Electronic Waste Management with Numerical Forecasting Models

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Abstract

This research aims on the data collection of electronic waste in case of light bulb and dry battery in 6 building locations on green community of the Kasetsart university from 2016 to 2020 though these 5 years. The statistical assessment from the data collection case to forecasting with numerical modelling of the Moving average, the Weight moving average, the Simple exponential smoothing and the Holt's exponential smoothing. The correlation between quantity of light bulb and dry batter y in 5 years from year 2016 to 2020, the correlation between the quantity e-waste is 0.1127 which mean weak correlation or almost no correlation. The prediction for dry battery in 2021 stay around 0 – 5 units. The forecasting e-waste for women's dormitory location in 2021 indicate that Both of prediction for light bulb and dry batter for women's dormitory location in 2021 are stable, but only the prediction in May and September are high. The prediction in light bulb for research institute in 2021 is high in the last 3 months of 2021, but Holt's Exponential Smoothing has high prediction's line in first 4 months then stable until September then the prediction's line rises around 10 units. The prediction in dry battery in 2021 is high in January and August then stay under 10 units in 2021. The research result benefits from Pearson's correlation and the forecasting techniques of this research with the Moving average, the Weight moving average, the Simple exponential smoothing, the Holt's exponential smoothing can be used to prepare for what will happen in the future, gain the valuable in insight, and thee result from prediction methods could decrease cost for the environmental management on the green community on the e-waste.

Keywords: Forecasting; Electronic waste; Community; Correlation; Statistic; Numerical modelling

Introduction

The present statistical Analysis from the data collection case to forecasting with statistic numerical modelling. The analysis have Pearson's correlation measure correlation between interested data, but not causation and the forecasting techniques in the present are Moving average, Weight moving average, Simple exponential smoothing, Holt's exponential smoothing. The Pearson's correlation in this research is Technique to measure correlation between interested data, but not causation. The Purpose of the Correlation used to measure how linearly related between two random variables or interested data. The result is in range of –1 to 1, –1 mean the variables have negative relationship and correlation value equal to 1 mean both of variables have position relationship. The value of correlation equal 0 means both of interested data have no relationship between them. Generally, if the values of correlation lay on –0.1 to 0.1, the researchers can assume that there is no relationship and if the values of correlation have values greater than 0.7 or less than –0.7, the researchers can assume that there is strong relationship between those interested data.

The benefits of Pearson's correlation are measure the relationship between interested data, the correlation offers a starting position for research, easy to interpret, the related data would have relationship, can be applied to several forecasting method, non–relationship could lead to irrelevant between interested data, ignore these data or manipulate to do the forecasting techniques. The forecasting technique of the Moving average as one of the simplest forecasting techniques have the benefits on the prediction values are stable and The simplest forecasting technique. The forecasting technique of the Weight moving average as more advanced by adding a weight as coefficient in the equation. The set of coefficients that will be assigned a greater weight to newer data point, while past data points are assigned to be less weight, have the benefits on adding the Weight parameter though time, the present data has more value than older data, and may capture present's event that affect the raw data. The forecasting technique of the Simple exponential smoothing as one of the techniques in exponential smoothing forecasting.

The simple exponential smoothing technique is weighting between the observed data and the forecasting data, have the benefits on the easiest in exponential smoothing technique, and weight between past forecasting value and actual value could perform better than moving average. The forecasting technique of the Holt's exponential smoothing as the concept is to introduce a term of capturing the trend from the data.

This research has done the exponential smoothing by using Python's library called stats model, have the benefits on Holt's exponential smoothing technique can capture trend in raw data, and more accurate than simple exponential smoothing in general.

Research Objectives

This research study on the data collection of e-waste of light bulb and dry battery in 6 building location on green community of the Kasetsart University from 2016 to 2020 though these 5 years. The statistical analysis from the data collection case to forecasting with statistic numerical modelling. Pearson's correlation of this research is technique to measure correlation between interested data, but not causation. The forecasting techniques of this research are the Moving average, the Weight moving average, the Simple exponential smoothing, the Holt's exponential smoothing.

Literature Review

Electronic waste (e-waste) arising from end-of-life electronic products. Lot of the e-waste are computers and mobile phones that the fastest present growing waste streams in the world. Annual global production of the e-waste is estimated to surpass 50 million tons in 2020. E-waste contains several precious metals, rare earth metals, ferrous and non-ferrous metals, plastic, wood and glass. Unscientific practices in the processing of e-waste are associated with several environmental and health externalities (Turaga et al., 2019). The e-waste is unique because of the toxic, hazardousness, and nonbiodegradable nature of its components. The e-waste of the new environmental threats attributed to technological advancements, urbanization, industrialization, increasing population, and economic development. e-waste is waste generated from any equipment running on electricity or a battery including computers, laptops, televisions (TVs), digital video disc (DVD) players, mobile phones, MPEG-1 audio layer III (MP3) players, and many others which have been disposed by their original users. e-waste also includes a broad range of electronic devices from large household appliances to personal products such as handheld cellular phones, personal stereos, consumer electronics, and computers huge numbers of ICT equipment will eventually become e-waste in the near future hence there is a need for better planning. Furthermore, in an effort to make ICT affordable, the government of Uganda put tax waivers on importation of computers which promotes the importation of used and refurbished devices such as computers, laptops, and mobile telephones. e-waste contains more than 1,000 different substances such as lead, mercury, arsenic, cadmium, selenium, hexavalent chromium, and flame retardants that create dioxins emissions when burned. Poor handling, recycling, and disposal of e-waste can cause severe impacts on public health and the environment. Toxins arising from e-waste have been found to cause brain damage, birth defects, allergic reactions, and cancer (Xianlai, 2017).

