ISSN 2347 - 3983
Volume 11. No.11, November 2023
International Journal of Emerging Trends in Engineering Research
Available Online at http://www.warse.org/IJETER/static/pdf/file/ijeter0611112023.pdf
https://doi.org/10.30534/ijeter/2023/0611112023

Preventing Animals Interference using Intelligence Camera and RFID System

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Received Date: October 1, 2023 Accepted Date: October 26, 2023 Published Date : November 07, 2023

ABSTRACT

Animals' interference into operation centers has become major headaches for some companies. Although it is a trivial case, the animals' interference has disrupted major operations of the company. The article takes case of an Indonesian utility company, PN, that has challenges to distribute electricity to nationwide, especially in the rural areas, mountain, and forest areas, and thousand islands. Those areas are surrounded by animal presences that might trespass and interference into distribution sites such as transmission lines and transformers. The common presence of animals' interference was found such as snakes, birds, and squirrels have created blackouts in some areas. The article proposes the use of intelligence cameras and RFID systems, along with preventive devices to assist animal trespassing in the distribution area. The article takes pilot of project in Payakumbuh area that is in West Sumatera, that has high animal interferences to the distribution system. Since the last decade, PN has promoted digital transformation in all her business units. The use of digital technology is expected to provide solution reference for animal interfere cases around Indonesia area, considering that each area in Indonesia has an unique animal interference that might differ from other area.

Key words: Animal interference, distribution center, transmission lines and transformer area, animal preventive devices, intelligence cameras and RFID system.

1. INTRODUCTION

Securing the operation sites is an essential task that needs to be taken by all companies. Securing sites has the objective of removing unwanted objects that may interfere with the current operation [1]. The article takes case of a state-owned energy company, PN, in Indonesia that has installed many distribution sites such as transmission lines and transformers in far remote areas around Indonesia. Indonesia is surrounded with many mountains, forests, islands, and remote area with few inhabitants. This situation makes electricity distribution and maintenance require special attention [2] . It is exacerbated due to the presence of surrounded animals that frequently trespass and interfere into transmission lines and transformers areas. Their presence has caused frequent blackouts and major damage to both transmission lines and transformers. Different areas may have different types of animal trespassing, and it makes the operation and maintenance case of distribution area become difficult. The article takes the case of Payakumbuh area that has the highest animal trespassing cases recorded (PN interference cases) in 2021, as high as 271, and 2022 as high as 80 cases (see Fig.1 statistics of common animal trespassing cases in major area in Sumatera). The trespassing case has created many interruptions to transformer operation.

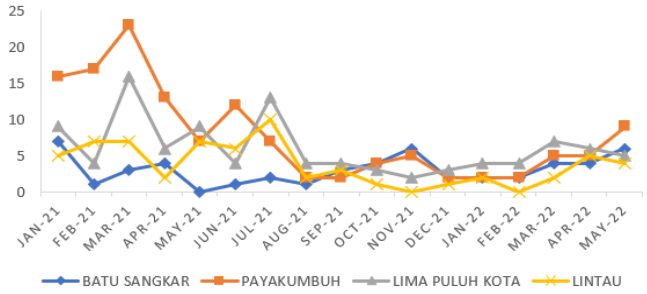

Figure 1: Statistics the common animal trespassing in Indonesia in Sumatera area.

The comparison of the common animal trespassing cases in similar records are shown below:

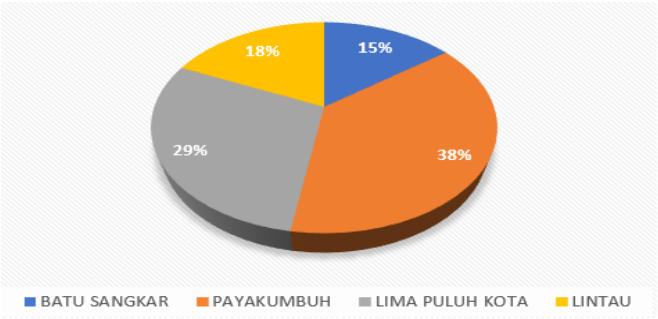

Figure 2: Percentage of common animal trespassing in similar records

Fig.2 shows that Payakumbuh case contributes 38% of common animal trespassing. Since the last decade, PN has actively promoted digital transformation in all business units, including distribution area, especially located in the rural area. The article examines the use of integrated intelligence cameras and RFID technology to assist the operation and maintenance staff to secure the distribution area. The outcome of the article is expected to provide reference of animal' prevention based on digital solution and can be applied in nationwide.

