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Embedding Sustainability: Sociotechnical Knowledge Management Guidelines for Digital Decarbonization in the Society 5.0 Era

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Abstract: Economic, social, and environmental sustainability emphasizes the need for organizations to integrate sustainability strategies into their core business and business development plans. The era of Society 5.0 is characterized by human-centeredness and digital leadership. It requires embedding sustainability practices and Green Information Technology (IT) while leveraging human–technology relationships to promote social good. However, embedding these practices into organizational culture is challenging due to resistance to change and the need for widespread mindset shifts. This study selected a focus group of eight South African participants to define sociotechnical knowledge management (KM) guidelines for embedding sustainable practices in organizations to promote digital decarbonization aligned with the Society 5.0 vision. Our findings suggest ten elements for the guidelines to incorporate: external environment, organizational context, business drivers, business outcomes, monitoring and evaluation, KM processes, technology enablers, sociotechnical KM tactics, knowledge assets, and execution considerations. By adopting such guidelines as a sustainability strategy, organizations can integrate KM practices into the human-centered and cyber-physical philosophy of Society 5.0. This approach aligns employee behavior with technological tools, enabling organizations to make data-driven decisions, reduce digital waste, and foster a culture of environmental responsibility. In addition, this approach enhances collaboration and innovation, benefiting all stakeholders and advancing sustainable development.

Keywords: sustainability; sociotechnical guidelines; knowledge management; digital decarbonization; Society 5.0

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1. Introduction

Economic, social, and environmental (ESE) sustainability advocates for organizations to consider sustainability strategies as part of their business operations, growth, and development strategies [1]. Business leaders use organizational sustainability to generate meaningful profits and change while reducing their environmental impact [2]. In the digital leadership age, such focus on sustainability also incorporates Green IT considerations [3]. Green IT encompasses digital waste management that entices organizations to strategize and implement Green IT practices, such as production processes (green software programming, data management, digital decarbonization) or its supply chain (e-waste management, circular economy) [4,5]. These green strategies could be addressed by implementing digitalization, thus enabling organizations to achieve sustainability goals [4,6].

Knowledge is a recognized key resource for success in organizations, and knowledge management (KM) initiatives can be applied to improve organizational performance in a

competitive environment. Furthermore, as KM is associated with transforming data into actionable insights in organizations, KM practices might assist in managing dark data [7,8]. Effective data management practices directly influence data center operations, and data application optimization can significantly contribute to digital decarbonization efforts [9].

Several scholars have applied a sociotechnical lens, yet only as related to specific focus areas. Thomas [5] identified four drivers of a sociotechnical system for digital transformation, while He et. al. [10] focused on mapping interorganizational knowledge-sharing mechanisms from a sociotechnical perspective. Handzic [11] examined the validity of an integrated sociotechnical KM framework to explain the main elements of KM, their relationships, and the principles of how these elements interact. Kosonen and Kianto [12] considered applying wikis to manage knowledge through a sociotechnical approach. These studies do not explicitly focus on sustainability nor on the Society 5.0 framework in the context of applying KM as a sustainability tactic.

Organizations can apply KM as a sustainability tactic [9]. This study aims to answer the question: "What sociotechnical knowledge management guidelines can embed sustainable practices in organizations and promote digital decarbonization within the Society 5.0 framework?". By using sociotechnical KM guidelines as a sustainability tactic, organizations can integrate KM practices with the human-centered, cyber-physical philosophy of Society 5.0 and align employee behavior with technological tools to foster sustainable operations. Organizations can make data-driven decisions, reduce digital waste, and promote a culture of environmental responsibility while enhancing collaboration and innovation, benefiting all stakeholders.

This paper presents preliminary findings as part of a broader Design Science Research (DSR) project, which comprises four development cycles. DSR is particularly well-suited to this research, as it facilitates the iterative creation of artifacts or utilities, such as frameworks, through independent, structured cycles [13]. This broad study follows the DSR steps of awareness, suggestion, development, evaluation, and conclusion proposed by Vaishnavi and Kuechler [14]. This paper examines the third cycle of the development phase, offering key insights and contributions to inform the subsequent fourth cycle.

This paper is structured as follows: Section 2 describes the background, and Section 3 outlines the materials and methods. Section 4 presents the study findings, and in Section 5, the authors discuss the study findings and contribution. Section 6 concludes the paper.

