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Advancing conceptual understanding of technology adoption decisions in E-waste urban mining sector

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ABSTRACT

The e-waste urban mining technology adoption at the organizational level remains an underexplored area, with a lack of conceptual clarity, theory development, and a structured research direction. This study aims to bridge this theoretical gap by offering a comprehensive conceptual framework that identifies key determinants influencing technology adoption in e-waste urban mining businesses. Drawing upon the Theory of Planned Behaviour (TPB), Technology-Organization-Environment (TOE) framework, and the Diffusion of Innovation (DOI) theory, this study establishes a robust theoretical foundation for e-waste urban mining technology adoption. The proposed conceptual framework incorporated five critical dimensions: knowledge (awareness, technical, and principle knowledge), device competence (relative advantage, complexity, security risk, and compatibility), human readiness (attitude, confidence, and subjective norms), organizational readiness (organizational resources and management support), and external pressure (coercive and competitive pressure). By integrating these dimensions, this pioneering study enhances the predictive accuracy of technology adoption decisions in the e-waste urban mining businesses. Unlike existing e-waste sector research, which primarily focuses on consumer and household perspectives, this study shifts the focus to organizational-level decision-making, offering valuable insights for practitioners and policymakers to promote sustainable e-waste urban mining technologies.

1. Introduction

Technological advancement often leads to an exponential increase in the supply and demand of electronic devices, resulting in a surge in e-waste. In 2022, 62 million metric tons of e-waste were generated globally, but only 22.3% was properly collected and recycled, with the majority leaking into the environment [1]. The situation is even more critical in developing countries, where most e-waste is handled unsustainably, leading to the disposal of hazardous materials in water bodies, illegal dumps, and unregulated landfills [2,3]. In contrast, outdated and rudimentary techniques continue to dominate e-waste processing in developing countries, resulting in resource depletion, economic losses, environmental harm, and health risks [4,2]. For instance, the majority of e-waste urban mining operations in India rely on rudimentary and outdated processing methods. As a result, only 5–10% of the total e-waste generated is sustainably collected and recycled [5,3].

In response to this escalating crisis, the adoption of sustainable e-waste urban mining technologies is proposed as a viable solution, offering substantial benefits while also introducing new challenges and demands for businesses [4,3,6]. The World Resources Forum defines sustainable e-waste urban mining technologies as advanced technologies with the ability to safely collect and recycle e-waste minimizing adverse health and environmental impacts [7–9]. Despite its potential, the adoption of e-waste urban mining technology in developing countries has progressed slowly over the years [10,11]. This highlights the urgent need for a deeper and more precise understanding of technology adoption within the e-waste sector. In particular, it is crucial to identify the key factors that influence decision-making around the adoption of such technologies in the context of e-waste urban mining. Although the concept of technology adoption has received increased attention across various disciplines [12–14], particularly in organizational contexts [15–17], studies within the e-waste sector remain limited. Further, existing conceptual models in the e-waste sector largely focus on individual level technology adoption decisions, which are largely

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unexplored at the organizational-level [18–21]. Also, these models and theories are often criticized for their technocentric focus, primarily emphasizing technology adoption from the household and/or consumer level perspective, which is not sufficient to offer a comprehensive perspective of technology adoption decisions at the organization level [22,23]. As a result, there remains an ongoing debate regarding the need for a solid theoretical foundation to provide evidence-based guidance for technology adoption in the e-waste urban mining businesses, particularly in developing countries [20]. To bridge this knowledge gap, the study adopts the "theory adaptation" approach outlined by Jaakkola [24], shifting the analytical focus from consumer or household-level perspectives to an organisational-level within the e-waste urban mining context. Accordingly, the primary aim of this study is to establish a robust theoretical foundation for understanding the key factors that influence the adoption of e-waste urban mining technologies at the organizational level. The study integrates the Technology-Organisation-Environment (TOE) framework and the Diffusion of Innovation (DOI) theory alongside TPB to construct a more holistic conceptual foundation.

In light of that, the study offers four key contributions. First, the study enhances the conceptual understanding of technology adoption in the e-waste sector, extending the existing argument from the household or consumer-level perspective to an organizational-level perspective. Second, the study revises the existing knowledge on determinants of e-waste urban mining technology adoption by integrating salient constructs from the Theory of Planned Behaviour (TPB), Technology-Organization-Environment (TOE) framework, and the Diffusion of Innovation (DOI) theory. Third, this research introduces a theoretically supported framework linking the unique characteristics of the e-waste sector. In light of that, the framework incorporates five critical constructs, supported by existing e-waste urban mining literature, enriching its explanatory and predictive power. Fourth, the review proposes research directions that identify areas for future exploration, contributing to a deeper understanding of technology adoption in the e-waste sector, particularly in developing countries.

The remainder of this paper is structured as follows: Section 2 examines the application of technology adoption theories and frameworks in e-waste sector. Section 3 outlines the research methodology, and Section 4 defines key constructs that support the conceptual argument. Section 5 presents the propositions of the proposed conceptual model. Section 6 discusses the theoretical and practical implications of the study. Section 7 highlights the study's limitations and provides directions for future research.

