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Enhancing animal care through digital tools: a challenge and hindrance perspective of technology adoption in a zoological institution

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ABSTRACT

The adoption of digital technologies in zoological institutions is transforming animal care management. However, challenges persist in integrating mobile applications into daily workflows. This qualitative study examines technology adoption in a Southeast Asian zoological institution, focusing on a mobile application designed for animal care. Using the Technology-Organisation-Environment framework and the challenge-hindrance perspective, we conducted four focus group interviews with 21 users to explore the factors influencing adoption, including perceived usefulness, ease of use, organisational support, and environmental pressures. Findings reveal that while the Application enhances efficiency, collaboration, and animal welfare, fostering a challenge appraisal and voluntary adoption, barriers such as usability issues, security fatigue, and interoperability contribute to a hindrance appraisal and involuntary adoption. Organisational support, including onboarding, co-creation, and technical assistance, is crucial in mitigating the hindrance appraisal and resistance. The study contributes to a holistic adoption framework, offering practical insights for designing and implementing digital tools in specialised work environments, ultimately enhancing technology-driven wildlife management and conservation efforts.

1. Introduction

In recent years, there has been a significant rise in the adoption of digital technologies across various organisational contexts (Yu, Xu, and Ashton 2023). The growing reliance on technology, especially mobile applications and digital platforms, is a critical development for enhancing operational efficiency, facilitating communication, and improving data management in organisations (Marsh, Vallejos, and Spence 2022), including zoological institutions and conservation centres, where the well-being of animals is the primary concern. To this end, digital tools are instrumental in optimising care routines, tracking animal health, and promoting collaborative decision-making among staff (Bök and Micucci 2024). This trend is further accelerated by broader economic and industry forces, including rising operational costs, labour shortages in specialised animal care roles, increased pressure to demonstrate transparency and accountability to stakeholders, and the global movement towards

standardising conservation practices through data-driven evidence (Zhang et al. 2023). However, the key challenge lies in understanding the perspectives of users responsible for the care of animals, which is crucial for the successful implementation and sustained use of such tools (Venkatesh et al. 2003). Given the specialised and sensitive nature of animal welfare tasks, ensuring that staff appraise digital innovations positively, enhancing rather than hindering their professional role, is critical for achieving meaningful technological integration.

Expectedly, the literature on technology adoption has grown significantly over the past two decades. Yet, notable gaps that make this study unique can still be observed. First, integrating technology into animal care presents a unique set of challenges. Research on technology acceptance has mainly focused on technological innovations in agricultural practices (Mwalupaso et al. 2019), tourist behaviour (Vietnam News 2023), public service (Sousa et al. 2023) and general workplace

productivity (Deb, Nafi, and Valeri 2022), with relatively little attention paid to how these tools are received and utilised in animal care environments (Silva et al. 2022). Besides, the nature of animal care work is distinct, requiring specialist knowledge that may foster attitudes towards technology that differ from those found in more traditional office environments (Zhang et al. 2023). For instance, animal care professionals may often emphasise animal well-being, making technologies less of a priority. Therefore, adopting findings meant for other contexts may yield limited effectiveness.

In the same vein, the role of user perception in shaping the successful implementation of technology in conservation and animal welfare settings remains underexplored. As highlighted by Bök and Micucci (2024), there is a growing need to understand the compatibility of human and animal health platforms with the overall objective of enhancing animal care and welfare. In this regard, while factors such as employee engagement, ease of use, technological literacy, and alignment with daily workflows have been identified as significant determinants of technology adoption in other industries (see Jayarathne et al. 2023; Khan et al. 2022; Lorentzon, Fotoh, and Mugwira 2023), the applicability of these factors in the context of animal care is nascent and requires further investigation.

Moreover, the literature on integrating technology in animal care has often focused on the theoretical benefits of these tools, such as improving health monitoring, facilitating data-driven decision-making, and enhancing communication between departments (Haritha 2023; Yu, Xu, and Ashton 2023). While these studies provide good insights, they overlook the perspectives that users experience during the adoption process (Haritha 2023). To this end, Zhang et al. (2023) have argued that introducing new changes to workflow triggers that challenge or hindrance perspectives, which would encourage or inhibit the adoption of technology, respectively. In line with this thinking, Clay et al. (2011) pointed out that while there is potential for technology to improve visitor experience, research, and animal welfare in the zoo, careful application and evaluation are necessary to realise this potential and ensure that any technology implementation is worth the cost.