2. Background

Society 5.0 refers to a human-centered society. Economic progress helps resolve social issues through systems that integrate cyberspace and physical spaces [15]. Digital decarbonization, Green IT, and dark data management are key enablers of sustainability and the ESE goals of Society 5.0 [16,17]. For a sustainable future, organizations can reduce their environmental footprints, support inclusive societal development, and drive innovation by optimizing IT practices and leveraging untapped data responsibly [18]. Digital decarbonization refers to the responsible and efficient use of knowledge and data within organizations, emphasizing the adoption of digital best practices in sustainability strategies to minimize data-related carbon emissions [19]. Advanced digital technologies must address environmental challenges to meet digital decarbonization requirements while leveraging the KM discipline to reduce the overall carbon footprint through more effective practices [20] in specific industries [21], policy setting [22], and data [23]. Clear guidelines, as investigated in this study, provide a structured approach to implementing these practices, helping organizations align their operations with sustainability goals, ensure consistent application across all levels, and measure progress effectively over time.

2.1. Sustainability in Society 5.0

The United Nations (UN) has raised awareness of global challenges and ratified 17 Sustainable Development Goals (SDGs) at the UN SDG Summit in 2015 [24]. These goals strive to fulfill the UN pledge to leave no one behind, which aligns closely with the Society 5.0 vision of leveraging the cyber-physical world to the benefit of all members of society [25]. From an organizational perspective, businesses should share common goals and plan environmentally sound business activities to achieve authentic sustainability [24–26]. The Society 5.0 era could deliver social, economic, and ecological benefits, thereby enhancing societal sustainability and stability [27,28].

Organizational sustainability is defined as economic, social, and environmental (ESE) sustainability or environmental, social, and governance (ESG) sustainability [3,29,30]. Whether framed as ESE or ESG, balancing profitability with meeting human needs supports sustainable development, thus conserving the Earth's ecology and alleviating poverty [2,31]. From an organizational perspective, achieving sustainability requires a deep understanding of the knowledge that defines and supports it. Accordingly, organizations can effectively embed sustainability principles into their operations by thoroughly understanding this knowledge, its systemic nature, and the KM processes needed to manage it [32].

2.2. Sociotechnical Knowledge Management Guidelines

Handzic [11] identified a KM taxonomy with three viewpoints: economic, behavioral, and technocratic. The economic viewpoint is concerned with extracting value from organizational knowledge assets by maximizing the interrelationships between different types of organizational intellectual capital. From the social and technical perspectives, KM is concerned with factors that might enable or facilitate knowledge processes, thus fostering the development of working knowledge and impacting performance [11,33]. Organizations must apply these KM perspectives to isolate KM initiatives and investments that align with their specific contexts and operational needs [11]. IT provides a platform for the communication and knowledge sharing of KM repositories, data analytics, knowledge graphs, and decision support systems [34]. Such a sociotechnical approach and guideline act as a knowledge catalyst, enabling KM processes and leadership, culture, and organizational structure interventions to create an organizational environment conducive to knowledge development [5,35].

Guidelines are critical decision-making tools since they are based on currently available knowledge and direct practices stepwise [36]. Many factors influence whether or not and how employees would apply guidelines. The impact of extrinsic factors includes the organizational capacity to collect, adapt, share, and apply evidence, the nature of the newly recommended practice or technology, and system-level environmental factors [37]. Although organizational leaders develop guidelines to encourage buy-in and embed sustainable practices, organizations must go beyond ensuring employees adopt environmentally friendly procedures. They should lead by example, demonstrating the behaviors they expect and, in so doing, reinforcing their commitment to sustainability [38]. Ultimately, sociotechnical KM guidelines for digital decarbonization in the Society 5.0 era should enhance employees' environmental knowledge to assist them in exhibiting pro-environmental behavior [38].

3. Materials and Methods

This study applied a focus group research strategy to collect data for developing a sociotechnical KM guideline to implement digital decarbonization in Society 5.0. A focus group is a small group of participants who share their perceptions on a particular topic with researchers. This approach was deemed relevant because this research study aimed

to discover new insights and obtain feedback on how concepts are presented in organizations [39]. The nature of the focus group and the different backgrounds of the participants supported the generation of ideas that might not have been considered beforehand.

The focus group approach consisted of four main steps: (1) Research Design, (2) Data Collection, (3) Data Analysis, and (4) Reporting the Results [40]. The first step, Research Design, includes defining the study objectives and identifying the research participants. A focus group was chosen to obtain input on embedding sustainable practices within organizations to promote digital decarbonization in alignment with the Society 5.0 framework. According to Kontio et. al. [41], a typical focus group consists of four to eight participants because smaller groups generate higher levels of participant involvement. Eight South African focus group participants were identified through purposive sampling based on their organizational job roles and the type of industry they represented. Table 1 depicts the focus group participants' profiles.