2. Application of technology adoption models and theories in the E-waste sector

The extant literature provides sufficient ground for the application of technology adoption theories and models in the e-waste sector. For instance, Ramzan et al. [19], using the Theory of Planned Behavior (TPB) and Technology Acceptance Model (TAM) investigated the Chinese millennials' intentions to adopt online e-waste collection platforms. The study further integrated perceived risk with the TPB and TAM to increase the predictive power of the proposed framework. Verma et al. [6] recently explored the psychological and functional factors that facilitate the adoption of e-waste recycling mobile applications among Indian households, using the Theory of Planned Behaviour (TPB) as the theoretical framework. Their findings highlight that functional enablers—such as ease of use, perceived value, trust, and security—along with psychological factors like positive social influence and cultural alignment, significantly impact the adoption of these recycling applications. Further, Gao et al. [18] investigated the adoption of online household e-waste collection services in China using a simplified version of the Unified Theory of Acceptance and Use of Technology (UTAUT) model. In this study, they found that performance expectancy, effort expectancy, social influence, and facilitating conditions strongly influenced the intention to use online household e-waste collection services [18]. Extending the TPB, Wang et al. [21] examined the willingness of Chinese households to participate in online recycling programs. The study revealed that attitude, perceived behavioural control, economic motivation, income, subjective norms, and education were key factors shaping residents' willingness to engage in e-waste online recycling. Additionally, a study in India explored the Electronic Word of Mouth (eWoM) role and the perceived usability of online collection portals in influencing millennials' e-waste disposal practices [20]. The study extended the TPB framework and found that attitude, subjective norms, perceived behavioural control, eWoM, and online collection platforms significantly affected millennials' behavioural intentions regarding e-waste disposal [20].

Although existing technology adoption models and theories have advanced understanding of e-waste urban mining technology adoption, their focus has predominantly been on the individual level (households and consumers). However, there remains a noticeable gap in the literature when it comes to establishing a robust theoretical basis for technology adoption at the organizational level. This highlights the necessity for a comprehensive and clearly articulated framework tailored to organizational contexts. Therefore, this review seeks to construct a strong theoretical foundation by identifying and integrating the key factors that influence the adoption of e-waste urban mining technologies within organizations.

3. Methodology

3.1. Research design

Conceptual papers aim to generate new knowledge by drawing from carefully chosen information sources. Unlike empirical papers, conceptual papers do not rely on traditional data analysis; instead, they construct arguments by integrating evidence from existing theories and concepts [24]. In light of that, Jaakkola [24] outlined four research designs for conceptual papers: (i) theory synthesis, (ii) theory adaptation, (iii) typology, and (iv) model, which is widely applied in research studies to develop conceptual arguments (See [25–28]). The present study employs the "theory adaptation " approach to reframe the understanding of factors influencing the adoption of e-waste urban mining technology by shifting the focus from consumer or household-level analysis to an organizational-level perspective within the e-waste urban mining context. In doing that, the "theory adaptation" approach guides the careful selection and justification of the theories used in a conceptual framework, as this plays a crucial role in refining and clarifying the paper's arguments [24].

3.2. Underpinning Theories and Frameworks

Following the guidance of Jaakkola [24], this study adopts the Theory of Planned Behaviour (TPB) as the core theoretical framework, given its established relevance in explaining the adoption of e-waste urban mining technologies, especially from household and consumer viewpoints (see, for instance, [20,21]). TPB has been widely employed to explore individual intentions in the e-waste sector, emphasizing the roles of attitude, subjective norms, and perceived behavioural control [29]. Nonetheless, critics argue that TPB's individual-centric focus limits its applicability in capturing organizational-level dynamics [22]. To address this gap, scholars have called for more comprehensive frameworks that incorporate additional organizational factors such as top management support, business scope, normative pressures, and mimetic influences [30].

In response, this study integrates the Technology-Organisation-Environment (TOE) framework and the Diffusion of Innovation (DOI) theory alongside TPB to construct a more holistic conceptual foundation. Organizational-level studies increasingly combine TPB with TOE and DOI to enhance the depth and predictive utility of technology adoption models [22]. Rooted in the foundational work of Tornatzky et al. [31], the TOE framework examines how technological, organizational, and environmental elements collectively shape organizational adoption behaviour [16]. However, TOE alone does not fully capture the alignment between technology functionality and task-specific requirements—an issue that integration with TPB helps to resolve [30]. Furthermore, recent research [16,32] emphasizes the benefits of synergetic integration of TOE with DOI theory to broaden the explanatory reach of adoption frameworks. DOI offers valuable insights into both the pre-adoption stage (awareness and knowledge development) and the post-adoption stage (technology acquisition and assimilation) [16]. Studies affirm that DOI is effective in explaining technology adoption behaviours at both the individual and organizational levels [29,33]. Crucially, DOI highlights the centrality of knowledge and its psychological impact on decision-making—an aspect often underexplored in traditional models. Emerging literature in the e-waste sector supports the view that knowledge, when linked to psychological drivers, plays a pivotal role in shaping e-waste urban mining technology adoption decisions.

