

## Implementasi Algoritma Vernam Cipher Untuk Keamanan Data Nilai Siswa Studi Kasus SMK Swasta Rahmat Islamiyah Medan

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### ABSTRACT

Student score data at SMK Swasta Rahmat Islamiyah Medan must be protected to prevent unauthorized access, modification, or data loss. To ensure confidentiality and data integrity, this research implements the Vernam Cipher encryption algorithm, which uses a one-time pad key and XOR operations to secure data. The algorithm provides strong protection when the key is used only once and kept confidential. By applying Vernam Cipher to the student score data process, all stored or transmitted information becomes unreadable without the correct key. This method helps reduce the risk of data leakage and manipulation. The results show that Vernam Cipher is effective in enhancing the security of student score data, ensuring a fair and reliable assessment process.



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### INTRODUCTION

SMK Rahmat Islamiyah is a private vocational high school located at Jl. Gaperta Ujung/Bakti No. 25, Medan City. The school has been operating since 1996 and currently implements the 2013 Revised Vocational Curriculum in accordance with government guidelines. The school is led by Principal Mhd. Hammim and supported by a school operator, Siti Mardiani [1]. SMK Swasta Rahmat Islamiyah Medan offers several study programs, including Light Vehicle Engineering, Motorcycle Engineering, Computer and Network Engineering, and Office Administration [2].

Student score data at SMK Swasta Rahmat Islamiyah Medan contains important and confidential information related to academic performance, evaluation, and student graduation. This data must be protected from unauthorized access, modification, or deletion. If the security of student score data is compromised, it may lead to serious consequences such as loss of parental trust, damage to the school's reputation, and unfair assessment results.

To maintain the confidentiality and authenticity of score data, a reliable security method is required to ensure that only authorized parties can access or modify the information. One method that can be applied is cryptography, specifically the Vernam Cipher algorithm.

Vernam Cipher uses a random key (one-time pad) that is the same length as the original message and is theoretically capable of providing perfect security when the key is used only once and kept confidential. This algorithm performs encryption by applying the XOR (exclusive OR) operation between each bit of the plaintext and the key [3].

In the context of securing student score data, Vernam Cipher ensures that every stored or transmitted data is encrypted, making it unreadable without the correct key. This helps minimize the risk of data leakage or manipulation and supports a fair, accurate assessment process in SMK Swasta Rahmat Islamiyah Medan.

Previous studies by Febrian and Ade Hastuty (2023), Yanuar Chris Milian and Wiwin Sulisty (2023), as well as Janter Manuel Gultom et al. (2022), have demonstrated that Vernam Cipher is effective in securing various types of data, including documents and files transmitted over networks. These studies support the implementation of Vernam Cipher in this research. [4][5][6].

Based on the success of previous studies and the need to protect confidential academic information, the researcher chose to apply Vernam Cipher for securing student score data at SMK Swasta Rahmat Islamiyah Medan.

## METHODS

The working steps used in this study are:

### 1. Needs Analysis

In this stage, the researcher conducts a needs analysis related to the student score data used in the study.

### 2. Design

In this stage, the design model used is based on theoretical calculations, which are then implemented into program code.

### 3. Program Code

is developed using web-based programming with HTML, PHP, JavaScript, and MySQL.

### 4. Testing

The testing process is carried out using two methods: black-box testing and practical testing. If errors are found in the application, the research process requires a review and revision.

### 5. Result

The final result of this research is the implementation of the Vernam Cipher Algorithm for securing student score data in the case study of SMK Swasta Rahmat Islamiyah Medan.

## Implementation

Implementation refers to the actions carried out by individuals, officials, or groups – either from the government or the private sector – directed toward achieving the objectives outlined in a policy decision [7][8]. In principle, implementation is the execution or action taken based on a plan that has been carefully prepared [9].

## Vernam Cipher Algorithm

The Vernam Cipher algorithm is a symmetric cryptographic method that encrypts data by performing a logical XOR (exclusive OR) operation between each bit of the plaintext and the key [3].

