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Research Article

THE COST PERFORMANCE OF ELECTRONIC ARTICLE SURVEILLANCE SYSTEM WITH ESP-32 AND UC-15 FOR TOP MANAGEMENT JUDGMENT

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ABSTRACT

This research aims to obtain the optimize results between performance and investment cost of the Electronic Article Surveillance System (EAS) with Digital Camera Technology (ESP-32) and Electronic Article Surveillance System (EAS) with UC-15 for the university top management decision making; what system is worth to deploy at the University. The evaluation parameters of the system are reliability and availability are used to evaluated with the investment cost on each system in order to find the right answer. The simulation times are 1 year, 5 years and 9.8 years to deployed as 3 different time constraint cases to be analyzed. The simulation will apply M/M/1 model to measure the reliability and accessibility on each system, the historical data of the number of power outage, power outage duration time, number of internet connection failure and duration time of internet connection failure are performed in time series to obtain mean time arrival rate which is injected to the simulation in order to match real world problem. The EZsim is used to conduct the simulation model to obtain the results. Finally, we found the answer to support top university management decision making.

Keywords: accMM1, Ezsim, forecast, decision making.

INTRODUCTION

The first system is Electronic Article Surveillance System (EAS) & Digital Camera Technology for Higher security [Surasee, 2021]. It is integrated of EAS, Arduino and ESP32-cam. Arduino microcontroller was programmed to control ESP32-cam to send the message notification to laboratory administrator via line application. The EAS used RFID tag as trigger to detect the person who brought the device which attached the RFID tag when it across the EAS pole beside this the Arduino keep monitor the trigger signal from the EAS system, if signal is generated, it mean device is stolen, then the Arduino will order the ESP32-cam to capture thief image and send thief's photo and message to the laboratory administrator via the line application. This system is illustrated in Figure. 1

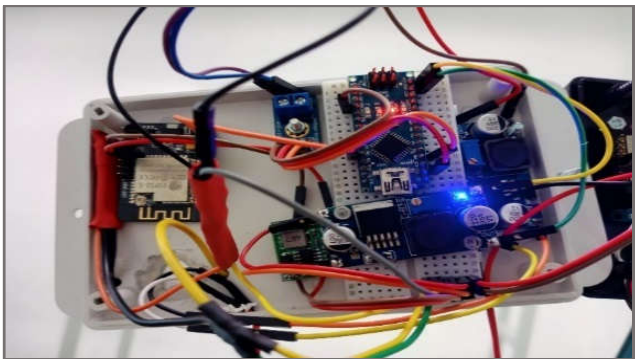

Figure 1 EAS & Digital Camera Technology

The second system is Electronic Article Surveillance System with UC-15 [Surasee, 2021] is integrated of EAS, Arduino and 3G module (UC15-T). They are composed as the system. Arduino microcontroller and 3G module (UC15-T) composed in box as main control, when the EAS detected the RFID tag across the EAS pole the signal is generated where the Arduino are programmed to monitor this signal, when this signal active, Arduino commanded the 3G module (UC15-T) to send the notification via short message service protocol such as "Please check the LAB 2743 now" to the laboratory administrator. The message will appear on laboratory administrator phone which he/she is able to quick respond at that circumstance. The Arduino and 3G module (UC15-T) is shown in Figure. 2

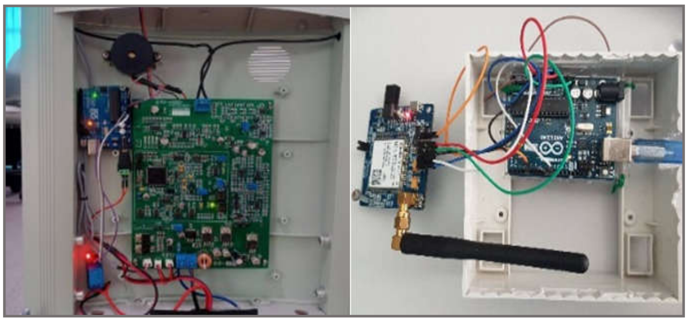

Figure 2 EAS with UC-15

The EAS & Digital Camera Technology (ESP-32) system has established at computer laboratory room 2762 and Electronic Article Surveillance System (EAS) with UC-15 has established at room 2743, at Department of Information communications Technology, Phanakhon Rajabhat University. Both systems are tested and evaluated for 3 months. The results are collected as reliability [3], [4] and availability [5] parameters. EAS & Digital Camera Technology (ESP-32) system has reliability for the first month equal to 100%, second month equal to 98% and last month equal to 96%, also availability results are 100% for the first month, 95% for the second month and 95% for the last month. Another system is Electronic Article Surveillance System (EAS) with UC-15 has reliability result at 100% for the first month, 97% for the second month and 97% for the last month, also availability results are 100% for the first month, 94%

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for the second month and 94% for the last month. The problems of incomplete reliability and availability not 100% are the power outages for long time and internet connection fail even through the power supply is installed on both systems.