The use and consumption of mobile devices are increasing thanks to easy access to this type of technology, which inherently increases the generation of electronic waste. Determining the psychometric properties of an instrument measures adolescent attitudes towards the management of electronic waste. A validation of content and construct supported by the application of exploratory and confirmatory factorial analysis was performed. This scale could be applied in high school student populations and could be input for various works of research (Pascuas-Rengifo et al., 2021). One of the problems facing public education institutions in Brazil is the question of the correct handling and treatment of waste electrical and electronic equipment (WEEE). Considering the regulations for disposal of public goods that institutions have no WEEE management model which the lack of such a management model, the university warehouse is at full capacity and unable to receive additional electronic equipment. Therefore, creating a management model for WEEE to be used at public education institutions using the guidelines. Action research is an adequate management tool for public institutions looking to deal with problems of this nature, being that these institutions are almost always subject to bureaucratic controls with respect to their public property and expected to follow rigorous legislation that is often times controversial (Paes et al., 2017).

The management of used and end-of-life (EOL) electronics for over a decade, promotes the reuse and recycling of used and EOL electronics through various programs, including Plug-In To eCycling and the Federal Electronics Challenge. EOL electronics stems from three primary concerns about rapiding growth and change in this product sector, leading to a constant stream of new product offerings and a wide array of obsolete products needing appropriate management; the presence of toxic substances in many products which can cause problematic exposures during recycling or disposal, if these products are not properly managed; and the need for widespread, convenient and affordable opportunities to reuse/recycle electronics (with initial emphasis on TVs, PCs and cell phones). Reuse and recovery of electronics conserves energy and materials embodied in used electronics and reduces the environmental impact of these products (Peyton, 2010).

E-waste management has become the top global issue in terms of environmental protection and resource recycling. Although many attempts have been carried out to address the issue, many problems remain. With respect to most developing countries, legislation improving and collection channel strengthening will significantly contribute to e-waste recycling. Regarding small countries or regions ratifying the Basel Convention, mobile plants with efficient amounts of equipment can be promising candidates for e-waste recycling. And for some countries with little e-waste production, a feasible solution for e-waste recycling is that related countries can unite to establish some field facilities for a synergic management of their e-waste. This book is dedicated to solve the e-waste problem with some feasible solutions. It will provide some assistance for many stakeholders in e-waste areas. According to the obtained results and implications, academic researchers can find the future direction of unsolved subjects, and governments can make more reasonable decisions. (Turaga et al., 2019). With advancements in the electronic world almost occur on a day-to-day basis and increased availability of products to the public. The plastic materials from e-waste; challenges and opportunities of e-waste management in developing countries and to recovery of valuable metals from flat panel displays of spent liquid crystal and plasma televisions (Li & Wang, 2012). The recycling and reuse of waste from electrical and electronic equipment (WEEE) plays a critical role in sustainable urban development. The behavior strategies of the government and recyclers under WEEE subsidies as the optimal solution to the game for the government.

The recycler is the separating equilibrium (SE) reduce cheating (Fu et al., 2020). e-waste is the fast-growing waste streams in the world increasing concern worldwide, e-waste has not yet been discussed in depth in the Middle East and North Africa (MENA) region. Giving an estimate of the past and future trends in the generation of obsolete computers in Algeria. Combining two models: the Carnegie Mellon model and the market supply (distribution delay) model. The Carnegie Mellon model offers the following options for obsolete computers and monitors: the device could be reused, stored, or discarded. The amounts of devices falling into each category were determined based on these options. The outcomes from the market supply (distribution delay) model show that high amounts of computer and monitor waste were registered for the period from 2014 to 2016 (Hamouda & Adjroudi, 2017). The economic opportunity that e-waste offers, therefore, also brings along with it a gnarly web of environmental justice and public health challenges that local and global e-waste regulators are grappling with. However, the bill doesn't extend access to these resources to unaccredited e-waste companies. One of the first steps towards building a circular economy as e-waste become raw materials rather than waste (Cheng, 2021).

