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Supporting National Food Security Through the Implementation of Radio Frequency Identification (RFID) in the Warehouses of Badan Urusan Logistik

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ABSTRACTS

As many as 20,000 tons of rice in 2019 were discarded from the Logistics Agency (BULOG) warehouses due to their declining quality, making them unfit for consumption. The cause of rice damage is that the storage owned by BULOG is not a special warehouse for storing rice. This study aims to analyze BULOG rice storage and formulate ways to improve rice quality in realizing food security The method used in this research is qualitative approach and data collection using Focus Group Discussion (FGD) involving 15 people in the Edu Logistics Hub community. The application of Radio Frequency Identification (RFID) which processes information from rice stored in warehouses can minimize human error. The decline in the quality of rice in BULOG warehouses can be overcome by applying the First In First Out (FIFO) method and the application of RFID technology.

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1. INTRODUCTION

Quoting from Consumer News and Business Channel (CNBC) Indonesia in 2021, the country is estimated to have incurred losses of 1.25 trillion due to a decrease in the quality of rice, rendering it unsuitable for consumption (https://www.cnbcindonesia.com/news/20210324131915- 4-232504/duh-beras-impor-lama-di-gudang-negara-potensi-rugi-rp125-t). Economic stability is closely linked to food security (Devi, et al., 2020), where economic instability can occur when the demand for food exceeds its supply. According to Article 1, Paragraph 4 of Food Law No. 18 of 2012, food security is defined as "the condition of fulfilling food for the state up to individuals, reflected in the availability of sufficient food, both in quantity and quality, safe, diverse, nutritious, equitable, affordable, and not conflicting with the religion, beliefs, and culture of the society, in order to live healthy, active, and sustainably productive lives".

The Central Statistics Agency (BPS) stated that in 2022, the production of rice was 55.67 million tons of milled dry paddy (GKG), and the rice production for consumption was 32.07 million tons, both of which increased from the previous year. The increase in both figures is attributed to the growth of the population, leading to an upsurge in the demand for rice as a staple food (panen-padi-diperkirakan-sebesar-10-61-juta-hektare-dengan-produksi- sekitar-55-67-juta-ton-gkg.html).

The Logistics Bureau (BULOG) has the main task of providing quality and adequate logistics for basic food needs to fulfill the requirements of Indonesia's population, as a supportive effort for the three main pillars of national food security. Throughout its efforts to achieve this goal, BULOG faces various challenges, one of which is related to the quality of rice stored in warehouses. Quoting from CNBC, in 2019 BULOG discarded 20 thousand tons of rice due to its deteriorated quality, making it unfit for consumption. Budi Waseso, the CEO of Perum BULOG, stated, "BULOG's warehouses for storing rice are not specialized warehouses for rice storage. There are regulations for storing corn, soybeans, rice, and others. The warehouses currently available throughout Indonesia are generally regular warehouses. So, storing in this manner tends to lead to quick spoilage" (https://www.cnbcindonesia.com/news/20220627185212-4- 350806/pantes-ternyata-gegara-ini-beras-bulog-gampang-rusak).