BACKGROUND & SIMULATION REVIEW

Background

The Electronic Article Surveillance System (EAS) & Digital Camera Technology (ESP-32) has a system architecture as illustrated on Figure 3. and Electronic Article Surveillance System (EAS) with UC-15 system has a system architecture configuration as illustrated in Figure 4.The architecture on both systems are different in the technique to notify the laboratory administrator when the devices in laboratory is stolen. The EAS with ESP32-CAM used Line application to notify with picture to laboratory administrator, unlike the EAS with UC-15 used SMS with "Please check the LAB 2743 now" message to notify laboratory administrator. The figure 5 illustrated the flow of detection and notification. The system performance parameters for both systems were explained on the introduction part. The system performance was degraded by the rate and duration of Power outage and Internet connection fail. If no Power outage and Internet connection fail, both systems can perform a 100% of reliability and availability. The university top management can make investment decision with the cheap system. However, ideal case never exits so the Cost performance [GuoqiXie *et al.,* 2021] can help the university top management to perform investment decision making from the simulation results.

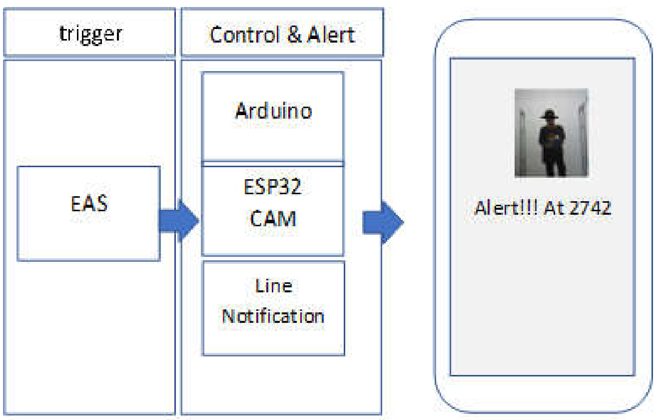

Figure 3 EAS & Digital Camera Technology

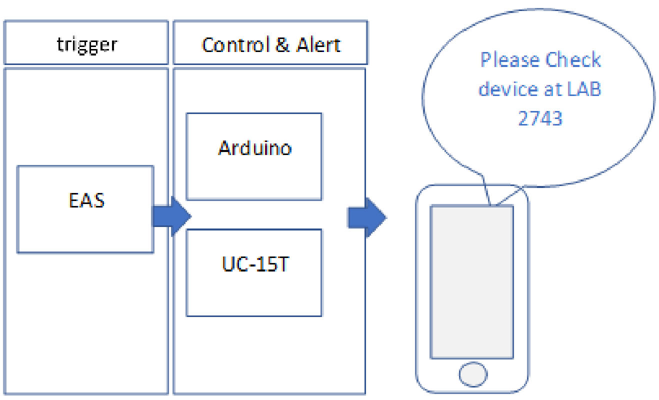

Figure 4 EAS with UC-15

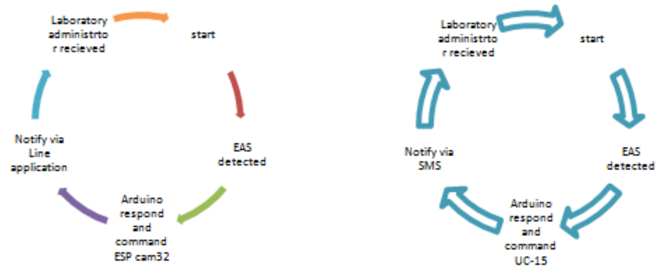

Figure 5 Detection and notification system flow

Both systems were run for 3 months, the systems performance parameters also uncontrollable parameters such as Power outage and Internet connection fail were collected. As the business point of view, the system must be run over more than 5 years in order to compile with procurement and depreciation accounting for Thai government standard. Then, the simulation can help to predict the performance parameters and uncontrollable parameters to find the Cost performance at long term period to evaluate the systems performance parameters, uncontrollable parameters at any period of time in order to find the best Cost performance system for university top management investment decision. The performance parameters of both systems were mentioned in Introduction section, the power outage and internet connection fail are defined as uncontrollable parameter which is collected during the systems test run for 3 months. The logs file was extracted and plot into the graph as represented in Figure. 6

