/IEC 25010 software standard. It includes Functional Suitability, Performance Efficiency, Interaction Capability, Reliability, Security, Maintainability, and Flexibility. Out of all seven (7) quality characteristics, Interaction Capability was ranked first while Reliability was ranked as last. The rest of the characteristics were interpreted as “Acceptable”. Overall, the interpreted data for the evaluation result of ZiPlus is “Acceptable” with a mean average of 3.46.

#### IV. CONCLUSION

The researchers of ZiPlus with the objectives of developing a digital file compression using Deflate algorithm was met and properly developed the way it was expected to be.

According to the results of the functionality testing done by ten (10) IT experts, the components of the system were proved to be functional. It has 100% passing rate for all the test cases for functionality of ZiPlus. Aside from functionality, there were also test cases for the compatibility of ZiPlus. When it comes to browsers, ZiPlus will have a 100% passing rate, however if it includes the compatibility of ZiPlus with Chrome Web Store, it will have 85.71% passing rate because there are only seven (7) test cases under compatibility. Nonetheless, the compatibility of ZiPlus with Chromium-based browsers is working perfectly.

In Figure 12, it can be seen that the overall evaluation results of thirty-five (35) subject matter (students) and ten (10) IT experts had a mean average of “Acceptable”. This evaluation is based on the ISO/IEC 25010 software standard.

As for ZiPlus itself, ZiPlus is a browser extension; it means that it can be added to a web browser to extend its functionality. Aside from that, this browser can also be used in offline mode. Moreover, users are able to do batch upload, compression, and decompression, and put a passphrase on the files for additional security. Not only that, ZiPlus also accepts various file types which includes images, videos, documents, etc.

ZiPlus was developed using Microsoft Visual Studio Code with JavaScript as the programming language. Deflate algorithm was applied for the compression and decompression functions and AES for additional security of the encrypted files. Secondly, the effectiveness of file compression in terms of speed and security were also evaluated which resulted to an “Acceptable” interpretation in both aspects. Thirdly, ZiPlus has been evaluated for its compatibility with Chromium-based browsers which includes Google Chrome, Opera, Microsoft Edge, Brave, and Vivaldi. Fourthly, the functionality of ZiPlus has been evaluated by both subject matter and IT experts. The results showed satisfactory results as the system demonstrated a proficient performance when it comes to the functionalities of the system. Lastly, the acceptability of ZiPlus based on ISO/IEC 25010 software standards which covers Functional Suitability, Performance Efficiency, Interaction Capability,

Usability, Reliability, Security, Maintainability, and Flexibility, all of which have been met with the most interpretation of “Acceptable” as its mean response. The researchers therefore conclude that the users are interested in using ZiPlus for its functional suitability. It was deemed efficient and convenient for the students as they can easily use ZiPlus by simply installing it as their browser extension.

#### **A. Figures, Graphs and Tables**

Figures, graphs and tables should be inside the margins of page. Figure caption is placed below the figures and written as Fig. 1. Similarly, Table caption is placed above the Tables and written as TABLE I. Do not use to put figure inside the border. Figures, Graph and Tables captions are flush centre and labels should be legible, 8 to 9 point. Fig. 1, is used for referring figure in the text body. Similarly, Tables and Graphs are used for referring table and graph in the text body. First figure starts from Fig. 1 and last figure ends with Fig. N (N is last figure of research paper).

#### **B. Conclusion Acknowledgement and Appendix**

Conclusion section is mandatory and contains advantages, disadvantages, review the main part of research paper and use of research work. If author want to acknowledge someone, then acknowledgement section should include in research paper after conclusion. Appendix section (if required) appears before acknowledgement section.

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