Research Methodology

The data collection of e-waste of light bulb and dry battery in 6 building locations on green community of the Kasetsart University from 2016 to 2020 though these 5 years. The locations consist of Library, Healthcare facility, Veterinary faculty, Environment faculty, Women's dormitory, and Research institute.

The statistical Analysis from the data collection case to forecasting with statistic numerical modelling follow as;

1. Pearson's correlation: Technique to measure correlation between interested data, but not causation (Kirch, 2008).

$$r_{xy} = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}$$

Parameter:

r_{xy} correlation between x and y

x_t value of x at time t

$\bar{x}$ average of x

y_t value of y at time t

$\bar{y}$ average of y

2. Moving average: This technique is one of the simplest forecasting techniques. The formula is as follow:

$$\hat{y}_{t+1} = MA(k)_t$$

Parameter:

$\hat{y}_{t+1}$ forecasting value at t+1 period

k number of time periods

3. Weight moving average: This technique is more advanced by adding a weight as coefficient in the equation. The set of coefficients that will be assigned a greater weight to newer data point, while past data points are assigned to be less weight. The formula is as follow:

$$\hat{y}_{t+1} = WMA(k)_t$$

Parameter:

W coefficient value as weight

4. Simple exponential smoothing: This is one of the techniques in exponential smoothing forecasting. The simple exponential smoothing technique is weighting between the observed data and the forecasting data (Brown,1963)

$$\hat{y}_{t+1} = \alpha y_t + (1-\alpha)\hat{y}_t$$

Parameter:

$\hat{y}_t$ forecasting value at t period

y_t actual data at t period

α the smoothing factor, $0 < \alpha < 1$

5. Holt's exponential smoothing: The concept is to introduce a term of capturing the trend from the data (Holt,1957). This research has done the exponential smoothing by using Python's library called stats model (Seabold & Perktold, 2010).

$$L_t = \alpha y_t + (1-\alpha)(L_{t-1} + T_{t-1})$$

$$T_t = \beta(L_t - L_{t-1}) + (1-\beta)T_{t-1}$$

$$\hat{y}_{t+p} = L_t + pT_t$$

Parameter:

α the smoothing factor for level, $0 < \alpha < 1$

β the smoothing factor for trend, $0 < \beta < 1$

Research Results

1. The e-waste number comparison of the 6 building locations are library location, Healthcare facility location, veterinary faculty location, environment faculty location, women's dormitory location from 2016 to 2020 (Table 1). The e-waste in 2 categories, light bulb and dry battery that the light bulb seems to be large in library, veterinary faculty, and women’s dormitory. The quantity of dry battery is around 100 – 400 units which is a lot less than light bulb (Figure 1). The e-waste number summary of the 6 locations show light bulb of 9081 and dry battery of 1,171 from 2016 to 2020 (Figure 2). Lot of e- waste appear to be light bulbs. Since every building install the light bulbs, but not every people using dry battery in daily.

Table 1 Number summary of light bulb and dry battery in 6 buildings from 2016 to 2020.

Building Locations	Light bulb	Dry battery
Library	2,233	178
Healthcare facility	488	394
Veterinary faculty	3,042	251
Environment faculty	185	96
Women's dormitory	2,818	32
Research institute	315	220

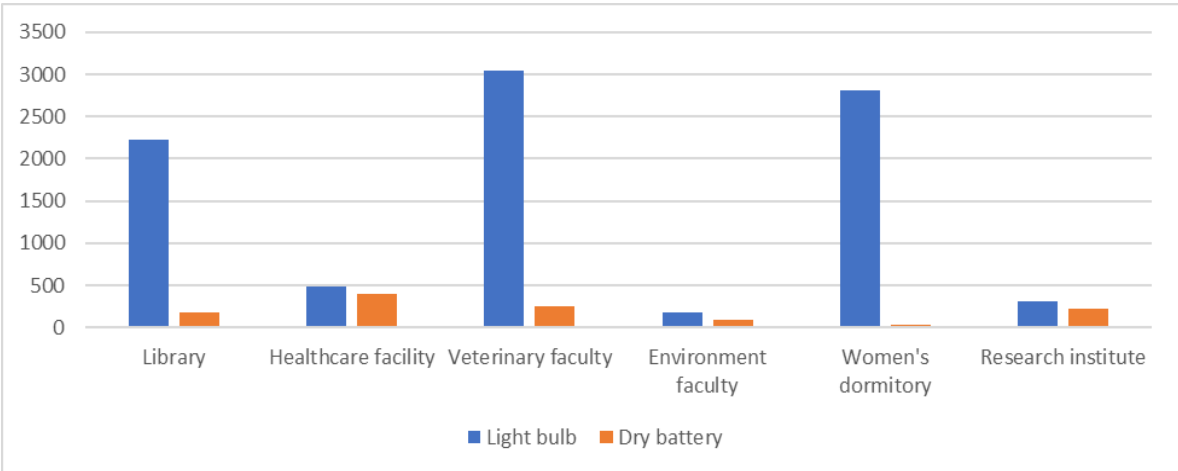

Fig.1 The light bulb and dry battery from 2016 until 2020.