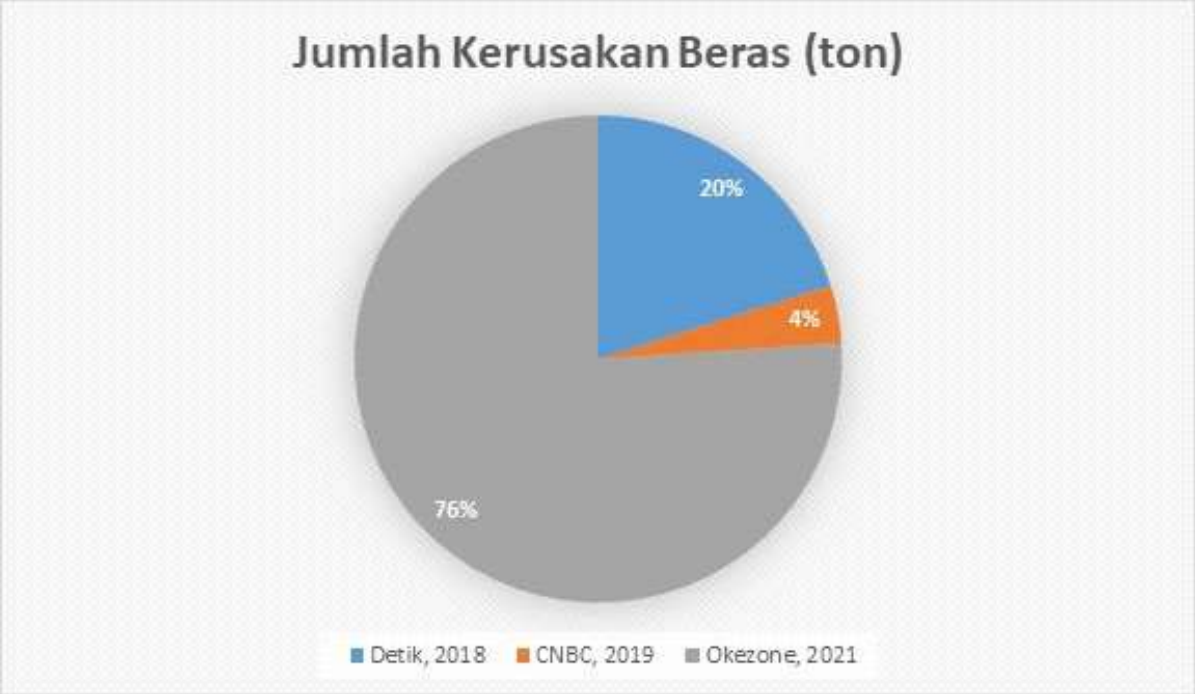

Figure 1. Rice Damage Quantity (tons)
Source: Compiled from Detik, CNBC, and Okezone

The issue can be addressed using Radio Frequency Identification (RFID) technology and the First In First Out (FIFO) inventory management method, where RFID technology can provide information about incoming and outgoing goods to be utilized in the FIFO method. This can help mitigate the issue of rapid deterioration in rice storage.

Based on the above explanation, the objective of this research is to analyze BULOG's rice storage and formulate ways to enhance rice quality in achieving food security. The implementation of RFID and the FIFO method can assist the country in reducing incurred losses and maintaining food sovereignty through logistic digitalization and improving the management quality of BULOG's warehouses.

2. METHODS

The method employed in this research is a qualitative approach. Data collection was carried out through Focus Group Discussions (FGD) with predetermined topics. The FGD method is one method of collecting research data, with the final result providing data originating from the results of interactions among a number of participants in a study, as is generally the case with other data collection methods (Afiyanti, 2008).

The FGD results underwent data processing supported by Expert Judgment through triangulation of secondary data sources based on research from national journals. Triangulation is a data analysis approach that synthesizes data from various sources (Bachri, 2010). This study was conducted for one month involving 13 students and 2 experts in the logistics field, all affiliated with the Edu Logistic Hub. Over the course of one month, 5 meetings were held, each discussing different topics.

Table 1. Discussion Topics for Each Meeting

Meeting number-	Date	Location	Discussion Topic
1	October 3, 2022	UPI	Rice damage
2	October 10, 2022	UPI	Factors causing rice damage
3	October 17, 2022	UPI	Impacts of rice damage that occurs
4	October 24, 2022	UPI	RFID
5	October 31, 2022	UPI	RFID method in rice storage

The first stage carried out in the research is a preliminary study derived from a case study. Subsequently, the process involves developing instruments, where the instrument used consists of discussion materials derived from secondary data, sourced from Google Scholar and official government websites using keywords such as rice, BULOG, food security, and RFID.