2. THEORETICAL FRAMEWORK

2.1. RFID

RFID stands for radio frequency identification and enables to quickly identify items in remote areas. RFID provides benefits such as easy tracking assets, monitoring conditions for safety, and helping staff to prevent trespassing [3]. RFID is an essential part that integrates Internet and mobile devices that enables to integrate the electricity distribution centers with enterprise application in the HQ.

The article proposes of using RFID solution with microwave technology with the following specification:

Table 1. Passive RFID with Microwave Technology .

Frequency	2.45 GHz and 5.8 GHz.
Reading/Writing data rate	Fast
Ability to read/write multiple tags in field	Ability to read/write high-density tags.
Approximate range	Up to 2 m.
Limitations (cannot work on)	Metal, Liquid
Applications	Monitoring real-time movements.

The article uses the passive RFID device with integrated camera to detect animal's trespassing/interference and prevent potential damage to the distribution devices.

2.2. RFID System

The common RFID system comprises of: [3], [4]

1. tags, can be differentiated into labels, transponders, and inlays.
2. an RFID reader, retrieves data. RFID readers normally come with one or more internal or external antennae. Interfaces that supported with host computer such as: RS232, RS485, USB, Ethernet, Wi-Fi, PCMCIA, or CompactFlash.
3. an application in host computer, monitors and controls the RFID reader. Application gives instruction to operation/maintenance staff to take necessary action to secure transformer area.

The RFID system comprised of three basic components such as: [4]

1. RFID tag is attached to an asset (integrated smart camera).
2. RFID communicates with RFID tags.
3. backend system, RFID connects to central database.

The RFID devices is enabled to connects with cloud computing platform and centralized database system. Normally, RFID hardware can be differentiated into: RFID tag, reader antenna and reader [5] .

RFID has advantages for operation and maintenance center such as:

1. high speed reading, multiple reading and writing simultaneously.
2. can tag data through or around blocking materials;
3. data RFID is rewriteable.
4. RFID has a longer reading/writing range compared to barcodes and most other identification technologies.
5. security checks to prevent unauthorized reading and writing.
6. combination with sensor technology can deliver more value to enterprise application.

Due to its advantages, RFID has disadvantages that needs to be addressed such as: [6]

1. costs. The costs of RFID may be higher in some applications.
2. reading and writing reliability are largely affected by material of the tagged product and its surrounding environment.

The common use of RFID tags can be summarized into four categories such as: [3]

- Passive (no battery or no on-board power source),
- Active (with battery or on-board power source).
- Semi-active (having an onboard power supply powering a microchip (intelligence), a transmitter, and a passive receiver),
- Semi-passive (having an onboard power supply powering only the microchip (intelligence), a passive receiver, and uses backscatter to communicate).

The article uses semi-passive RFID system with affordable solutions. Other areas may have different category of use, and it depends on the situation of the area.

3. RESEARCH FRAMEWORK

3.1. Research Method

The article applies the research method comprises of following steps:

1. Collect data and identify the main problems that commonly disrupt the distribution operation (transmission lines and transformers).
2. Propose solution to avoid animal trespassing/interferences.
3. Propose RFID Architecture System integration with intelligence cameras and enterprise application in the HQ.

3.2. Data Gathering Method.

The article applies data gathering methods such as: observation, interviews with operation/maintenance staff in the remote area and gather statistics of animal trespassing. The data collection will be used to improve the architecture of RFID system in distribution and enterprise application in the HQ.