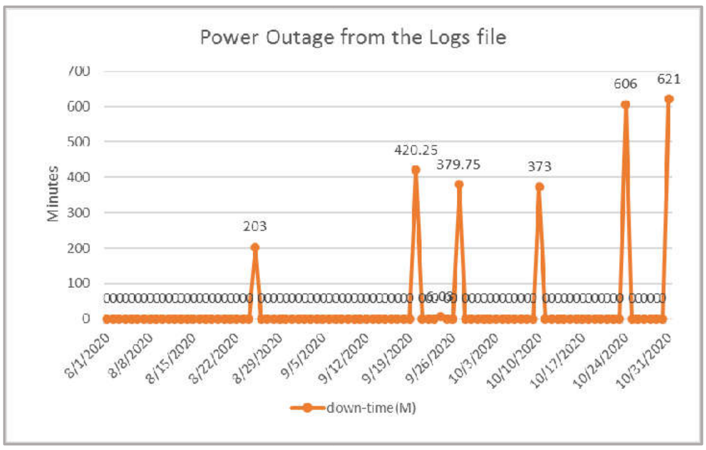

Figure 6 Power Outage data

The internet connection fail rate which is collected during the systems test run for 3 months is 99.7%. The notification message from the Internet Service Provider received 12 times and total time of internet connection fail is 24 hours where is recorded in 3 months. About the price for the EAS with ESP32-CAM system is 39500 baht and The EAS with UC-15 is 37500 baht

Simulation review

The system development in many industries make substantial use of simulation to measure the system performance. Simulation are currently used to help support arguments presented in the analysis of alternatives such as cost and operational effectiveness analyses in order to justify for long term analysis with system development cost performance. The simulation can define as below

Input pattern: [Griffin, 1978]

Arrivals pattern

M: Markovian refers to the number of jobs per unit of time. There is a distribution of Poisson's or the period between the arrival of the service provider.
D: Deterministic refers to the period between the entry of the job with a fixed value.
G: General refers to the period between the entry of the job. There is a general distribution. The mean and variance must be known.
Ek: Means the entry of the job which came to receive the service. There is a k-th order Erlank distribution.

Behavior of service job enter to the system

- The job arrives at the system and waits until receiving the service.
- Service may not be admitted upon arrival. Because the queue is full (balking)
- When waiting in the queue for a period of time, it refuses to wait any longer and drop out (Reneging)
- In the case of more than one buffer A job in a row may switch to another buffer (Jockeying).

Provider Service: [Grübler *et al.,* 2018]

Service pattern

M: Markovian means service time per unit of time. There is an exponential distribution.
D: Deterministic means time of service is constant.
G: General means service time. There is a general distribution. The mean and variance must be known.
Ek: Refers to the time of service. There is a k-th order Erlank distribution.

Number and service units

- Single-channel, one server: This mean a system that has one step of serving one-line, and one serving unit, such as a pay counter at supermarket which has only 1 counter.
- Multi-channel, one server: This means a system with many waiting lines, but there is one service units. Jobs from the waiting line will enter the service from an available line. such as a pay counter at supermarket which has 2 or more counters.
- Single-channel, multi-phase server: This means a system with a multi-stage queuing system. One waiting lines but at each step there are several service units.
- Multi-channel, multi-phase server: This means a system of one queuing line. Many service units, multiple steps, free to find the channel with condition setting.

Output performance: [Kumar Mishra *et al.,* 2020]

The capacity of the waiting line refers to the size of the waiting line. Some queuing systems have a limited number of jobs waiting to receive services because of limited space. When a job is fully waiting, new waiters will not be able to enter the waiting line system. It must be dropped out without being serviced. Then, the system performance parameters, such as reliability, availability are collected by counting the unsuccessful job serviced by the system. The results represent what system can be tolerated to uncontrollable parameters where it performed as input parameter which injected into the simulation.

