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ENABLERS TO FACILITATE INDUSTRIAL SYMBIOSIS FOR BETTER WASTE MANAGEMENT OF INDUSTRIAL ZONES IN SRI LANKA

Pubudu Herath[1], Piumi Dissanayake[2] and Binashi Kumarasiri[3]

ABSTRACT

Industrialisation has led to a massive increment in resource consumption and waste generation, which demands improved management strategies for Waste Management (WM), especially in Industrial Zones (IZ). Thus, Industrial Symbiosis (IS) concept was raised as a suggestion for WM in IZs through resource optimisation. IS concept being a sustainable solution focuses on waste elimination by creating a network of firms for the purpose of exchanging waste, by-products, utilities, infrastructure, and knowledge. Sri Lankan IZs still have not yet established a proper method to manage IW, which has led to heaps of waste. Since IS is an effective and timely solution for this issue, this paper was intended to analyse the enablers which will be vital in facilitating the application of the concept of IS for better WM of IZs in Sri Lanka. Despite the abundant research on IS concept, a gap in literature could be identified when it comes to exploring enablers to adapt IS for better WM of IZs in Sri Lanka. A qualitative research approach with two case studies were used in this study. A total of 12 interviews were conducted and collected data was analysed using code-based content analysis. The enablers were extracted through the analysis of case findings using an abductive analysis. The empirical findings revealed 34 enablers under environmental, economic, social, regulatory, organisational, technology, and market categories. Reduction of environmental deletion, reduction of WM cost, public pressure, environmental regulations, social relationships, availability of technology and recognition from buyers were some of the key enablers identified in this study. The knowledge generated through this research can be used by respective industry practitioners in Sri Lanka in adapting IS concept for better WM of IZs in Sri Lanka.

Keywords: *Enablers; Industrial Symbiosis; Industrial Zones; Waste Management.*

1. INTRODUCTION

Industrialisation and urbanisation resulted in the generation of massive amounts of Industrial Waste (IW), which is a key social issue (Karunasena and Kannangara, 2012). Kaza, et al. (2018) predict a 70 percent increase in the current generation of global waste by 2050 while waste generation will rise by more the double of its current waste stream in South Asia. Industrial Zones (IZ) can be identified as the most visible morphological

[1] Department of Building Economics, University of Moratuwa, Sri Lanka, pubudu.chamikara663@gmail.com
[2] Department of Building Economics, University of Moratuwa, Sri Lanka, piumid@uom.lk
[3] Department of Building Economics, University of Moratuwa, Sri Lanka, binashik@uom.lk

form of industrial facilities (Sacirovic, Ketin and Vignjevic, 2019) and it has become a common concept around the world where their functions create adverse impacts on human health, environment, and communities through higher pollution, safety problems, loss of biodiversity, and increase in cost associated with social externalities (Geng, et al., 2008). Similarly, IW is generated massively in Sri Lanka where IZs have been accountable for a higher proportion of IW (Karunasena and Kannangara, 2012). Unpleasant surroundings, loss of property values, increased flooding possibilities, creating health and safety issues for the public, spreading diseases, soil pollution and degradation of other natural resources are identified as environmental consequences of improper Waste Management (WM) (Bandara and Hettiaratchi, 2010).

There is an emerging need for a system to recover waste for secondary uses where it lowers the cost of manufacturing, enables efficient use of resources, encourages eco-friendly product designs and ultimately it minimises the environmental and human health issues (Mohamed, 2009). Industrial Symbiosis (IS) concept enables industries to shift to a circular model where waste generated from one organisation is transformed into another organisation as its feedstock and vice versa (Bocken, et al., 2016). IS engages a variety of organisations in different sectors in a network to bring up long-term culture change and eco-innovation through facilitating the creation and sharing of knowledge for novel sourcing of inputs, value adding usage of non-product outputs, and enhancing the efficiency and effectiveness of business and technical processes (Lombardi and Laybourn, 2012).

In the process of facilitating and developing a robust IS network, it is increasingly important to have a greater understanding of enablers applicable to the development as it plays a critical role in the context (Chertow and Park, 2016). Enablers can be considered an important attribute of industrial symbiosis, which directly affects to the success of developing IS networks where there is a data deficit about the enablers (Rahman, Islam and Islam, 2016). This implies that there is a necessity in investigating the enablers for the successful application of the IS concept as a solution, which has a knowledge gap in the Sri Lankan context. This paper aimed in bridging this knowledge gap to facilitate the successful application of IS concept for better WM of IZs in Sri Lanka.