4. Theoretical development

The present study employed a narrative review, following the guidance of previous conceptual research [34,35], to validate the key constructs of the TPB, TOE, and DOI frameworks within the context of e-waste urban mining. The review focused on identifying factors that influence technology adoption decisions in the e-waste sector, utilizing databases such as Scopus and Google Scholar. Based on the findings from the narrative review, the study introduced additional behavioural constructs and sector-specific variables into the proposed framework. For instance, constructs like security risk and confidence—recognized in recent studies as significant predictors of technology adoption in the e-waste domain [19,6]—were incorporated. A similar methodological approach was adopted by Vorobeva et al. [36] to enhance frameworks using emerging features in waste management. Furthermore, seminal works in technology adoption were also drawn upon to reinforce the theoretical basis of this research. Drawing from the literature, we argue that five dimensions shape the technology adoption of the e-waste urban mining businesses: knowledge, device competence, human readiness, organizational readiness, and external pressure.

4.1. Knowledge

Traditional technology adoption frameworks have historically given limited attention to the role of knowledge in the technology adoption process. Rogers [37] divided knowledge into three pillars: awareness knowledge, technical knowledge, and principle knowledge (refer to Table 1). Collectively, these three knowledge constructs—awareness, technical, and principle knowledge—play a crucial role in shaping human readiness toward technology adoption, as an individual cannot form a meaningful perspective without first understanding the technology [37]. Cimbaljević et al. [38] highlighted the importance of knowledge in adopting sustainable technologies, identifying knowledge as a crucial yet often overlooked determinant in the technology adoption process. Recent studies emphasize that the technology adoption process begins with knowing about the technologies and their real-world applications [39–41]. Empirical evidence, particularly from the e-waste sector, further underscores the significance of adequate knowledge in facilitating technology adoption decisions within e-waste sector organizations [19,42,43]. For instance, Tripathy et al. [42] highlight that insufficient knowledge of end of life (EOL) management techniques and recyclying technologies at this stage increases the likelihood of technology being rejected or discontinued later in the decision-making process.

Table 1
Root constructs of knowledge.

Construct	Definition	Reference
Awareness Knowledge	The degree to which a person acquires information regarding the existence of a technology	[44,29,37,42]
Technical Knowlege	The degree to which a person acquires information regarding how to use a technology properly	[11,45,37]
Principle Knowledge	The degree to which a person acquires information regarding the impact of technology	[46,11,37]

4.1.1. Awareness knowledge

Awareness knowledge refers to basic information about a particular technology that exists [47,37]. Kagoya et al. [44] unveil that the technology adoption process consists of multiple stages, beginning is the gaining awareness of the specific technology. The studies emphasize that awareness knowledge positively influences technology adoption [39,44,48]. The extant literature in the e-waste sector highlights that awareness of new technologies in the field is more likely to lead to the adoption of technologies than unawareness. Therefore, awareness knowledge is a strong predictor for e-waste urban mining technology adoption in the organizational context.

4.1.2. Technical knowledge

Technical knowledge involves the information required to use new technologies effectively [49,37]. Further, awareness knowledge serves as the initial motivator for individuals to seek "technical knowledge," which guides them on how to use the technology for desired outcomes effectively [37]. For successful adoption, individuals must possess a sufficient understanding of how to utilize the technology to achieve the desired results in the organizational context [11,37]. The studies from the e-waste sector stress that technical knowledge shapes technology adoption decisions [4,45]. For instance, Adanu et al. [4] unveiled that young workers who have better technical knowledge in the e-waste sector support the effective adoption of technologies. Therefore, technical knowledge is a significant determinant of e-waste urban mining technology adoption in the organizational context.

4.1.3. Principle knowledge

Principle knowledge provides insight into how the technology operates and how it can enhance performance of the organization [50]. Rogers [37] highlights that principle knowledge is also valuable in situations where technologies present problems. Therefore, principle knowledge has recently gained significant attention in technology adoption decisions, especially in the e-waste sector [11,45]. Kankanamge et al. [11] emphasized that managers in e-waste sector organizations prioritize how technology can enhance organizational performance, such as the impact on the process. In fact, principle knowledge is a strong predictor of e-waste urban mining technology adoption in the organizational context.

4.2. Device competence

Device factors have traditionally been addressed separately in established technology adoption theories and frameworks. However, recent research highlights the importance of device factors for adopting technologies within organizational settings [51,11]. Ibrahim et al. [51] emphasized that recognizing the unique benefits of advanced technologies relative to other technologies plays a critical role in determining the level of their adoption within an organization. The empirical and theoretical evidence from the e-waste sector, including Adanu et al. [4] and Kankanamge et al. [11], further highlights the criticality of device competence driving e-waste urban mining technologies. For instance, Kankanamge et al. [11] stress that smart tags with extended battery life reduce the effort needed to track e-waste items across their entire lifecycle, facilitating transparency in e-waste transportation and enabling a global examination of e-waste disposal paths. Adanu et al. [4] emphasized that when potential users believe that sustainable technologies will deliver improved outcomes, they are more likely to adopt them. Table 2 shows the constructs of device competence.

4.2.1. Relative advantage

Relative advantage refers to the extent to which the technology is perceived as better than the technology it supersedes [51,52,54]. Tiwari et al. [52] said that organizations often choose technologies over manual methods because of the various advantages of technologies. Therefore, for a technology to be more likely to be adopted, it should demonstrate a clear advantage over the technology it replaces [52]. When employees in the organization recognize the relative advantage of the technology, it has a positive impact on the decision to adopt that technology in the organizational context [51,57,58]. The evidence drawn from the e-waste sector also indicates that relative advantage is positively associated with e-waste technology adoption in the organizational context [59,19]. Therefore, relative advantage is a critical determinant of e-waste urban mining technology adoption in the organizational context.