The main characteristics of the Vernam Cipher are as follows:

1. **The key length must be equal to the message length** – this enables the algorithm to function as a perfect cipher when the key is truly random and used only once (one-time pad).
2. **The encryption and decryption processes are identical** – both are performed simply by applying the XOR operation between the data and the key.

3. **Very high security** – when the one-time pad conditions are met (random key, equal length, never reused, and kept secret), the cipher is theoretically impossible to break.

**Vernam Cipher formulas:****Encryption:**  $C = P \text{ XOR } K$ **Decryption:**  $P = C \text{ XOR } K$ **Explanation:**

P = Plaintext (original data)

C = Ciphertext (encrypted data)

K = Key

**Simple example:**

Plaintext: HELLO

Key: XMCKL

Process: Convert letters to ASCII → convert to binary → apply XOR → produce ciphertext.

**Security**

Data security is an essential process to ensure that stored data remains protected and its availability is maintained [10]. In general, security consists of three main aspects, known as the CIA Triad:

1. **Confidentiality** – ensuring that information can only be accessed by authorized parties.
2. **Integrity** – maintaining the accuracy and completeness of data, ensuring it is not altered without permission.
3. **Availability** – ensuring that information and resources are accessible when needed by authorized users [11].

**Data**

Data is the result of recordings made by a researcher, whether in the form of words or numbers. Another definition states that data refers to all measurement or observation results that have been recorded for a specific purpose [12]. According to the Indonesian Dictionary (KBBI), data is defined as accurate and factual information that can be used as a basis for analysis [8].

**Value**

In general, value refers to something considered important, meaningful, and used as a guideline or principle in life. It represents goodness, wisdom, and appropriate behavior [13]. According to the Indonesian Dictionary (KBBI), the term “value” is defined as worth, a score representing ability, quality or standard, characteristics that are essential and beneficial to humanity, or something that completes and enhances human nature [14].

**Student**

A student is an individual who is formally registered and participates in the educational process within an educational institution, such as an elementary school, secondary school, or vocational school [15]. Students are a central human component in the teaching and learning process, where they are individuals who aspire to achieve goals and strive to reach them optimally [16].

**Vocational High School**

A Vocational High School (SMK) is a formal educational institution at the secondary level that provides vocational education [1]. Its primary objectives include:

1. Preparing students to enter the workforce directly.

2. Developing vocational and professional skills.
3. Fostering an entrepreneurial mindset.
4. Aligning education with the needs of the business and industrial sectors.
5. Providing opportunities for skills certification [17].

## RESULTS AND DISCUSSION

The following is the implementation of the Vernam Cipher Algorithm in securing student score data:

Student Score Data:

**Table 1.** Data of Male and Female Students

NO	NO INDUK	NISN	NAMA SISWA	JENIS KELAMIN
1	23.2018	0074601770	ADITYA ERLANGGA PRANATA	LAKI-LAKI
2	23.2019	0084658374	ALIF AL WAHAB NASUTION	LAKI-LAKI
3	23.2020	0086846664	ANDIKA LIMUDDIN	LAKI-LAKI
4	23.2021	0081109137	ANDREA REVALINO	LAKI-LAKI
5	24.2147	0074751754	CELVIN ANDRIAN	LAKI-LAKI
6	23.2023	0084019855	DIMAS PRATAMA	LAKI-LAKI
7	23.2024	0088799632	IZHAM TAUSHIKAL	LAKI-LAKI
8	23.2026	0086476676	MUHAMMAD DAFFA KHUZAIFI	LAKI-LAKI
9	23.2029	0088569402	NAZWA FADILLA ANDIRA	LAKI-LAKI
10	23.2030	0082952630	REIHAN ADITYA	LAKI-LAKI
11	23.2031	0071993663	RIFKI PRASTIAWAN	LAKI-LAKI
12	22.1975	0072494571	REFYANDA ABDILLAH	LAKI-LAKI