Table 1. Focus group participant profiles.

Participant Code (PC)	Level of Role	Industry Sector
PC1	Executive Management	Management consulting
PC2	User Experience Designer	Software development
PC3	Data Scientist	Insurance
PC4	Software Engineer	Banking
PC5	Knowledge and Information Management	Government
PC6	General Manager	Technology education
PC7	Senior Manager	Government
PC8	Manager	Telecommunication

During the second step, Data Collection, the participants shared some key definitions: (1) Society 5.0 values both human welfare and technological advancement, (2) it is a guideline for a principle directing appropriate behavior, and (3) Green IT refers to creating and using environmentally sustainable computing resources (hardware, software development, disposal, etc.). The focus group participants provided informed consent, and the study collected data based on the four questions detailed in Table 2.

Table 2. Focus group questions.

Focus Group	Question	Rationale	References
Engagement question	What frameworks/steps do you use in your organization to embed organizational sustainability practices (economic, environmental, and social sustainability)?	Understanding existing focus in the organization to create a baseline	[42–44]
Exploration question	How would your approach to embedding Green IT practices in your organization differ (if at all) from institutionalizing, e.g., a new operational business process?	Establishing a comparison to current practices	[45,46]
Exploration question	If you believe it is feasible to use knowledge management (KM) as a tactic, how would you approach implementing organizational sustainability and Green IT strategies and practices, and what would your key priorities be from a KM perspective?	Collecting input about implementation approaches	[47–50]
Exit question	The guideline development domains below can support the implementation of sustainability strategies and practices in your organization. How would you apply these domains, and are there any you would add or omit?	Confirming guidelines elements and establish additional aspects	[36]

With the third step, Data Analysis, the study documented feedback based on one key thought per comment and created groupings stemming from common comments through thematic analysis [51]. *Miro* software (https://miro.com/about/, accessed on 6 December 2024) was employed to document and categorize inputs. *Miro* utilizes a visual workspace that enables distributed teams to brainstorm and capture inputs. Section 4 presents a detailed analysis and discussion of the data, and Section 5 presents the fourth step, Reporting the Results.

4. Results

This study proposed to identify which sociotechnical KM guidelines can embed sustainable practices in organizations and promote digital decarbonization within the Society 5.0 framework. Each question in Table 2 is represented by a different *Miro* board and illustrated in a figure (refer to Figures 1–5).

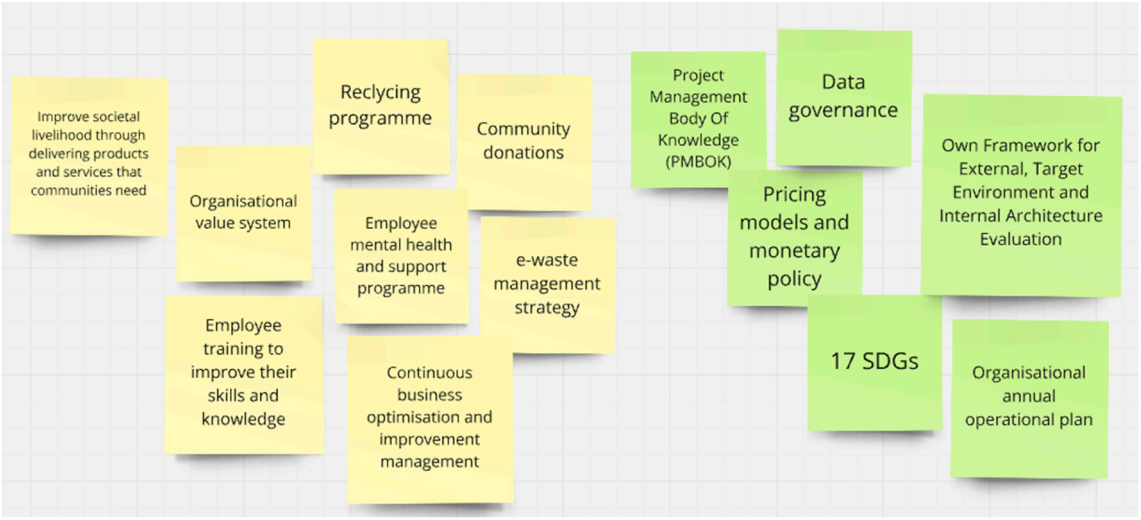

Figure 1. Current practices in the focus group participants' organizations related to sustainability in Society 5.0.

The first focus group question (Table 3) established the current practices of the focus group participants' organizations related to sustainability in Society 5.0. Figure 1 displays the *Miro* board.

