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Guidelines for Effective Industrial Waste Management of the Industrial Business Sectors

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Abstract: The continuous rise of industrial waste has a tremendous impact on communities and the environment of Thailand. The purpose of this study was to develop a Structural Equation Model (SEM) for industrial waste management in the industrial business sectors. Four aspects arranged in the order of importance were as follows: Process Management, Business Ethics, Technology and Innovation, and Participation respectively. The hypothesis test result showed that the Business Ethics directly influenced the Participation and the Technology and Innovation, the Technology and Innovation directly influenced the Participation and the Participation directly influenced the Process Management; all the four paths were at the statistical significant level of 0.001, the Technology and Innovation directly influenced the Process Management at the statistical significant level of 0.01. As a whole, no differences between industrial waste management for enterprises in and outside the industrial estates at the statistical significance level of 0.05. The analysis of SEM revealed that it passed the assessment criteria and was consistent with the empirical data. The chi-square probability level, the relative chi-square, the goodness of fit index, and the root mean square error of approximation were 0.089, 1.143, 0.961, and 0.017, respectively.

Key words: Industrial waste, sustainable waste management, structural equation modeling, SEM.

Introduction

The continuous rise of industrial waste has a tremendous impact on communities and the environment. So industrial waste management is an urgent necessity. This research aimed to study the guideline for effective industrial waste management in industrial business sectors. Thailand's government driving policies define the long-term national development strategy (2018-2037) to be sustainable and stable. With economics and social development in an environmentally friendly way, more green areas, lower carbon footprint, having environmentally friendly production and consumption behaviour (Ministry of Public Health, 2021). These include water pollution, air, noise, and pollution caused by industrial waste. Industrial wastes cause natural resources, water resources, and natural ecological problems (Grenni et al., 2018). Hazardous industrial waste has an impact on the environment and the body (Fazzo et al., 2017) causing dangerous, life-threatening diseases. Industrial waste can be divided into two sub-categories: hazardous and non-hazardous industrial waste (Department of Disease Control, 2020) From the data, it can be seen that the amount of industrial waste tends to be higher as in Figure 1.

Department of Pollution Control received an approved budget allocation for industrial waste management compared to the total annual budget with a continuously high number, but the amount of industrial waste is getting higher to contaminate the community

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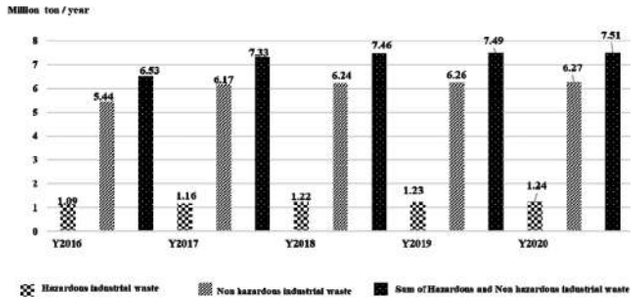
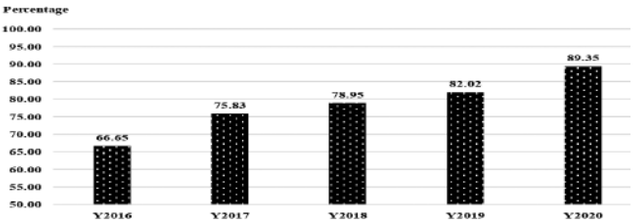


(Department of Industrial Work, 2020)

Figure 1: Amount of hazardous and non-hazardous industrial waste.



(Department of Pollution Control, 2020)

Figure 2: Percentage of industrial waste management budget.

and the environment. The budget for industrial waste management compared to the total annual budget is shown in Figure 2.

Industrial waste is contaminating the food chain, which is harmful to human health. Inhalation, ingestion, and skin contact with industrial wastes can cause injury and illness. If there is no good management, it will become a serious problem for the country soon. Therefore, the researcher is interested to study and find an effective industrial waste management solution to bring benefits to the industrial business sectors.

Objectives

The objective of this research was to develop the Structural Equation Model (SEM) of guidelines for effective industrial waste management in the industrial business sectors in Thailand.