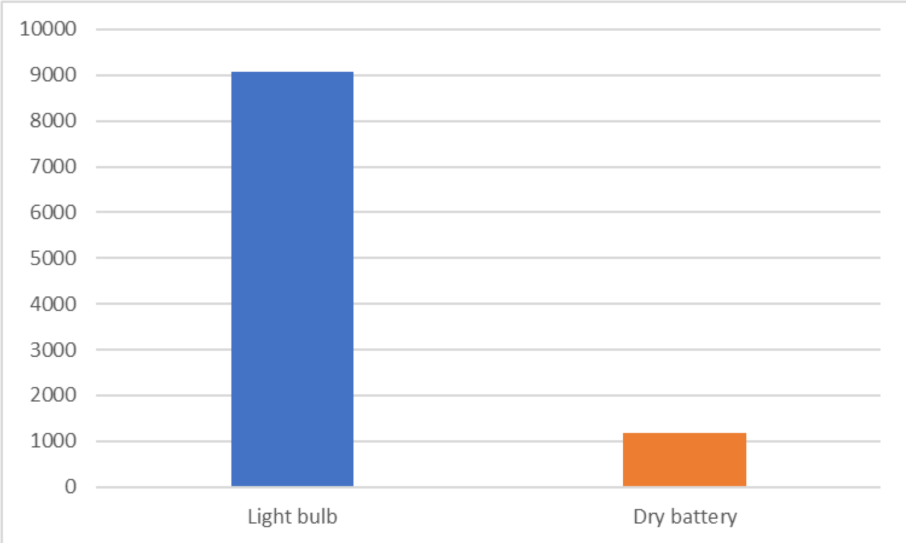

Fig.2 The quantity of electronic waste from 2016 until 2020.

2. The number comparison of light bulb and dry battery in each year from 2016 to 2020 from the 6 building locations of library location, Healthcare facility location, veterinary faculty location, environment faculty location, women's dormitory location (Table 2). The light bulb's line moving around 1,300 – 2,100 units though these 5 years and dry battery's line moving around 50 – 400 units in these 5 years (Figure 3).

3. The correlation between quantity of light bulb and dry battery in 5 years from year 2016 to 2020, the correlation between the quantity e-waste is 0.1127 which mean weak correlation or almost no correlation. Therefore, both light bulb and dry battery have no correlation between them (Table 3).

4. The prediction of light bulb and forecasting techniques in library location in 2021 from the 5 years data collection and the prediction analysis, and the prediction of dry battery and forecasting techniques in library in 2021 from the 5 years data collection and the prediction analysis. The forecasting for library location in 2021 indicate that the forecasting value rise at the ending of year 2021. The Holt's Exponential Smoothing technique predict the emerging quantity in September and drop in October. The other techniques lines are moving around 0 to 10 units (Table 4-5 and Figure 4-5).

Table 2 Number of light bulb and dry battery in 6 buildings each year from 2016 to 2020.

Year	Light bulb	Dry battery
2016	2,094	233
2017	2,055	270
2018	1,290	72
2019	1,930	216
2020	1,712	380

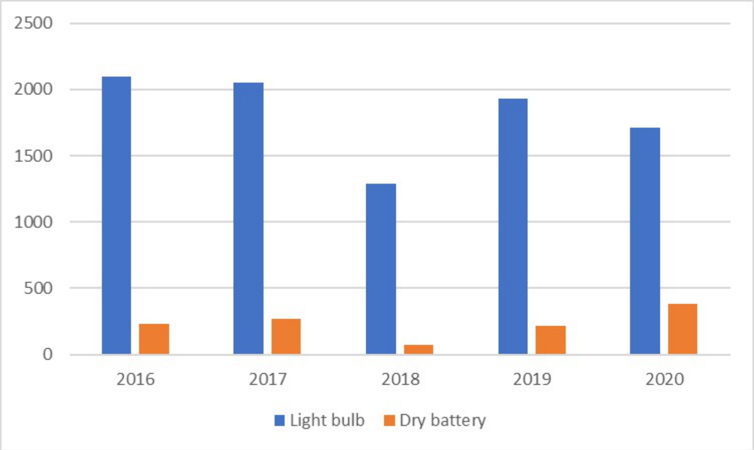

Fig.3 The quantity of light bulb and dry battery from 2016 until 2020 each year.

Table 3 Correlation between light bulb and dry battery in 5 years.

Correlation	Light bulb	Dry battery
Light bulb	1	
Dry battery	0.1127	1

Table 4 The prediction of light bulb in library location in 2021.

