The Role of Intellectual Capital and Environmental Regulations in Escalating Innovative and Business Performance

Binh Thi Thanh Truong[1] Phuong V. Nguyen[2] Hieu Thuc Tran[3] and Thien Minh Tran[4]

Abstract

Although intellectual capital and environmental regulations have been considered critical driving forces of sustainable business performance, how and under what conditions they affect innovativeness and business performance are still unclear. Extending the institutional theory, this paper used data collection from 207 companies in Vietnam to examine how environmental regulations influence firm innovation and performance under interplaying with intellectual capital. Moreover, this study also investigates the relationship between innovativeness and business performance. The findings illustrated that environmental regulations stimulated business performance but did not significantly impact corporate innovation. Meanwhile, intellectual capital enhanced innovativeness. Specifically, innovativeness has positive impacts on business performance. The results underline the role of each actor of intellectual capital in promoting firm innovativeness. This study not only contributes to intellectual capital theory and innovation literature but also provides managerial implications to develop sustainable business performance.

[1] Center for Public Administration, International University, Vietnam National University-Ho Chi Minh City, Vietnam
Saigon 3 Garment Joint-Stock Company, VIETNAM.
E-mail: binht79@gmail.com
[2] Center for Public Administration, International University, Vietnam National University-Ho Chi Minh City, Vietnam
Saigon 3 Garment Joint-Stock Company, VIETNAM.
E-mail: nvphuong@hcmiu.edu.vn
[3] Center for Public Administration, International University, Vietnam National University-Ho Chi Minh City, Vietnam
Kobe Viet Co., Ltd, VIETNAM.
E-mail: tranthuchieu@kobeviet.com.vn
[4] The School of Business, International University, Vietnam National University-Ho Chi Minh City, Vietnam.
E-mail: minhthien04112000@gmail.com

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Introduction

Intangible assets are the resources currently used by most worldwide businesses to maintain their sustainability and development. According to Ahmad et al. (2019), it includes the ability of knowledge, human resources assets, a branch of knowledge, and the relationship with internal and external stakeholders. These factors represent the key sources of benefits compared to other competitors in such a harsh economic climate. In the last few decades, a large number of studies have emerged due to the increasing significance of intangible assets. Stewart (1991) pointed out that intellectual capital (IC) is one of the popular resources of intangible assets used wisely by organizations, as it could help them create more value for their businesses. There has been much research and study about this valuable element. Therefore, its definitions and classifications of Intellectual Capital (IC) have been proposed using different terminologies. The scholars pointed out that IC will include three primary factors: structural capital, social capital (or relational), and finally is human capital (Sumedrea, 2013; Mehralian, Nazari, and Ghasemzadeh, 2018). Previous studies showed that all three IC elements are essential for enhancing firm performance (Subramaniam & Youndt, 2005; Chen et al., 2006; Mehralian, Nazari, and Ghasemzadeh, 2018). However, few studies exist in this field in an emerging country like Vietnam.

First of all, as one of the most important parts of IC, human capital (HC) is usually highly appreciated and focused on development by current companies Bogers et al. (2019). They believe that human capital includes implicit and explicit knowledge that may create a deep valuation for the company. Also, several scholars considered structural capital as a non- physical asset, including information, knowledge, organizational structures, operational structures, management processes and company strategies (Asiaei et al, 2018; Torre et al., 2020). Firms consider structural capital an instrument to gather and spread knowledge within their business, enabling them to connect (Ali et al., 2021). The last factor, relational capital, includes information implicit in all the external connections a business could make with its stakeholders, including clients, vendors, and trading partners. These connections help businesses develop a long-term competitive advantage (Bontis, 1998).

Furthermore, the government also plays a significant role in helping businesses improve their competitiveness and innovation through the national innovation system (Lankhuizen & Woolthuis, 2004). In all countries worldwide, the environment is always a top priority. The government's first priorities in enforcing environmental regulations included reducing environmental pollution, enhancing environmental quality, and supporting sustainable effectiveness. Companies worldwide are encouraged to grow thanks to the regulations of the government, which heavily polluting firms would be banned and strictly closed their business and regulatory assistance for the environmental protection sector. With these regulatory actions, prices will significantly increase due to the cost fluctuation of the relevant industries, which will unavoidably be impacted, which may eventually turn into an internal and external push to encourage businesses to engage in creative activities. However, there is little research on the interactions between IC, firm innovation, and business performance with environmental regulations. Therefore, this study fulfills the gaps in investigating such relationships in an emerging country like Vietnam.

Literature review

Theoretical Framework

Intellectual Capital

In the last three decades, IC has been recognized as an important field of study addressing problems relating to knowledge in organizations. According to Asiaei et al. (2020), since knowledge serves as a crucial value-creating resource for enterprises, IC has garnered much momentum in the literature. However, even today, the definition of the IC and its constituent parts are not widely understood (Bellucci, 2020). Chen (2015) supposed that the foundation of IC is information resources with the ability to create value. Dumay (2016) stated that IC is referred to as a complicated asset with multifaced items that can provide long-term benefits, such as experience, comprehensive skills, and empirical knowledge that enhance a firm's worth. In his stud, IC was measured with four key items, and “renewal capital” was added, along with three basic ones.

The non-financial resource helps firms build value through knowledge (Allameh, 2018). Human, structural, and relational capital are the three types of IC that are most

broadly categorized (Allameh, 2018; Alves et al., 2020). Moreover, other studies (Edvinsson & Malone, 2007; Nahapiet & Ghoshal, 1998) describe IC as a theoretical construct with three key parts, beginning with human capital, which was defined as the ability to gain information, knowledge, improving skills, and experience for the company personnel. Next structural (or organizational) capital (SC), represents how firms can arrange their work and business, the form of their structure, also the ability to enhance and improve future infrastructure. Last but not least is relational capital (SC), one of the usual methods of IC to maintain the value of knowledge associated with relationships among all departments in firms (Nahapiet et al., 1998).

Therefore, numerous organizations worldwide have acknowledged the significance of the fundamental components of their intellectual capital for economic growth (Cabrilo et al. 2018). Based on this field, intellectual capital is recognized as a crucial element in bolstering an organization's resources and gaining competitive advantages in a constantly evolving market (Mutuc et al., 2019). IC must be a crucial asset for every firm worldwide that would try their best to become extraordinary, compared to other competitors, to establish ordinary activities now. Using intellectual capital in conjunction with innovation initiatives can benefit businesses, but only if the theoretically abstract concept of intellectual capital is applied in actual business operations Bogers et al. (2019). According to Ferreira (2020), if firms could handle this asset well, it may be a great advantage for them, as many organizational issues could be solved and give the company competitive benefits in the future.