The focus group participants raised fourteen comments categorized into two themes. The first theme (yellow sticky notes) presents current practices and includes some sustainability organizational initiatives such as recycling, e-waste management, mental health support, and community support. The second theme (green sticky notes) identifies some frameworks the focus group participants used in their respective organizations to embed sustainability in their organizations. The focus group participants highlighted the following frameworks: SDGs, data governance framework, PMBOK framework, operational plan, and pricing models. PC1 highlighted that "an organization is influenced by the ESG and other external factors but can only influence the target environment (suppliers, customers, market, competitors, and other stakeholders such as shareholders)."

The second question (Table 3) investigated whether the focus group participants' organizations applied other practices to embed sustainability rather than implementing standard operational transformation. Figure 2 depicts sixteen comments, categorized into three themes, namely operational tactics (blue sticky notes), employee management tactics (pink sticky notes), and resources (green sticky notes).

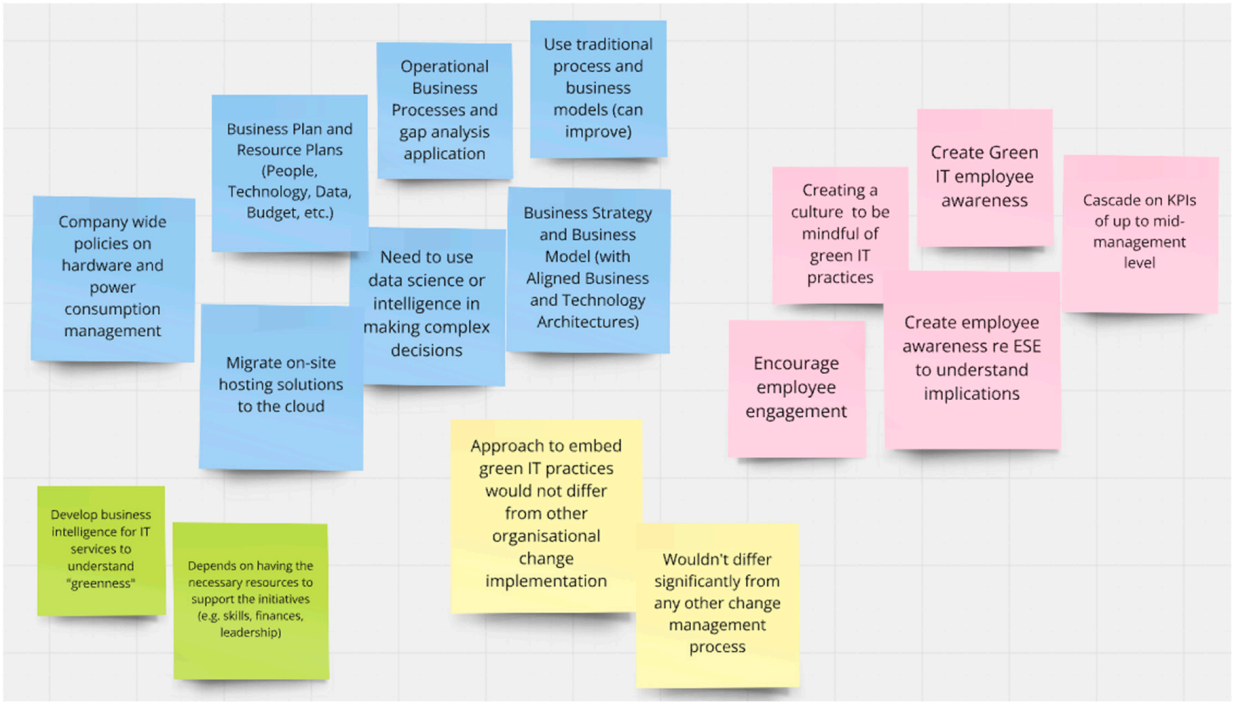

Figure 2. Practices to embed sustainability and organizational transformation.

Figure 3. KM tactics to embed sustainability and Green IT practices in an organization.

Figure 4. Focus group opinion about the guideline implementability framework proposed by Gagliardi and Brouwers [36].

Figure 5. Reflection on implementability framework elements suggested for addition to the existing framework.

Table 3. Integrated and categorized focus group data.