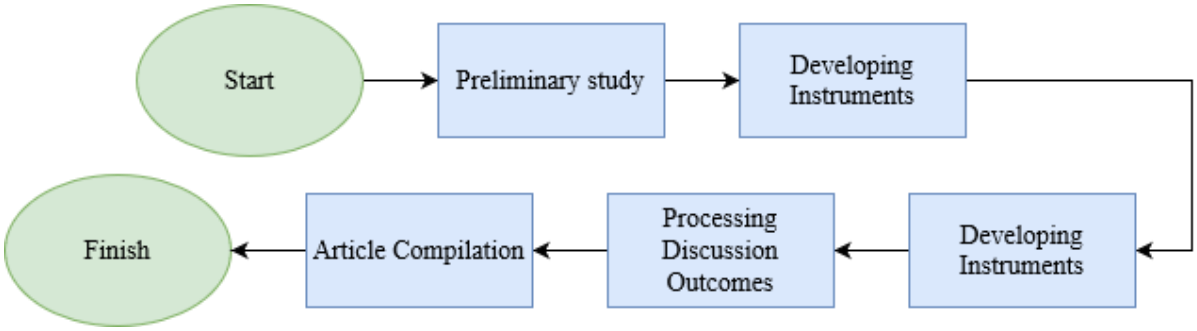

Figure 2. Research Flowchart Diagram

After devising the instruments, the next step involves conducting a Focus Group Discussion (FGD) involving 15 individuals affiliated with the Edu Logistic Hub. These individuals include Vina Dwiyanti, Hannisa Okitasari, Aldi Adista, Aldi Palah Pamungkas, Ari Ilya Sariu, Davin Arkan Admokoputra, Fahmi Arif Fajar, Fatimatuz Zahroh, Galuh Chisyti, Ihsan Nurhadi, Indira Shaffiyah, Najma Sekar Langit, Syifa Nurhaliza, and Steven Julianto Situmeang, all from a logistics engineering background. The obtained results from the discussion are then processed for the final step, which is the compilation of an article to reinforce the FGD outcomes compared with previous research findings related to the FGD topic.

3. RESULTS AND DISCUSSION

Table 2. Damaged Rice Data

Source	Year	News Content
Detik	2018	106,000 tons of imported rice are at risk of spoilage or rot.
CNBC	2019	20,000 tons of BULOG rice deemed unfit for consumption.
Okezone	2021	About 400,000 tons of rice found in poor condition, some even rotten.

Source: Compiled from Detik, CNBC, and Okezone

In **Table 2**, information related to BULOG's rice damage data for the years 2018, 2019, and 2021 is presented from various sources of news articles (https://finance.detik.com/berita-ekonomi-bisnis/d-5507716/106000- ton-beras-impor-2018-terancam-busuk-di-gudang-bulog; https://www.cnbcindonesia.com/news/20191203154922-4-119983/20000- ton-beras-bulog-dibuang-karena-rusak-kok-bisa-sih; https://economy.okezone.com/read/2021/05/18/320/2411986/mengejutkan-400-000-ton-

beras-bulog-busuk?). It's evident that the quantity of damaged rice fluctuates, leading to significant losses for the country. However, BULOG has not resolved this issue with an appropriate solution. Instead, BULOG has opted to import rice despite the high level of domestic rice production in Indonesia, resulting in an overstock of rice.