**Table 2.** Student Score Data

NO	MAPEL																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	94	96	81	92	96	95	95	91	92	95	94	85	97	81	88	86	93	88
2	84	92	90	81	84	92	95	95	83	88	94	93	89	92	85	97	81	91
3	86	91	87	88	86	97	95	91	88	88	85	93	83	88	89	95	92	97
4	91	86	93	82	92	94	89	87	86	94	93	85	97	89	84	93	85	88
5	81	94	94	94	93	94	82	83	95	83	95	89	94	87	86	91	82	87
6	96	91	97	96	84	86	92	89	96	86	84	86	88	83	94	93	88	81
7	91	97	96	86	93	87	89	96	83	90	90	89	81	97	95	90	84	83
8	91	94	91	88	89	90	81	81	92	87	92	84	82	84	97	93	88	96
9	90	91	82	91	83	81	92	83	88	87	93	86	95	93	96	92	90	89
10	94	91	91	85	97	86	93	88	81	97	90	84	81	97	97	93	84	82
11	81	94	94	91	84	89	92	97	90	82	82	89	96	97	90	94	92	91
12	96	83	92	92	84	86	97	97	97	83	93	82	89	88	96	95	86	87

### Description:

Subject 1: Religious Education and Character Development

Subject 2: Pancasila and Civic Education

Subject 3: Indonesian Language

Subject 4: Mathematics

Subject 5: Indonesian History

Subject 6: English

- Subject 7: Arts and Culture
- Subject 8: Physical Education, Sports, and Health
- Subject 9: Digital Simulation
- Subject 10: Physics
- Subject 11: Chemistry
- Subject 12: Automotive Technical Drawing
- Subject 13: Basic Automotive Technology
- Subject 14: Basic Automotive Engineering Work
- Subject 15: Light Vehicle Engine Maintenance
- Subject 16: Light Vehicle Chassis and Power Transfer Maintenance
- Subject 17: Light Vehicle Electrical System Maintenance
- Subject 18: Creative Products and Entrepreneurship

**Vernam Cipher Formula:**

Encryption:  $C = P \text{ XOR } K$

Decryption:  $P = C \text{ XOR } K$

**Explanation:**

P = Plaintext (original data)

C = Ciphertext (encrypted data)

K = Key

**Implementation:**

K = Letter **A** converted to ASCII  $\rightarrow$  65

P = Score value

**Example:**

**Table 3. Example**

NO	1
1	94

**Solution:**

**Convert to ASCII:**

9 becomes 57

4 becomes 52

1. **Encryption**

Use the formula:

**Encryption:**  $C = P \text{ XOR } K$

$C1 = 57 \text{ XOR } 65 = 120$

$C2 = 52 \text{ XOR } 65 = 117$

**Convert to Characters:**

120 becomes **x**

117 becomes **u**

Thus, the result is:

**Table 4. Result**

NO	1
1	xu

Thus, when calculated entirely, the result is shown in:

**Table 5. Overall Results**

NO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	xu	x <sub>w</sub>	qx	x <sup>^</sup>	x <sub>w</sub>	x <sub>-</sub>	x <sub>-</sub>	x[	x\	x <sub>-</sub>	xu	q <sub>-</sub>	x`	qx	q <sup>^</sup>	q\	x]	q <sup>^</sup>
2	q <sub>-</sub>	x <sup>^</sup>	x\	qx	q <sub>-</sub>	x <sup>^</sup>	x <sub>-</sub>	x <sub>-</sub>	q[	q <sup>^</sup>	xu	x <sub>-</sub>	q\	x <sup>^</sup>	q <sub>-</sub>	x <sub>-</sub>	qx	x <sup>^</sup>
3	q <sup>^</sup>	x[	q <sub>-</sub>	q <sup>^</sup>	q <sup>^</sup>	x`	x <sub>-</sub>	x[	q <sup>^</sup>	q <sup>^</sup>	q <sub>-</sub>	x <sub>-</sub>	q[	q <sup>^</sup>	q <sub>-</sub>	x <sub>-</sub>	x[	x`
4	x[	q <sup>^</sup>	x <sub>-</sub>	q <sup>^</sup>	x <sub>-</sub>	x <sub>-</sub>	q[	q <sup>^</sup>	q <sup>^</sup>	x <sub>-</sub>	x <sub>-</sub>	q <sub>-</sub>	x`	q <sub>-</sub>	q <sup>^</sup>	x <sub>-</sub>	q <sub>-</sub>	q <sup>^</sup>
5	qx	x <sub>-</sub>	x <sub>-</sub>	x <sub>-</sub>	x <sub>-</sub>	x <sub>-</sub>	q <sub>-</sub>	q <sub>-</sub>	x <sub>-</sub>	q <sub>-</sub>	x <sub>-</sub>	q <sub>-</sub>	x <sub>-</sub>	q <sub>-</sub>	q <sup>^</sup>	x <sub>-</sub>	q <sub>-</sub>	q <sup>^</sup>
6	x <sub>-</sub>	q <sup>^</sup>	x`	x <sub>-</sub>	q <sub>-</sub>	q <sup>^</sup>	x <sub>-</sub>	q <sub>-</sub>	x <sub>-</sub>	q <sup>^</sup>	q <sub>-</sub>	q <sup>^</sup>	q <sup>^</sup>	q[	x <sub>-</sub>	x <sub>-</sub>	q <sup>^</sup>	qx
7	x[	x`	x <sub>-</sub>	q <sup>^</sup>	x <sub>-</sub>	q <sub>-</sub>	q <sub>-</sub>	x <sub>-</sub>	q <sub>-</sub>	q <sup>^</sup>	q <sup>^</sup>	q <sub>-</sub>	qx	x`	x <sub>-</sub>	q <sup>^</sup>	q <sub>-</sub>	q[
8	x[	x <sub>-</sub>	x[	q <sup>^</sup>	q <sub>-</sub>	q <sup>^</sup>	qx	qx	x\	q <sup>^</sup>	x\	q <sub>-</sub>	q <sub>-</sub>	q <sub>-</sub>	x`	x <sub>-</sub>	q <sup>^</sup>	x <sub>-</sub>
9	q <sup>^</sup>	x[	qx	x[	q <sub>-</sub>	qx	x\	q <sub>-</sub>	q <sup>^</sup>	q <sup>^</sup>	x <sub>-</sub>	q <sup>^</sup>	x <sub>-</sub>	x <sub>-</sub>	x <sub>-</sub>	x\	q <sup>^</sup>	q <sub>-</sub>
10	xu	x[	x[	q <sub>-</sub>	x`	q <sup>^</sup>	x <sub>-</sub>	q <sup>^</sup>	qx	x`	q <sup>^</sup>	q <sub>-</sub>	qx	x`	x`	x <sub>-</sub>	q <sup>^</sup>	qx
11	qx	x <sub>-</sub>	x <sub>-</sub>	x[	q <sub>-</sub>	q <sub>-</sub>	x\	x`	q <sup>^</sup>	qx	qx	q <sub>-</sub>	x <sub>-</sub>	x`	q <sup>^</sup>	x <sub>-</sub>	x\	x[
12	x <sub>-</sub>	q[	x\	x\	q <sub>-</sub>	q <sup>^</sup>	x`	x`	x`	q[	x <sub>-</sub>	qx	q <sub>-</sub>	q <sup>^</sup>	x <sub>-</sub>	x <sub>-</sub>	q <sup>^</sup>	q <sup>^</sup>

Its security lies in the fact that the encrypted data cannot be read or understood.

**2. Decryption**

Use the formula:

**Decryption: P = C XOR K**

P1 = 120 XOR 65 = 57

P2 = 117 XOR 65 = 52

**Convert to Characters:**

57 becomes 9

52 becomes 4

Thus, the result is shown in:

**Table 6. Result**

NO	1
1	94

Thus, when calculated entirely, the result is shown in:

**Table 7. Overall Results**

NO	MAPEL																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	94	96	81	92	96	95	95	91	92	95	94	85	97	81	88	86	93	88
2	84	92	90	81	84	92	95	95	83	88	94	93	89	92	85	97	81	91
3	86	91	87	88	86	97	95	91	88	88	85	93	83	88	89	95	92	97
4	91	86	93	82	92	94	89	87	86	94	93	85	97	89	84	93	85	88
5	81	94	94	94	93	94	82	83	95	83	95	89	94	87	86	91	82	87