3.2. Architecture of an RFID System.

The article proposes the RFID architecture (see Figure 3 Architecture of an RFID system) as follows:

1. RFID Data Integration Layer. The data integration layer is managed through an enterprise application that is in the HQ computer system.

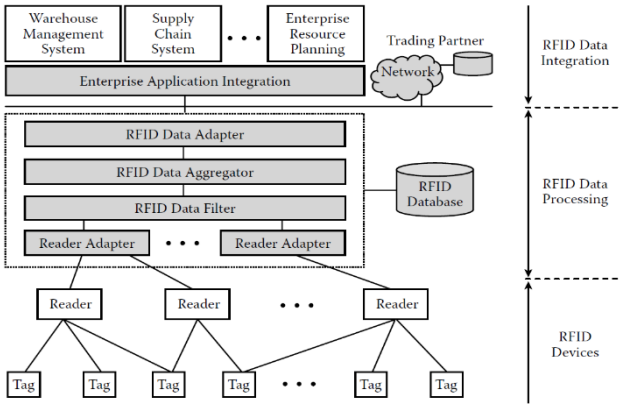

Figure 3: Archiecture of an RFID system [3].

The enterprise application comprises of enterprise resource planning (ERP) applications, business intelligence app, and connects with third-party RFID contractors. Connection with RFID contractors is beneficial to provide real-time technical support. The RFID data can be monitored through the current mobile application. The Data integration layer enables to monitor all interference cases in distribution centers, including animal trespassing. This layer also can direct further operation and prevention steps to the remote sites including preparing logistics delivery to support operation in the remote areas.

2. RFID Data Processing Layer. This layer comprises of:
   (a). RFID data adapter publishes data/events topic among data/events/services in all distribution sites through cloud service. Data adapter connects RFID data to enterprise data (ERP system).
   (b). RFID data aggregator enables to integrate the RFID data from all distribution areas and monitor statistics of events.
   (c) RFID data filter enables to correct invalid or incomplete data.
   (d) Reader adapter enables to collect reader data from various reader devices.
3. RFID Devices Layer, comprises readers that are embedded with additional tag sensors to identify type of animals/human trespassing/interference. We use Hikvision solar-powered thermal camera kit as RFID devices that support night vision with infrared. The use of thermal camera kit suits remote areas with limited power and minimum maintenance efforts.

3.3. Solar-powered Thermal Camera Kit and RFID reader.

The article uses solar-powered thermal cameras that are suitable to be installed for distribution areas with minimum power to device and minimum maintenance efforts [7] . The camera kit suits far remote areas such as rural areas, mountains, forests, and remote islands.

Figure 4: Solar-powered thermal Camera Kit.

The camera specification is illustrated below:

- 80 W photovoltaic panel, 360 Wh chargeable lithium battery.
- Clear imaging against strong back light due to 120 dB true WDR technology.
- Focus on human and vehicle targets classification based on deep learning.
- Support battery management, battery display, battery high-low temperature protection, charge-discharge protection, low-battery sleep protection and remote wakeup.
- LTE-TDD/LTE-FDD/WCDMA/GSM 4G wireless network transmission, support Micro SIM card.
- Ethernet Interface: 1 RJ45 10 M/ 100 M self-adaptive Ethernet port.
- Water and dust resistant (IP66).
- 25-30 fps (2560 x 1440, 1920 x 1080, 1280 x 720).
- Mainstream: H.264/H.265.
- Video Bit rate 32 Kbps to 8 Mbps.

Figure 5: Ci-RF231 Omni-directional Active Reader.

We connect RJ45 port with RFID reader devices with following specification:

- Ci-RF231 Omni-directional Active Reader supports 100 m reading radius, high reliability suitable for tunnel personnel tracking, industrial data acquisition, asset monitoring and tracking.

- Data Ports RS232, Ethernet.
- Application Software API in C++/C#.
- Tag Protocol Private.
- Reading Distance 0-150 m (antenna/tag type matter) suitable for distance of transmission lines/ transformer to nearest office.
- Dimensions 168*145*42.5mm (antenna excluded).
- Weight 500g.
- Power Supply DV 5V/2A.
- Power Consumption 200 mw standby, 400 mw working.
- Installation Ceiling or desktop.