4.2.2. Complexity

Complexity refers to a potential user's evaluation of the level of effort required to perform a specific technological application [53,51,54]. Awa et al. [22] indicate that technologies that are perceived as complex or have steep learning curves are often considered risky and less likely to be adopted. The scholars highlight that employees are more likely to adopt technologies when they are clear and easy to understand [53,19, 37]. The empirical evidence from the e-waste sector such as Ramzan et al. [19] and Verma et al. [6], highlights that the user-friendly interface of online applications significantly influences consumers' willingness to utilize online e-waste collection services. Therefore, complexity plays a critical role in determining e-waste urban mining technology adoption in the organizational context.

4.2.3. Security risk

Security risk refers to the extent to which an individual believes that utilizing a particular technology poses minimal security threats to them [55,52]. When the perceived security risk is high, it tends to have a negative impact on the decision to adopt the technology [55,51,58]. The studies indicate that concerns regarding the security of e-waste sector technologies constrain technology adoption [2,11,56]. Drawing examples from the e-waste sector, Ramzan et al. [19] indicate that high levels of subjective uncertainty surrounding a technology can significantly diminish users' intention to adopt it. Additionally, Verma et al. [6] emphasize that safety, privacy, and reliability are critical factors influencing technology adoption decisions within the e-waste sector. Therefore, security risk is a critical determinant of e-waste urban mining technology adoption in the modern context.

4.2.4. Compatibility

Compatibility refers to the extent to which technology aligns with the existing values, needs, and experiences of potential adopters within an organization [37,54,60]. The studies highlight that technologies are more likely to be accepted and viewed with less uncertainty when they fit well with the adopters' real-life contexts [61,62]. In contrast, the compatibility is influenced by factors such as sociocultural values, individual needs, and past experiences with similar technologies. The studies emphasize that incompatibility between the potential adopter's values and the technology initiative hinders technology adoption [61, 62]. Literature from the e-waste sector emphasizes that successful technology adoption is more likely when the technology aligns with individuals' existing values and beliefs [6]. Therefore, technology compatibility is a strong determinant of e-waste urban mining technology adoption in the organizational context.

Table 2
Root constructs of device competence.

Construct	Definition	Reference
Relative Advantage	The degree to which the new technology is perceived as better than the technology it supersedes	[51,37, 52];
Complexity	The degree to which a person believes that using technology shall be effortless	[53,51, 54]
Security Risk	The degree to which a person believes that the use of technology poses a low data security risk	[55,56, 19]
Compatibility	The degree to which the technology is perceived as consistent with prevailing values, needs and experience of potential adopters	[29,37, 54]

4.3. Human readiness

Human readiness has historically received immense attention on how human factors influence technology adoption within organizations [51,63]. Ibrahim et al. [51] investigated that technology adoption in the organizational setting is significantly shaped by human factors, such as attitudes toward technological change. Understanding these factors helps explain why employees, despite being aware of various technologies, hesitate to adopt them. As employees become ready to adopt new technology, they move from a cognitive understanding in the initial knowledge phase to a more emotional engagement with technology [37, 6]. The empirical evidence from the e-waste sector further evidence the criticality of human psychology in the decision to adopt technologies [29,59,6]. Without human readiness, technology awareness remains at the knowledge stage, short of further progression [64]. Table 3 shows the constructs of the human readiness of the organizations.

4.3.1. Attitude

Attitude refers to the degree to which the employee's beliefs about the technology improves the control, flexibility and efficiency of performance [38]. The attitude is shaped by an individual's beliefs or knowledge regarding the adoption of technology to advance specific actions [69,65,19]. Ibrahim et al. [51] unveil that employees' attitudes toward technology significantly affect their willingness to embrace technologies within an organization. Also, Rogers [37] indicated that the choice to adopt or reject a technology largely depends on an individual's attitude toward it. Studies indicate that individuals are more inclined to adopt e-waste urban mining technologies if they hold a positive attitude toward them [29,19]. Therefore, attitude is considered a powerful determinant of e-waste urban mining technology adoption.

4.3.2. Confidence

Confidence refers to the degree to which the employee is certain about his or her attitude towards technology adoption [66]. Although confidence has traditionally been an undervalued factor in technology adoption frameworks, it has gained attention in the recent past [70,67, 71]. Berkowsky et al. [70] found that a lack of confidence can significantly hinder technology adoption. Consequently, organizations with confident staff have a greater opportunity to achieve smooth technology adoption [51,57]. Instructors who feel confident in using advanced technologies are more likely to integrate online learning management

Table 3
Root constructs of human readiness.

Construct	Definition	Reference
Attitude	The degree to which the individual's positive or negative beliefs about the technology and its performance	[38,65]
Confidence	The degree to which the individual is certain about his or her attitude towards technology adoption	[66,67]
Subjective Norms	The degree to which the individuals shape their decisions based on superior and peer group opinions	[22,68,6]

systems [67]. Research also suggests that when individuals see technology widely adopted, they gain confidence in its general acceptability. Further, Ibrahim et al. [51] highlighted that employees with prior experience in information technologies tend to adopt cloud technologies confidently, while those without such expertise may need support in adopting technologies in the organizational context. Therefore, confidence is a powerful predictor of technology adoption.