2. LITERATURE REVIEW

2.1 WASTE MANAGEMENT OF INDUSTRIAL ZONES

IZs are one key area where a huge amount of IW is generated (Karunasena and Kannangara, 2012). Industrial activities have a significant environmental impact which has the potential to harm the environment (Duflou, et al., 2012). In IZs, improper and isolated WM procedures cause more environmental problems and spread diseases (Karunasena and Kannangara, 2012). Furthermore, the authors stated that public nuisances like soil pollution, unauthorised dumping, and inland water pollution have been created due to poor WM procedures in IZs. Discharge of industrial wastewater into storm water drains and surface water sources, and improper discharge of solid waste containing hazardous materials into open dumps directly contribute to the degradation of the quality of the water resources (Bandara, 2003). According to Van-Berkel, et al. (2009), recycling can be identified as the most common and favourable WM mechanism in use. Handing over to scavengers, landfilling, reuse, recycling (Geng, Zhu, and Haight, 2007) incineration, export, co-disposal with municipal waste and on-site storage (El-Fadel, et

al., 2001) are some existing WM mechanisms in IZs. Resource eco-efficiency, cleaner products, eco-designs, life cycle assessment (Mohamed, 2009), Pay as a throw, polluter pays principle, 3R strategy, green purchasing, and extended producer responsibility are novel concepts applied in WM in IZs (Karunasena and Kannangara, 2012). According to Guerrero, Maas and Holand (2013), existing WM approaches capture only a limited proposition of actual waste generation which routes to various issues. Mohamed (2009) shows that the increasing pace of industrialization produces massive amounts of waste, signalling the need for a new approach to WM in IZs.

2.2 INDUSTRIAL SYMBIOSIS CONCEPT

In the past 150 years, production and consumption patterns of the industrial economy followed the Linear Economy (LE) concept (Wautelet, 2018). LE is based on taking, make, consume, and discard principle (Drljaca, 2015). This linear system consumes large volumes of resources which creates negative impacts on the environment and people (EMF, 2017). Even though the LE has been successfully implemented in industrial nations up to the 20th century, it is forecasted that it will affect negatively in near future (Sariatli, 2017). The Circular Economy (CE) concept has become a key solution for achieving economic growth while ensuring environmental sustainability due to the limitations and challenges of the LE concept (Lieder and Rashid, 2016). In this metabolism organisations are interacting together to create IS where energy and materials flowing out from one organization or process are used as inputs for another (Ashton, 2008). According to Bocken, et al. (2016), IS concept enables industries to shift from a linear model to a circular model where waste generated from one organization is transformed into another organization as its feedstock and vice versa. The emergence of IS concept has been highly demanded due to the negative impacts of LE.

2.3 ENABLERS FOR APPLICATION OF INDUSTRIAL SYMBIOSIS CONCEPT

Enablers can be considered as an important attribute of IS which directly affect to the success of developing IS networks (Rahman, Islam and Islam, 2016). Hence, it is important to have a considerable concern on enablers in the application of IS concept for WM of IZs. Table 1 summarises the enabling factors of IS network development under environmental, economic, social, regulatory, and organisational categories. This was based on the previous studies, which have been conducted by many researchers in the same area.

Table 1: Enablers of IS network development

Enabler category	Enabling factors
Environmental enablers	• Reduction of natural resource depletion • Reduction of waste outflow • Reduction of environmental impact
Economic enablers	• Reduction of input resource cost • Creation of new areas of revenue • Increased turnover • Spatial proximity
Social enablers	• Pleasant and cleaner environment • Creation of new employment opportunities • Satisfaction of cooperate social responsibilities

Enabler category	Enabling factors
Regulatory enablers	• Environmental policies • Pollution control regulatory framework • Supportive initiation policies and laws • Facilitated IS programmes
Organisational enablers	• New partnership opportunities • Enhance organizational sustainability • Trust, reciprocity, short mental distance, positive attitudes, social ties, common vision • Diversity of participants

[1] Domenech, et al. (2019); [2] Haq, et al. (2020); [3] Aparisi (2010); [4] Chertow and Park (2016); [5] Lin (2020); [6] Paquin and Howard-Grenville (2009); [7] Liu, et al. (2018)

However, when it comes to the Sri Lankan context, enablers of IS network development have not been discussed in literature yet. Thus, in bridging this knowledge gap, this paper intends to discuss the enablers of IS network development. The next section discussed the research process adopted in bridging this knowledge gap.