PROPOSED MODEL

The simulation model applied the M/M/1 method to perform as Figure7.

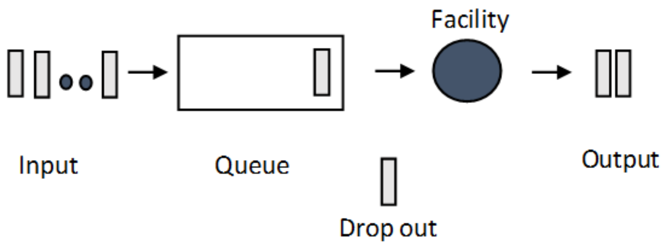

Figure 7 Simulation model.

Input evaluation

The event of power outage and duration are collected during the system test run process to evaluate the performance of the system are illustrated in Figure 8. The data is brought from the logs file and extracted and plotted into graph.

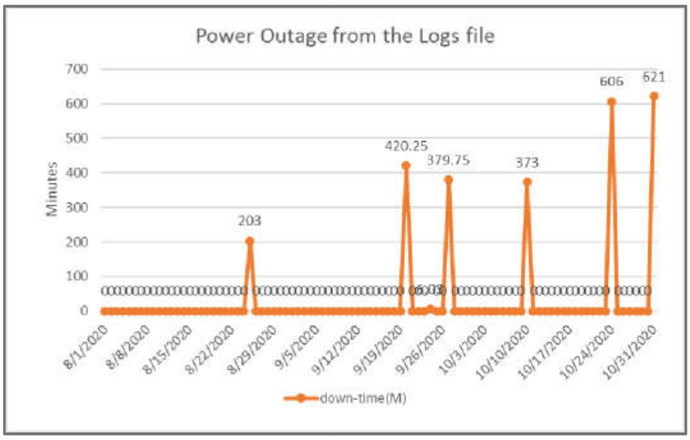

Figure 8. Power Outage data

Figure 8 represented the time series of power outage parameter for 3 months but simulation need the mean time inter arrival to define the simulation input. Then, the first date of power outage occurred to second power outage again is 24 days, to the third is 26 days, to the fourth is 4 days, to the fifth is 3 days, to the sixth is 13 days, to the seventh is 17 days, and last is 7 days for 3 months. So, the mean inter arrival time of event power outage occurred is 13 days. Beside this the duration of power outage is collected to supplied the input parameter as minimum and maximum values for simulation input parameters. Then, the mean of power outage time duration is 434.88 minutes. Base on [Alpay *et al.,* 2020] it shown that the Poisson regression gave the best performance for power outage prediction. Then probability function to use as the time of event in each arrival rate with t, it can be described with the probability function (density) of inter arrival time. Then formula to be used as the result of probability function (density), in case of the inter-arrival time t is bigger than value x so that the average of arrival rate is λ events per second is shown below,

$$fx(t) = \begin{cases} e^{-\lambda t} & \text{for } t \geq 0 \\ 0 \text{ for } t < 0 \end{cases} \quad (1)$$

$$p(t \le x) = F(x) = \int_0^x e^{-\lambda x} dt = 1 - \lambda e^{-\lambda x} \quad (2)$$

$$p(t > x) = \lambda e^{-\lambda x} \quad (3)$$

The process of probability function is described as formula below

$$p(x > s + t| X > t) = p(X > s) = e^{-\lambda s}, \text{for } s_i t > 0 \quad (4)$$

The Markov processes is described by the chance of n that freely emerging event with a time period with T unit of time, this can be applied the Poisson distribution to be performed and the formula is shown below.

$$p(T > x) = 1 - F(x) \quad (5)$$

$$p(n, T) = \frac{(\lambda T)^n e^{-\lambda T}}{n!} \quad (6)$$

Hints: p(X) is chance of X to emerge,
n is the units of arrivals which measure in period of time,
λ is the rate of arrival in average,
E (n|T) = λ*T = estimated value n

at interval rate T, and e = 13 days or 18720 minutes

The internet connection fail rate which is collected during the systems test run for 3 months is 99.7 %. But the THAILAND Mobile Network Experience Report 2020 [Sam Fenwick, 2020] had shown the whole year reliability scores of three operator's 4G in Thailand which have collected since January 2020 to December 2020 as 95.3% for AIS, 93.9% for TRUEMOVE H, and 92.9% for DTAC. Both systems used the AIS operator for internet connection. Then the average of arrival rate is λ events per second can calculate from 95.3%.