4.3.3. Subjective norms

Subjective norms refer to the degree to which an employee's decisions are shaped by the impact of other people, superiors, and peer groups [22,19,60]. The psychological theories highlight subjective norms as a key factor in evaluating intentions, reflecting how others perceive certain behaviours [22,68]. Jennings et al. [72] and Graf-Vlachy et al. [68] emphasized that subjective norms are a strong predictor of technology adoption in the organizational context. Notably, research in the e-waste sector underscores that subjective norms significantly and positively influence individuals' intention to adopt new technologies [29,19,6]. Verma et al. [6] further emphasize that individuals are more inclined to use e-waste recycling applications when they perceive greater social support and guidance. Therefore, subjective norms are considered a powerful determinant of e-waste urban mining technology adoption.

4.4. Organizational readiness

Sustainable technologies present a significant opportunity to advance e-waste management . However, many organizations fail to capitalize on these opportunities due to inadequate organizational readiness [73]. Organizational readiness refers to the capability (resources and ability) of businesses to adopt technologies [73,74]. Extensive empirical studies have highlighted the critical role that organizational readiness plays in technology adoption [75–77]. Salim et al. [74] emphasized the importance of organizational readiness when adopting advanced technologies, noting that financial capacity of an organization is essential for a successful adoption of technologies. Additionally, the empirical evidence from the e-waste sector proves the importance of organizational readiness for e-waste businesses [78,42]. Consequently, evaluating organizational readiness is essential before adopting new technologies to mitigate the risk of failure [77]. Table 4 shows the constructs of organizational readiness.

4.4.1. Organizational resources

Organizational resources refer to the flexibility and capability of an organization to support technology adoption, including resources and decision-making agility [79,80]. However, e-waste sector organizations often face resource constraints such as financial resources, which are a popular antecedent of technology diffusion and hinder their ability to adopt new technologies [79]. Adanu et al. [4] highlight that while e-waste sector organizations may have a strong perception of acquiring sustainable technologies, their limited budgets often prevent them from investing in these costly solutions. Jangre et al. [2] also emphasize that the high upfront financial costs associated with technologies in the e-waste sector pose a major constraint to adopting technologies. Additionally, managerial structure, communication process, and firm size significantly influence the organizational internal resources, thereby influencing technology adoption at the organizational level [51]. Therefore, organizations with adequate resources are more likely to adopt e-waste urban mining technologies.

4.4.2. Management support

Management support refers to the financial and non-financial backing provided by leadership to facilitate technology adoption decisions at the organizational level [30,51]. The significance of management support lies in the extent to which leadership fosters an environment of encouragement, trust, and assistance for successful technology adoption in organizations [81,82]. Also, studies emphasize that management influences individual behaviour through established organizational policies, routines, and procedures in the [30]. The evidence drawn from the e-waste sector literarure further highlight that management support is a key determinant within organizations towards technology adoption [42]. Therefore, organizations with management support have a strong possibility of adopting e-waste urban mining technologies.

4.5. External pressure

External pressure refers to the external influences that compel or encourage an organization to shift its strategies to avoid inferior performance [83–85]. The external pressure typically stems from various stakeholders, including government agencies, customers, and competitors [86,87,84]. Kateb et al. [88] indicate that government-imposed lockdown and distance measures during the COVID-19 pandemic created external pressures that both enabled and accelerated technology adoption as traditional processes became increasingly vulnerable during unprecedented disruptions. The scholars underscore the importance of external pressure in contemporary settings, emphasizing its pivotal role in shaping e-waste technology adoption decisions [11,42]. Table 5 shows the constructs of the external pressure.

4.5.1. Coercive pressure

Coercive pressure refers to the influence exerted by powerful actors, such as the government, involving rules and regulations to shape the technology adoption decision [83,84]. The studies indicate that coercive pressure can manifest as persuasion, force, or invitations for the organizations to adopt technologies [83,79]. Zhu and Kraemer [79] emphasize that governments can promote technology adoption by implementing supportive regulations and/or offering incentives to organizations that embrace new technologies. Scholars further argue that coercive pressure is a critical driving force of sustainable technology adoption in the e-waste sector [2,20,42]. For instance, scholars highlight that sector-specific policies in the e-waste sector drive businesses towards sustainable e-waste urban mining technologies [2]. Therefore, coercive pressure has a significant influence on e-waste urban mining technology adoption.

4.5.2. Competitive pressure

Competitive pressure refers to the influence exerted by competitors within the industry, which shapes the technology adoption decision of the organizations [79]. In the dynamic business environment,

Table 4
Root constructs of organizational readiness.

Construct	Definition	Reference
Organizational Resources	The degree to which an organization has resources and expertise to facilitate technologies	[79,80]; Baker, 2011; [46,11]
Management Support	The degree to which the management of an organization supports the technology adoption	[30,81,42]

Table 5
Root constructs of external pressure.

Construct	Definition	Reference
Coercive pressure	The degree to which influence comes from powerful actors to shape the technology adoption decision	[83,11, 84]
Competitive pressure	The degree to which the influence comes from competitors shapes the technology adoption decision	[79,89]

organizations often observe and analyze the actions and strategies of their competitors to adapt and respond effectively [30,90]. The studies highlight that organizations can reshape competitive dynamics and gain an edge over rivals by adopting new technologies [83,84,79]. As a result, competitive pressure has recently garnered considerable attention as a critical determinant of the key technology adoption from the organizational perspective [89,91,79]. Drawing from the e-waste literature, the evidence highlights that organizations facing higher competitive pressure are more likely to drive towards adopting advanced technologies [42]. Therefore, competitive pressure has a strong predictive power of e-waste urban mining technology adoption.