Corporate innovation

Innovation is defined as the development and execution of new ideas that are improved or modernized (Koryak et al., 2015). It can also refer to more effective changes to enhance adopting of new strategies in the firm. As a result, it occurs whenever people or clients try to reach offer any of the sources from companies, which is considered as the products, supplier demands, or any policies that could gain the benefits and the goal to create the relationship and connection in these organizations. People understand the current concept of innovation is an attempt to enhance the value of the process of production, policy, also internal operations by creating new products that could improve their quality, and professional service, which can satisfy the expectations of the clients in the future (Kamau & Oluoch, 2016). Additionally, McDowell et al. (2018) supported that human capital and ability are essential components for the development of innovations.

In the study of Wendra et al. (2019), innovative and knowledgeable employees either come up with fresh ideas or challenge the organization's standard operating procedures. The organization's innovation success is predicted by the total human ability and knowledge. This is considered as the process of innovation is the crucial factor that affects future procedures and any business's outcomes, allowing for a better representation of the actions and impacts that must be realized inside the business. A previous study by Jabbouri (2016) also revealed a strong and supportive relationship between innovation and the final outcomes of firms. Additionally, Cabrilo (2020) also supports this by pointing out that the effectiveness of innovation is counted as one of the essential criteria that decide on the ultimate productivity of firms if they want to extend their business.

As per the research by Denopoljac et al. (2016), adopting innovative processes can be a crucial stimulant that advances many aspects of the company. To achieve continual innovation, organizational top managers must concentrate on various factors, including production, technology, process, culture, values, and legislation (Marlina & Tjahjadi, 2019). In fact, innovation substantially impacts an organization's ability to survive, compete, and grow due to its effects on client loyalty and gratification, staff orientation, and other internal factors that could benefit its own. According to Hammad (2016), innovative performance could boost sales and market shares while significantly increasing consumer loyalty. Additionally, the innovation may be able to bring financial benefit to the organizations, boosting their profitability and performance. Moreover, by improving the internal adopting new procedures, it could successfully develop results that lead to innovative or considerably enhanced company performance is a succinct way to describe an organization's innovation performance (Rosenbusch et al., 2019).

Business Performance

There have been many changes and evaluations in firms from different countries to improve their performance over the years. Usually, when people think of performance, it comes to their mind that, it would be the report presented in the literature is generally determined by the success or failure of the company in terms of its yearly finances. Numerous studies were carried out to assess the effectiveness of business performance, they usually rely on the innovation process to enhance (Bogers et al., 2019). Alford et al. (2018) supposed that if the company has made a great and effective innovation process the outcomes of firms at the end of the year also can be improved. Moreover, firms can use intellectual property,

sometimes referred to as intangible assets, to enhance their innovation processes (Ahmed & Guozhu, 2019).

Environmental regulations

Due to tightening environmental restrictions in recent years, businesses have been under growing pressure, which somewhat hinders economic growth (Zhang et al., 2021). Coordinating environmental regulations with economic growth is a highly effective strategy. The first goals of the government's implementation of environmental control were to reduce environmental pollution, enhance environmental quality, and increase environmental efficiency (Tu et al., 2022). Most importantly, efficient environmental regulation measures must balance ecological sustainability and economic growth (Ozcan et al., 2020). It has been heavily utilized in environmental protection practices and has steadily grown essential to governmental duties. All levels of government have created a full range of legal instruments under environmental regulations as a way to compel businesses to absorb external costs (Bernauer et al., 2006). Governments all over the world use a variety of environmental regulations to control businesses for sustainable development. These regulations range from general economic tools like CO2 taxes and tradable emission permits to general economic measures like technology-forcing standards or market incentives for specific technologies (Bergek et al., 2014).

Environmental regulations encompass a range of measures aimed at promoting sustainable business practices, reducing environmental harm, and fostering innovation in business operations. There are several dimensions of environmental measures. We list out some common measures as follows:

Command and Control Measures:

Prescriptive Regulations: These set specific limits or requirements that businesses must adhere to, such as emission standards, pollution limits, waste disposal guidelines, or mandatory use of certain technologies. Permits and Licenses: Businesses need permits or licenses to operate, which are issued based on compliance with environmental standards and regulations. Violation of these permits can result in penalties or revocation. A comprehensive insight into Waste to Energy conversion strategies (Karmakar et al., 2023)

Economic Measures:

Market-Based Instruments:

(1) Environmental regulations of carbon emissions and air pollution had a positive effect on the cities' green technology innovation as measured by green invention patent applications, which is consistent with the "Porter Hypothesis"; (2) Environmental regulations of carbon emissions had a greater impact on green technology innovation than those of air pollution; (3) Local governments' human resource and financial investments in R&D activities positively moderated the association between environmental regulations and green technology innovation (Chen et al., 2022)

Voluntary Initiatives:

Voluntary Agreements: Encouraging businesses to voluntarily commit to environmental goals, often negotiated between industry stakeholders and government agencies, with the aim of achieving better environmental outcomes without strict regulations.

Environmental Management Systems (EMS): Encouraging businesses to adopt structured systems (e.g., ISO 14001) to manage and improve their environmental performance voluntarily.

Cooperative Approaches:

Environmental regulations, when effectively designed and implemented, can drive innovation by incentivizing businesses to develop and adopt new technologies, processes, and products that are more environmentally sustainable. These regulations play a crucial role in shaping the trajectory of businesses toward a more sustainable and responsible future (Zhou et al., 2023)

Hypothesis development

Intellectual capital and corporate innovation

IC is the value of a company's staff members' knowledge, abilities, business training, or any confidential information that could offer the business a competitive edge. IC is broadly acknowledged as a valuable resource as a company's ability to gain and transfer knowledge capital, then utilized to boost sales, draw in new customers, create new products, or otherwise enhance the company's operations (Limijaya et al., 2021). A company's human resources, operational procedures, and other intangible assets that increase revenue are also included in its intellectual capital. The field of intellectual capital has been the subject of several in-depth reviews (Bontis et al., 2013; Capilla et al., 2021; Chatterjee et al, 2021). Nevertheless, thorough research has pointed out that relational, structural, and human capital are the three main factors forming the concept of IC.

Barney (1991) stated that HC is said to be one of the special and competitive sources, as it could relate to the value of people and human resources and cannot be the same. Therefore, companies that are able to capture and transform HC will be very beneficial for future business. In addition, It is also recognized as a crucial component of innovation (Uden et al., 2017). Its significance stems from the fact that businesses could be more flexible in obtaining new knowledge and have a higher potential for innovation firms have recruited employees with honing skills and knowledge of the business field for years. A company's innovation efforts are positively enhanced by increased human capital. Some prior studies found a beneficial relationship between human capital and innovative capacities (Danquah, 2017; Sun, 2020).