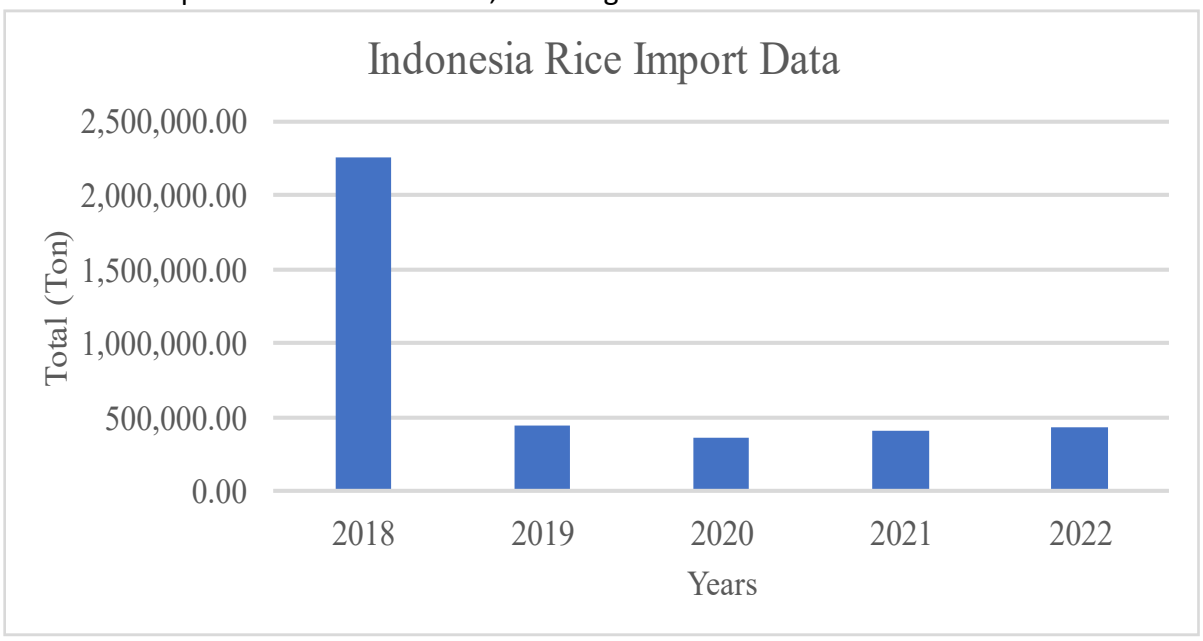

Figure 3. Rice Import Data
(Source: https://www.bps.go.id/statictable/2014/09/08/1043/impor-beras-menurut- negara-asal-utama-2000-2021.html)

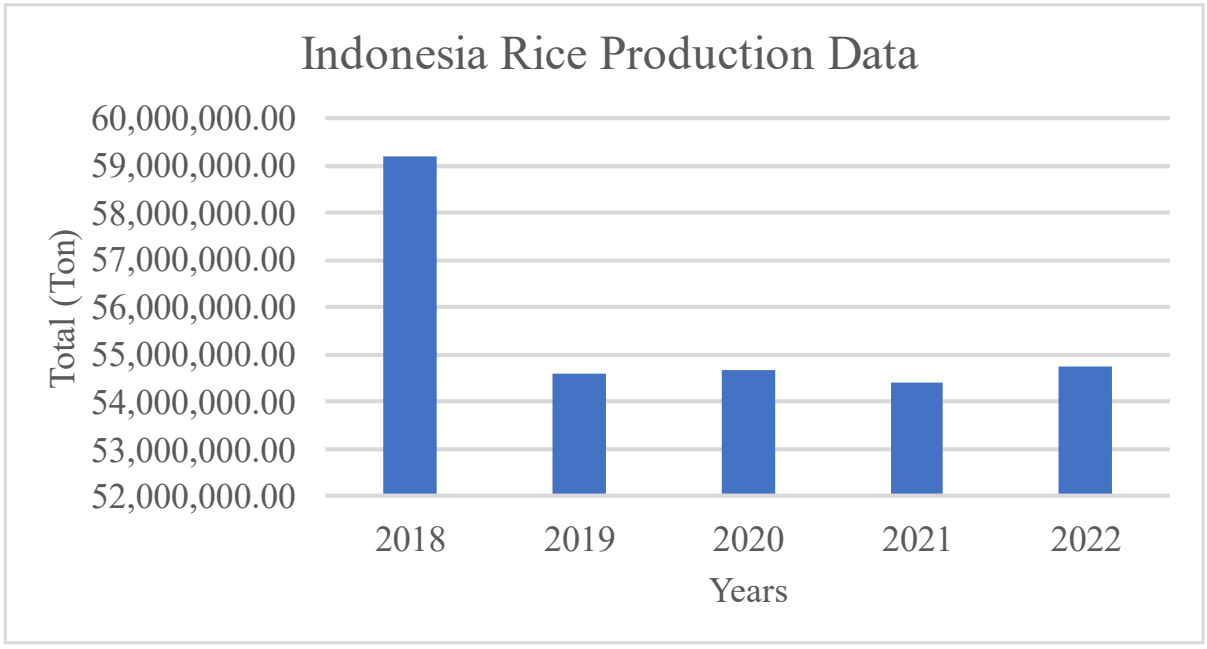

Figure 4. Rice Production in Indonesia
(Source: https://www.bps.go.id/indicator/53/1498/1/luas-panen-produksi-dan-produktivitas-padi-menurut-provinsi.html)

In **Figure 3**, it can be observed that in 2018, Indonesia experienced the highest rice imports, reaching 2,253,824.4 tons. In **Figure 4**, the highest rice production is also seen in the same year, 2018, with a total production of 59,200,533.72 tons. It can be concluded that BULOG's import efforts have violated existing regulations since domestic rice production adequately

meets market demand. Thus, importing rice only leads to an overstock of rice domestically. Instead of resorting to rice imports to address this issue, BULOG should focus on implementing proper rice storage methods to ensure efficient distribution and prevent rice from deteriorating. One of the methods BULOG can apply in warehouse rice storage is the FIFO method.