5. Conceptual framework

Building on the findings from the previous section, we have developed a conceptual framework that integrates the TPB, TOE framework, and DOI theory, tailored to the distinctive characteristics of e-waste urban mining. In line with Jaakkola's (2020) methodology, we have shifted the focus of the analysis from a household or consumer-level perspective to an organizational-level perspective on e-waste urban mining technology adoption. The proposed framework is illustrated in Fig. 1, and the following section will discuss the propositions of the framework.

5.1. Formulation of propositions

5.1.1. Technological knowledge associated with E-waste urban mining technology adoption

Studies have documented that businesses in the e-waste sector often struggle to adopt sustainable e-waste urban mining technologies due to a lack of technological knowledge among employees. We argue that knowledge and e-waste urban mining technology adoption are closely interlinked. Business practitioners frequently recognize that e-waste sector employees who are aware of the existence of sustainable and more advanced technologies, possess the skills to use them effectively, and have the capacity to improve organizational performance are better equipped to make informed decisions about sustainable e-waste urban mining technology adoption and to translate these decisions into actionable steps. This underscores the potential relationship between technological knowledge and the adoption of sustainable e-waste urban mining technologies. E-waste sector businesses with greater technological knowledge tend to be more proactive in decision-making compared to their counterparts. Consequently, a higher (or lower) level of technological knowledge of employees in e-waste sector businesses positively (or negatively) influences their ability to make informed decisions, thereby positively (negatively) impacting the intensity of e-waste urban mining technology adoption in the organizational context (*P1*).

5.1.2. Device competence shape E-waste urban mining technology adoption

Device factors have traditionally been considered separately in established technology adoption frameworks. We argue that identifying a technology's internal and external characteristics is essential for making informed decisions towards e-waste urban mining technology adoption. Business practitioners often observe that employees in e-waste sector businesses who recognize a technology's relative advantage positively influence their e-waste urban mining technology adoption decisions. This suggests a potential relationship between device competence and sustainable e-waste urban mining technology adoption. Employees who are persuaded of the benefits are more likely to take action to adopt e-waste urban mining technologies than those who are not. Consequently, a higher (or lower) level of device competence in the e-waste sector positively (or negatively) influences their persuasion to adopt sustainable e-waste urban mining technologies, ultimately influencing the degree to which sustainable e-waste urban mining technologies are adopted (*P2*).

5.1.3. Human readiness empowers E-waste urban mining technology adoption

Existing literature highlights that knowing a technology differs from applying it within an organizational context, which requires human support towards that technology. Although human factors have received increased attention over the years, a few studies have explored the influence of human factors in the adoption of sustainable e-waste urban

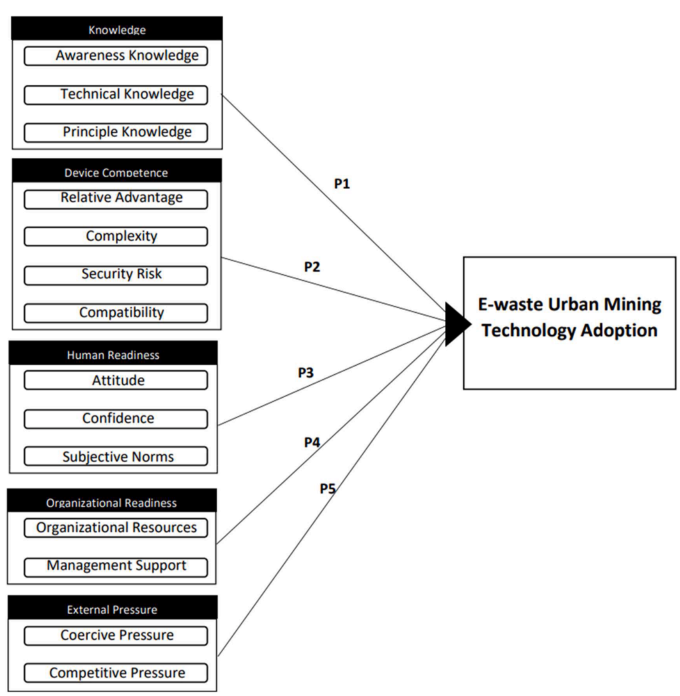

Fig. 1. Urban Mining Technology Adoption Model (UMTAM).
Source: Authors own work

mining technologies from the organizational perspective. We argue that while e-waste sector businesses may be aware of various e-waste urban mining technologies, they often hesitate to adopt them due to the insufficient readiness of their employees. Business practitioners frequently observe that employees in businesses in the e-waste sector who believe that e-waste urban mining technology will improve their performance, high acceptance among peer groups and society and feel confident in using advanced technologies are more likely to embrace sustainable e-waste urban mining technology. This suggests a potential relationship between human readiness and sustainable e-waste urban mining technology adoption. Employees who feel confident in what they believe are more proactive in taking action than those who do not. Consequently, a higher (or lower) level of employee readiness in e-waste sector businesses positively (or negatively) influences their willingness to adopt sustainable e-waste urban mining technologies, thus impacting positively (negatively) the intensity of e-waste urban mining technology adoption in the organizational context (*P3*).