In practice, the accelerated adoption of various technological tools has been observed in zoological operations and related sectors, such as veterinary care, conservation technology initiatives, and wildlife sanctuary management. For example, in veterinary settings, mobile technologies and digital records are increasingly deployed to streamline care practices and regulatory reporting (Duggirala et al. 2025). Similarly, in conservation programs, adopting digital tracking tools, health monitoring systems, and AI-based conservation management platforms reflects a parallel evolution (Ullah, Saqib, and Xiong 2024). This rapid adoption is driven by external environmental factors such as tightening regulatory requirements for animal welfare documentation, conservation certifications, and public expectations for transparency (Paulovics and Vetter 2024; Rayner et al. 2025). However, across these fields, studies like Zhang et al. (2023) reported common adoption barriers that include the need for technological compatibility with field practices, concerns over interoperability across systems, digital fatigue among users, and the critical role of organisational support such as onboarding and technical assistance.

In summary, the gaps in the literature and the dilemma faced in practice suggest a need to investigate how to reduce resistance and encourage technology adoption in this unique work environment. This study thus seeks to extend the current literature by examining the perspectives within a zoological institution on using a mobile application designed for animal care management. By exploring the factors that influence users' attitudes toward technology, including perceived usefulness, ease of use, and alignment with their core responsibilities, this study provides a comprehensive understanding of how digital tools are integrated into animal care workflows. In doing so, it contributes to the broader discourse on technology adoption in specialised work environments, pushes the body of knowledge, and offers insights to inform the design and implementation of future technological innovations in wildlife management and conservation. Moreover, by situating the zoological context within the broader ecosystem of animal care and conservation technology adoption, this research offers implications beyond a single institution. The findings are relevant to other fields where similar digital transformation challenges are observed. Thus, this study provides valuable guidance for various animal welfare organisations navigating technology integration in specialised operational contexts.

2. Research context

This qualitative study is undertaken in a large zoological institution in Southeast Asia, focusing on adopting a mobile application developed to manage animal care tasks, health monitoring, enrichment planning, and reporting workflows. The institution is a leading player in conservation, animal welfare, and public education. Yet, it is facing increasing external pressures to digitalise operational processes to enhance efficiency, transparency, and compliance with international standards.

Having said that, a zoological institution faces an additional layer of complexity when it comes to business processes digitalisation. Unlike traditional corporate environments where technology adoption is often evaluated primarily in terms of operational efficiency or return on investment, zoological institutions must also consider how technological tools align with their core values and public responsibilities (Fernandez et al. 2009). First and foremost, conservation imperatives demand tools that enhance animal wellbeing, facilitate evidence-based care, and support the collection and analysis of longitudinal data for research and accreditation purposes. Education-focused mandates, meanwhile, may drive the adoption of platforms that promote effective knowledge sharing among staff, foster transparency and storytelling and inform the public about animal care practices. Similarly, the emphasis on public engagement – central to building trust and securing funding – positions digital adoption as a means of signalling institutional credibility, innovation, and ethical commitment. Consequently, technology in these settings is not adopted solely for task automation or internal convenience but is scrutinised through the lens of whether it strengthens the institution's capacity to fulfil its mission.

In response to evolving operational demands and the increasing expectations for data-driven animal care, the zoological institution embarked on a comprehensive digital transformation initiative aimed at modernising its workflow systems and record-keeping processes. This transformation was driven by the need to enhance efficiency, accuracy, and accessibility of critical animal care information, while also supporting staff collaboration across departments.

