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Analysis of the Rivest Shamir Aldeman (RSA) Algorithm in Securing Text File Data

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***Abstract*—** Text is also found in several files on the computer, such as Microsoft Word. The text in the file on the computer does not have confidentiality in its data contents, so that when someone steals the file data, they can find out the contents of the data and can be used for personal gain, for example, file data related to customer data or company assets. A common problem is the theft of information from files containing text so that the thief can use the contents of the file in the form of text data for his personal gain. Therefore, a technique is needed to secure text data so that when a file containing important text is stolen, it does not harm the file owner. In this study, researchers conducted an analysis related to the Rivest Shamir Adleman (RSA) Algorithm in securing text data. Analysis is the process of investigating or examining an event to find out the actual situation. The difference with previous research is that this study encrypts and decrypts all files containing text. With the analysis of the Rivest Shamir Aldeman (RSA) Algorithm in securing text data, researchers know the use of the RSA algorithm in securing text data.

Keywords: Analysis, RSA, Securing, Text, File, Data

I. INTRODUCTION

Text is a form of written communication consisting of a series of words, sentences, and paragraphs that are systematically arranged to convey certain information, ideas, or messages. Text can be found in various forms, such as articles, stories, reports, or even short messages. Each text has a different structure and purpose, depending on the context of its use. For example, narrative text aims to tell an event, while expository text aims to explain or provide information. By understanding the text, readers can grasp the meaning and intent that the author wants to convey. Text is also found in several files on the computer, such as Microsoft Word. The text in the file on the computer does not have confidentiality in its data contents, so that when someone steals the file data, they can find out the contents of the data and can be used for personal gain, for example, file data related to customer data or company assets. A common problem is the theft of information from files containing text so that the thief can use the contents of the file in the form of text data for his personal gain. Therefore, a technique is needed to secure text data so that when a file containing important text is stolen, it does not harm the file owner.

In computer science, there are several techniques that can keep text data secret, including cryptography. Cryptography was originally described as the science of how to hide messages. However, in the modern sense, cryptography is a science that relies on mathematical techniques to deal with information security such as confidentiality, data integrity and entity authentication. So the modern understanding of cryptography is not only dealing with hiding information security. (Niko, 2024). Therefore, this study uses cryptography to secure text data. However, the use of cryptography requires the right algorithm so that its security is better.

Research conducted by Susanto (2023) on Text Message Security With Encryption and Decryption Methods Using the RSA Algorithm (Rivest Shamir Adleman), concluded that cryptography, especially in the world of computing, will always be related to mathematical theories so that if you want to master cryptography, you must first study mathematical techniques related to aspects of information security. Research conducted by Sinaga & Nurhayati (2023) on the Implementation of Cryptography Applications with the RSA Method on Text Security, concluded that the system built is a data security system, which has an impact on securing information in the form of text data. In this case, text data security is achieved by using the RSA method as the encryption and decryption process.

From several previous studies that have successfully used the RSA algorithm for various text security, researchers also use the RSA algorithm to secure text data so that they have references based on previous research. The Rivest Shamir Adleman (RSA) algorithm is one of the popular public key algorithms used and even today the RSA algorithm is still considered safe is an extension of the Caesar cipher, which extracts plaintext with a value and adds it with a shift. In this study, researchers conducted an analysis related to the Rivest Shamir Adleman (RSA) Algorithm in securing text data. Analysis is the process of investigating or examining an event to find out the actual situation. The difference with previous research is that this study encrypts and decrypts all files containing text. With the analysis of the Rivest Shamir Aldeman (RSA) Algorithm in securing text data, researchers know the use of the RSA algorithm in securing text data.