5.1.4. Organizational readiness is critical in E-waste urban mining technology adoption

In today's context, businesses often struggle to take advantage of emerging technologies due to a lack of organizational support. We argue that organizational readiness is closely tied to e-waste urban mining technology adoption, thereby bringing high importance for businesses seeking to adopt sustainable e-waste urban mining technologies. Business practitioners often observe that e-waste sector businesses that demonstrate agility in decisions, financial and non-financial capabilities, and leadership support have the dynamic qualities necessary to make sustainable e-waste urban mining technology adoption feasible and to translate potential opportunities into tangible outcomes. This suggests a strong relationship between organizational readiness and sustainable e-waste urban mining technology adoption. The businesses that have access to resources and stakeholder support are better positioned to seize opportunities for e-waste urban mining technology adoption compared to their counterparts. Therefore, higher (or lower) organizational readiness increases (or decreases) the likelihood of adopting sustainable e-waste urban mining technologies, ultimately influencing positively (negatively) the intensity of e-waste urban mining technology adoption within organizations (*P4*).

5.1.5. External pressure affects the E-waste urban mining technology adoption decisions

Drawing on previous research on technology adoption, the findings indicate that external influences often compel or encourage businesses to shift strategies in order to avoid poor performance. However, many businesses struggle to adapt to evolving conditions shaped by external changes, actions, and behaviours. We argue that external pressure plays a crucial role in shaping e-waste urban mining technology adoption decisions, serving as a key driver for organizational change. Business practitioners highlight that e-waste sector businesses that can effectively respond to external pressures have the dynamic capabilities to translate these changes into actionable strategies, such as e-waste urban mining technology adoption. This suggests a strong relationship between external pressure and sustainable e-waste urban mining technology adoption. E-waste sector businesses facing higher external pressure are more likely to lead in decision-making to adopt e-waste urban mining technologies compared to other e-waste sector businesses. Therefore, greater (or lesser) external pressure increases (or decreases) the weight of their decisions to adopt sustainable e-waste urban mining technologies, ultimately influencing the degree to which sustainable e-waste urban mining technologies are adopted in organizational context (*P 5*).

6. Discussion

Despite the increasing need for sustainable e-waste urban mining technologies for the e-waste sector, there is a lack of a comprehensive theoretical argument that adequately explains the factors influencing e-waste urban mining technology adoption in organizational context. The proposed model in this study addresses this gap by identifying key determinants of e-waste urban mining technology adoption from the organizational perspective:awareness knowledge, technical knowledge, principle knowledge, coercive pressure, competitive pressure, relative advantage, complexity, security risk, compatibility, attitude, confidence, subjective norms, management support, and organizational resources. This will enable key stakeholders to better understand the complexity of e-waste urban mining technology adoption and identify potential strategies for enhancing the adoption of sustainable e-waste urban mining technologies, particularly within the context of developing countries.

6.1. Theoretical Implications

The study provides several substantial theoretical contributions to the adoption of e-waste urban mining technology, particularly in developing countries. Given that research on e-waste urban mining technology adoption is still in its early stages, this study represents a pioneering effort in conceptualizing the factors influencing the adoption of e-waste urban mining technology from the organizational point of view. In contrast, while existing studies have largely focused on household or consumer perspectives for conceptualizing the technology adoption in the e-waste sector [18–21], this research fills that gap by identifying critical dimensions of e-waste urban mining technology adoption at the organizational level. Therefore, the present study provides a structured approach for e-waste urban mining businesses to think holistically about e-waste urban mining technology adoption, which is useful for operating in today's dynamic and competitive business environment.

A critical limitation in the existing e-waste urban mining literature is the limited application of the TPB, TOE framework and DOI theory for conceptual arguments at the organizational level [42], despite its widespread application in various industries and sectors [29,92–94]. Therefore, integration of TPB, TOE framework and DOI theory to evaluate the critical factors that influence the e-waste urban mining technology adoption from the organization perspective adds significant value to the existing body of knowledge. Further, the proposed framework highlights the dynamic role of knowledge, device competence, and human readiness in shaping organizational decisions toward e-waste urban mining technology adoption—factors that are often overlooked in recent studies [95]. By integrating these factors, the present study enhances the predictive accuracy of the decisions in the e-waste urban mining businesses. Also, the conceptual argument presented in this study, particularly regarding knowledge, organizational readiness and external pressure, complements the previous research across various industries [43,93,96]. Consequently, this study highlights the importance of developing both tangible and intangible capabilities within organizations to facilitate e-waste urban mining technology adoption efforts.

Further, the proposed conceptual framework - Urban Mining Technology Adoption Model (UMTAM) synthesizes these findings, highlighting the complex relationships and dynamics involved in e-waste urban mining technology adoption. Additionally, this study advances the original TPB, TOE, and DOI models to a more comprehensive level, enhancing their explanatory and predictive capabilities in the context of e-waste urban mining adoption from an organizational perspective. Notably, previous scholars have critiqued TPB for its narrow focus on individual and task-specific factors and its technocentric approach [22]. The proposed model addresses these limitations by extending the TPB with the TOE and DOI frameworks, which are widely used in organizational technology adoption decisions, thereby incorporating both human and non-human factors [30]. Furthermore, while TOE has limited focus on the fit between technology functionality and task requirements, its integration with TPB helps overcome this limitation, broadening the scope of the study. As such, the present study not only validates the existing theoretical constructs in the TPB, TOE framework, and DOI, but also integrates these theories into a more comprehensive and refined perspective on e-waste urban mining technology adoption.