Additionally, Diaz-Diaz et al. (2006) explored Spanish industrial enterprises and provided evidence that employing staff with extensive knowledge and expertise benefits innovation. Other research on SMEs has shown that the more qualified a workforce is, the higher their capacity for learning will be, which will lead to more innovation (Quian & Huan, 2017). The research conducted with Italian SMEs by Agostini and Nosella (2017) also reveals a strong relationship between HC and firm innovation. Therefore, the first hypothesis was proposed:

H1. Human capital positively affects corporate innovation.

A company's procedures, working trends, culture, environment, and swift customer market responsiveness are all characterized by structural capital. It is considered that if SC is built professionally, it would be such a good base for a firm to enhance their future business, also experience and improve their outcomes through a process that uses cutting-edge technology and a wealth of knowledge that is integrated into the information system and converted into useful resources. Additionally, SC is one of the factors of IC that could integrate with technological ability and innovation.

Based the report of Diaz et al. (2016), it showed that firms that required innovative processes to enhance themselves would need tools that enable them to control and follow up their environment. These findings are consistent with the conclusion of Frishammar et al. (2005). It stated that innovative businesses are also the best at handling external knowledge and information assets. Similarly, they also stated that a company specializing in the industrial business in Dutch highlights how their capabilities for innovation are increased by structural capital that promotes employee collaboration in decision providing and connection with multiple intellectual assets. Moreover, the company can produce a beneficial impact when they point out strategies to innovate its product line, create new services and construct new

processes. Therefore, for firms with a great foundation of SC in their business, the innovative process would be highly beneficial. Thus, the following hypothesis was suggested:

H2: Structural capital positively affects corporate innovation.

According to Bontis et al. (1998), relational capital can be easily aware whenever firms express their exterior business to develop its strengths to their stakeholders, such as clients, suppliers, business partners in order to expand their outcomes. A strong network of relationships enables knowledge acquisition and sharing based on mutual respect and understanding, which enhances the creation of new innovations and developments (Hashim et al., 2015)

Previous studies by Zerenler et al. (2008) with the Turkish auto parts industry, Delgado-Verde et al. (2011) with the Spanish companies specializing in technological sectors, Dost et al. (2016) about the Thai service of drug industry all found that RC had a great positive on innovation process and their financial outcomes. Moreover, Gampoli et al. (2019) also conclude concluded that RC also has a similar impact on their innovative process, based on the market of Italian. Therefore, we propose the next hypothesis:

H3: Relational capital positively affects corporate innovation.

Corporate innovation and business performance

The ability to innovate is regarded as one of the most important factors in a company's competitiveness (Ali et al., 2021). It was argued that an innovative company has greater process capabilities and a higher likelihood of achieving superior overall performance (Racela et al., 2020). According to Mir et al. (2016), Hamidi et al. (2017), and Maldonado-Guzmán et al. (2019), there is a significant and favorable correlation between innovation capability and business performance. The prior research assessed the role of innovation capabilities in enhancing the firm performance using the theory based on resource views. Several hypotheses were created to explain the findings better and they showed a connection between intellectual capital and creative capacity (Ali et al., 2021). Thus, the following hypothesis was suggested:

H4: Relational capital positively affects corporate innovation.

Environmental regulations and corporate innovation

Technology innovation is regarded as the most important aspect in creating high-performance enterprises because competition between businesses nowadays is innovation-driven rather than resource driven (Li et al., 2019). Additionally, stricter environmental regulations have led to ever stricter criteria for the quality of production, necessitating the need for technological innovation (Tan & Guo, 2019). It is also acknowledged as a practical means of resolving the conflict in environmental preservation and expansion of business (Lin et al., 2021)

Academic research on the impact of environmental restrictions has centered by Porter (1991). His theory contends that, in order to ensure sustainable development, businesses should aggressively pursue technological innovation and mitigate environmental damage when faced with a high level of environmental regulation intensity. Numerous researchs concur with Porter's assertion that environmental laws foster business innovation, based on Zhao (2018). Enterprises are encouraged to enhance innovative equipment and product investments by more stringent environmental requirements, which improves operational performance (Testa et al., 2011). In reality, because of its off-set effect, environmental regulations have an impact on business performance through innovation. German and Italian chemical industries initially incur higher compliance expenses, but later discover that they all respond favorably to investments made to boost efficiency (Manello, 2017). Through the innovation compensation effect, increasing the level of environmental protection in Chinese cities can enhance innovation process. (Deng et al., 2019). Hence, we suggested a new hypothesis:

H5: Environmental regulations positively affect corporate innovation.

Environmental regulations and business performance

Zhu et al. (2007) used a survey and statistical analysis to examine the operations strategies (in the form of green supply chain practices) and performance of Chinese firms in response to institutional and environmental challenges. They discovered that Chinese manufacturers were under greater environmental strain, and more significantly, that the presence of regulatory pressures boosted business performance. According to Berman et al. (2001), stronger rules in the US petroleum refining sector typically result in higher abatement costs but also higher productivity. For the best-performing corporations in the United Kingdom, Salama (2005) discovered strong positive connections in financial performance results versus the environmental protection. Environmental restrictions typically result in a considerable level of additional capital requirements for sectors that produce large amounts of pollutants. Thus, we proposed the following hypothesis:

H6: Environmental regulations positively affect business performance

Research Framework

This study is aim to is explore the effects of intellectual capital on corporate innovation and business performance under the interaction of environmental regulations. Figure 1 describes the theoretical framework of the research.

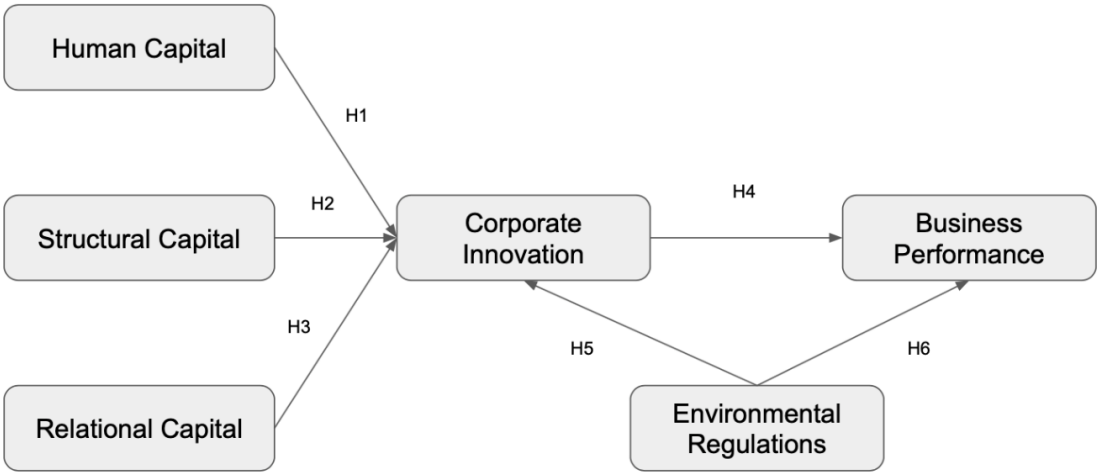

Figure 1: Research Framework

Method

Research design

The research aims to assess the impact of several elements of intellectual capital (human capital, structural capital, and relational capital) on a firm's ability for innovation and performance. Stratified sampling for finite populations is the core of the sample structure. Additionally, this study employs the deductive method approach to identify the chosen variables' root causes. This study used a survey methodology, which makes it possible to collect quantitative data from a large population.