Service evaluation

The service times applied by the deterministic means time distribution for probability function due to the data logs of both systems implied the constant working period of time after power outage emerged. The service time which is deployed over this simulation is specified by the maximum system working time after power outage emerged, its giving at 35 minutes for EAS & Digital Camera Technology system and 25 minutes for EAS with UC-15 system.

Output evaluation

The number of services which run over the power outage of both systems will be collected and evaluated.

RESULTS AND DISCUSSION

The evaluation of the system performance evaluated by the number of services which successful ran over the power outage and Internet connect failure on both systems are used as criteria parameter to be collected. The period to perform on the simulation is 1 year, 5 years and 9.8 years. The results are represented in Table 1.

Table 1 The results of the Simulation.

Period of Time	Results			
	EAS with UC-15		EAS& Digital Camera Technology (ESP-32)	
	NO# Event	NO# service success	NO# Events	NO# service success
1 years	24	0	24	1
5 year	143	1	143	4
9.8 year	288	1	288	8

From the Table 1 the EAS with UC-15 system can run success over the power outage and internet connection failure once in five years period and 9.8 years period. Then the EAS Digital Camera Technology system can run success over the power outage and internet connection failure once for a year period, 4 times in a 5 years period and 8 times in a 9.8 years period.

CONCLUSIONS

From the Table 1 is summarized that the EAS& Digital Camera Technology (ESP-32) perform better than EAS with UC-15 system. Even though the total service time after the power outage is difference in 10 minutes when compared for both systems, the EAS & Digital Camera Technology can run longer 10 minutes (35 minutes) than EAS with UC-15 system (25 minutes), however it affected to the number of successful service parameter which reflected to the performance of the system as represented in Figure 9a and Figure 9b.

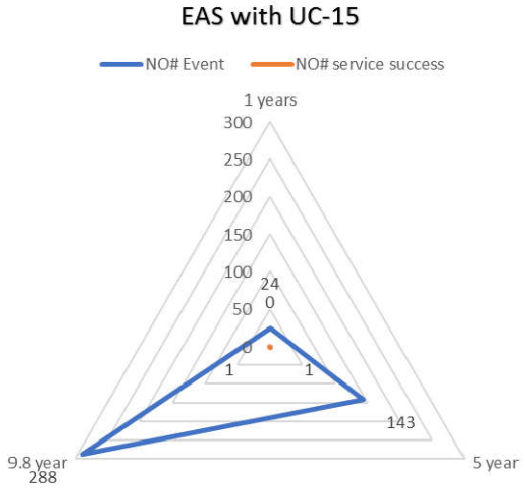

Figure 9 a Results of Power outage and System successful service by EAS with UC-15

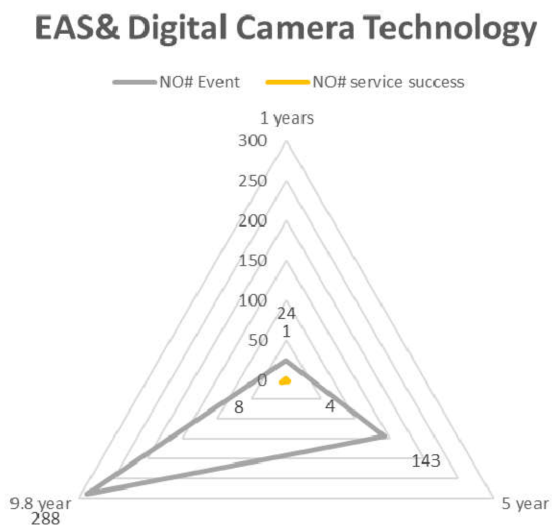

Figure 9b Results of Power outage and System successful service by EAS & Digital Camera Technology (ESP-32)

The result is evaluated and transform into reliability [*Sam Fenwick, 2020*] - [GuoqiXie *et al.,* 2021] parameter in order to ease understanding the system performance which is represented in Table2.