A cornerstone of this initiative was the development of the Animal Care Application (the Application), a mobile-first digital platform specifically designed to meet the practical and technical needs of animal care professionals. The Application has four primary functions. First, it allows keepers, veterinarians, and welfare specialists to record and access real-time data on various aspects of animal management, including health metrics, dietary intake, behavioural enrichment activities, and welfare assessments. Second, it integrates tools for scheduling and task management, enabling team members to coordinate feeding routines, medical treatments, habitat maintenance, and enrichment programs more effectively, while also allowing supervisors to conduct daily safety checks with team members. Third, the Application provides a platform for team members to submit enrichment proposals for supervisor approval and feedback. Fourth, built-in notification, sharing and communication features streamline inter-departmental communication.

By transitioning away from fragmented systems – such as handwritten logs, paper records, and isolated Excel spreadsheets – the institution has not only reduced administrative overhead but also improved data accuracy, consistency, and long-term accessibility. The Application represents a significant step towards a more agile, responsive, and insight-driven model of animal care, aligning with best practices in modern zoological management.

3. Theoretical background

This paper's theoretical foundation is built on two key frameworks. Firstly, the Technology-Organisation-Environment (TOE) framework provides the structural basis for our research. Secondly, the Challenge-Hindrance Stressor Framework (CHSF) highlights the importance of individual readiness as a crucial precursor to organisational change.

3.1. Technology-organisation-environment (TOE) framework

Developed by Tornatzky, Fleischer, and Chakrabarti (1990), the TOE framework outlines three key contextual factors – technology, organisation, and environment – that shape users' technology adoption behaviours. Over the years, many scholars have acknowledged this framework's robustness and adaptability, applying it across diverse fields including supply chain management, digital transformation, and more recently, human resource management (Kumar and Shankar 2024; Lu, Yeh, and Kuo 2024; N'Dri and Su 2024; Rehman et al. 2024). This includes Pan et al. (2021), who demonstrated that technological factors (e.g. perceived complexity), organisational factors (e.g. technological competence), and environmental factors (e.g. regulatory support) significantly influence employees' adoption of AI. Given the comprehensive nature of the TOE framework, our study applied it to analyse the technology characteristics (technology), organisational support and leader's role (organisation), and institutional forces (environment) that influence users' technology adoption behaviours.

3.1.1. Technology
The characteristics of a technology play a crucial role in the end user's willingness to adopt it (Venkatesh, Raman, and Cruz-Jesus 2023). Instead of focusing on specific types of technology, research on the characteristics provides scholars with a more versatile framework

for analysing adoption intentions across a wide range of technologies, including new and emerging ones (Venkatesh, Raman, and Cruz-Jesus 2023). In this regard, scholars have extensively studied the different factors through several foundational theories, including the Technology Acceptance Model (Davis 1989b), the Unified Theory of Acceptance and Use of Technology (Venkatesh, Thong, and Xu 2012), and the Diffusion of Innovations Theory (DIT) (Rogers 2003). These frameworks outline a range of technology characteristics, such as perceived ease of use, perceived usefulness, and perceived compatibility, which have been leveraged in this study.

3.1.2. Organisation

The second aspect of the TOE framework is the organisational factors that influence the shaping of users' behaviours. Leaders' attitudes, actions, and organisational support have been identified as two important organisational factors that facilitate or hinder technology adoption.

Organisational support is the degree to which users believe the organisation acknowledges their contributions and cares about their well-being (Suifan, Abdallah, and Janini 2018). According to social support theory, Cohen and Wills (1985) identified three types of support relevant to our research context. First, emotional support reflects an individual's sense of being valued and accepted by the organisation, including being trusted, empathised with, and cared for by the organisation (Cohen and Wills 1985; Malecki and Demary 2002). Second, informational support refers to the organisation providing advice, guidance, and information to help users address the problems they encounter (Cohen and Wills 1985), including aspects such as receiving feedback from leaders and knowledge sharing with co-workers. Third, instrumental support is defined as the extent to which users perceive the organisation provides financial assistance, material resources, or other services, including skill training, technological support, and other tangible supports (Cohen and Wills 1985). Compared to technological characteristics, organisational support yields a broader range of positive outcomes.

