Supplementary Information

Table S1. Initial implementation and adaptive management of the ZW model using the i-ZEWATA methodology for the iron and Steel industry in developing countries.

Steps	i-ZEWATA model Implementation Framework Components	Input	Methods, components, tools, or data as input suggestion	Output
Step 1 Implementation	Formulate ZW goal	Formulate ZW Goal	Company policies, legal requirements and licenses, stakeholder input, social requirements, environmental and sustainability requirements, economic requirements, company operating plan and company outlook	Draft ZW policy and draft procedures. ZW plan outline.

Steps	i-ZEWATA model Implementation Framework Components	Input	Methods, components, tools, or data as input suggestion	Output
Step 1 Review and Assessment	**Revisit ZW goal**	Revisit ZW Goal	Company policies, legal requirements, stakeholder input, social requirements, environmental and sustainability requirements, economic requirements, company operating plan, and outlook	Amend ZW policy and procedures. ZW plan review.
Step 2 Implementation	**Determine critical system components**	Determine the status quo of the critical ZW system components: company culture, waste accounting,	Perform a detailed and exploratory waste system audit and gap analysis to determine the status quo,	Understanding of the critical system component status quo.

Steps	i-ZEWATA model Implementation Framework Components	Input	Methods, components, tools, or data as input suggestion	Output
		environmental externality accounting, regulatory, waste data system, and monitoring protocol.	representativeness, and accuracy of available critical system components. Apply qualitative and quantitative methods to support the audit.	Develop a plan to address critical system components. Update and align ZW policy and draft procedures.
Step 2 Review and Assessment	**Review critical system components**	Review the status quo of the critical ZW system requirements: company culture, waste accounting, environmental externality accounting, regulatory,	Perform exploratory and detailed waste system audit and gap analysis to review the status quo, representativeness, and accuracy of available critical system components. Apply	Understanding of the critical system component status quo. Review plans to address gaps, as identified in the initial implementation.

Steps	i-ZEWATA model Implementation Framework Components	Input	Methods, components, tools, or data as input suggestion	Output
		waste data system, and monitoring protocol.	qualitative and quantitative methods to support the audit.	Develop a plan to address critical system components challenges. Update and align ZW policy and procedures.
Step 3 Implementation	**Determine the status of baseline information (i-ZEWATA Step 1)**	Determine the status quo of the baseline information: environmental conditions, waste characterization, waste externalities, sustainability practices, and	Specialist reports, local and national government information documents, available EIA's, available waste data, historical data, monitoring data, annual	Identification of baseline information available and the identification of information gaps.

Steps	i-ZEWATA model Implementation Framework Components	Input	Methods, components, tools, or data as input suggestion	Output
		system integration, and compliance to legal requirements.	reports, environmental management, sustainability plans, circular economy guidelines and tools, legal register, and compliance status legal documents.	Develop a plan to address baseline data gaps.
Step 3 Review and Assessment	**Baseline information (i-ZEWATA Step 1)**	Review the status quo of the baseline information: environmental conditions, waste characterization, waste externalities, sustainability practices, and system integration and compliance requirements	Specialist reports, local and national government information documents, available EIA's, available waste data, circular economy guidelines and tools, historical data, monitoring data, legal	Review of baseline information available and the identification of information gaps. Review and update the plan to address baseline data gaps.

Steps	i-ZEWATA model Implementation Framework Components	Input	Methods, components, tools, or data as input suggestion	Output
			register, and compliance status legal documents.	
Step 4 Implementation	**Design components (i-ZEWATA Step 1)**	i-ZEWATA implementation with input data from VSM three-phase approach	i-ZEWATA analysis (hybrid VSM / AHP / ANP method)	ZW model for the facility ZW model priority criteria and alternatives.
Step 4 Review and Assessment	**Review design components (i-ZEWATA Steps 2a and b)**	i-ZEWATA review with input data from VSM three-phase approach	i-ZEWATA analysis (hybrid VSM / AHP / ANP method)	Updated ZW model for the facility Review the actual state VSM map. Update future state VSM map.