3. RESEARCH METHODOLOGY

This study aims to analyse enablers which are vital to ensure the success of the application of IS concept for WM of IZs in Sri Lanka. Thus, the research question of the study was as follows:

> ***RQ.*** "How the IS concept can be successfully applied for waste management of Industrial Zones in Sri Lanka?''

Yin (2015) suggested that a research approach has to be selected based on the type of research question, the extent of control an investigator has over actual behavioural events and the degree of focus on contemporary or historical events. Since, this research followed an in-depth exploration of the contemporary phenomenon, within its real-world context, with a "How" type of research question, a case study research strategy could be justified. A multiple-case design (Yin, 2015) was selected as this research area is broad and not limited to a certain industry as it focuses on IZs where variety of industries are operated with "application of IS concept for WM in IZs" as the unit of analysis. Since the research area is broad and not limited to a certain industry as it focuses on IZs where a variety of industries are operated, it is necessary to compare several cases to derive a more accurate output. Therefore, multiple case study was selected and limited to two (02) case studies based on the literal replications and theoretical replications (Yin, 2015) expected through the study. The profile of selected cases is given in Table 2.

Table 2: Profile of the selected cases

Case	Area (in acres)	Number of Factories	Number of workers	Main categories of factories operated	Estimated waste generated per year
A	531	86	39000	Hi end apparel, rubber production, electronic production	21,328 tonnes
B	450	77	26000	Fabric production, rubber productions, chemical production, printing services, and ceramics	38,487 tonnes

Referring to both cases, "handing over to scavengers" and "co-disposal" are commonly used WM strategies where the ultimate disposal mechanism is questionable. Moreover, "landfilling" and "incineration" are practised as waste management strategies which have a huge effect on biodiversity. In addition to that, "3R strategy", "life cycle assessment", and "green purchasing" are used as WM strategies which cover only a small portion of waste generated at IZs. Only a few organisations adhere to advanced strategies such as "cleaner products", "eco-designs" and "extended producer's responsibility" for WM. A higher portion of waste generated at IZs is being open dumping, open burning, or incinerated. These inappropriate WM practices at IZs are a huge threat to the environment and create public nuisance and severe health issues.

A total of 12 semi-structured interviews with six personnel from each case were used as the data collection technique (refer Table 3). The number of interviews was decided based on the data saturation and was limited by the fact that there are no experts on IS network development as there have not been practical applications yet in the Sri Lankan context. The interview guideline focused on 18 enablers identified through the literature review. Respondents were requested to elaborate their answers as per the current exposure to the aforementioned enablers.

Data analysis was carried out using code-based content analysis. It is vital to have an in-depth understanding of the enablers, which is vital to ensure the success of the application of IS concept for WM of IZs in Sri Lanka. However, so far, there has been no systematic academic analysis of the application of IS for WM in IZs in Sri Lanka. Thus, to investigate enablers, this paper applies the categorisations of Environmental', 'Economic', 'Social', 'Regulatory', 'Technological', 'Marketing' and 'Organisational' to analyse the macro-environment of the IS application in IZs of Sri Lanka. Similar categorisations have been widely used for such purposes all around the world (Aparisi, 2010; Domenech, et al., 2019). According to Domenech, et al. (2019), the use of such categorisations provides a multifaceted approach to assess big-picture forces for better understanding the enablers in a broader view and to assist in making considered and informed decisions. The enablers under were extracted through analysis of case findings using an abductive analysis.

Table 3: Profiles of respondents

Case	Years of experience	Interviewee code	Designation
A	6 years	CA-I1	Senior Manager – Environmental Sustainability
	5 years	CA-I2	Assistant Manager – Sustainability
	3 years	CA-I3	Executive – Sustainability
	3 years	CA-I4	Executive – Compliance and Sustainability
	3 years	CA-I5	Executive – Environmental Sustainability
	4 years	CA-I6	Executive – Environmental Safety and Health
B	4 years	CB-I1	Executive – Compliance and Sustainability
	5 years	CB-I2	Executive – Environmental Safety and Health
	3 years	CB-I3	Executive – Compliance and Sustainability
	5 years	CB-I4	Factory Engineer – Head of Engineering
	4 years	CB-I5	Assistant Manager – In charge of Operation
	5 years	CB-I6	Manager – Facilities and Administration