II. LITERATURE REVIEW

Analysis

Analysis is the process of investigating or examining an event to find out the actual situation. The goal is to identify relationships, patterns, or principles underlying a phenomenon, so that appropriate conclusions or solutions can be drawn. Analysis often involves the use of certain methods, tools, or approaches, depending on the field being studied, such as statistics in scientific research, or a critical approach in literary studies. In practice, analysis is not just about breaking down information, but also includes interpreting and synthesizing data to produce a deeper understanding. For example, in economics, analysis is used to study market trends and make predictions based on historical data. Meanwhile, in literature, text analysis can reveal hidden meanings or messages that the author wants to convey. Thus, analysis is an important step in the process of critical thinking and decision-making, because it helps us understand the complexity of a problem and find effective solutions based on evidence and logic. [1]

Analysis is a method or approach used to study, research, and understand something in depth by separating it into smaller parts. This is done so that each aspect or component that forms the whole can be studied separately, so that the underlying relationships, patterns, or principles can be revealed. The analysis process not only focuses on collecting data or facts, but also involves interpreting and evaluating the information to produce a more comprehensive understanding. In various fields, such as science, business, or art, analysis is an important tool for solving problems, making decisions, or developing theories. In addition, analysis also plays a role as a foundation in the development of knowledge and innovation. For example, in the field of technology, data analysis is used to Identify trends and patterns that can drive the development of new products. Meanwhile, in the social field, analysis helps understand the dynamics of society or human behavior through a systematic approach. By conducting analysis, we are not only able to see the big picture of a problem, but can also dive into details that might be missed. Therefore, analysis is a very valuable skill in facing the complex and diverse challenges of this modern era.[2][3]

Cryptography

Cryptography was originally described as the science of how to hide messages. However, in the modern sense, cryptography is a science that relies on mathematical techniques to deal with information security such as confidentiality, data integrity and entity authentication. So the modern understanding of cryptography Is not only dealing with hiding information security.

Rivest Shamir Adleman (RSA) Algorithm

The Rivest Shamir Adleman (RSA) Algorithm is one of the popular public key algorithms used and even today the RSA algorithm is still considered safe is an extension of the caesar cipher, which digs the plaintext with a value and adds it with a shift.

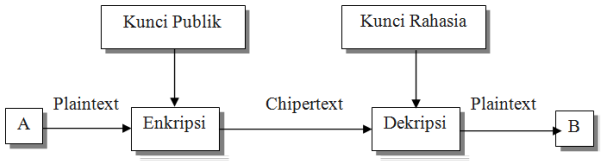

Figure 1. RSA Key Algorithm Scheme

Here is the key formation process of the RSA algorithm:

1. Choose different prime numbers p and q
2. Calculate the value of n = p*q, which is the public value of the modulus
3. Calculate the totient, φ(n)= (p-1)(q-1)
4. Choose an integer e, where 1<e< φ(n) and

e = 2

While 0n mod e ≠ 0

e = e + 1

End While

1. Hitung d, dimana $d = e^{-1} \bmod \varphi(n)$ atau

$U_1 = 1$

$U_2 = 0$

$U_3 = 0n$ –

$V_1 = 0$

$V_2 = 1$

$V_3 = e$

While $V_3 = 0$

$Q = Int(U_3 / V_3)$

$N_1 = U_1 – (Q \times V_1)$

$N_2 = U_2 – (Q \times V_2)$

$N_3 = U_3 – (Q \times V_3)$

$U_1 = V_1$

$U_2 = V_2$

$U_3 = V_3$

$V_1 = N_1$

$V_2 = N_2$

$V_3 = N_3$

End While

The public key is e,n and the private key is d,n

The encryption process is the process of encoding a message so that the original message (plaintext) is difficult to read or cannot be understood. The following is the encryption process using the RSA algorithm:

Ci = Pie mod n

Description:

Ci = Encrypted ciphertext

Pi = Plaintext to be encrypted

e = Exponential function

mod = Remainder / Modulus

n = Result of multiplying two prime numbers

The decryption process is the process of returning the ciphertext to the original message, so that the message can be read and understood. [4][5][6]. The following is the decryption process using the RSA algorithm:

Pi = Ci – Ki

Description:

P = Plaintext from the reduction

C = Ciphertext to be decrypted

K = Key used for encryption

I = Repetition according to the length of the message.

Securing

Securing is a verb in Indonesian which means taking action or effort to protect, maintain, or ensure the security of something. [7]. This action can include preventing threats, damage, loss, or disruption to an object, person, or situation.
Examples of use:

1. Securing important documents means storing the documents in a safe place so that they are not lost or accessed by unauthorized parties.
2. Securing the location of the incident means taking action to keep the location from being disturbed or damaged, for example by the police or security officers.
3. Securing investment means taking steps to ensure that the investment is safe from the risk of loss. [8].