Guideline Element	Description	Focus Group	Sources [11,36]
External environment	SDGs, PMBOK, suppliers, customers, market competitors, digital decarbonization	x	x
Organizational context	Organizational transformation maturity, improvement baseline, organizational change capability, relevance, applicability, dark data	x	x
Business drivers	Organizational value system, continuous business improvement, organizational operational plan	x	x
Business outcomes	Sustainability, innovation	x	x
Monitor and evaluate	Organizational transformation maturity	x	x
KM processes	Centralized knowledge ecosystem, access to knowledge, minimize redundant knowledge	x	
Technology enablers	Green IT, AI, ML, knowledge graphs, platform	x	
Sociotechnical KM tactics	Operational tactics (support complex decision-making processes, ensuring that operational and strategic decisions are data-driven and effective), employee management tactics (encouraging employee engagement, creating ESE awareness, fostering a culture of mindfulness around Green IT practices), resources (skills, finances, leadership)	x	
Knowledge assets	Making knowledge a strategic asset for long-term success, knowledge is accessible and supports core business objectives	x	
Execution	Time frame, roles, and responsibilities (e.g., implementation), change management (e.g., communicability), employee experience design (e.g., usability)	x	x

The operational tactics followed by the focus group participants' organizations included aligning with company-wide policies on hardware and power consumption management, following the business plan, and specifying that resource allocation should emphasize migrating on-site hosting solutions to the cloud. This transition not only reduces energy consumption and hardware maintenance costs but also enhances scalability and efficiency. By leveraging data science and intelligent analytics, the organization can optimize resource utilization and support complex decision-making processes, ensuring that operational and strategic decisions are data-driven and effective. PC 8 mentioned they would "start off by understanding existing IT services within the organization." Furthermore, integrating traditional processes and business models with a refined business strategy and aligned technology architecture provides a foundation for sustainable growth. This approach allows for improvements to established practices while adopting innovative, cloud-based solutions to achieve operational efficiency and long-term resource optimization.

Employee management tactics entail encouraging employee engagement and creating awareness of the ESE implications essential to fostering a mindfulness culture around Green IT practices. By embedding Green IT awareness into training programs and regular communication, employees at all levels can better understand their role in promoting sustainable technology use. Key performance indicators (KPIs) related to Green IT objectives should be cascaded to mid-management levels to reinforce this cultural shift, thus ensuring accountability and alignment with organizational sustainability goals. This integrated approach empowers employees to contribute actively to green initiatives while embedding sustainability into the organization's operational ethos. However, PC6 highlighted that

"...only up to management level so far has a KPI for ESG—we now need to cascade it down to all staff."

The resources theme consists of two comments highlighting the necessity of the requisite resources to measure and support sustainability initiatives (e.g., skills, finances, and leadership). PC8 mentioned: "We [organization] optimize where the gaps exist." Two focus group participants stated that they approached sustainability adoption the same as any organizational transformation (yellow sticky notes), as confirmed by PC6: "... a business process where they [employees] are familiar with business and required outputs."

The third question (Table 3) examined the application of KM as a tactic to implement organizational sustainability and Green IT strategies and practices. Figure 3 shows twenty-three comments categorized into six themes.

The employee engagement KM tactic theme consists of six comments (dark yellow sticky notes), the operating model KM tactic (light yellow sticky notes) five, the knowledge acquisition KM tactic (pink sticky notes) three, the technology KM tactic (blue sticky notes) three, the measurement KM tactic (green sticky notes) four and, lastly, the knowledge-sharing KM tactic (orange sticky notes) two.

The employee engagement theme highlights that KM can drive buy-in for green technology by identifying early adopters and simplifying implementation. Educating stakeholders on the value of Green IT and demonstrating its achievements reinforces its business impact. Creating a community of practice to share insights and celebrate successes fosters a culture that embraces sustainability and drives continued engagement. PC3 confirmed they would "demonstrate the achievements to business so that they see value in it".

The operating model theme emphasizes that effective Green IT implementation requires a top-down approach, with management leading by example and prioritizing innovation through visionary leadership that fosters an enabling environment. An optimal process for acquiring and implementing Green IT should be clearly defined yet sufficiently flexible to incorporate employees' valuable inputs and adapt over time. Success relies on achieving organizational buy-in through sufficient knowledge transfer and consistently sharing key focus points, thus ensuring everyone understands and supports the Green IT initiative goals. PC 1 suggested, "...set up a task force that is responsible for increasing the organization's Green IT maturity".

The knowledge acquisition theme underlines that KM can facilitate the transition from paper-based documentation to a fully digital approach, streamlining how knowledge is stored, shared, and accessed across the organization. By improving access to existing knowledge, KM minimizes redundant knowledge production across business units, reducing inefficiencies and lowering the organization's carbon footprint. This approach promotes sustainability and enhances operational effectiveness by eliminating duplicate efforts and fostering a centralized knowledge ecosystem. PC 2 highlighted they would "identify areas which need to use knowledge management in the short term, then identify those that will adopt it with fewer challenges or complexity."