4. CASE STUDY FINDINGS

The case study findings of enablers to facilitate IS to manage waste in IZs are discussed and presented under environmental enablers (Section 4.1), economic enablers (Section 4.2), regulatory enablers (Section 4.3), social enablers (Section 4.4), organisational enablers (Section 4.5), technological enablers (Section 4.6), and market enablers (Section 4.7) as below;

4.1 ENVIRONMENTAL ENABLERS

Findings generated through the case study analysis revelated that almost all the enablers under the environmental category directly or indirectly contribute to the reduction of environmental impact. Amongst the all-environmental barriers, 'reduction of environmental impact (En/E6)' was identified as the main enabler by all the respondents from both cases. 'Reduction of natural resource depletion (En/E4)' and 'reduction of waste outflow (En/E5)' are environmental enablers reasoning reduction in the institutional and public pressure on the organisations. Reduction of external pressure as a result of reduced use of raw materials and reduced waste disposal encourages organisations to involve in IS networks. Further, 'Reduction of water contaminations (En/E1)' and 'waste dumps (En/E2)' encourage organisations to involve in IS network which prevents water pollution and enhances land usability. In addition, CA-I4 stated that IS provides solutions to scarcity of resources where scarcity has been a major issue in the current industrial system which is another environmental enabler of IS. A summary of Environmental enablers of IS network development has listed in Table 4.

Table 4: Summary of environmental enablers

Code	Enabler
En/E1	**Reduces effect on water bodies by waste contaminations***
En/E2	**Reduces waste dumps on lands***
En/E3	**Control scarcity***
En/E4	Reduction of natural resource depletion
En/E5	Reduction of waste outflow
En/E6	Reduction of environmental impact

En/E - '**En**vironmental/**E**nabler'

Note: *Findings that are identified only from the analysis of cases.

4.2 ECONOMIC ENABLERS

'Reduction of input resource cost (E/E5)', 'reduction of waste processing cost (E/E1)' and 'creation of new areas of revenue (E/E6)' are the most highlighted economic enablers where CA-I4 stated that "*alternative use of waste reduces the raw material cost for buying participants and generate revenue to selling participants and also it reduces the waste outflow from the network which reduces waste processing cost*". 'Spatial proximity of the participant organisations (E/E8)' is identified as an economic enabler by all respondents, where it reduces the cost on transportation and infrastructure. CA-I1 added that "*close proximity of organisations enables the use of immovable properties in a shared basis and reduces cost on movements*". Shared cost on utilities and infrastructure (E/E2)' was identified as an economic enabler where CB-I5 stated that "*IS enables participants to*

share the cost associated with initiation, operation, and maintenance of utility and infrastructure projects". 'Innovative production opportunities (E/E4)' are an economic enabler too as per case study findings. It was further evident through the perspective of CB-I3 where he stressed that "*IS provides huge exposure to novel and innovative knowledge where new production applications open up new income generation paths".* In addition, increment in turnover (E/E7)' and 'financial strength to enter new initiatives (E/E3)' were recognised as economic enablers of IS by respondents. Table 5 shows the economic enablers of IS network development.

Table 5: Summary of economic enablers

Code	Enabler
E/E1	**Reduction of waste processing cost***
E/E2	**Shared cost on utilities and infrastructure***
E/E3	**Financial capabilities to enter new initiatives***
E/E4	**Innovative production opportunities***
E/E5	Reduction of input resource cost
E/E6	Creation of new areas of revenue
E/E7	Increased turnover
E/E8	Spatial proximity

E/E - '**E**conomic/**E**nabler'

Note: *Findings that are identified only from the analysis of cases.

4.3 SOCIAL ENABLERS

A summary of social enablers of IS network development are listed in Table 6.

Table 6: Summary of social enablers

Code	Enabler
S/E1	**Social recognition***
S/E2	**Goodwill***
S/E3	**Public pressure***
S/E4	Pleasant and cleaner environment
S/E5	Creation of new employment opportunities
S/E6	Satisfaction of cooperate social responsibilities

S/E - '**S**ocial/**E**nabler'

Note: *Findings that are identified only from the analysis of cases.

'Creation of pleasant and cleaner environment (S/E4) is a major social enabler which was accepted by all the respondents from both cases. According to CA-I5, "*IS prevents improper waste disposal and social externalities associated with WM of IZs where it creates a pleasant and cleaner environment*". Many respondents highlighted that 'creation of employment opportunities (S/E5)', 'satisfaction of cooperate social responsibilities (S/E6), social recognition (S/E1) and 'goodwill (S/E2)' are social enablers which are interconnected. CB-I4 stated that "*creation of employment opportunities through new projects satisfy the cooperate social responsibilities where it creates a good image to the organisations*". Further, finding generated from the analysis

of both cases revealed that complaints and objections on public nuisance (i.e., 'public pressure (S/E3)') tends organisations to apply more sustainable WM approaches" which was raised by other respondents as well.