Information security is one of the important issues, along with the development of software and internet users. Computer security is related to preventing theft of data or information from irresponsible people, both accessing and modifying information. Computer security functions to protect information from being accessed by unauthorized people. There are many methods that can be used in computer security, one of which is using cryptography. [9].

Data

Data is a collection of facts, figures, or raw information collected through observation, measurement, or recording. Data can be in the form of text, numbers, images, sounds, or other forms that have not been processed or analyzed. Data itself does not have a specific meaning or context until it is processed or interpreted to produce useful information. [10]
According to the Big Indonesian Dictionary, the definition of data is true and real information that can be used as a basis for study. While Personal itself means humans as individuals (human self or self), so it can be concluded that personal data is true and real information owned by humans as individuals. [11]

Text

The term text actually comes from the word text which means "weaving". Text in philology is defined as "weaving of words", namely a series of words that interact to form a complete unity of meaning. From the definition above, it is interpreted that text is a unit of language that has content and form, both oral and written, which is conveyed by the sender to the recipient to convey a certain message. [12][13]

III. METHOD

A. Key Formation

1. Determine two prime numbers
   Determine two large prime numbers provided that the two prime numbers cannot be the same.
   P1 = 31
   P2 = 37
2. Finding the value of n
   In finding the value of n, use the following formula:
   n = P1 x P2
   = 31 x 37
   = 1147
3. Finding the value of 0n (Theta n)
   In finding the value of 0n, use the following formula:
   0n = (P1 – 1) x (P2 – 1)
   0n = (31 – 1) x (37 – 1)
   0n = 30 x 36
   0n = 1080
4. Finding the value of e
   In determining the value of e, use the following algorithm:
   e = 2
   While 0n mod e ≠ 0
   e = e + 1
   End While
   Meaning:
   Until 0n mod e ≠ 0, do e = e + 1. The process stops when the value of 0n divided by the value of e has a remainder that is not equal to the value of 0, then the value of e will be obtained.
   e = 3
   First Iteration:
   0n mod e = 1080 mod 3
   = 0
   e = 3 + 1
   e = 4
   Second Iteration:
   0n mod e = 1080 mod 4
   = 0
   e = 4 + 1
   e = 5
   Third Iteration:
   0n mod e = 1080 mod 5
   = 0
   e = 5 + 1
   e = 6
   Fourth Iteration:
   0n mod e = 1080 mod 6
   = 0
   e = 6 + 1
   e = 7

   Fifth Iteration:
   0n mod e = 1080 mod 7
   = 2
   The process stops at the fifth iteration, then the value e = 7 is obtained.
5. Find the value of d
   In finding the value of d, the extended Euclid theorem can be used as follows:
   U1 = 1
   U2 = 0
   U3 = 0n
   V1 = 0
   V2 = 1
   V3 = e
   While V3 = 0
   Q = Int(U3 /V3)
   N1 = U1 – (Q x V1)
   N2 = U2 – (Q x V2)
   N3 = U3 – (Q x V3)
   U1 = V1
   U2 = V2
   U3 = V3

V1 = N1
V2 = N2
V3 = N3
End While

Meaning:

Until V3 = 0, do the extended euclid theorem. The process stops when the value of V3 is equal to the value of 0, then the value of d will be obtained.

U1 = 1
U2 = 0
U3 = 0n
V1 = 0
V2 = 1
V3 = e

First Iteration:

Q = Int(U3 /V3)
= Int(1080 /7)
= 154
N1 = U1 – (Q x V1)
= 1 – (154 x 0)
= 1
N2 = U2 – (Q x V2)
= 0 – (154 x 1)
= -154
N3 = U3 – (Q x V3)
= 1080 – (154 x 7)
= 1080 – 1078
= 2
U1 = 0
U2 = 1
U3 = 7
V1 = 1
V2 = -154
V3 = 2

Second Iteration:

Q = Int(U3 /V3)
= Int(7 /2)
= 3
N1 = U1 – (Q x V1)
= 0 – (3 x 1)
= -3
N2 = U2 – (Q x V2)
= 1 – (3 x -154)
= 463
N3 = U3 – (Q x V3)
= 7 – (3 x 2)
= 7 – 6
= 1
U1 = 1
U2 = -154
U3 = 2
V1 = -3
V2 = 463
V3 = 1

Third Iteration:

Q = Int(U3 /V3)
= Int(2 /1)
= 2
N1 = U1 – (Q x V1)
= 1 – (2 x -3)
= 7
N2 = U2 – (Q x V2)
= -154 – (2 x 463)
= -154 – 926
= - 1080
N3 = U3 – (Q x V3)
= 2 – (2 x 1)
= 2 – 2
= 0
U1 = -3
U2 = 463
U3 = 1
V1 = 7
V2 = -1080
V3 = 0

The process stops when V3 = 0, then the value of d = 463 has been obtained.

Then the private key for encryption has been obtained as follows:

e = 7
n = 1147

And the public key for decryption has been obtained as follows:

d = 463
n = 1147

B. Plaintext Encryption

The encryption process is the process of encoding a message so that the original message (plaintext) is difficult to read or cannot be understood. The following is the encryption process using the RSA algorithm:

Example of the Encryption Process:

Plaintext: Universitas Potensi Utama

1. U (ASCII = 85):
   857 = 85×85×85×85×85×85×85
   = 4434264882430374364
   = 4434264882430374364 mod 1147
   = 248 = ø
2. n (ASCII = 110):
   1107 = 110×110×110×110×110×110×110
   = 194871710000000000
   = 194871710000000000 mod 1147
   = 680 = Ƨ
3. I (ASCII = 105):
   1057 = 105×105×105×105×105×105×105
   = 553614619953125
   = 553614619953125 mod 1147
   = 784 = ɐ
4. v (ASCII = 118):
   1187 = 118×118×118×118×118×118×118
   = 2914693402233152
   = 2914693402233152 mod 1147
   = 871 = ϖ
5. e (ASCII = 101):
   1017 = 101×101×101×101×101×101×101
   = 1038582660110601
   = 1038582660110601 mod 1147
   = 408 = ɔ
6. r(ASCII=114):
   1147 = 114×114×114×114×114×114×114
   = 3101301274841308
   = 3101301274841308 mod 1147

= 1010 = ŋ

7. s (ASCII = 115):
1157 = 115×115×115×115×115×115×115
= 613106625078125
= 613106625078125 mod 1147
= 986 = ƙ

8. I (ASCII = 105):
1057 = 105×105×105×105×105×105×105
= 553614619953125
= 553614619953125 mod 1147
= 784 = ɐ

9.t(ASCII=116):
1167 = 116×116×116×116×116×116×116
= 4093457812453896
= 4093457812453896 mod 1147
= 754 = ″

10. a (ASCII = 97):
977 = 97×97×97×97×97×97×97
= 813067000221
= 813067000221 mod 1147
= 777 = ʻ

11. s (ASCII = 115):
1157 = 115×115×115×115×115×115×115
= 613106625078125
= 613106625078125 mod 1147
= 986 = ƙ

12. (space) (ASCII = 32):
327 = 32×32×32×32×32×32×32
= 3513430528
= 3513430528 mod 1147
= 789 = ʾ

13. P(ASCII=80):
807 = 80×80×80×80×80×80×80
= 209715200000
= 209715200000 mod 1147
= 12 = _

14. o (ASCII = 111):
1117 = 111×111×111×111×111×111×111
= 1214016430490001
= 1214016430490001 mod 1147
= 1014 = ŋ

15. t (ASCII = 116):
1167 = 116×116×116×116×116×116×116
= 4093457812453896
= 4093457812453896 mod 1147
= 754 = ″

16. e (ASCII = 101):
1017 = 101×101×101×101×101×101×101
= 1038582660110601
= 1038582660110601 mod 1147
= 408 = ɘ

17. n (ASCII = 110):
1107 = 110×110×110×110×110×110×110
= 194871710000000000
= 194871710000000000 mod 1147
= 680 = Ƚ

18. s (ASCII = 115):
1157 = 115×115×115×115×115×115×115
= 613106625078125
= 613106625078125 mod 1147
= 986 = ƙ