Data collection

Stratified sampling for finite populations is the foundation of the sample structure. The population is made up of operating companies with different sectors, such as manufacturing, services trading, and others, that are located in Vietnam. They were also divided into categories based on the activities.

In this research, the data was conducted with the survey, including means of a questionnaire, which is the method of the Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree) (Cabrita et al., 2007). Since top managers are the ones who have a broader understanding of the various activities undertaken as well as interactions between their employees and with respect to their competitors, they are best suited to respond to

comparative questions regarding the topic. The questionnaire was developed from a pilot test that involved in-depth interviews with eight managers, with minor modifications made to address the questionnaire's shortcomings and adequately represent the unique dynamics of the industry. Then we applied and choose the method of interviewing these people. The data was conducted from October 2022 to December 2022. Finally, 207 of firms in total 220 interviews were obtained for this research. Table 1 shows the characteristics of data collection.

Table 1: Demographic characteristics

Characteristics (N=207)		Number	Percentage (%)
Type of industry	Services - Trading	26	12.6%
	Manufacturing	160	77.3%
	Consulting-Design-Construction	9	4.3%
	Healthcare-Education	5	2.4%
	Others	7	3.4%
Job title	Administrative council	2	1%
	Board of directors	19	9.2%
	Managers	78	37.7%
	Team leaders	108	52.1%
Number of employees	Less than 20	10	4.8%
	20-50	20	9.7%
	51-99	7	3.4%
	100-200	17	8.2%
	201-300	7	3.4%
	301-400	9	4.3%
	401-500	19	9.2%
	More than 500	118	57%
Years of firm operations	Less than 5	15	7.2%
	5 - 10	17	8.2%
	11-20	32	15.5%
	More than 20	143	69.1%

Measurement

In this research, three parts of IC representing human capital, relational capital and structural capital will be established. Corporate innovation would contain five items for each, which was adopted in four out of five items from Allameh (2018). Business performance also include 5 items that were adapted from Sharabati (2010). And finally, the factor of environmental regulations is self-development including 5 items.

The technique utilized in the study is the method of PLS-SEM, which calculates the model parameters by maximizing the explained variance of all the dependent variables (latent and observable), working with blocks of variables (components) (Chin, 1998). Additionally, we chose this method for two main reasons: (1) PLS has become more prevalent recently in the social sciences, particularly in business management, based on the theory of Chin (2009), (2) it is a method that can be applied to a variety of data sets (Ali et al., 2010).

Results

Validity and reliability

Table 2 represents the factor analysis with reliability and validity statistics in the research. In this table, the valuation of Cronbach's Alpha (α) and Composite Reliability (CR) were tested and measured to assess the internal consistency. According to the recommendations of Fornell et al. (1981), the factor loading is confirmed when it is higher than 0.5, when the AVE has a valuation upper than 0.5. Also, Cronbach's Alpha is more than 0.7. All items had the factor loading exceed the range of 0.5.

Moreover, Fornell stated that AVE scores more than 0.5. In Table 2, we can recognize the results, for AVE, the lowest score is 0.503, while the highest one is 0.8. Next, the composite reliability (CR) had to have a threshold of 0.80, as Fornell (1981) recommended. It is shown that the CR score of all items is higher than 0.8, specifically lowest point is 0.833 and the highest point is 0.952. Finally, Cronbach's alpha should have a score of more in the table ranging from 0.864 to 0.936 (> 0.7). Therefore, all of the research items have been achieved. Therefore, the validity and reliability criteria of this research had achieved.

Table 2: Factor analysis with reliability and validity statistics

Constructs	Code	Factor loading	Cronbach's alpha	CR	AVE
Human capital	HC1	0,803	0,855	0,895	0,631
	HC2	0,744			
	HC3	0,761			
	HC4	0,854			
	HC5	0,804			
Relational capital	RC1	0,610	0,756	0,833	0,503
	RC2	0,796			
	RC3	0,622			
	RC4	0,797			
	RC5	0,700			
Structural Capital	SC1	0,797	0,833	0,883	0,602
	SC2	0,857			
	SC3	0,791			
	SC4	0,761			
	SC5	0,661			
Corporate Innovation	INV1	0,736	0,767	0,866	0,685
	INV2	0,872			
	INV3	0,867			
Business performance	BP1	0,751	0,830	0,878	0,590
	BP2	0,790			
	BP3	0,785			
	BP4	0,771			
	BP5	0,742			
Environmental Regulations	ER1	0,886	0,938	0,952	0,800
	ER2	0,878			
	ER3	0,948			
	ER4	0,900			
	ER5	0,858			

Table 3: Heterotrait-monotrait ratio and Fornell-Larcker criterion for discriminant validity.

Heterotrait-monotrait ratio (HTMT)

Variables	BP	INV	ER	HC	RC	SC
Business performance (BP)						
Corporate innovation (INV)	0,729					
Environmental Regulations (ER)	0,495	0,378				
Human capital (HC)	0,562	0,642	0,274			
Relational capital (RC)	0,607	0,682	0,544	0,484		
Structural capital (SC)	0,692	0,873	0,357	0,751	0,748	

Fornell-Larcker criterion

Variables	BP	INV	ER	HC	RC	SC
Business performance (BP)						
Corporate innovation (INV)	0,729					
Environmental Regulations (ER)	0,495	0,378				
Human capital (HC)	0,562	0,642	0,274			
Relational capital (RC)	0,607	0,682	0,544	0,484		
Structural capital (SC)	0,692	0,873	0,357	0,751	0,748	

Table 3 refers to the ratio of construct correlations to construct correlation (Li, X et al., 2018), which was used to address the dissemination validity. Based on the table, the HTMT score were not above 0.90, which is smaller than 1, due to Li's recommendation. Therefore, based on the results, suggesting that discriminant validity should be established.

In Table 4, the three main components of the IC are listed out, which are human capital, relational capital and structural capital including 5 items for each. The Environmental

Regulations has its own five-part structure, while the business performance and corporate innovation constructs include three and five items.