The technology theme highlights that providing stakeholders with the necessary resources to implement Green IT ensures they are empowered to drive sustainable initiatives effectively. Integrating AI technologies into these efforts enhances knowledge management practices by enabling more dynamic, efficient, and scalable approaches to knowledge creation and distribution. Such integration not only supports Green IT adoption but also streamlines organizational processes, thus fostering innovation and sustainability simultaneously. PC 5 emphasized that "these [AI] technologies act as catalysts and game-changers, fostering innovation in this evolving environment."

The measurement theme emphasizes that regularly comparing actual metric values with targeted values is essential to informing strategy and guiding the transformation lifecycle, ensuring alignment with organizational goals. By analyzing the current state of Green IT maturity and collecting comprehensive data on organizational operations, leaders can identify deficits and opportunities for improvement. In addition, gathering intelligence on future ESG influences allows the organization to adapt its strategies proactively, thereby ensuring sustainability remains at the core of its transformation journey.

Lastly, the knowledge-sharing theme highlights that creating an environment that encourages knowledge-sharing by employees working at the "coalface" ensures the integration of valuable, detailed insights into organizational practices. This approach empowers individuals to contribute to enhancing KM capabilities and tools, thus fostering innovations that are both environmentally sustainable and aligned with organizational goals. PC 6 stated, "I think there is a lot of knowledge in business—what I mean is that the employee working with the detail of his role is the one who understands best what is required to address these issues." PC 5 added, "AI technologies will advance knowledge management practices beyond the physical realm and enable more dynamic, efficient, and scalable approaches to knowledge creation and distribution."

The final focus group question collected data from two perspectives. First, opinions on the guideline implementability framework (Section 2.2) and second, a reflection on framework elements for addition to the existing framework, as proposed by Gagliardi and Brouwers [36]. Regarding the guideline implementability framework shown in Figure 3, the focus group participants generally agreed with the domains and commented that to remain competitive, organizations must enhance efficiency, innovation, and performance through effective execution and adaptability. By evaluating execution, companies can seize new opportunities, making knowledge a strategic asset for long-term success. Using the right platforms and domain guidelines helps standardize processes, monitor progress, and align sustainability goals. Responsible collaboration and information protection foster a competitive edge, while usability ensures that knowledge is accessible and supports core business objectives. Domains guide the creation of knowledge artifacts, ensuring actions are realistic and relevant. This approach allows organizations to adapt quickly to new technologies and market shifts, thus sustaining growth and resilience.

Figure 5 shows the focus group participants' proposed twelve dimensions to add to the implementability framework (Section 2.2). PC3 highlighted that "Adaptability is non-negotiable in today's rapidly evolving world."

The participants suggested twelve dimensions to consider in addition to the domains defined by Gagliardi and Brouwers [36], including the suggestion to determine a weight for each domain:

- Current point in time and targeted future time frames.
- Right platform: The implementation of the strategy should be built on the correct platform.
- Context: Incorporate the maturity of an organization and determine the baseline from where it would transform/improve.
- Responsibility: Business unit or individual(s) responsible for creating/driving the initiative.
- The ability of the organization to transform and implement change.
- Impact: What business units or areas of the organization are impacted?
- Identify implementation risks.
- Assign weight to each domain pertaining to organizational goals and culture.
- Capacity building.
- Monitoring.
- Innovation.
- Iterative approach of the guidelines.

In closing, PC7 commented that "...it would be useful to test the implementation model/framework against different organizational industries," and PC1 stated that "relevance goes hand-in-hand with usability and validity." Table 3 displays the integrated and categorized dataset created with the focus group data. The table is based on reviewing considerable existing research on KM approaches and extending the implementability guidelines proposed by Gagliardi and Brouwers [36] and the model proposed by Handzic [11] (Section 2.2).

The guideline elements presented in Table 3 are more comprehensive than the findings shared by Thomas [5], who identified four independent drivers for a sociotechnical system for digital transformation, namely motivation, technology, people interaction, and organizational drivers. He et. al. [10] have focused on knowledge sharing only and proposed two dimensions, namely knowledge categorization and interorganizational knowledge-sharing mechanisms. However, a sustainability focus is implied in these studies; they do not directly derive elements for sociotechnical KM guidelines that may embed sustainable practices in organizations and promote digital decarbonization within the Society 5.0 framework.