Table 2 The Reliability values of both system

Period Of Time	Reliability	
	EAS with UC-15	**EAS & Digital Camera Technology**
1 years	0.979732	0.979798
5 year	0.975856	0.975873
9.8 year	0.975421	0.97547

The results of reliability values of both systems are not much different due to the time period of power outage is very large when compare to the service time for each system which can run over to win on each power outage event and internet connection failure. If the number of power outage event and number of service successful for both systems are accounted as winning criteria, EAS & Digital Camera Technology (ESP-32) is best performed. From Table 3, the price on EAS uc15 had increased because of yearly fee service charged for Mobile operator. But EAS cam used Wi-Fi at the university was provided. If we had evaluated in term of Cost-Performance with the difference between price and reliability on each system, and the depreciation accounting calculation result on each system vs. Reliability as shown on Figure 10, the EAS & Digital Camera Technology (ESP-32) give us the best Cost-Performance to invest and deploy at university.

Table 3. The summary of Price and Reliability comparison

Year	Price x 1000 baht		
	EAS uc15	**EAS cam**	**Diff (EAS uc15 – EAS cam)**
1	38.5	39.5	-1
5	40	39.5	0.5
9.8	42.5	39.5	3
Year	**Reliability**		
	EAS uc15	**EAS cam**	**Diff (EAS uc15 – EAS cam)**
1	0.979732	0.979798	-0.000066
5	0.975856	0.975873	-0.000017
9.8	0.975421	0.97547	-0.000049

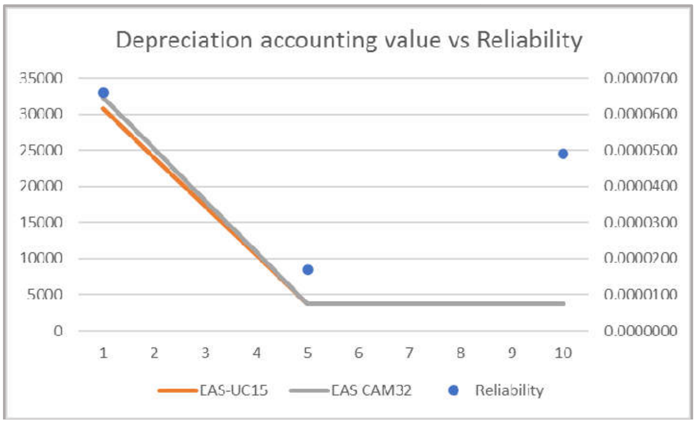

Figure 10. Depreciation accounting result vs. Reliability

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REFERENCES

1. Surasee P. Electronic Article Surveillance System (EAS) & Digital Camera Technology for Higher security. International Journal of Emerging Trends in Engineering Research. 2021 9(4): 485 – 490.
2. Surasee P. The Performance Of Electronic Article Surveillance System (EAS) With UC-15 For Laboratory Security. International Journal of Scientific & Technology Research 2021 10(2):249-253
3. Department of Defend United States of America. Military Handbook Reliability Prediction of Electronic Equipment (MIL-HDBK-338B), 1991
4. Department of Defend United States of America. Military Handbook Reliability Prediction of Electronic Equipment (MIL-HDBK-217F). 1991
5. Department of Defend United States of America, DoD Guide for Achieving Reliability, Availability, And Maintainability. 2005
6. Alpay, B.A.; Wanik, D.; Watson, P.; Cerrai, D.; Liang, G.; Anagnostou, E. Dynamic Modeling of Power Outages Caused by Thunderstorms. Forecasting 2020. 2:151-162.
7. Internet outage https://app.fing.com/internet/provider/True/Thailand/all/Bangkok Accessed 26 October 2020
8. Griffin, W. Queuing: Basic Theory and Applications. Ohio: Grid 1978.
9. M. D. S. Grübler, C. A. Da Costa, and et al, “A hospital bed allocation hybrid model based on situation awareness,” CIN: Computers, Informatics, Nursing, vol. 36, no. 5, pp. 249–255, 2018.
10. Kumar Mishra, Anjay and Koju, Lalit, “Cost Performance Assessment of High Rise Hospital Building Construction Project”,East African Scholars Journal of Economics, Business and Management. 2020
11. Sam Fenwick, “THAILAND Mobile Network Experience Report November 2020” at https://www.opensignal.com/reports/2020/11/thailand/mobile-network-experience
12. GuoqiXie, Wenhong Ma and etl “Price Performance-Driven Hardware Cost Optimization Under Functional Safety Requirement in Large-Scale Heterogeneous Distributed Embedded Systems”, IEEE Transactions on Industrial Electronics (Volume: 68, Issue: 5, May 2021) p 4485 - 4497.

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