Table 4: Path Analysis

Hypothesis (direct effect)	Estimates	t-values	p-values	Remarks
H1. Human Capital -> Corporate Innovation	0,123	2,091	0,037	Supported
H2. Structural Capital -> Corporate Innovation	0,481	7,161	0,000	Supported
H3. Relational Capital -> Corporate Innovation	0,199	3,140	0,002	Supported
H4. Corporate Innovation -> Business Performance	0,476	7,378	0,000	Supported
H5. Environmental Regulation -> Corporate Innovation	0,060	1,081	0,280	Not Supported
H6. Environmental Regulation -> Business Performance	0,323	4,819	0,000	Supported

Intellectual Capital, including 3 factors will have a great effect on corporate innovation. For more specifics, the score is shown at (β = 0.123, p = 0.037) for human Capital. For relational capital, the score is shown at (β = 0,.99, p = 0.002). For structural capital, the score is shown at (β = 0,481, p = 0.00). Besides, corporate innovation (β = 0.476, p=0.00) and environmental regulations (β = 0.323, p = 0.00) also play an important role in positively enhancing the performance of a firm. In addition, the table also shows that the relationship between Environmental regulations and Firm Innovation has no impact. With the p-value = 0.280 > 0.1, we can conclude environmental regulation does not support firms in enhancing their innovation.

Discussion

This study developed various hypotheses to determine whether the intellectual capital components positively correlate to innovation capability and firm performance. In this result, IC with its all 3 factors will have a strong supportive connection with a company's innovation process. Due to the research of Ali et al. (2021), the consequences of the research are defined to be well fit with his findings. Therefore, confirms the importance of intangible assets in the future development of companies, especially in their process of innovation. Thus, Companies

should also review how far their intellectual capital is and figure out how to optimize and manage it well in order to bring about more efficiency and specificity, such as optimizing products, production lines, and operating apparatus (Kleim – Padilha, 2016). This study has also provided concrete evidence that all aspects of Intellectual Capital bring optimal efficiency to many different areas of a company, and each brings unique values in the process of long-term innovation. Therefore, top managers, should focus on developing evenly in all aspects to optimize IC, avoiding the case of focusing on only one factor and ignoring other aspects.

For decades, innovation has always been seen as an important and essential process for every business. In this research, it has been demonstrated that innovation has a positive relationship with building stability and improving business results, and this is also said to be the highest benefit that a company can apply to innovate wisely. Especially in the context that the economy is gradually unstable in the Vietnamese market, for industrial companies, innovation, and change are also key to their long-term survival. We can mention the positive and direct effects such as reducing production costs and better operating the management apparatus, thereby creating a high competitive advantage over other competitors in the industry. market, in addition, employees in the company also become more skillful when successfully applying innovations (Ruiz et al., 2018)

Additionally, from the initial purpose, the government's introduction of new environmental legislation encourages businesses to innovate and develop, boosting their productivity and performance. However, the testing results did not support corporate innovation. Promote cross-sectoral collaboration and contribute to a deeper understanding of the complex relationship between regulation and innovation in the context of sustainable development.

Environmental issues should be institutionalized by businesses in all sectors as a part of their long-term strategic plans. Since environmental policies from the government have a strong connection to a company's outcomes, it is crucial that innovation efforts be integrated into environmental initiatives. Because many innovation efforts are frequently closely linked with based on competition and treated as a way to obtain the benefits within a short period, their benefits in the future, however, are lost. As a result, environmental compliance decisions that are part of an organization's strategic decision-making process can significantly impact both financial performance and innovative activities.

Conclusion and limitations

Conclusion

The initial purpose of this study is to investigate the relationships among IC, firm innovation, and business performance with environmental regulations. As a result, all hypotheses were supported, except H5. The information gained from this study will allow enterprises to harness the full power of IC, leading to unprecedented levels of success and prosperity.

This study offered insightful advice and a useful plan for academics, politicians, and owners/ managers of industrial businesses to use. Additionally, it was agreed upon by academics, entrepreneurs, and politicians that they needed to play a more active role in fostering the development of intellectual capital within their organizations. Thanks to the study's structure, they will be able to get appropriate and useful metrics for detecting intellectual capital in multidimensional connections. The results of this study suggest that industrial enterprises may develop precise rules for appreciating and developing their strategic assets and competencies. However, when it comes to the contribution of innovative techniques, analytical methodologies are often utilized to track and evaluate the nature and effectiveness of the study. As a result, it is suggested that pertinent cooperation, whether at the business or academic level, may be required to identify the optimal opportunity for firm success. Finally, corporate innovation capabilities mostly focus on developing fresh concepts that can improve business performance when encouraged by environmental legislation.

Limitations

Many companies nowadays face a number of difficulties due to the changes and harsh from several policies and changes in the market. In this scenario, important company resources, like intellectual capital, are utilized in various ways at various stages and functions. To improve performance, industrial organizations have found that integrating intellectual capital and innovation activities is a crucial resource. This could be one way to increase awareness of the use of intellectual property in Vietnamese industrial firms while also giving owners/managers a stable platform to better utilize their awareness to enhance their business in the future. This claim can assist those top managers in developing successful and practical

market-competitive strategies, hence supplying academics with more data regarding to the connection of Intangible Assets to enhance their outcomes.

Future scholars are strongly encouraged to look into the relationship of IC and the innovation process, especially in industrial activities, in order to reach a high degree of company performance. Future studies may also look at additional variables affecting the relationship between intellectual capital and company performance or between intellectual capital and innovation skills. Future research may look into additional elements that could have a stronger impact, which could improve the research model of the current study.

Future investigations may focus on countries other than Vietnam since the current study was only applied to a single nation, which might have another result in different nations. Future studies could examine how a firm's capacity for innovation focused on sustainability and its choices in research and investment activities affect its financial performance.

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Municipal solid waste management Integrated with Income Generated from Recyclable Waste in Satun Municipality

Samnang Tim[1] Niramon Kuamsab[2] and Warangkana Jutidamrongphan[3]

Abstract

Satun municipality plays a crucial role in waste management, covering the entire process from the waste disposal to downstream landfill. A study revealed that the municipality generates approximately 18.4 tons of solid waste per day, with an average generation rate of 0.74 kg/capita/day. The waste composition primarily consists of 55% food waste, 20% plastics, and 10% paper with other residue 15% (Glass, metal, clothes, wood, rubber, napkin, etc.). Implementing waste separation at source is an effective approach to enhance waste management efficiency. Through the implementation of recycling waste management activities, Satun municipality has achieved notable results. A significant portion of the recyclable waste, 59%, is separated and sold to waste collector called Saleng. Additionally, 21% is directed send to waste banks, 16% is donated in special events, 2% is recycled through local inventions such as brooms from plastic bottles, tote bag from coffee sachets, flower from fruit foam net and 2% is allocated for other purposes. These innovative approaches not only support waste reduction but also provides an opportunity to generate income from recycling efforts.