Date	Moving Average k=3	Weight Moving Average k=3	Simple Exponential Smoothing	Holt's Exponential Smoothing
Jan 2021	37.67	41.00	41.50	51.99
Feb 2021	24.00	34.83	10.75	0
Mar 2021	11.33	13.83	24.50	11.50
Apr 2021	7.67	10.50	13.00	0
May 2021	26.67	33.17	31.50	12.50
Jun 2021	23.00	18.67	15.00	0
Jul 2021	34.33	31.83	38.75	34.00
Aug 2021	29.33	32.00	12.00	1.50
Sep 2021	35.00	32.50	20.00	10.50
Oct 2021	38.67	40.50	51.75	42.00
Nov 2021	25.67	22.67	49.50	20.50
Dec 2021	46.67	45.83	65.00	69.50

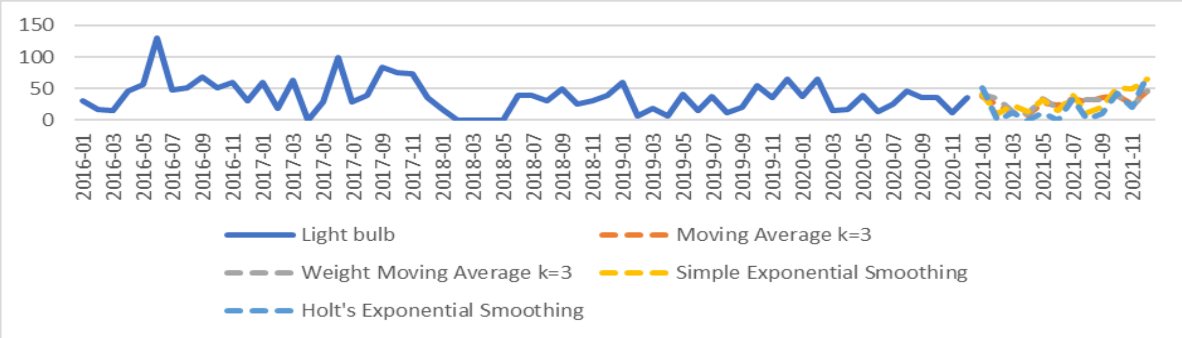

Fig.4 Forecasting techniques in light bulb for library location in year 2020.

Table 5 The prediction of dry battery in library location in 2021.

Date	Moving Average k=3	Weight Moving Average k=3	Simple Exponential Smoothing	Holt's Exponential Smoothing
Jan 2021	3.00	3.00	2.25	8.99
Feb 2021	0	0	0	0
Mar 2021	4.00	4.83	4.25	7.00
Apr 2021	0	0	0	0
May 2021	4.67	5.83	3.50	7.00
Jun 2021	4.00	4.33	5.00	2.50
Jul 2021	2.33	3.50	1.00	0
Aug 2021	0	0	5.00	0
Sep 2021	5.00	5.00	5.00	15.00
Oct 2021	4.67	4.67	1.75	3.50
Nov 2021	0	0	0	0
Dec 2021	0	0	0	0

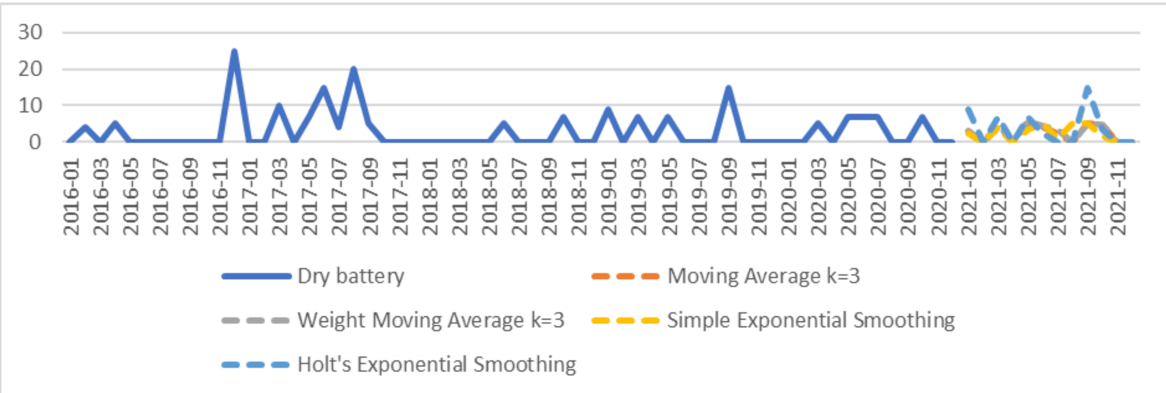

Fig.5 Forecasting techniques in dry battery for library location in year 2021.

5. The prediction of light bulb and forecasting techniques in healthcare facility location in 2021 from the 5 years data collection and the prediction analysis, and the prediction of dry battery and forecasting techniques in healthcare facility location in 2021 from the 5 years data collection and the prediction analysis. The forecasting e– waste for healthcare facility location in 2021 indicate that quantity of light bulb and dry battery are almost equal in healthcare facility location. Both predict of light bulb and dry battery in 2021 are high in July and stay around 10 – 20 units after October (Table 6–7 and Figure 6–7).