Hypotheses

Following relevant literatures, the researcher determined six hypotheses based on the related theories as follows:

H1: Business Ethics directly influence Participation.

Ethics in business correlated to success in the current role of employee participation and future success potential (Dust et al., 2018). If employees were mentally exhausted, it would harm inspiration and if leaders are unethical or less, they can have an impact on organizational participation and success (Huang and Paterson, 2017). Ethics and employee participation build positive organisational outcomes (Ahmad and Gao, 2018).

H2: Business Ethics directly influence Technology and Innovation.

Although investing in green technology had a higher cost, entrepreneurs should have care and ethics in business to bring technology and innovation to develop the environment and community (Chuang and Huang, 2018). Entrepreneurs should be ethical to adapt and conduct green business activities through green technology and innovation. (EI-Kassar and Singh, 2019). Green technology marketing is synonymous with ethical marketing. Entrepreneurs needed to have a highly ethical marketing model in industrial business management (Bradley and Ziniel, 2017).

H3: Technology and Innovation directly influence Process Management.

Bringing technology and innovation to create tools and expand knowledge would also provide means and processes to monitor, treat and restore the natural environment and reduce the pollution problem from industrial waste (Priya and Hait, 2017). Dangerous industrial waste was found to be environmentally toxic so technology and innovation were implemented for sustainability (Capodaglio, 2017).

H4: The Technology and Innovation directly influence the Participation.

The Industrial business management research discussed the influence of utilising technology to facilitate participation in the city (Mukhtarov et al., 2018). An innovation that was actively participated and developed would increase competitiveness and once it had already been promoted, it was even more able to carry out the overall objectives sustainably (Collins et al., 2019).

H5: Participation directly influences Process Management.

Process management for reuse was necessary to go through the supply chain to be successful in putting together good products to deliver to customers, participation needed to be the key factor (Kianpour et al., 2017). The industrial waste management process of recycling would help sustainability and development of product quality through participation from employees and expertise (Jin et al., 2017).

H6: The importance level of effective industrial waste management guidelines as a whole, classified by the industrial business location was no different.

Sustainability assessment to reduce the impact on the community and the environment needed the study of pollution caused by industrial waste. The proper disposal and recycling of these industrial wastes by not littering industrial waste in the environment (Alidade et al., 2019). The same one was applied to entrepreneurs inside and outside the industrial estate area in this regard, appropriate human resource development and industrial waste management must be developed (Ghobadi et al., 2020).

Methodology

This study was designed as an Inductive Research with a mixed methodology. Firstly, the qualitative research was performed with an in-depth interview. Secondly, the quantitative research surveyed from management level of 500 Green Industry (level 3 upward) of industrial business sectors with a total population of 4,828 (Department of Industrial Works, 2020). Dividing samples into 2 groups, they were inside and outside the industrial estate. And the third step was qualitative research with Focus group discussion. The results of the discrimination analysis of each item showed that the standard deviation of the items was between 0.41 and 1.86 and the corrected item Total Correlation analysis of the items with the Likert scale was between 0.32 and 0.83. The Cronbach's Alpha Coefficient of the reliability of the questionnaire was 0.98.

Result

The statistical analysis results of the guidelines for effective industrial waste management of the industrial business sectors are as in Table 1.

The SEM was created and improved until passing all four criteria and found that (1) the chi-square probability (CMIN-p) of 0.089 was higher than 0.05 indicating statistical insignificance, (2) the relative chi-squared (CMIN/DF) of 1.143 which was lower than 2.00, (3) the goodness of fit index (GFI) of 0.961 which was higher than 0.90 and (4) the root mean square error of approximation (RMSEA) of 0.017 which was lower than 0.08. The SEM of the guidelines for effective industrial waste management of the industrial business sectors after improving was perfectly fit to the empirical data as shown in Figure 3.