Keywords: Solid Waste Management, Recycling, Waste Separation

[1] Department of Forest and Natural Resource Management, Faculty of Agriculture,
University of Heng Samrin ThbongKhmum, CAMBODIA.
E-mail: -

[2] Faculty of Environmental Management,
Prince of Songkla University, Hatyai, Songkhla, THAILAND.
E-mail: -

[3] Faculty of Environmental Management,
Prince of Songkla University, Hatyai, Songkhla, THAILAND.
E-mail: warangkana.j@psu.ac.th

Introduction

The efficient management of municipal solid waste (MSW) is a crucial responsibility of Local Administrative Organizations (LAOs) to ensure sustainable and environmentally friendly practices in their respective areas. However, the effectiveness of waste management can vary due to diverse spatial contexts and influencing factors. This research aims to draw valuable lessons from the experiences of Satun municipality, specifically focusing on best practices in solid waste management integrated with income generation from recyclable waste.

LAOs play a critical role in waste management, but they face unique challenges in implementing efficient waste management systems. By examining the successful approaches adopted by Satun municipality, valuable insights can be gained to enhance waste management strategies in other areas.

Satun municipality covers an area of 6.8 square kilometers and has 20 communities with a population of 23,144 people. The municipality encourages waste sorting at the source and has an average waste generation rate of 0.74 kg/person/day. Waste bins are placed in tourist attractions and government offices, while 6 kilometers of roads are designated as waste bin-free. There are 2,956 local volunteers, representing 60.17% of households, involved in waste management. The municipality has seven waste management learning centers.

The primary objective of this research is to understand the challenges faced by LAOs in waste management and identify the effective measures undertaken by Satun municipality. Through an in-depth analysis of their experiences, this study aims to extract lessons learned that can be applied to improve solid waste management practices in other localities.

Literature review

The efficient management of municipal solid waste (MSW) is a critical concern for Local Administrative Organizations (LAOs) worldwide. Numerous studies have investigated waste management practices, highlighting the need for sustainable and environmentally friendly approaches. This literature review focuses on the integration of solid waste management with income generation from recyclable waste, drawing insights from Satun municipality's experiences.

The concept of integrated solid waste management emphasizes the holistic approach of waste management, encompassing various stages from waste generation to disposal. LAOs play a pivotal role in implementing effective waste management systems tailored to their specific contexts. However, challenges arise due to diverse spatial contexts and influencing factors that impact waste management efficiency.

Studies have emphasized the significance of waste sorting at the source as a means to enhance waste management. Satun municipality's commitment to waste sorting initiatives reflects the broader trend towards encouraging residents to segregate waste into different categories, such as food scraps, plastics, and paper. This approach facilitates the recycling of valuable materials and reduces the amount of waste requiring proper disposal.

Recycling plays a crucial role in waste management and contributes to sustainable development goals. Satun municipality's efforts in recycling waste management activities have yielded positive results. The municipality has focused on generating income from recyclable waste, such as selling materials to waste collectors and utilizing innovative methods like producing brooms from plastic bottles. This integration of income generation serves as an incentive for both individuals and communities to actively participate in waste management practices.

The challenges faced by LAOs in waste management are not uniform across all regions. Urban areas, characterized by high population density and diverse occupational patterns, pose specific difficulties in promoting waste separation and collection. In contrast, semi-urban and rural areas may have more favorable conditions for waste management initiatives. Satun municipality's experiences shed light on the strategies employed in different contexts and offer insights into overcoming challenges specific to urban areas.

The literature also emphasizes the importance of comprehensive waste management systems. Satun municipality's approach encompasses waste generation monitoring, waste composition analysis, waste sorting, recycling activities, and income generation from recyclable waste. Such comprehensive strategies enable LAOs to gain a holistic understanding of waste management practices and tailor their approaches accordingly.

A circular economy and upcycling play a crucial role in waste management, especially at the municipal level, covering the entire process from waste disposal to downstream landfill. A study revealed that the municipality generates approximately 18.4 tons of solid waste per day, with an average generation rate of 0.74 kg per capita per day. The waste composition primarily consists of 55% food waste, 20% plastics, and 10% paper, with the remaining 15% consisting of materials such as glass, metal, clothes, wood, rubber, napkins, and more.

In conclusion, the integration of solid waste management with income generation from recyclable waste is a crucial aspect of sustainable waste management practices. Satun municipality's experiences offer valuable insights into successful approaches in waste management. The literature supports the need for waste sorting at the source, effective recycling initiatives, and the integration of income generation to encourage community participation. Further research should focus on evaluating the scalability and replicability of Satun municipality's practices in different local government contexts, considering the unique challenges faced by each region.

Methodology

The methodology for the research on municipal solid waste management integrated with income generated from recyclable waste in Satun Municipality involved the following steps:

Study Design: A mixed-methods approach was adopted, combining quantitative and qualitative data collection methods to gain a comprehensive understanding of waste management practices and income generation activities related to recyclable waste in Satun Municipality.

Data Collection:

a. Quantitative Data: Quantitative data on waste generation were collected through site visits and waste sampling. Daily waste generation was measured, and waste composition

analysis was conducted to determine the percentage of food waste, plastics, paper, and other waste categories.

b. Qualitative Data: Qualitative data were collected through interviews and focus group discussions with key stakeholders involved in waste management, including municipal officials, waste collectors, recycling entrepreneurs, and community members. These qualitative data provided insights into the challenges, opportunities, and best practices in waste management and income generation from recyclable waste.

Sampling: A representative sample of households, businesses, waste collectors, and recycling entrepreneurs was selected to ensure the diversity and representativeness of the data. The sample size was determined based on statistical considerations and feasibility.

Data Analysis:

a. Quantitative Data Analysis: Quantitative data on waste generation were analyzed to determine the average daily waste generation rate per capita and the composition of waste in terms of food waste, plastics, paper, and other categories.

b. Qualitative Data Analysis: Qualitative data from interviews and focus group discussions were analyzed using thematic analysis techniques. The data were coded and categorized to identify key themes and patterns related to waste management practices, income generation, and community engagement.

Integration of Data: The quantitative and qualitative findings were integrated to provide a comprehensive understanding of the interconnections between waste management practices and income generation from recyclable waste in Satun Municipality. Triangulation of data from different sources was used to enhance the validity and reliability of the research findings.

Data Validation: Data validation techniques, such as member checking and peer debriefing, were employed to ensure the accuracy and reliability of the data. Feedback was sought from participants and experts in the field to verify the findings and interpretations.

Ethical Considerations: Ethical guidelines for research involving human subjects were followed throughout the study. Informed consent was obtained from all participants, and their privacy and confidentiality were ensured. The study complied with ethical standards set by relevant institutional review boards and ethical review committees.