Result:

3.1. FIFO

FIFO stands for "First in, First Out," an inventory management method where items are stored and sold based on the date of receipt and sale. In other words, this method sells the items that were received first in the warehouse to customers. Aside from its application for products with short shelf lives, this method is also employed when a business owner aims to achieve high gross profit and low Cost of Goods Sold (COGS). FIFO ensures that a company always has a supply of fresh inventory, and the oldest stock is always used up first (Ramdasi & Shinde, 2021; Ummah & Siyamto, 2022). FIFO calculations and implementations are relatively simple and are believed to prevent profit manipulation by the company. The ending inventory value is the price of the last goods purchased. This method will generate high profits if the price tends to increase (Tanaka & Respati, 2021). Below are examples illustrating the application of the First-In-First-Out (FIFO) storage method across various types of commodities.

Table 3. Application of FIFO

No.	Paper	Application
1.	Fachrurrazi S.,	Drug
2.	Asrozy, et al., 2022	Food and Beverage
3.	Kartinah D., 2021	Food Ingredients
4.	Thakre S., 2021	Automobile Sector
5.	Shokouhifar et al., 2021; Das & Biwas, 2022	Blood
6.	Baylen, 2020	Food Ingredients
7.	Sukasih et al., 2020	Drug

However, manual inventory recording in a company's warehouse increases the likelihood of discrepancies between recorded data and actual stock in the warehouse. Errors in recording inbound and outbound transactions and in preparing inventory reports can also occur (Sumaryanto, et al., 2022; Masrukha, et al., 2021). Therefore, the presence of RFID technology can minimize human errors or discrepancies arising from human actions (Rahmawati, 2019).

3.2. Implementation of RFID in the Warehouse

Radio Frequency Identification (RFID) technology is a sensor technology capable of identifying objects through radio frequency (Tao, et al., 2021). As an advanced generation of barcode technology, RFID offers advantages not previously available with barcodes. Data transmission via RFID doesn't require close proximity like barcodes do (Paryanto, et al., 2022). RFID use doesn't rely on line of sight or direct contact to function under various environmental conditions. The technology is difficult to counterfeit, enhancing RFID's appeal by providing a high level of data security and integrity (Latief, 2016; Djenna, et al., 2021).

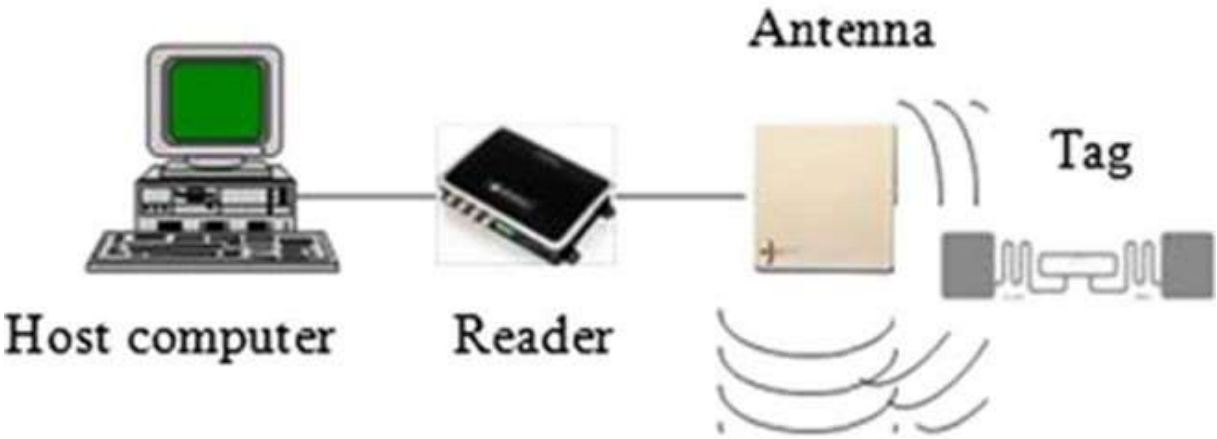

Figure 5. RFID Working Concept
Source: Adapted from Biswal, A. K., Jenamani, M., & Kumar, S. K. (2018).

RFID Tag, a device that stores information for object identification. RFID tags are often referred to as transponders, and each tag has a unique serial number.

1. Antenna, to transmit radio frequency signals between the RFID reader and RFID tag.
2. RFID Reader, a device compatible with RFID tags that communicates wirelessly with the tag, reading the serial number on the tag.
3. Application Software, a program or application installed on a computer to read data from tags through the RFID reader. Both the RFID tag and reader are equipped with antennas to receive and emit electromagnetic waves.