19. I (ASCII = 105):
1057 = 105×105×105×105×105×105×105
= 553614619953125
= 553614619953125 mod 1147
= 784 = ɐ

20. (space) (ASCII = 32):
327 = 32×32×32×32×32×32×32
= 3513430528
= 3513430528 mod 1147
= 789 = ʾ

21. U (ASCII = 85):
857 = 85×85×85×85×85×85×85
= 4434264882430374364
= 4434264882430374364 mod 1147
= 248 = ø

22. t (ASCII = 116):
1167 = 116×116×116×116×116×116×116
= 4093457812453896
= 4093457812453896 mod 1147
= 754 = ″

23. a (ASCII = 97):
977 = 97×97×97×97×97×97×97
= 813067000221
= 813067000221 mod 1147
= 777 = ʻ

24. m (ASCII = 109):
1097 = 109×109×109×109×109×109×109
= 3111338017027585
= 3111338017027585 mod 1147
= 191 = ¿

25. a (ASCII = 97):
977 = 97×97×97×97×97×97×97
= 813067000221
= 813067000221 mod 1147
= 777 = ʻ

Ciphertext: øɬɐɷɘŋƙɐ″ʻƙ ʾŋ″ɘɬƙɐ ʾø″ʻ¿ʻ

C. Method Description RSA

The following is a decryption of the RSA method, the decryption of the RSA method is an exponential function in modular n using the following private key:

Pi = Cid mod n
Description:
Pi = Plaintext of the decryption result
Ci = Ciphertext to be decrypted
d = Exponential function of the public key
mod = Remainder / Modulus
n = Multiplication function of two prime numbers
Receive the key:
d = 463
n = 1147
2) Decrypt Ciphertext
Ciphertext: øɬɐɷɘŋƙɐ″ʻƙ ʾŋ″ɘɬƙɐ ʾø″ʻ¿ʻ

1. ø (ASCII = 248):
= 248463 mod 1147
= 85
= U
2. Ƚ (ASCII = 680):
= 680463 mod 1147
= 110
= n

3. ɐ (ASCII = 784):
= 784463 mod 1147
= 105
= i
4. ɷ (ASCII = 871):
= 871463 mod 1147
= 118
= v
5. ɘ (ASCII = 408):
= 408463 mod 1147
= 101
= e
6. ŋ (ASCII = 1010):
= 1010463 mod 1147
= 114
= r
7. ʜ (ASCII = 986):
= 986463 mod 1147
= 115
= s
8. ɐ (ASCII = 784):
= 784463 mods 1147
= 105
= i
9. ″ (ASCII = 754):
= 754463 mod 1147
= 116
= t
10. ʿ (ASCII = 777):
= 777463 mod 1147
= 97
= a
11. ʜ (ASCII = 986):
= 986463 mod 1147
= 115
= s
12. ʾ (ASCII = 789):
= 789463 mod 1147
= 32
= (space)
13. _ (ASCII = 12):
= 12463 mod 1147
= 80
= P
14. ŋ (ASCII = 1014):
= 1014463 mod 1147
= 111
= o

15. ″ (ASCII = 754):
= 754463 mod 1147
= 116
= t
16. ɘ (ASCII = 408):
= 408463 mod 1147
= 101
= e
17. ɟ (ASCII = 680):
= 680463 mod 1147
= 110
= n
18. ʜ (ASCII = 986):
= 986463 mod 1147
= 115
= s
19. ɐ (ASCII = 784):
= 784463 mod 1147
= 105
= i
20. ʾ (ASCII = 789):
= 789463 mod 1147
= 32
= (space)
21. ø (ASCII = 248):
= 248463 mod 1147
= 85
= U
22. ″ (ASCII = 754):
= 754463 mod 1147
= 116
= t
23. ʿ (ASCII = 777):
= 777463 mod 1147
= 97
= a
24. ¿ (ASCII = 191):
= 191463 mod 1147
= 109
= m
25. ʿ (ASCII = 777):
= 777463 mod 1147
= 97
= a