Research consistently shows that organisational support enhances users' mental health by alleviating job burnout (Irfan et al. 2023), reducing work stress (Canboy et al. 2023), and minimising role conflict and ambiguity (Zheng et al. 2018). It also boosts work engagement (Pimenta, Duarte, and Simões 2023), job satisfaction (Bahadır et al. 2022), overall well-being (Kurtessis et al. 2015), and the sense of work meaningfulness (Canboy et al. 2023). These mental health benefits of organisational support, in turn, increase users' work motivation (van Woerkom and Kroon 2020), organisational commitment (Kurtessis et al. 2015; Pimenta, Duarte, and Simões 2023), job involvement (Rhoades and Eisenberger 2002), as well as individual innovativeness and creativity (Lee et al. 2023; Suifan, Abdallah, and Janini 2018), ultimately leading to improved work performance (Irfan et al. 2023; Rhoades and Eisenberger 2002).

3.1.3. Environment

The environment context encompasses the external factors that influence a business's operations, including government incentives and regulations, customer demands, competitive pressures, influences from trading partners, industry life cycles, socio-cultural norms, market uncertainty, and vendor support (Bök and Micucci 2024; N'Dri and Su 2024)

One such norm is digital transformation, which has become a key focus for companies worldwide. Executives across industries leverage digital advancements such as analytics, mobility, social media, and smart embedded devices while enhancing their use of traditional technologies like enterprise resource planning to reshape customer relationships, internal processes, and value propositions. The tourism industry, in particular, has been at the forefront of digital innovation, undergoing rapid transformation globally (Bulchand-Gidumal et al. 2024). The adoption and diffusion of digital technologies, including the Internet of Things, artificial intelligence, virtual reality, and big data analytics, have significantly altered customer expectations and experiences. As expected, the zoological industry is also experiencing digitisation (Bök and Micucci 2024; Collado, Martín, and Serena 2022; Williams et al. 2024; Zhang et al. 2023)

Beyond technological advancements, external pressures such as evolving regulatory frameworks for animal welfare, tightening data protection laws concerning animal information, and increasing public demands for transparency and ethical stewardship influence the technology adoption landscape. For instance, compliance with international conservation standards and accreditation bodies often necessitates digital reporting and evidence-based animal care practices (Liptovszky 2024; Melfi 2009). Furthermore, rising external competition among zoological institutions, wildlife sanctuaries, and conservation programs to showcase innovation, operational excellence, and commitment to animal welfare standards is creating additional pressure to adopt digital solutions(Kanade et al. 2024). Industry trends such as the growing integration of AI-driven monitoring systems, mobile-based animal health tracking, and data-

driven conservation management strategies are reshaping expectations for animal care operations (Liptovszky 2024). These broader external factors act as significant drivers of digital transformation not only in zoological settings but also in veterinary care facilities and conservation-focused organisations, where maintaining reputational standing and meeting stakeholder expectations are increasingly tied to successful technology integration.

3.2. Challenge-hindrance stressor framework (CHSF)

While the TOE framework is useful for identifying factors influencing technology adoption, it does not explain how those factors exert their effects. In this regard, the CHSF can provide additional insights by considering how users perceive the changes brought about by technology adoption in terms of stressors (Maier et al. 2021) According to LePine (2022), this framework distinguishes between challenge and hindrance stressors, with each influencing users' behaviours and attitudes toward technology adoption differently.

Challenge stressors are elements of a job or technology that users perceive as opportunities for growth, learning, or achievement (Yang and Li 2021). When new technologies present users with the potential to improve their skills, efficiency, or overall performance, they are more likely to view the technology positively (Mazzola and Disselhorst 2019). In such cases, users are motivated to overcome the challenges because they see the benefits of personal development or enhanced job performance. Technologies perceived as useful, easy to use, and compatible with existing work processes often fall into this category, as they are viewed as tools that can improve workflows and lead to better outcomes (Tan et al. 2023). As such, users may invest time and effort in learning and mastering these technologies because they see long-term benefits, leading to higher adoption and engagement rates.

Conversely, hindrance stressors refer to aspects of technology perceived as barriers or obstacles that interfere with an employee's ability to perform effectively (LePine 2022). These hindrance stressors create frustration and resistance, often decreasing an individual's willingness to adopt the technology (Horan et al. 2020). For example, if the technology is complex, dysfunctional, or incompatible with existing workflows, users may perceive it as hindering their work. Such technologies can create additional stress by requiring more effort, disrupting routine processes, or failing to meet expectations for improving work performance, leading

users to resist or abandon the adoption process altogether.