As shown in Figure 3, the SEM is comprised of four latent variables: one exogenous latent variable, namely Business Ethics, and three endogenous latent variables i.e., Participation, Process Management, and Technology and Innovation. The hypothesis testing results showed that the Business Ethics directly influenced the Participation at the 0.001 level of statistical significance

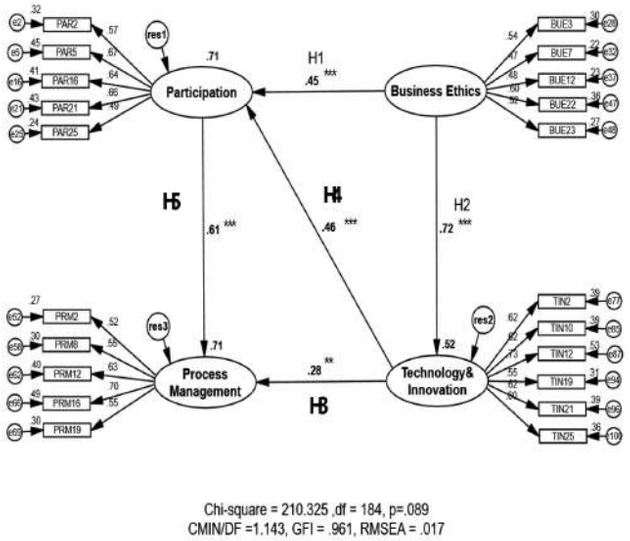


Figure 3: The structural equation model (SEM) of guideline for effective industrial waste management of the industrial business sectors after improving.

Table 1: The mean and standard deviation of guidelines for effective industrial waste management of industrial business sectors

Guidelines for effective industrial waste management of industrial business sectors	*Inside industrial estate*			*Outside industrial estate*		
	$\overline{X}$	*SD.*	*Sig. level*	$\overline{X}$	*SD.*	*Sig. level*
Overall	4.01	0.44	High	3.97	0.45	High
1. Business Ethics	4.04	0.45	High	4.05	0.44	High
2. Participation	3.93	0.54	High	3.83	0.53	High
3. Process Management	4.07	0.52	High	4.06	0.45	High
4. Technology & Innovation	3.98	0.50	High	3.95	0.54	High

with a regression weight of 0.45. Business Ethics directly influenced Technology and Innovation at the 0.001 level of statistical significance with a regression weight of 0.72. The Technology and Innovation directly influenced the Process Management at the 0.01 level of statistical significance with a regression weight of 0.28. The Technology and Innovation directly influenced the Participation at the 0.001 level of statistical significance with a regression weight of 0.46. And the Participation directly influenced the Process Management at the 0.001 level of statistical significance with a regression weight of 0.61. The standardised regression weight of observed variables for each latent variable could be explained as follows:

The Process Management latent variable consists of five observed variables, arranged in the first three regression weight order as follows: (1) Organisation supports the project for processing of used raw materials. Continuously (PRM16) of 0.70 (2) Having campaigned for ways to reduce industrial waste and energy through energy labeling (PRM12) of 0.63; (3) Encourage all parties to find ways to convert industrial waste to be recycled (PRM8) of 0.55(C.R.= 8.76), respectively.

The Business Ethics latent variable consists of five observed variables, arranged in the first three regression weight order as follows; (1) Organisations and stakeholders have a common audit process about solutions to the problem of industrial waste (BUE22) of 0.60. (2) Organisation reviews manual of hazardous industrial waste separation for lives and environment every year (BUE3) of 0.54. (3) Organisation shows responsibility towards the community and the environment through remedial measures if affected by industrial waste (BUE23) of 0.52, respectively.

The Technology and Innovation latent variable consist of six observed variables, arranged in the first three regression weight order as follows: (1) Promote in house technology for industrial waste management in the organization (TIN12) of 0.73; (2) Promote employee development to have the knowledge and apply technology to enhance industrial waste management (TIN21) of 0.623; (3) There is analysis to find the causes of the industrial waste problem to provide suitable technology (TIN2) of 0.622 respectively.

The Participation latent variable consists of 5 observed variables, arranged in the first three regression weight order as follows; (1) Encourage everyone to operate and follow the policy for industrial waste management project strictly (PAR5) of 0.67 (2) Promote organisation of the activities such as reduction of industrial waste to allow employees participating in the management of industrial waste (PAR21) of 0.66 and (3) Organisation has established guidelines for evaluating industrial waste management together with employees every end of the year (PAR16) of 0.64, respectively.