Reporting and Dissemination: The research findings were compiled into a comprehensive report, including the methodology, results, discussion, and recommendations. The report was shared with Satun Municipality, relevant government agencies, waste management

stakeholders, and the academic community through presentations, publications, and conferences.

By following this methodology, the research provided valuable insights into waste management practices in Satun Municipality and the integration of recycling activities to generate income. The findings contributed to the development of sustainable waste management strategies and the promotion of a circular economy approach in the municipality.

Results

The Challenges faced by Satun Lao: Waste management in the community is plagued by a lack of proper knowledge and appropriate disposal practices. Residents frequently dispose of their waste without discretion, and there is a deficiency in continuous training and education for households. The allocated budget for waste management activities is constrained, resulting in minimal training opportunities for residents. Moreover, there is a lack of awareness regarding responsible waste disposal, and waste is not segregated before disposal. The practice of indiscriminate dumping and, in some cases, burning of waste is widespread. The effective measures were presented such as awareness raising, arrangement through special events and campaigns, collaboration and monitoring of local volunteers, including incentive from raising recycle waste price when selling to LAOs. The tangible results were illustrated in terms of waste reduction rate at disposal site or end-of-pipe management.

Waste Characteristic

Between 2017 and 2020, Satun municipality generated an average of 6,425.47 tons/year of solid waste. The waste composition primarily consists of 55% food waste, 20% plastic, 10% paper with other residue i.e. metal, glass, clothes, wood, rubber, napkin, 15%. Based on a sample of 345 people, recycling waste management activities in Satun municipality produced a total of 477.90 kg/month of recyclable waste. The majority (59%) is sold to saleng, 21% goes to waste banks, 16% is donated, 2% is recycled, and 2% is allocated for other purposes. Creating a broom from plastic bottles requires approximately 1 kg of plastic or 30 bottles. Plastic bottles cost around 7-10 baht/kg, while a broom can be sold for 179 baht or more. This presents an opportunity to generate income through recycling waste.

Waste management

The practice of waste segregation in Satun municipality plays a significant role in waste management, enabling effective management of different types of waste and maximizing their potential for recycling and proper disposal. Organic waste is repurposed as animal feed and fertilizer, reducing landfill waste and benefiting the local community and agricultural sector. Recyclable waste is sorted and sold to waste banks and collectors, supporting the circular economy and reducing the environmental impact of waste. The municipality encourages donations that benefit the community and promotes innovative inventions from recycled materials. Separate garbage bins ensure proper disposal of general waste. These practices reflect a comprehensive waste management system, contributing to waste reduction, environmental preservation, and income generation. Satun municipality serves as a model for sustainability, resourcefulness, and community engagement in waste management, showcasing the benefits of waste segregation for environmental and economic well-being.

Waste recycling

The data for Satun municipality provides valuable insights into waste management practices and the potential for income generation through recycling. The municipality encourages waste sorting at the source and actively involves local volunteers in waste management activities. Between 2017 and 2020, the municipality generated an average of 6,425.47 tons/year of solid waste, with food waste, plastics, and paper being the main components. Recycling efforts produced 477.90 kg/month of recyclable waste, with the majority being sold to waste collectors. Creating products from recyclable waste, such as brooms from plastic bottles, presents a profitable opportunity. Satun municipality's commitment to sustainability and economic development is evident in its waste management initiatives and involvement of the community. By further exploring innovative approaches, the municipality can continue promoting sustainable waste management and economic growth.

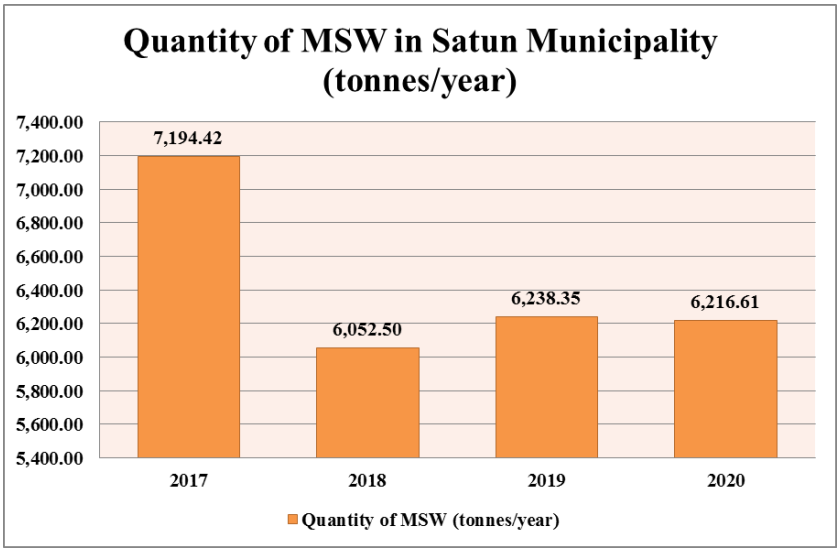

Figure 1: Quantity of Municipal Solid Waste Generated in Satun Municipality

Figure 1 provides insights into waste generation in Satun municipality, showing higher levels in 2017 compared to subsequent years. The outbreak of Covid-19 in 2019 coincided with a decrease in waste generation. Lockdowns and restrictions impacted consumption patterns and commercial activities, leading to reduced waste generation. This highlights the interplay between social factors and waste generation. The Covid-19 period offers an opportunity to reflect on potential long-term changes in waste management practices. Adaptable strategies considering societal changes are essential. Further research is needed to explore sustainable waste management practices based on lessons learned during the pandemic.

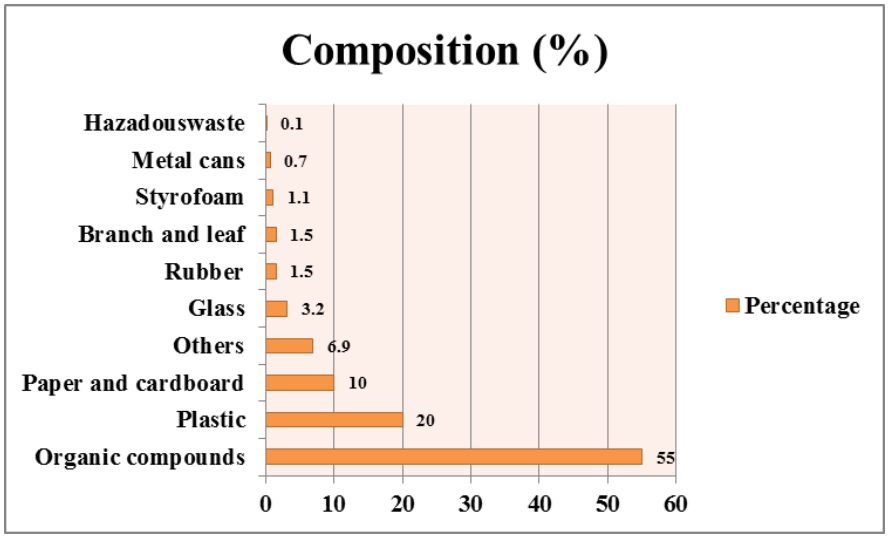

Figure 2: Composition of Municipal solid waste by percentage in Satun Municipality

The data from Figure 2 reveals that Satun municipality generated an average of 6,425.47 tons/year of solid waste between 2017 and 2020. The waste composition indicates that food waste accounted for the largest proportion at 55%, emphasizing the importance of addressing food waste management. Plastic waste constituted 20% of the total, highlighting the need for initiatives to reduce plastic waste. Paper waste accounted for 10% of the waste, suggesting the implementation of recycling and paper reduction measures. The remaining 6.9% categorized as "others" requires further investigation for effective waste management planning. Overall, the data underscores the need for a comprehensive waste management approach, focusing on waste reduction, recycling programs, and raising awareness for sustainable waste management practices in Satun municipality.