Employees are not passive recipients of new technology. Their subjective perceptions of whether technology is a challenge to overcome or a hindrance to their work – directly impact their adoption behaviours (Cheng, Lin, and Kong 2023), ranging from voluntary adoption and involuntary adoption to non-adoption. Integrating the CSHF framework with the TOE framework clarifies how TOE factors shape employees' hindrance or challenge perceptions of a technology, further shaping the success or failure of technology adoption within an organisation.

4. Method

4.1. Research approach, sampling strategy and data collection

To understand how digital tools are integrated into animal care workflows, we applied a qualitative research approach by undertaking focus groups in a semi-structured interview setting following the approach of Saunders, Lewis, and Thornhill (2012). Focus groups provide an interactive, peer-based environment that encourages personal disclosure and elicits a broader range of perspectives and ideas, thereby enabling us to generate rich data and deeper insights aligned with our research objectives (Cyr 2015).

To understand how digital tools are integrated into animal care workflows, we applied a qualitative research approach by undertaking focus groups in a semi-structured interview setting (Saunders, Lewis, and Thornhill 2012). In doing so, we captured the richness and depth of our research subject of interest (Cyr 2015).

We derived a sample from a zoological institution in Southeast Asia, where the Application was introduced in 2023. A purposive sampling strategy was employed to select participants for the study (Saunders, Lewis, and Thornhill 2012). Given the focus of this study, only users with direct experience using the Application were included, as they are best positioned to provide relevant insights into the adoption and usage of the technology. Specifically, the following inclusion criteria were used to identify eligible respondents within the zoo institution: (1) participants must be 18 years or older; (2) employed full-time at the institution; and (3) have used the Application for at least six months, with a usage frequency of at least three times per week. These criteria ensured that participants possessed familiarity and engagement with the technology to provide insights into its adoption and use. Participants were drawn from various departments within the zoology

institution, including zookeepers and supervisors. The selection of diverse participants allowed for a comprehensive understanding of how the Application is perceived across different roles and work functions.

A total of 21 participants were recruited across four focus group sessions, aligning with the qualitative research standards that prioritise data richness while ensuring feasibility. According to Hennink and Kaiser (2022), data saturation can be empirically assessed, and their systematic review of 23 qualitative studies suggests that saturation is commonly achieved with approximately 12 participants or four to eight focus groups. The sample size also aligns with recent research by Orji, Chan, and Orji (2025), supporting its adequacy in capturing diverse perspectives while maintaining manageable data collection and analysis.

All focus groups were conducted in person in the first half of 2024. The discussion questions explored users' experiences and perceptions of using the Application, drawing on the TOE model and CHSF as theoretical underpinnings. Sample questions include how users perceive the Application's usefulness in daily tasks. What challenges do they face when using the Application? How easily or difficult can users navigate the Application's interface and functions? To what extent do they feel the Application aligns with their work processes and values? In addition to the pre-determined questions, additional follow-up and probing questions were asked to better understand the participants' responses and uncover underlying factors influencing their attitudes toward the Application. Each focus group session lasted 45 to 60 minutes.

4.2. Data analyses

The data obtained from the focus groups were transcribed verbatim, de-identified and analysed using thematic analysis. The thematic analysis identifies, analyzes, and reports patterns (themes) within data (Bansal, Smith, and Vaara 2018). Thematic analysis is a flexible qualitative analytical method that accommodates both deductive and inductive approaches (Clarke and Braun 2016). Deductive analysis is theory-driven, enabling researchers to identify themes guided by existing theoretical frameworks (Braun and Clarke 2006). In contrast, inductive analysis is data-driven, allowing themes to emerge directly from the data in relation to the research questions (Braun and Clarke 2006).

Given that our study aims to explore the factors influencing employee adoption of the Application, we employed a hybrid thematic analysis approach. This approach combined both deductive and inductive strategies to maximise analytical depth. Specifically, we initiated the analysis using deductive coding, guided by the core dimensions of the TOE framework. These dimensions – technological, organisational, and environmental contexts – provided a structured lens through which to examine the data and identify predefined categories aligned with existing literature.