Discussion

Discussion to summarise the solutions with relevant research papers cited as follows:

1. Results testing of the assumptions classified by the location of the industrial business found the importance of the effective industrial waste management guideline component of the overall industrial sector. There was no statistically significant difference at the 0.05 level. Entrepreneurs inside the industrial estate are the key bases of production. The same applied to entrepreneurs outside the industrial estate area. In this regard, appropriate management of industrial waste must be developed (Feng et al., 2017). Industrial waste management practices were the conceptual framework for an integrated industrial waste management system for both inside and outside the industrial estate (Pai et al., 2018). We needed to link waste management practices to the product lifecycle, therefore proper process control, and correct industrial waste management for any place (Farzadkia et al., 2020).
2. It was found that the Overall process management latent variable was averaged at 4.07 (SD = 0.49), which was the highest mean. It was consistent with study research done by Walker and Xanthos (2018) that focusses on the importance of industrial waste management in several interconnected processes management including designing, planning, implementing, monitoring, improving, and evaluating to optimise the use of resources. Liu et al. (2018) studied and supported the process to reduce and circulate industrial waste by using a strategy of zero-waste, transferring industrial waste management technology. Applying the Process Management to reduce industrial waste to zero by having to deal with industrial waste reuse through the transfer of industrial waste management technology and switching to renewable energy would lead to cost reductions and added value for industrial businesses (Rosa et al., 2020).
3. In the Process Management latent variables, observed variable of organization improved the production process by reducing the generation

of industrial waste at source of production was the most important with an average of 4.27 (SD = 0.49). It was crucial for creating a process to reduce industrial waste generation at the source. Zero waste production was a process that transcends the concept of a Circular Economy (CE) by developing production technologies and systems (Kerdlap et al., 2019). In addition, to develop standard processes in a Circular Economy, it was also necessary to create processes to reduce industrial waste at the source from all parties in the organization (Shen and Wang, 2020). And it was important to urgently address the need to create processes to reduce industrial waste by reducing consumption and focusing on reducing industrial waste generation. (Bogusz et al.,2021).

4. Based on the hypothesis testing results, it was found that Business Ethics directly influenced Technology and Innovation. The direct standardised regression weight of 0.72 showed that having Business Ethics in the organisation would be an important key to solving environmental and community issues (Garcia and Sanz, 2018). It was important to have the business ethics for executives to select technology and innovation (Amoah and Ahen, 2021). Executives should understand that technology and innovation did not reduce the profits of the organisation, but helped organisations achieve higher economic efficiency (Guo et al., 2020).
5. The Business Ethics directly influenced the Participation of everyone in the organisation. The total standardised regression weight of 0.78 also showed that Business Ethics from leaders would lead to employee participation and the success of the organisation (Dust et al., 2018). Also if the employee was mentally exhausted, it would harm their motivation. Unethical leaders could have an impact on organisational participation and success (Huang and Paterson, 2017), as well as the findings of the study of ethical leadership and employee engagement established a positive relationship between business ethics and employee participation (Ahmad and Gao, 2018).

Conclusion

The organisation confronted great challenges in managing industrial waste effectively since the changes were becoming more drastic, it was intricate for organisations to continually improve and achieved goals just not only by implementing processes that fundamentally existed. Establishing Business Ethics that directly influenced the Participation of everyone in the organisation to achieve its goals was a key alternative, and having Business Ethics to bring Technology and Innovation to a clean environment and community. Participation together with Technology and innovation would drive Processes Management for expediting industrial waste to be green and eco-friendly. Dealing with industrial waste in the Process Management including planning, designing, implementing, monitoring, evaluating, and improving by Circular Economy is extremely important in an era of global warming and resources that are continually declining. It will be the sustainable ways for reducing industrial waste production, reducing negative impact on human beings and natural environment. It fosters the generation of economic value along with improving the quality of life based on living in harmony with the environment. At present, both the public and private sectors are concerned and come up with such ideas to apply to businesses. Consumers must recognise and cooperate for the country to transcend the traditional economy into new product opportunities that will create a sustainable economy along the way. It is an industrial process that is planned and designed to restore and give life to different materials in the product life cycle. This process of management can lead the organisation to reach the optimisation point of resource utilisation at maximum benefit.

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