Steps	i-ZEWATA model Implementation Framework Components	Input	Methods, components, tools, or data as input suggestion	Output
				Updated ZW model priority criteria and alternatives.
Step 5 Implementation	**Operation components (i-ZEWATA Steps 2 a and b)**	Zero waste model's priority criteria and alternatives	Facility management and treatment plan, ZW exchange initiatives and plan, ZW process improvement initiatives, circular economy guidelines and tools, ZW internalization plans, sustainability, and triple bottom line initiatives, site regulatory, and compliance components.	ZW plan with policy and procedures. Implementation of the plan.

Steps	i-ZEWATA model Implementation Framework Components	Input	Methods, components, tools, or data as input suggestion	Output
			The outcome of stakeholder consultations.	
Step 5 Review and Assessment	**Operation components review (i-ZEWATA Steps 2a and b, 3)**	Zero waste model's priority criteria and alternatives	Facility management and treatment plan, waste exchange initiatives, waste process improvement initiatives, waste internalization plans, sustainability, triple bottom line initiatives, circular economy guidelines and requirements, site regulatory, and compliance	Updated ZW plan

Steps	i-ZEWATA model Implementation Framework Components	Input	Methods, components, tools, or data as input suggestion	Output
			components. Stakeholder consultation.	
Step 6 Implementation	**Monitoring components (i-ZEWATA Step 1)**	ZW plan's i-ZW indicators	Audits, monitoring program data, and waste data	Developing i-ZW goals. Zero waste system reporting and review requirements and plan.
Step 6 Review and Assessment	**Monitoring components review (i-ZEWATA Step 1)**	ZW plan's i-ZW indicators	Audits, monitoring program data, and waste data	ZW performance review. ZW data and reporting system.

Steps	i-ZEWATA model Implementation Framework Components	Input	Methods, components, tools, or data as input suggestion	Output
Step 7 Implementation	**Adaptive management and ZW system performance measurement (i-ZEWATA Step 1)**	ZW performance of i-ZW indicators	i-ZW indicators	Zero waste goal progress. Decide on reporting hierarchy following the outcome of ZW system review. Prepare to participate in circular economy initiatives such as industrial symbiosis programs. Prepare to participate in incentive schemes.

Steps	i-ZEWATA model Implementation Framework Components	Input	Methods, components, tools, or data as input suggestion	Output
				Report on progress relating to regulatory instructions received.
Step 7 Review and Assessment	**Adaptive management and ZW system performance review (i-ZEWATA Step 1)**	ZW performance of i-ZW indicators	i-ZW indicators reporting data	Progress indication of ZW model implementation and CIWM system implementation. Progress indication of participation in circular economy initiatives such as industrial symbiosis programs.

Steps	i-ZEWATA model Implementation Framework Components	Input	Methods, components, tools, or data as input suggestion	Output
				Progress indication of participation in incentive schemes. Progress indication relating to regulatory instructions received.

Table S2. Industrial waste facility or complex management and waste valorization plan components

ZW System Management Components	**ZW Valorization Management Components**
Geo-Administrative	Manufacturing process analysis
Socio-cultural aspects	Waste minimization and waste characterization
Complex and waste characterization, monitoring and disposal plan	Treatment objectives
Waste streams and generation rates	Candidate technology selection protocol
Waste externalization quantification	Investigations protocol (bench-scale, pilot-scale)
Waste costs and accounting system	Preliminary treatment design protocol
Waste data system and monitoring protocol	Economic comparison protocol
Compliance requirements	Waste exchange protocol and waste stream identification
Company culture components	Waste internalization protocol and waste stream identification
Training	Compliance requirements
Other environmental, circular economy, CIWM and sustainability monitoring components	Treatment monitoring and data system protocol