4.4 REGULATORY ENABLERS

All the respondents identified 'implementation of environmental policies (R/E3)' and 'pollution control regulations (R/E4)' as regulatory enablers where it demands more sustainable WM solutions. CB-I6 stated that "*IS provides solutions to reduce environmental pollutions where an organisation may involve with IS network to adhere to rules and regulations".* 'Restrictions on non-renewable resources (E/E1)' and 'imposing taxes on non-renewable resources (R/E2)' are considered as regulatory enablers of IS as "*it provides alternatives to non-renewable resources which reduces tax cost and provide solutions to limitations of using non-renewable resources"* CA-I2 said. A summary of the regulatory enablers of IS network development are listed in Table 7.

Table 7: Summary of regulatory enablers

No.	Enabler
R/E1	**Restrictions on non-renewable resources***
R/E2	**Imposing taxes on non-renewable resources***
R/E3	Implementation of environmental policies
R/E4	Pollution control regulatory framework

R/E - '**R**egulatory/**E**nabler'

Note: *Findings that are identified only from the analysis of cases.

4.5 ORGANISATIONAL ENABLERS

All responses from case study shows that 'trust, reciprocity, short mental distance, positive attitudes, social ties, and common vision (O/E5)' are individual factors of participants which enables to initiate synergies in an IS network where CA-I3 further strengthen this fact as "*trust, reciprocity, short mental distance, positive attitudes, social ties and common vision creates strong relationships among participants which enhance sustaining synergies*". 'Diversity of participants (O/E6)' and 'new partnership opportunities (O/E3)' are co-related organisational enablers where both provide synergistic possibilities. CB-I2 stated that a "*higher number of synergistic possibilities occur with the diversity of participants which tempt participants to enter the IS network*". Knowledge of participants on the benefits of IS act as an organisational enabler. Executive – Compliance and Sustainability from Case B stated that "*organisations with proper knowledge on IS initiatives involve in IS network as there are vast a number of benefits to participants*". Also, 'enhancement of organisational sustainability (O/E4) and 'positive influence by management (O/E2)' were identified as organisational enablers. A summary of organisational enablers of IS network development are listed in Table 8.

Table 8: Summary of organisational enablers

Code	Enabler
O/E1	**Knowledge of participants***
O/E2	**Positive influence by management***

Code	Enabler
O/E3	New partnership opportunities
O/E4	Enhance organizational sustainability
O/E5	Trust, reciprocity, short mental distance, positive attitudes, social ties, common vision
O/E6	Diversity of participants

O/E - '**O**rganisational/**E**nabler'

Note: *Findings that are identified only from the analysis of cases.

4.6 TECHNOLOGICAL ENABLERS

'Availability of technological knowledge (T/E1) is an enabler to IS, which was identified by all respondents where it provides a greater understanding on the application and operation of the network. Executive – Compliance and Sustainability from Case B stated that "*IS network development demands higher-level technological expertise as it requires novel and innovative thinking*". 'Availability of advanced equipment and machinery (T/E2) was identified as another enabler of IS. CA-I5 stated that "*IS network is a complex network which needs critical decision making and advanced process handling which require automated operations where availability of advanced technologies enhance the performance of the network*". A summary of Technological enablers of IS network development are listed in Table 9.

Table 9: Summary of technological enablers

Code	Enabler
T/E1	**Availability of technological knowledge***
T/E2	**Availability of advanced equipment and machinery***

T/E – '**T**echnical/**E**nabler'

Note: *Findings that are identified only from the analysis of cases.

4.7 MARKET ENABLERS

'Recognition by buyers (M/E1)' and 'matching to international market requirements (M/E2)' were identified as market enablers by respondent from both cases. CA-I1 stated that "*sustainable overlook of the organisation increases the recognition, which creates new market spaces*" where CA-I5 also stated a similar view. "*Buyers who are looking for sustainable products increase the demand for the products and many developed countries concern highly on sustainable production where new market opportunities in international market arise by involving in IS operations*", CA-15 said. A summary of Market enablers of IS network development are listed in Table 10.