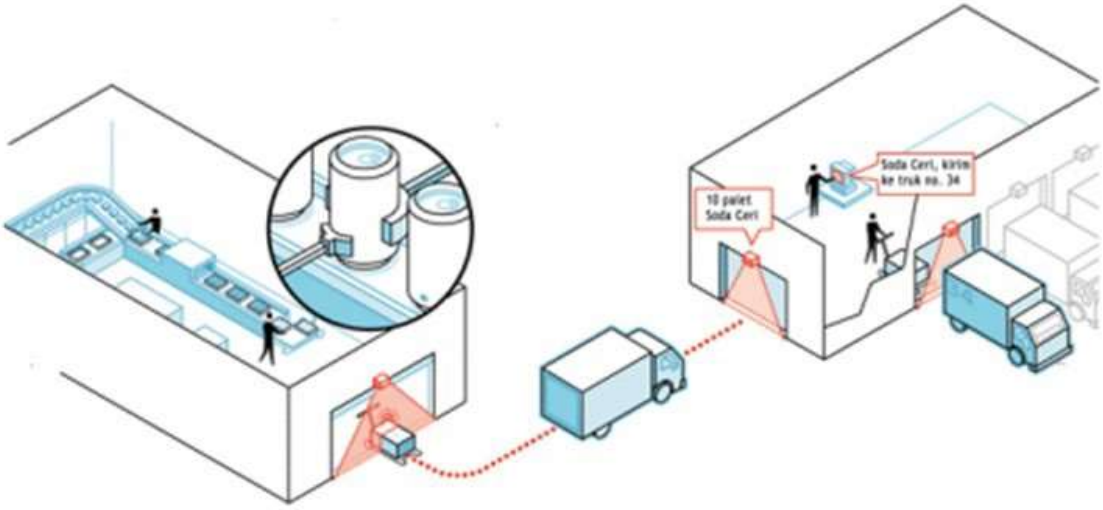

Figure 6. RFID Operation in WMS
Source: Adapted from Sebastian, K., Suakanto, S., & Hutagalung, M. (2017).

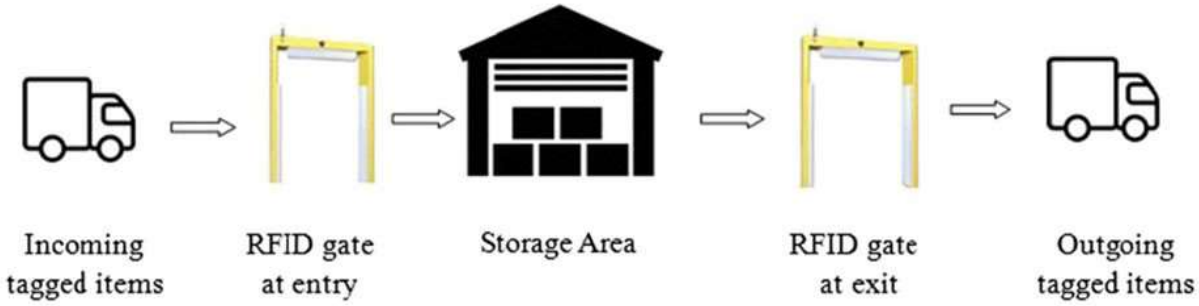

Figure 7. RFID System in the Warehouse
Source: Adapted from Biswal, A. K., Jenamani, M., & Kumar, S. K. (2018).

The operation of RFID in a Warehouse Management System (WMS) can be seen in **Figure 7**. The sequence of processes is as follows:

1. Each item is equipped with a tag containing its identity. The tag contains a microchip that functions as a communication device and a tool to store data such as the item's name, type, model, unique serial number, or other related information. This enables the automatic identification and recording of each item.
2. RFID readers are installed at the entrance/exit points. These reading devices are responsible for reading data on the tag.
3. When pallets containing items enter the warehouse, RFID readers situated above the entrance detect the items and record information about each pallet. This eliminates the need to manually inspect incoming and outgoing items. The data received by the RFID reader is sent to a computer and recorded in a database.

3.3. Agricultural and Food Companies Utilizing Warehouse RFID Technology

The use of Radio Frequency Identification (RFID) technology in food warehouses brings numerous benefits (Mahrjerdi, 2011; Hamadneh, et al., 2021). This technology has brought about changes in how we monitor and manage food stocks (Sahni, et al., 2021).