6	96	91	97	96	84	86	92	89	96	86	84	86	88	83	94	93	88	81
7	91	97	96	86	93	87	89	96	83	90	90	89	81	97	95	90	84	83
8	91	94	91	88	89	90	81	81	92	87	92	84	82	84	97	93	88	96
9	90	91	82	91	83	81	92	83	88	87	93	86	95	93	96	92	90	89
10	94	91	91	85	97	86	93	88	81	97	90	84	81	97	97	93	84	82
11	81	94	94	91	84	89	92	97	90	82	82	89	96	97	90	94	92	91
12	96	83	92	92	84	86	97	97	97	83	93	82	89	88	96	95	86	87

The results of the implementation of the Vernam Cipher Algorithm for securing student score data in the case study of SMK Swasta Rahmat Islamiyah Medan are as follows:



Figure 1. Login Form

Figure 1 is the login form displayed when the application is first opened. Users can enter a password to access the admin page, and if the password is correct, the following home page form will appear:



Figure 2. Home Form

Figure 2 is the home form, which provides several menu options. When the user clicks on the Department menu, the following department form will appear:

Implementasi Algoritma Vernam Cipher Untuk Keamanan Data  
Nilai Siswa Studi Kasus SMK Swasta Rahmat Islamiyah Medan

Raihan

**VernamCipher** HOME JURUSAN KELAS SISWA MAPEL T.A NILAI EXIT

Lokasi: Medan, Indonesia | Email: email@gmail.com | Hubungi: +62812-3456-7890

### Kelola Jurusan

Hitik apa saja

Tambah Jurusan

Id Jurusan	Nama Jurusan	Aksi
1	Teknik Kendaraan Ringan	Edit Hapus
2	Teknik komputer dan Jaringan	Edit Hapus
3	Teknik Sepeda Motor	Edit Hapus
4	Adm Perkantoran	Edit Hapus

**Figure 3.** Department Form

Figure 3 shows the *Department Form*, which provides several actions. When the user types in the search field, the application displays data that matches the typed keywords. If the user clicks Add Department (Light Vehicle Engineering, Computer & Network Engineering, Motorcycle Engineering, or Office Administration), a data entry form will appear, allowing the user to input and save new data. If the user clicks Edit, the application displays the edit form and saves the updated data. If the user clicks Delete, the application removes the selected data. When the user clicks the *Class* menu, the following class form will appear:

Implementasi Algoritma Vernam Cipher Untuk Keamanan Data  
Nilai Siswa Studi Kasus SMK Swasta Rahmat Islamiyah Medan

Raihan

**VernamCipher** HOME JURUSAN KELAS SISWA MAPEL T.A NILAI EXIT

Lokasi: Medan, Indonesia | Email: email@gmail.com | Hubungi: +62812-3456-7890

### Kelola Kelas

Hitik apa saja

Tambah Kelas

Id Kelas	Nama Kelas	Id Jurusan	Aksi
1	XX TKR	1	Edit Hapus
2	XX TKJ	2	Edit Hapus
3	XX TSM	3	Edit Hapus
4	XX AP	4	Edit Hapus

**Figure 4.** Class Form

Figure 4 shows the *Class Form*, which provides several actions. When the user types in the search field, the application displays data that matches the typed text. If the user clicks Add Class (X, XI, or XII), a data entry form will appear, allowing the user to input and save new data. If the user clicks Edit, the application displays an edit form and saves the updated data. If the user clicks Delete, the application removes the selected data. When the user clicks the *Student* menu, the following student form will appear:

Nilai	Nama Siswa	Id Kelas	Aksi
221975	BEFYANDA ABDILLAH	1	Edit Hapus
252018	ADITYA BERLANGGA PRANATA	1	Edit Hapus
252019	ALFAL WAHAB NASUTION	1	Edit Hapus
252020	ANDIKA LIMUDIN	1	Edit Hapus