5. Discussion

This paper proposed to define which sociotechnical KM guidelines can embed sustainable practices in organizations and promote digital decarbonization within the Society 5.0 framework. Based on the focus group data summarized and categorized in Table 3, a conceptual sociotechnical KM guideline for digital decarbonization in the Society 5.0 era was derived and visualized from the integrated sociotechnical KM model proposed by Handzic [11], as shown in Figure 6.

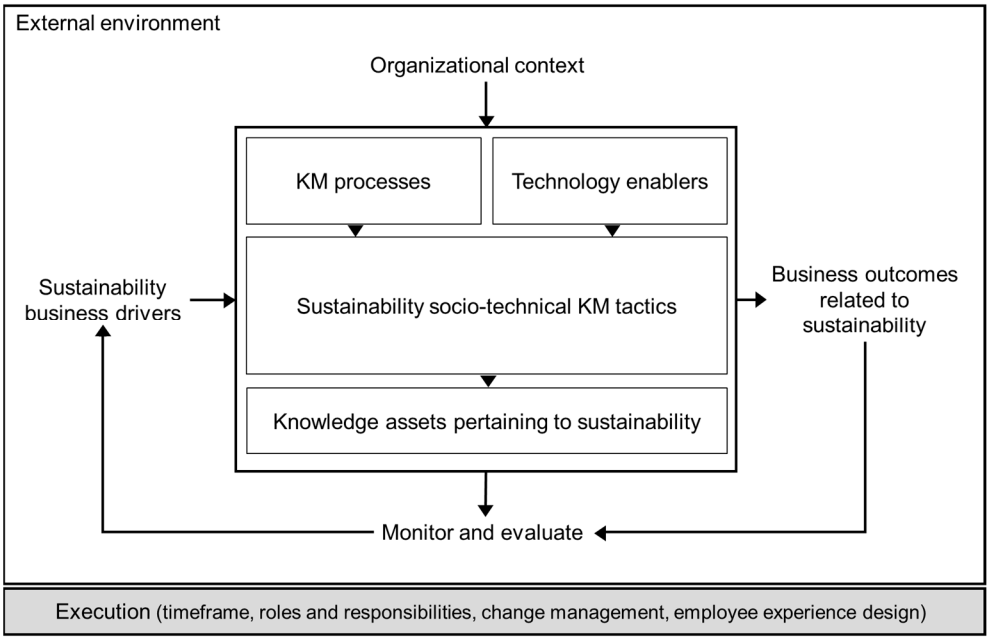

Figure 6. Conceptual sociotechnical KM guidelines for digital decarbonization to embed organizational sustainability in the Society 5.0 era.

Organizations operate within a dynamic external environment shaped by global forces, like the Sustainable Development Goals (SDGs), which highlight the urgency of sustainable practices. Utilizing frameworks such as PMBOK ensures effective project management while aligning with overarching sustainability goals. Suppliers, customers, and market competitors significantly influence operational strategies through their evolving demands and

actions. Digital decarbonization emerges as a key priority, driving organizations to adopt carbon-conscious strategies that minimize the environmental impact of digital operations.

In a rapidly evolving landscape, organizational context plays a key role. Organizations must assess their transformational maturity to gauge their readiness for change and adaptation. Establishing a clear improvement baseline enables sustainability progress tracking while evaluating change capabilities, highlighting both strengths and areas for growth. Strategies should remain relevant and tailored to the organization's goals and industry standards, particularly when addressing complex challenges like managing dark data. Organizations can unlock significant value, drive innovation, and reinforce sustainability efforts by effectively managing dark data.

The business drivers of the growth and transformation of an organization reside in its business and operating models, which guide decision-making and foster ethical practices. A commitment to continuous business improvement guided by sustainable practices ensures that operations evolve to meet emerging challenges and opportunities. These efforts are anchored by an operational plan integrating strategic sustainability priorities into daily activities, creating a cohesive pathway toward achieving organizational sustainability goals.

Business outcomes refer to achieving sustainability objectives and innovation. By embedding sustainable practices, organizations ensure long-term viability while addressing environmental and social responsibilities. At the same time, fostering a culture of innovation allows them to remain competitive, adapt to changes, innovate, and create new value for stakeholders.

Ongoing monitoring and evaluation are imperative for maintaining momentum and ensuring alignment with business objectives. Assessing organizational transformational maturity provides insights into its progress and readiness for achieving sustainable organizational goals. Such assessments allow for timely adjustments to strategies and processes beyond managing and accommodating changes in the external environment, e.g., climate change.