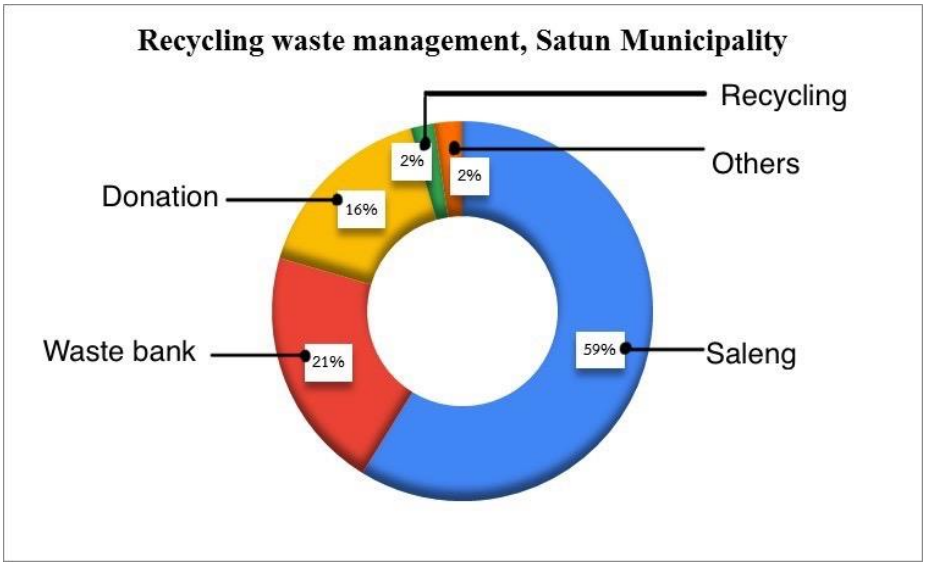

Figure 3: Recycling waste management, Satun Municipality

Figure 3 highlights the positive outcomes of recycling waste management activities in Satun municipality. The data indicates the generation of 477.90 kg/month of recyclable waste. The majority (59%) is sold to saleng, showcasing the market demand for recyclable materials. Waste banks receive 21% of the recyclable waste, promoting community participation and the circular economy. Additionally, 16% is donated, contributing to social and environmental initiatives. Recycling accounts for 2% of the waste, emphasizing its importance in sustainable waste management. The remaining 2% is allocated for other purposes. The findings underscore the significance of waste collectors, waste banks, and recycling initiatives in effective waste management. Fostering awareness, education campaigns, and infrastructure improvements

can further enhance recycling efforts and contribute to a more sustainable waste management system in Satun municipality.

Figure 4: Upcycling brooms from plastic bottles

Figure 4 indicates that creating brooms from plastic bottles presents a profitable opportunity for income generation through creative reuse or upcycling. With approximately 1 kg of plastic or 30 bottles required to produce a broom, the low cost of plastic bottles compared to the selling price of brooms suggests a favorable profit margin. This upcycling venture not only contributes to waste reduction but also offers economic benefits. To maximize the potential of this income-generating opportunity, support and training should be provided to individuals or communities interested in participating. Collaboration among local government organizations, waste management agencies, and the private sector can further enhance the efficiency and sustainability of this recycling enterprise. Overall, Figure 4 emphasizes the importance of innovative approaches that integrate environmental and economic considerations in waste management practices.

Figure 5: Products from Plastic Waste

Figure 5 demonstrates the positive impact of transforming plastic waste into innovative products like tote bags and flowers. These creative solutions contribute to waste reduction, and provide income-generating opportunities through upcycling efforts. The upcycling by-product was developed by volunteer group in community (The flower from fruit net foam and tote bag from coffee sachets). They use their free time and participant selection is interesting and skill which same interesting volunteers are participated. Several volunteers are elder people but the limitations are some processes required high force and good visuality which some elderly persons are not complied with this performance. By repurposing plastic waste, individuals and communities can contribute to a circular economy and reduce the amount of plastic pollution. These initiatives also raise awareness about upcycling and encourage individuals to reconsider their consumption habits. To maximize the potential of these approaches, support and resources should be provided, including training, access to materials,

and marketing assistance. Collaboration between various stakeholders can facilitate the development and scaling of these initiatives. Overall, promoting and supporting these innovative endeavors leads to environmental and economic benefits while fostering a sustainable mindset regarding plastic waste reduction.

Conclusion

The efficient management of municipal solid waste (MSW) is a critical concern for Local Administrative Organizations (LAOs) worldwide. This research aims to extract valuable lessons from Satun municipality's experiences in solid waste management and income generation from recyclable waste. By examining their successful approaches, this study seeks to enhance waste management strategies to similar context LAOs. Furthermore, this research focuses on understanding the challenges faced by Local Administrative Organizations (LAOs) in waste management and identifying effective measures implemented by Satun municipality. The study takes a comprehensive approach, analyzing waste generation rates, composition, sorting initiatives, recycling activities, and income generation from recyclable waste. The waste composition primarily consists of 55% food waste, 20% plastics, and 10% paper with other residues 15% (Glass, metal, clothes, wood, rubber, napkin, etc.). A significant portion of the recyclable waste, 59%, is separated and sold to waste collector called Saleng. Additionally, 21% is directed send to waste banks, 16% is donated in special events, 2% is recycled through local inventions such as brooms from plastic bottles, tote bag from coffee sachets, flower from fruit foam net and 2% is allocated for other purposes. Awareness raising, education campaigns, and infrastructure improvements can further enhance recycling efforts and contribute to a more sustainable waste management system in Satun municipality. These findings can contribute to sustainable waste management practices and serve as a reference for LAOs to improve waste management systems, emphasizing the integration of income generation from recyclable waste. Ultimately, the research aims to promote more effective and sustainable waste management practices across different local government organizations.

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