Table 6 The prediction of light bulb in healthcare facility location in 2021

Date	Moving Average k=3	Weight Moving Average k=3	Simple Exponential Smoothing	Holt's Exponential Smoothing
Jan 2021	14.00	13.50	13.50	33.50
Feb 2021	3.00	3.67	7.25	0.50
Mar 2021	2.67	3.00	5.25	5.00
Apr 2021	2.00	2.83	2.50	0
May 2021	4.00	4.67	4.75	4.99
Jun 2021	16.33	12.50	14.25	30.50
Jul 2021	6.67	6.00	6.25	7.49
Aug 2021	7.67	6.67	9.00	12.50
Sep 2021	15.00	10.50	13.50	16.00
Oct 2021	8.00	6.67	10.25	11.50
Nov 2021	11.00	10.00	10.25	14.99
Dec 2021	12.33	10.00	14.25	16.50

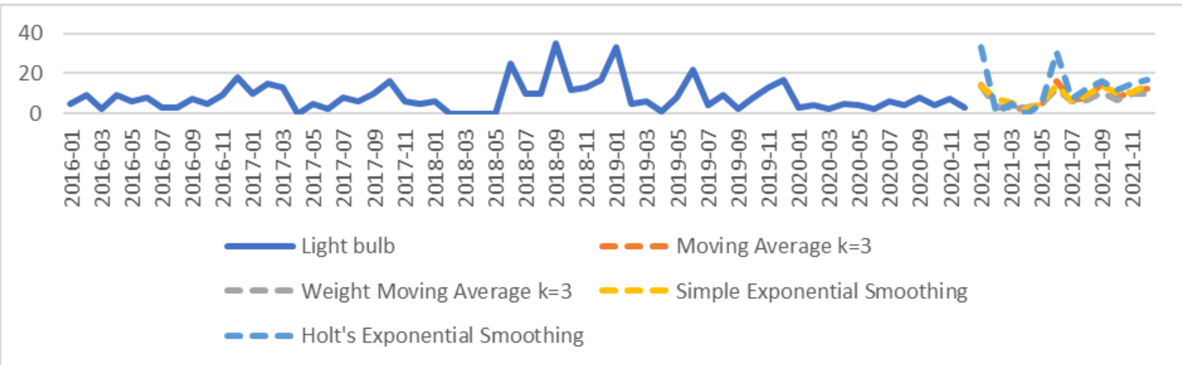

Fig.6 Forecasting techniques in light bulb for healthcare facility location in year 2021.

Table 7 Show the prediction of dry battery in healthcare facility location in 2021.

Date	Moving Average k=3	Weight Moving Average k=3	Simple Exponential Smoothing	Holt's Exponential Smoothing
Jan 2021	3.67	3.67	3.00	4.99
Feb 2021	4.67	5.83	4.50	14.00
Mar 2021	1.67	2.50	0	0
Apr 2021	6.00	8.50	2.75	0
May 2021	2.33	3.50	0	0
Jun 2021	4.33	5.50	2.00	0
Jul 2021	10.00	10.67	15.00	17.99
Aug 2021	4.00	4.33	4.25	0
Sep 2021	5.00	5.17	6.00	1.50
Oct 2021	4.67	5.00	6.00	3.00
Nov 2021	10.00	15.00	1.00	0
Dec 2021	9.00	9.33	13.50	2.00

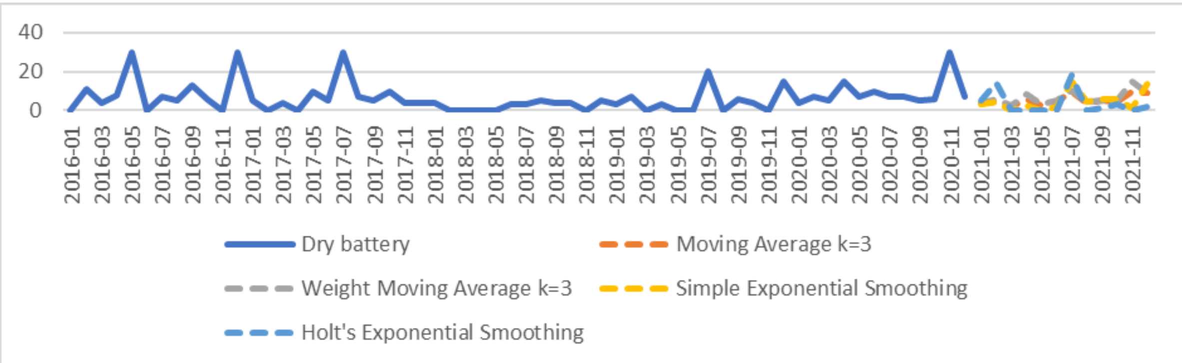

Fig.7 Forecasting techniques in dry battery for healthcare facility location in year 2021.