6.2. Practical implications

The present study offers important practical implications for practitioners and policymakers in the e-waste urban mining sector. The proposed conceptual framework serves as a practical guideline for assessing the complex technological factors influencing e-waste urban mining technology adoption. Over the years, the absence of such a comprehensive framework has hindered e-waste sector businesses from identifying the most effective approaches for adopting e-waste urban mining technologies and developing a pathway for sustainable e-waste management. With the insights provided by this study, managers and policymakers can evaluate the significance of each factor in terms of challenges for the e-waste sector business and opportunities available in the realm of e-waste urban mining context to make informed decisions. Furthermore, the study offers valuable insights that enable managers and policymakers to assess the current state of the technology adoption in the e-waste sector both at organizational level and the national level to craft and fine tune their strategies to promote sustainable e-waste urban mining technologies. Recognizing that businesses operate in an open system, the present study underscores the importance of considering external pressures in influencing e-waste urban mining technology adoption decisions. As a result, managers need to regularly update their knowledge of the business environment, driving their resource allocation and strategic decisions in order to effectively adopt e-waste urban mining technologies.

In addition, the present study emphasizes the need for a holistic approach in e-waste urban mining technology adoption, offering a nuanced understanding of the factors that stakeholders need to carefully consider, which have received limited attention from the majority of the stakeholders currently. As a result, business consultants have the opportunity to regularly engage with these stakeholders, including owners, managers and potential investors, to apply this knowledge effectively in decision-making processes, fostering a more informed and sustainable approach to technology adoption in the e-waste urban mining sector. Importantly, sustainable e-waste urban mining technologies significantly reduce the environmental consequences, health risks, and economic losses associated with improper e-waste urban mining practices. Therefore, the proposed conceptual framework guides the creation of supportive legislative and regulatory environments, considering the holistic conditions of the e-waste sector businesses.

7. Limitations and future research

7.1. Limitations

Although the present study offers conceptual clarity in the e-waste sector, it has certain limitations. The first limitation pertains to the scope of the conceptual framework, as the study only draws on the TPB, TOE and DOI to examine technology adoption within the e-waste sector. This highlights that there are numerous theories and frameworks not included in the present study, some of which may provide additional insights or constraints relevant to the e-waste sector. The second limitation involves defining sustainable e-waste urban mining technology adoption within the e-waste sector. Although the study thoroughly explores the dimensions of e-waste urban mining technology adoption, it lacks a specific definition to enrich the conceptual clarity of sustainable e-waste urban mining technologies and adoption. The third limitation is that the present study exclusively relied on Scopus and Google Scholar databases for the narrative review and consequent arguments. As a result, there is a possibility that some valuable sources outside these databases may have been overlooked. The fourth limitation highlights that this study does not consider regional disparities, as the scope of the conceptual model is restricted to developing countries, where businesses have made slow progress in adopting e-waste urban mining technologies. The fifth limitation stems from a lack of empirical evidence, as the study only identifies the factors influencing e-waste urban mining technology adoption, without providing evidence-based rankings or assessing their relative importance or applicability.

7.2. Future Research Direction

First and foremost, more empirical evidence on the e-waste urban mining technology adoption is needed. Although, the conceptual framework of this study is built on five main dimensions—knowledge, device competence, human readiness, organizational readiness, and external pressure—which represent as unique factors of the technology adoption in the e-waste urban mining sector, this research is primarily conceptual. Therefore, empirical studies are necessary to validate and strengthen these findings. Further, investigating the interactions among these factors is essential for expanding insights into how each dimension uniquely and interactively influences technology adoption in this sector. Also, the empirical research would benefit from a broader approach that examines how the proposed five dimensions function across various developing countries through cross-country comparisons. Additionally, secondary data analysis methods can allow researchers to explore this research's boundary conditions and potential moderating or mediating effects [16]. Moreover, future research can assess the influence of contextual elements, such as economic conditions and technological costs, on e-waste urban mining technology adoption decisions at the organizational level. Also, individual differences such as age and gender can be taken into consideration to enhance predictive accuracy of the proposed framework, as these traits may vary among owners, managers and workers in the e-waste urban mining industry. Additionally, the present framework offers a comprehensive approach that incorporates often-overlooked factors in traditional technology adoption models, such as knowledge, device competence, and human readiness. However, since these indicators can change over time due to organizational or contextual changes, capturing this dynamic through retrospective and prospective longitudinal studies will be critical for drawing conclusions on sustainable e-waste urban mining technology adoption. Furthermore, we invite researchers to take a holistic view of e-waste urban mining technology adoption by integrating undervalued factors, offering a robust methodology for future studies to refine and expand on this conceptual foundation. In comparing formal and informal organizations within the e-waste sector, researchers can examine how each of these factors influences their e-waste urban mining technology adoption decision.

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CRediT authorship contribution statement

Amila Kasun Sampath Udage Kankanamge: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Conceptualization. **Michael Odei Erdiaw-Kwasie:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Conceptualization. **Matthew Abunyewah:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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