Table 10: Summary of market enablers

Code	Enabler
M/E1	**Recognition by buyers***
M/E2	**Matching to international market requirements***

M/E - '**M**arket/**E**nabler'

Note: *Findings that are identified only from the analysis of cases.

5. DISCUSSION

By reviewing the existing literature, altogether 18 enablers were identified (refer Section 2.3). These findings were in general and are not specific to Sri Lanka. However, these enablers are almost similar to the Sri Lankan context according to case study findings, except for two enablers. The formation of "supportive initiation policies" and "facilitated IS programmes" should be raised with the involvement of a governing body, which has a long-term vision of the process. Since the IS concept is a novel concept currently not practicing in Sri Lanka, the governing bodies do not involve in such initiations due to a lack of expertise knowledge and risk attached to initiations. Moreover, in addition to the five enabler categories found through the literature (i.e., environmental, economic, social, regulatory and organisational), four enablers were revealed through the case studies under another two categories, namely; technological and market. Sri Lanka is being a developing country, technological enablers and market enablers need to be considered because, in the technological sense, Sri Lanka is been reluctant to adopt new technologies and most of the techniques are not affordable to implement. Thus, it is obvious that, identification of its enablers and how those enablers could assist in such context is utmost important.

Altogether, 18 enablers were solely identified from the case studies including 03 environmental (refer Section 4.1); 04 economical (refer Section 4.2); 03 social (refer Section 4.3); 02 regulatory (refer Section 4.4); 02 organisational (refer Section 4.5); 02 technological (refer Section 4.6); and 02 market (refer Section 4.7) enablers, which are required for the application of IS to manage waste in IZs successfully in Sri Lanka. The recent studies by Domenech, et al., (2019) and Haq, et al., (2020) highlighted in their studies that reduction of environmental impact as a foremost enabler. A similar perception was observed in Sri Lanka as per case study findings. Moreover, Domenech, et al., (2019) disclose environmental, economic, social, regulatory, and organisational enablers (refer Table1). These findings were applicable to the Sri Lankan context as well.

Reduction of input resource cost, reduction of waste processing cost and creation of new areas of revenue are the most highlighted economic enablers identified through the case studies. These findings are almost similar to the findings of the studies by Domenech et al., (2019) and Aparisi (2010). The creation of a pleasant and cleaner environment is the major social enabler which was solely identified through the case studies. Though the concept of IS is new to Sri Lanka, it is believed that a pleasant and cleaner environment could be generated through the implementation of IS concept in IZs of Sri Lanka. Case study findings further revealed that this finding could be generalised to other countries as well. Organisational barriers identified in this study are almost the same as the findings by Domenech, et al., (2019), Aparisi (2010), Lin (2020), Paquin and Howard-Grenville (2009); On a slightly different note, trust, reciprocity, short mental distance, positive attitudes, social ties, and common vision, knowledge of participants are the foremost organisational enablers in Sri Lanka in comparison to the findings by same researchers. These foremost enablers in Sri Lanka facilitate to initiate synergies in an IS network and let the implementation process be accelerated, as per case study findings.

6. CONCLUSIONS

Management of IW is becoming a decisive problem mainly in IZs in Sri Lanka. Except for sewer treatment plants which are established in IZs, there are no other proper

treatment techniques adapted to manage the waste generated. Therefore, instead of going for an open industrial system, which disposes of waste after consumption of energy and materials for production, should be replaced with a cyclic industrial system which is effective and efficient in resource flow. IS is such a concept, which can be adapted to manage IW successfully in an effective manner. However, the concept of IS being a novel concept to Sri Lanka, identifying its enablers is vital to get a better understanding of the concept and to accelerate the implementation process of IS in IZs for better waste management. Thus, this research was intended to analyse the enablers which will facilitate the successful implementation of IS concept for WM of IZs in Sri Lanka. Altogether, 34 enablers including 06 environmental, 08 economic, 06 social, 04 regulatory, 06 organisational, 02 technology, and 02 market enablers were identified in this study. Reduction of environmental deletion, reduction of WM cost, public pressure, environmental regulations, social relationships, availability of technology and recognition from buyers were the key enablers identified in this study. Understanding of these enablers will streamline the future adaptation of IS to manage IW in Sri Lanka. Overall, the knowledge generated through this research would be favourable for relevant industry practitioners i.e., policymakers, industry practitioners, investors, government bodies and researchers to make informed decisions on the implementation IS concept to initiate a centralised WM mechanism in IZs.

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