Plaintext: Universitas Potensi Utama

IV. Result And Discussion

Analysis of Rivest Shamir Aldeman (RSA) Algorithm in Securing Text Data is made using Visual Studio, starting with designing the application, implementing the method calculation and implementing the actual components into Visual Studio so that the application can be completed according to the design. Here are some of the views produced from the creation of the application that has been done:

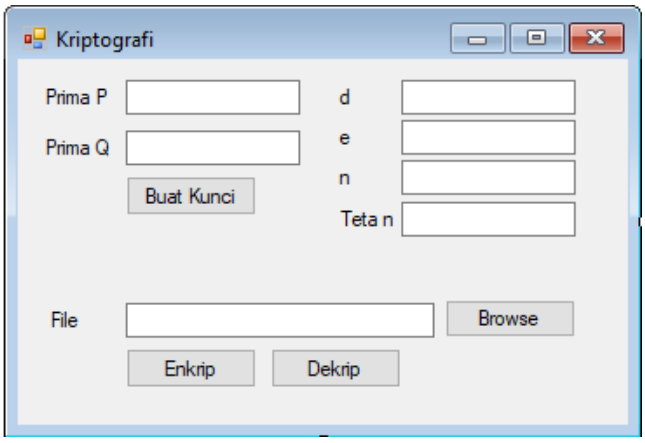

Figure 1. Cryptographic Form Display

Figure 1 is a cryptographic form, to be able to use it, you must first form a key by entering a prime number as in Figure 2.

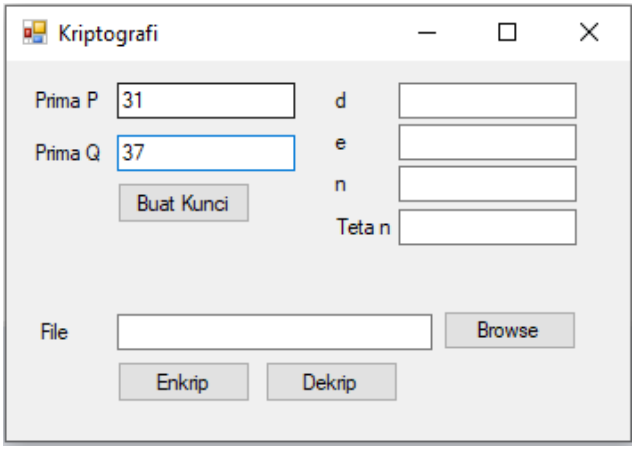

Figure 2. Prime Number Input Display

Figure 2 is the result of entering a prime number, then pressing the Create Key button and it appears as in Figure 3.

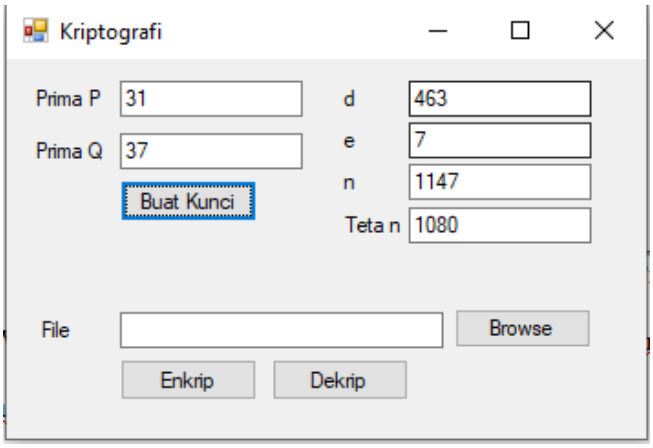

Figure 3. File Browser View

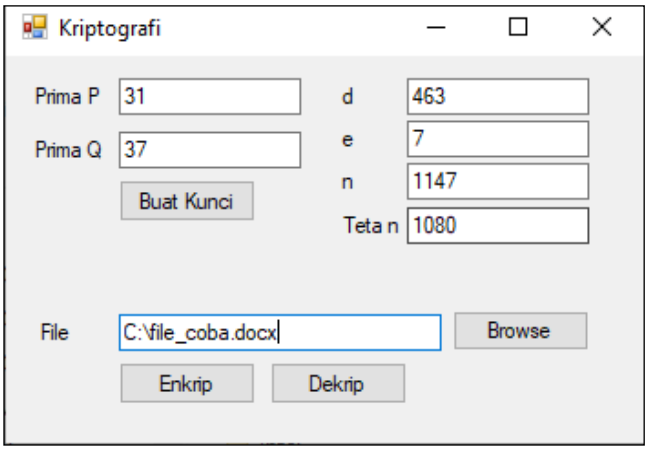

Figure 4. File Browser Results

Figure 4 is the file browser display, to keep the contents secret, the user only needs to press the encrypt button as in Figure 5.