The organizational knowledge ecosystem pertaining to organizational sustainability goals consists of four aspects, namely KM processes, technology enablers, sociotechnical KM tactics, and knowledge assets. These aspects ensure that knowledge is accessible and empower employees to make informed decisions, whereas minimizing redundant knowledge reduces inefficiencies and enhances productivity. These processes create a streamlined flow of information that supports both operational and strategic goals related to organizational sustainability. Technology is an enabler of organizational sustainability; hence, Green IT solutions reduce environmental impact, while AI and ML provide predictive and analytical capabilities to enhance decision-making. Knowledge graphs improve the organizing and retrieving of information and dark data, and scalable platforms ensure interoperability and accessibility, fostering a collaborative and innovative environment. Successful KM requires a balance between technology and human engagement. Operational tactics ensure that decisions are data-driven and effective, while employee management tactics foster engagement and create awareness of environmentally sustainable practices. Adequate resources, including skilled personnel, financial investments, and strong leadership, provide the foundation for implementing and maintaining these sustainability strategies and goals. Knowledge assets support sustainability by providing the insights needed to integrate sustainable practices into operations. When effectively managed, these assets help reduce inefficiencies, guide informed decision-making, and align efforts with environmental and social goals. Ensuring knowledge is accessible and directly supports sustainability objectives enables organizations to adapt to evolving challenges, drive innovation, and maintain resilience in a competitive environment.

The effective execution and implementation of sustainability goals require careful planning and coordination. Clear time frames and defined roles and responsibilities ensure accountability and focus. Change management strategies facilitate smooth transitions, supported by effective communication to build stakeholder buy-in. Designing positive employee experiences prioritizes usability and engagement, ensuring the successful adoption of initiatives and fostering a culture of continuous improvement as the organization works toward achieving sustainability.

In terms of operationalizing the sociotechnical KM guideline for digital decarbonization, Table 4 depicts typical example outputs of each step. This instantiation is only illustrative since the exemplary outputs depend on the organizational context and the maturity of an organization's sustainability practices and KM. Notably, the execution is not sequential but cyclical.

Table 4. Example outputs of each of the steps of the sociotechnical KM guideline for digital decarbonization.

Guideline Step	Description	Example Output
1	External environment	Sustainability goals report, including global trends, carbon footprint analysis
2	Organizational context	Transformational maturity assessment, improvement baseline and benchmark report, change capability assessment
3	Sustainability business drivers	Value system mapping, continuous improvement roadmap, operational plan integration
4	KM processes	Knowledge-sharing platform, knowledge accessibility report, knowledge redundancy audit
5	Technology enablers	Green IT Solutions Plan, AI and ML implementation strategy, technology integration report
6	Sustainability socio-technical KM tactics	Employee engagement program, sociotechnical KM tactics report, resource allocation plan
7	Knowledge assets pertaining to sustainability	Strategic KM framework knowledge resource alignment report, sustainability knowledge repository
8	Business outcomes related to sustainability	Sustainability strategy, innovation framework, stakeholder value creation plan
9	Monitoring and evaluation	Monitoring dashboard, maturity progress report, evaluation framework
10	Execution	Implementation timeline, roles and responsibilities matrix, change management communication plan, employee experience design framework

These example outputs guide the organization through each step of embedding sustainability within its culture and operations, creating a structured approach to achieving long-term environmental, social, and economic goals.

6. Conclusions

This study sought to define a sociotechnical KM guideline for embedding sustainable practices in organizations and promoting digital decarbonization in the Society 5.0 era. This study collected data for designing the guidelines from eight focus group participants and presented a guideline visualization (Figure 6) and an instantiation of the application of the guideline (Table 4). The sociotechnical KM guidelines address potential gaps in sustainability practices within Society 5.0 by offering ten guideline steps that include organizational strategy, processes, and technology. By considering the external environmental and organizational contexts, these guidelines provide a contextual understanding of global

sustainability trends and the organization's readiness for transformation. The focus on business drivers and business outcomes ensures sustainability is strategically embedded in operational goals, while the monitoring and evaluation components allow for real-time progress tracking and adaptability. The inclusion of knowledge assets and a clear execution plan ensures that sustainability knowledge is systematically developed, aligned, and embedded within organizational culture, thus facilitating long-term success in the digital decarbonization journey.

Future work might focus on testing the guidelines in different organizational contexts since the organizational context guideline step accounts for discrete industry sectors and levels of organizational maturity readiness to embed sustainability through sociotechnical KM guidelines. In addition, the organizational value system, specifically culture, impacting attitudes towards sustainability and knowledge sharing, could be considered.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets presented in this article are not readily available because the data are part of an ongoing study. Requests to access the datasets should be directed to Hanlie Smuts at hanlie.smuts@up.ac.za.

Conflicts of Interest: The authors declare no conflicts of interest.

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