First and foremost, RFID enables highly accurate monitoring. RFID tags placed on each food product allow us to monitor the movement of products within the warehouse in real-time (Yadav, et al., 2020). This enables us to easily track the inflow and outflow of goods, avoiding stock confusion, and reducing inventory errors (Zhu, et al., 2012). Furthermore, RFID technology assists in monitoring product quality. With temperature and humidity sensors integrated into RFID tags, we can ensure that storage conditions consistently meet specific standards (Vanderroost, et al., 2014; Rahman, et al., 2021). Keeping food products fresh and safe for consumption is of paramount importance.

There are many companies that have implemented RFID in their warehouses (Kosasi & Saragih, 2014). This implementation has certainly brought significant changes to the stored products, one of which is enhancing efficiency and security in warehouse management. Some examples of companies that have adopted RFID technology in their food warehouses are:

1. Nestle

   Nestlé, a multinational enterprise specializing in food and beverages, has experimented with RFID implementation across multiple supply chain initiatives. They exploit this technology to monitor food products throughout the production and distribution phases (Bottani, et al., 2017).
2. Tyson Food

   Tyson Foods, the largest meat manufacturer in the United States, has also initiated ventures incorporating RFID technology to optimize operational efficiency and warehouse stock management (Bottani, et al., 2009).
3. Dole Food Company

   Dole, a renowned company recognized for its fruit and vegetable offerings, has trialed RFID technology to enhance visibility and transparency within their supply chain (Kumari, et al., 2015).
4. Walmart

   Walmart, one of the biggest retail corporations globally, has integrated RFID technology into their supply chain operations. They've applied RFID to food items and various commodities to enhance inventory visibility and minimize shipping errors.

RFID is used in the handling of fresh fruits in warehouses, aimed at maintaining the quality of the fruits (Zeimpekis, et al., 2010).

5. Mercadona
   Mercadona is one of the supermarket and online shopping companies in Spain. The use of RFID in this company is employed in the handling of fresh fruits, with the aim of monitoring the fruit quality according to the required temperature and humidity to keep them fresh. (Zeimpekis, et al., 2010).

Discussion:

Food items have a certain storage duration before becoming unfit for consumption. This storage duration also depends on the treatment provided by the managers, whether the treatment given during the storage of food items is appropriate or not. Quoting from dpr.go.id, the operations of BULOG's warehouses are not accompanied by any supporting technology, and the maximum storage duration for rice in BULOG's warehouses is only 3-6 months. Exceeding this time frame would lead to a decrease in rice quality (https://www.dpr.go.id/berita/detail/id/15072/t/Mendesak%2C+Penerapan+Teknologi+Penyimpanan+Gudang+Bulog.). The short storage duration indicates that the FIFO method is an appropriate storage approach to be implemented in BULOG's warehouses. However, the large quantity of rice stored in BULOG's warehouses raises concerns about the potential workload and the limited physical strength and energy of humans, which could lead to human errors. The implementation of RFID technology will help alleviate the workload for warehouse workers. The information processing and monitoring of the stored rice within the warehouse will be facilitated through RFID technology. The working process of RFID in BULOG's warehouse can be described through the following steps.

1. Each rice sack will be equipped with a tag containing the identity of the sack, including its type, unique serial number, entry date to the warehouse, and the latest permissible storage date.
2. RFID readers will be installed at the entrance and exit points of the warehouse to read the data on the tags.
3. Then, as each sack of rice passes through the entrance and exit points of the warehouse, its information will be detected and recorded. The recorded data will be transmitted by the RFID readers to a computer and also stored in a database. Through the detected and recorded data, warehouse workers no longer need to individually check the storage duration for each sack of rice.

4. CONCLUSION

The issue of rice damage cannot be resolved through rice imports to meet Indonesia's rice needs. Instead of providing a solution, rice importation could lead to new problems. The cause of rice damage, stemming from the manual management system of warehouses, is not exempt from human error. Therefore, the needed solution involves minimizing errors through warehouse digitalization. The implementation of RFID technology and the FIFO system in BULOG's warehouses can mitigate damage and reduce human errors. Consequently, the losses experienced by the country can be anticipated and minimized, achieving rice self-sufficiency in Indonesia and maintaining food security in the country.

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