6. The prediction of light bulb and forecasting techniques in veterinary faculty location in 2021 from the 5 years data collection and the prediction analysis, and the prediction of dry battery and forecasting techniques in veterinary faculty location in 2021 from the 5 years data collection and the prediction analysis. The forecasting e-waste for veterinary faculty location in 2021 indicate that the prediction for light bulb in veterinary faculty location in 2021 is high in January and July then stay around 20 – 70 units whole year. In the prediction for dry battery in 2021 is high in July and September then stay around 5 – 20 units (Table 8-9 and Figure 8-9).

Table 8 The prediction of light bulb in veterinary faculty location in 2021.

Date	Moving Average k=3	Weight Moving Average k=3	Simple Exponential Smoothing	Holt's Exponential Smoothing
Jan 2021	128.67	141.50	142.99	203.00
Feb 2021	38.67	52.50	19.25	21.00
Mar 2021	26.33	31.33	47.25	8.00
Apr 2021	28.33	35.83	16.50	80.00
May 2021	35.33	46.17	23.25	35.00
Jun 2021	28.33	36.33	32.25	33.50
Jul 2021	65.67	68.67	60.50	124.00
Aug 2021	42.00	45.17	27.00	14.00
Sep 2021	55.67	53.50	57.50	30.00
Oct 2021	54.67	57.17	84.92	74.00
Nov 2021	55.67	51.83	58.00	51.50
Dec 2021	49.33	49.50	46.50	52.50

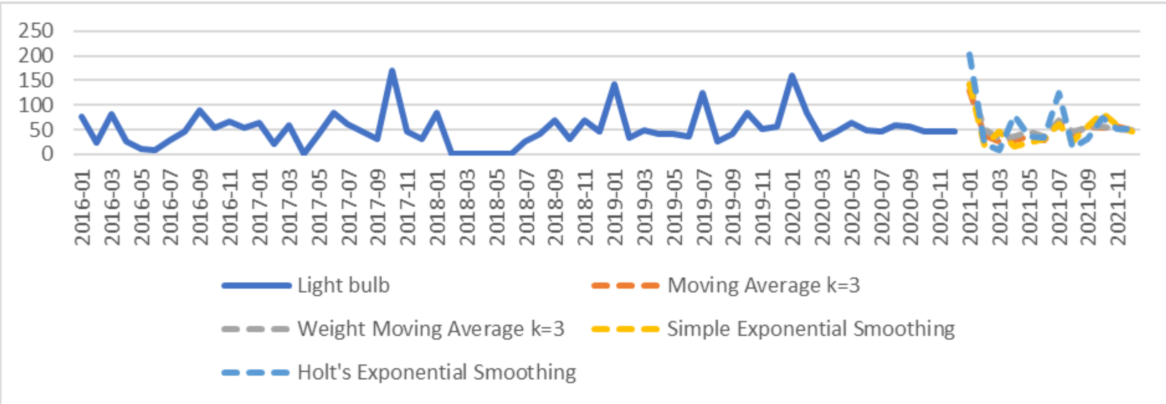

Fig.8 Forecasting techniques in light bulb for veterinary faculty location in year 2021.

Table 9 The prediction of dry battery in veterinary faculty location in 2021.

Date	Moving Average k=3	Weight Moving Average k=3	Simple Exponential Smoothing	Holt's Exponential Smoothing
Jan 2021	2.33	2.33	1.75	7.00
Feb 2021	0	0	0	0
Mar 2021	5.00	7.50	0	0
Apr 2021	0	0	0	0
May 2021	0	0	0	0
Jun 2021	0	0	3.75	0
Jul 2021	38.33	57.50	1.75	0
Aug 2021	0	0	0	0
Sep 2021	10.00	10.00	7.50	30.00
Oct 2021	5.67	8.50	3.75	0
Nov 2021	0	0	0	0
Dec 2021	0	0	0	0

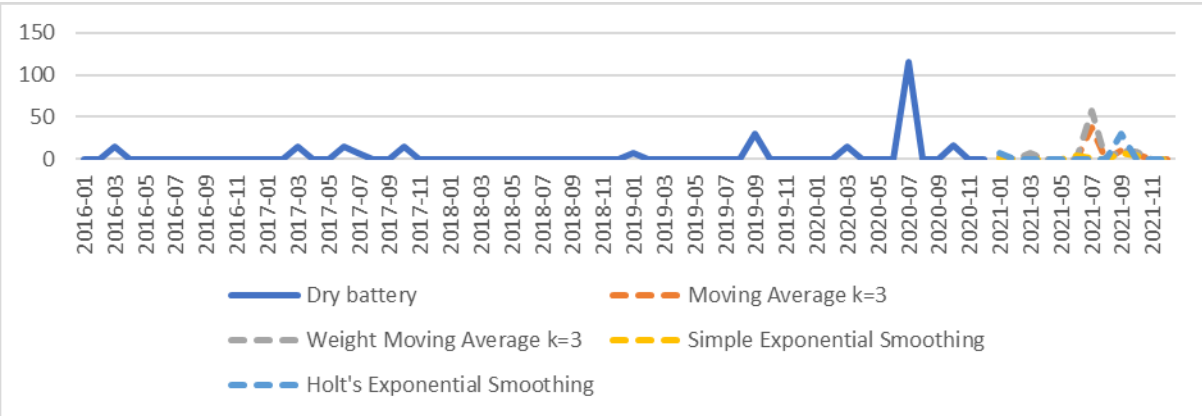

Fig. 9 Forecasting techniques in dry battery for veterinary faculty location in year 2021.