We connect active reader device with our current powerline modem that is located nearest distribution sites. The powerline modem sends data through our power cable to the application in the HQ. CCTV footage of animal trespassing can be monitored for further analysis and prepared further prevention action. The distribution staff can monitor the CCTV footage through mobile application.

4. FINDINGS AND DISCUSSION

4.1. Data Collection and Analysis

The CCTV recorded footage shows animal trespassing is the common disruption cases into distribution center such as transmission lines and transformers. They are shown below.

Figure 6: Snakes interferences into the transmission lines.

Figure 7: Squirrels are found walking on transmission lines..

Figure 8:. Bird nest and some bird corpses were found in the transformer mechanics.

The common animals' trespassing/interferences in the area such as: snakes, squirrels, and birds. They cause common short-circuits in transmission lines/transformer (blackouts) in that area.

4.2. Propose Solutions to avoid animal interference.

Figure 9:. Bird barrier block is installed on the transmission line.

Figure 10: Snake barrier.

Figure 11: Squirrels barrier.

Figure 12:. Bird barrier on the bushing transformer.

Figure 13: Isolator cap with electric shock to prevent animal walk closely.

Figure 14: several type of animal crawling barrier (1).

Figure 15:. several animal crawling barrier (2).

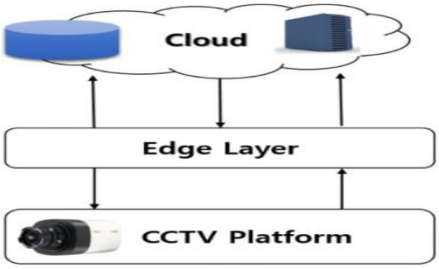

Figure 16:. CCTV-RFID platform.

The article applies solution to avoid animal interference through installing several types of barriers:

1. Operation/maintenance staff installs the barrier prevention device that enables to prohibit animals to interference on the transmission lines/transformers.
2. The barrier device is monitored through a CCTV and RFID device (edge layer) that is installed close to the pillar junction. RFID device sends data to power model that is located near distribution site (see Figure 16 CCTV-RFID platform). Power modem connects to HQ system through cloud service.
3. Reader Data Processing is a built-in Cloud service. We use PN private cloud that supports API (RFID adapter) connection to read data that stored in RFID readers.
4. RFID adapter feeds the data to the RFID filter to check data consistency and fix invalid format.
5. RFID aggregator collects all valid data from RFID filters.
6. RFID data adapter enables to convert the data into structured data that can be retrieved by the Enterprise Integration application (ERP and data analytics).
7. Enterprise integration application enables to make summary and analyses the findings and make recommendations. It updates the RFID data into the corporate ERP system. HQ staff can schedule to

send necessary supplies whenever are needed to the sites. The operation/maintenance staff can have real-time data analysis of the transmission/transformer monitoring on their mobile application.

5. CONCLUSION

Digital transformation has become major campaign for major enterprises in Indonesia. The article takes case study of PN, a state-owned energy company that has faced major problems with animal trespassing/interference into distribution sites such as transmission lines and transformers. Both sites are the essential sites for PN, since they play roles in distributing electricity nationwide. The article examines several types of animal interferences that are conducted by snakes, birds, and squirrels. The presence of those animals has caused major disruptions in electricity distribution. The article provides animal prevention framework that enables the operation staff in distribution site to identify and prevent the incoming animals' interferences. The framework proposes barrier prevention, integrated solar-based camera kits, and RFID readers that are suitable to be applied in rural areas. Indonesia has large area comprises of rural areas, mountains, forests, and islands are suitable for solar-based camera and RFID system. We connect RFID readers with the powerline model that is installed close to the distribution area. The RFID data from the camera can be monitored and analyzed in the enterprise application in the HQ to study the pattern of animal's interference and propose further preventions.

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