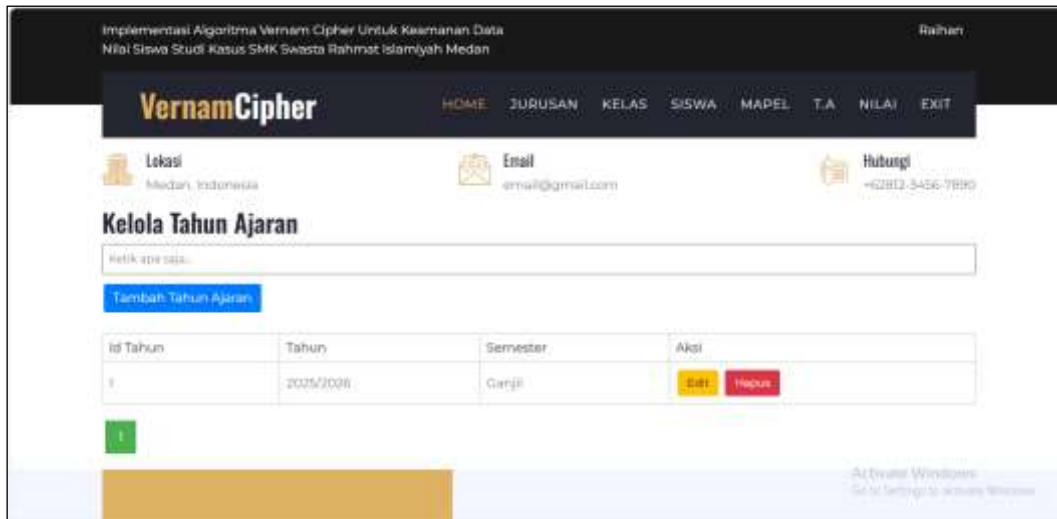
**Figure 5.** Student Form

Figure 5 shows the *Student Form*, which provides several actions. When the user types in the search field, the application displays data that matches the typed text. If the user clicks Add Student, a data entry form will appear, allowing the user to input and save new student data. If the user clicks Edit, the application displays an edit form and saves the updated data. If the user clicks Delete, the application removes the selected student data. When the user clicks the *Subject* menu, the following subject form will appear:

Id Mapel	Nama Mapel	Aksi
1	Pendidikan Agama dan Budi Pekerti	Edit Hapus
2	Pendidikan Pancasila dan Kewarganegaraan	Edit Hapus
3	Bahasa Indonesia	Edit Hapus
4	Matematika	Edit Hapus

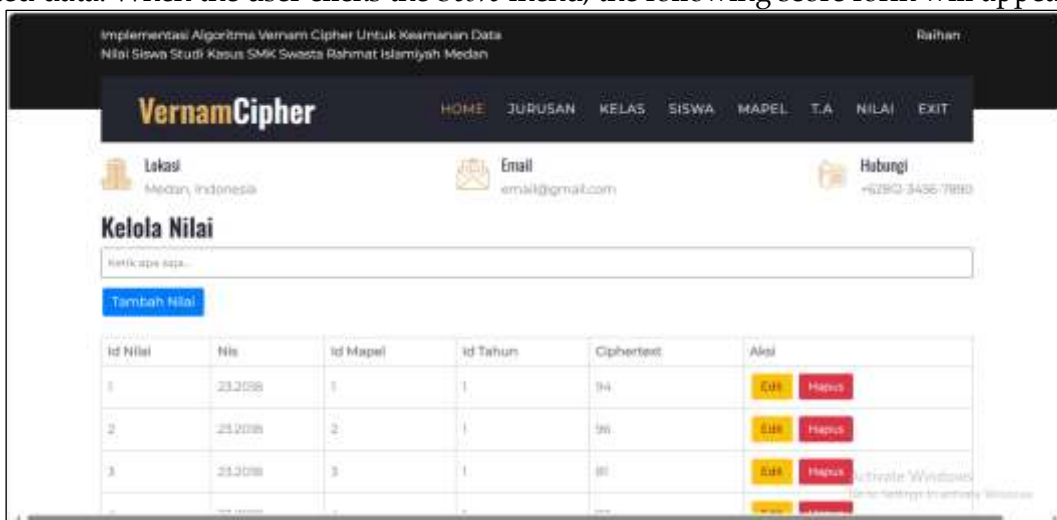
**Figure 6.** Mapel Form

Figure 6 shows the *Subject Form*, which provides several actions. When the user types in the search field, the application displays data that matches the typed text. If the user clicks **Add Subject** (English, Physical Education, Entrepreneurship, Religion, Pancasila Education, Indonesian Language, Specialization Subjects, Local Content, and Mathematics), a data entry form will appear, allowing the user to input and save new subject data. If the user clicks **Edit**, the application displays an edit form and saves the updated data. If the user clicks **Delete**, the application removes the selected subject data. When the user clicks the *Academic Year (T.A)* menu, the following academic year form will appear:



**Figure 7.** Academic Year Form

Figure 7 shows the *Academic Year (T.A)* Form, which provides several actions. When the user types in the search field, the application displays data that matches the typed text. If the user clicks Add Academic Year (e.g., 2025/2026 Odd Semester), a data entry form will appear, allowing the user to input and save new data. If the user clicks Edit, the application displays an edit form and saves the updated data. If the user clicks Delete, the application removes the selected data. When the user clicks the *Score* menu, the following score form will appear:



**Figure 8.** Score Form

Figure 8 shows the *Score Form*, which provides several actions. When the user types in the search field, the application displays data that matches the typed text. If the user clicks **Add Score**, a data entry form will appear, allowing the user to input and save new score data. If the user clicks **Edit**, the application displays an edit form and saves the updated data. If the user clicks **Delete**, the application removes the selected score data. If the user enters a key and clicks **Encrypt**, the data will be encrypted; and if the user enters a key and clicks **Decrypt**, the data will be decrypted. If the password entered is **123**, the encrypted result will appear as follows:

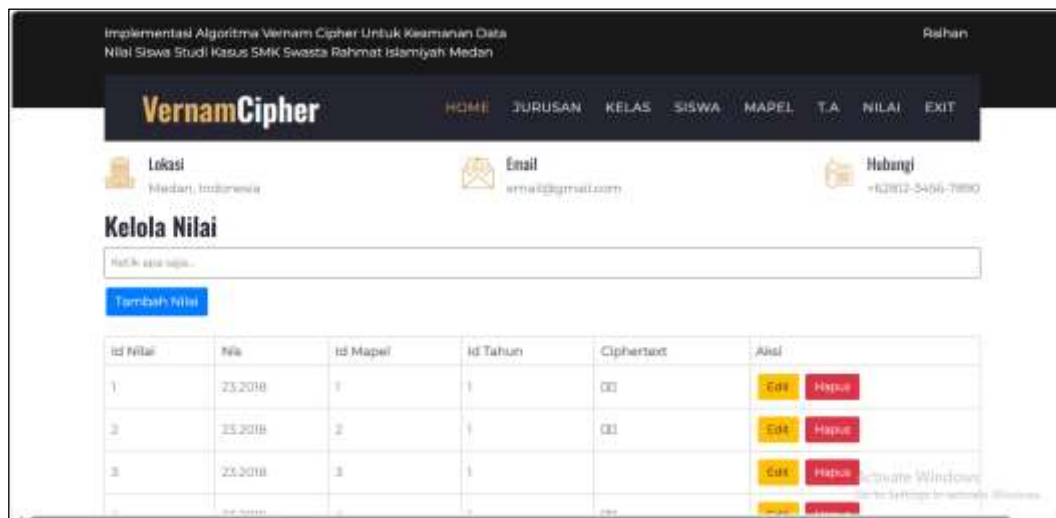


Figure 9. Encrypted Score Form

## CONCLUSION

Based on the research and implementation that have been carried out, several conclusions can be drawn. The security of student score data at SMK Swasta Rahmat Islamiyah Medan can be significantly improved by applying an encryption method, ensuring that the data can only be accessed by authorized parties who possess the correct key. This effectively prevents unauthorized access and manipulation of student scores. The implementation of the Vernam Cipher algorithm in the student score processing system has proven to successfully encrypt and decrypt data by using the XOR technique between the original message and a key of equal length, making the data unreadable without the appropriate key. Furthermore, the application developed for implementing the Vernam Cipher algorithm to secure student score data has been successfully created according to the needs of SMK Swasta Rahmat Islamiyah Medan. The application is capable of converting student score data into encrypted form before it is stored or transmitted and restoring it to its original form when the correct key is provided, thereby ensuring stronger data security.

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