Discussions

1. This research study on the data collection of e–waste of light bulb and dry battery in 6 building locations on green community of the Kasetsart university from 2016 to 2020 though these 5 years. The statistical Analysis from the data collection case to forecasting with statistic numerical modelling. Pearson's correlation of this research is technique to measure correlation between interested data, but not causation. The forecasting techniques of this research are the Moving average, the Weight moving average, the Simple exponential smoothing, the Holt's exponential smoothing.

2. The prediction of light bulb and forecasting techniques in veterinary faculty location in 2021 from the 5 years data collection and the prediction analysis, and the prediction of dry battery and forecasting techniques in veterinary faculty location in 2021 from the 5 years data collection and the prediction analysis. The forecasting e-waste for veterinary faculty location in 2021 indicate that the prediction for light bulb in veterinary faculty location in 2021 is high in January and July then stay around 20 – 70 units whole year. In the prediction for dry battery in 2021 is high in July and September then stay around 5 – 20 units.

3. The prediction of light bulb and forecasting techniques in environment faculty location in 2021 from the 5 years data collection and the prediction analysis, and the prediction of dry battery and forecasting techniques in environment faculty location in 2021 from the 5 years data collection and the prediction analysis. The forecasting e-waste for environment faculty location in 2021 indicate that the prediction for light bulb for environment faculty in 2021 stay around 0 – 8 units. And the prediction for dry battery in 2021 stay around 0 – 5 units.

4. The prediction of light bulb and forecasting techniques in women's dormitory location in 2021 from the 5 years data collection and the prediction analysis, and the prediction of dry battery and forecasting techniques in women's dormitory location in 2021 from the 5years data collection and the prediction analysis. The forecasting e-waste for women's dormitory location in 2021 indicate that Both of prediction for light bulb and dry batter for women's dormitory location in 2021 are stable, but only the prediction in May and September are high.

5. The research result benefits from Pearson's correlation and the forecasting techniques of this research with the Moving average, the Weight moving average, the Simple exponential smoothing, the Holt's exponential smoothing can be used to prepare for what will happen in the future, gain the valuable in insight, and thee result from prediction methods could decrease cost for the environmental management on the green community on the e-waste.

Conclusion

1. The correlation between quantity of light bulb and dry battery in 5 years from year 2016 to 2020, the correlation between the quantity e-waste is 0.1127 which mean weak correlation or almost no correlation. Therefore, both light bulb and dry battery have no correlation between them.

2. The prediction of light bulb and forecasting techniques in library location in 2021 from the 5 years data collection and the prediction analysis, and the prediction of dry battery and forecasting techniques in library in 2021 from the 5 years data collection and the prediction analysis. The forecasting for library location in 2021 indicates that the forecasting value rise at the ending of year 2021. The Holt's Exponential Smoothing technique predict the emerging quantity in September and drop in October. The other techniques lines are moving around 0 to 10 units.

3. The prediction of light bulb and forecasting techniques in healthcare facility location in 2021 from the 5 years data collection and the prediction analysis, and the prediction of dry battery and forecasting techniques in healthcare facility location in 2021 from the 5 years data collection and the prediction analysis. The forecasting e-waste for healthcare facility location in 2021 indicate that quantity of light bulb and dry battery are almost equal in healthcare facility location. Both predict of light bulb and dry battery in 2021 are high in July and stay around 10 – 20 units after October.

4. The prediction of light bulb and forecasting techniques in research institute location in 2021 from the 5 years data collection and the prediction analysis, and the prediction of dry battery and forecasting techniques in research institute location in 2021 from the 5 years data collection and the prediction analysis. The forecasting e-waste for research institute location in 2021 indicate that the prediction in light bulb for research institute in 2021 is high in the last 3 months of 2021, but Holt's Exponential Smoothing has high prediction's line in first 4 months then stable until September then the prediction's line rises around 10 units. The prediction in dry battery in 2021 is high in January and August then stay under 10 units in 2021.

Suggestions

This next research can study on the data collection of types the different electronic wastes on urban locations in experiment period with the statistical assessment to forecasting with numerical modelling of the Moving average, the Weight moving average, the Simple exponential smoothing and the Holt's exponential smoothing.

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