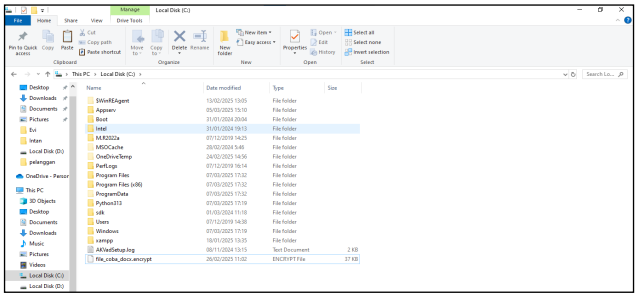

Figure 5. Encryption Result View

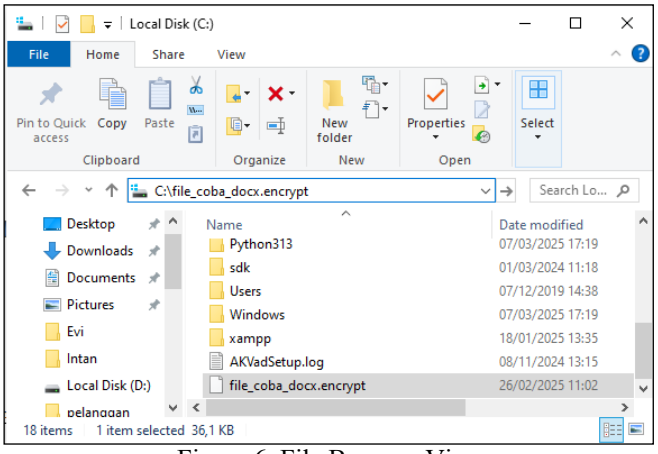

Figure 6. File Browser View

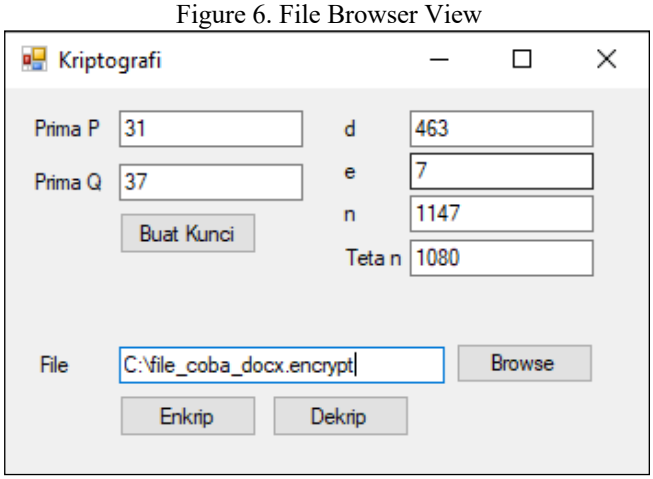

Figure 7. File Browser Results

Figure 7 is the result of browsing the file, to decrypt it, just click the decrypt button and the application will return the contents of the file.

V. CONCLUSION

Conclusion

Based on the discussion of the previous chapters that have been done, several conclusions can be drawn as follows:

1. By using the Rivest Shamir Aldeman (RSA) Algorithm application in Securing Text Data, it can analyze the Rivest Shamir Aldeman (RSA) Algorithm in securing text file data.

2. By using a text file, the message and key to be input, then the message and key are converted into ascii so that they can be processed using RSA into a secret message (ciphertext), then the Rivest Shamir Aldeman (RSA) Algorithm can be applied to text file data for security

3. By using visual studio programming, you can create an application that can secure text file data using the Rivest Shamir Aldeman (RSA) Algorithm.

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