However, to ensure we captured the full richness of participants' perspectives, we also integrated an inductive component that allows for the identification of unexpected themes and patterns that have directly emerged from the data, beyond the TOE framework. By doing so, we remained open to novel insights and context-specific nuances that could contribute to the refinement or extension of the theoretical model.

In summary, this hybrid approach allowed us to strike a balance between theoretical grounding and empirical sensitivity. The deductive phase ensured alignment with the study's conceptual foundation, while the inductive phase provided the flexibility to uncover new, data-driven understandings of the factors shaping employee adoption behaviours. The integration of both approaches enhanced the analytical rigour and allowed for a more comprehensive and nuanced interpretation of the findings.

Consistent with prior research (e.g. Bansal, Smith, and Vaara 2018; Joshi et al. 2025; Türkay et al. 2022), we followed Braun and Clarke (2006) six-phase process to ensure a rigourous and transparent thematic analysis.

First, all authors carefully reviewed the transcripts and audio recordings to develop a deeper familiarity and understanding of the content. Next, we conducted open coding to identify initial patterns related to factors influencing employees' adoption of the Application. This process involved assigning descriptive codes to words, phrases, and sentences that reflected these influencing factors. Third, codes with conceptual similarities were organised into 'sub-themes', which were then integrated into broader thematic categories, resulting in higher order 'themes'. Overlapping categories were subsequently clustered, culminating in 'overarching themes'. Fourth, we reviewed these themes to ensure their coherence with the coded extracts and the entire dataset, generating a thematic map. Fifth, we defined and named each theme to refine its specific scope and articulate the overarching narrative of the analysis. Finally, we produced the analysis results, selected vivid and compelling illustrative quotations, and conducted a final review of all themes to ensure alignment with the research objectives, culminating in a scholarly report of the findings.

Our analysis identified several sub-themes, such as perceived security, co-creation culture, and social expectations. Based on these sub-themes, we integrated them into broader categories, such as technological

drivers, organisational support, and environmental influences; and three overarching themes: technological, organisational, and environmental factors. Collectively, the findings illuminate the TOE-related factors affecting employees' adoption of the Application, the outcomes associated with employees' challenge–hindrance appraisals of the technology, and their actual usage. To ensure the credibility of the thematic analysis, each step was independently reviewed by all authors and further refined through collaborative discussion.

5. Results

5.1. Participants

As shown in Table 1, the respondents are 21 users of the Application, each holding various roles, including Aquarists, Keepers, Animal Care Officers, and Curators. The users have varying experience levels within the organisation, ranging from one year and five months to 27 years and six months. The sample includes a mix of junior, senior, and managerial positions, with some users occupying senior roles such as Senior Aquarist, Head Keeper, Deputy Head Aquarist, and Curator, reflecting a wide range of tenure and expertise within the organisation. This distribution ensures the representation of both frontline staff and management-level users. To facilitate the anonymity of the two groups of participants, keepers (K#) and section leads (SL#) represent first-liners and managers, respectively.

5.2. Key identified themes

Three overarching themes were identified. First, the reasons for individuals to adopt or not to adopt the

Application; second, the forms of organisational support provided to support adoption; and, finally, the outcome of adopting the Application. The results will be reported based on themes instead of groups of participants, facilitating cross-validation and comparing different stakeholders' views on the same issues. To this end, Table 2 lists the essential functions raised in the interviews, the target users and the number of participants giving comments.

5.3. Drivers for technology adoption – technological reasons

The interview reveals instrumental and institutional reasons for users to adopt the Application. The instrumental reasons refer to the users choosing to adopt the technologies based on the technologies' utility and practical reward (Ismatullaev and Kim 2024), such as improving efficiency through optimising processes and minimising costs. The instrumental perspective holds that behaviour may be explained by self-interested, inward-focused motives rooted in individuals' basic needs for control. This aligns with other traditional technology adoption models and the unified theory of acceptance and use of technology, focusing on usefulness/performance, ease of use or effort expectancies (Venkatesh et al. 2003).

5.3.1. Perceived usefulness

When users perceive an application as useful, their likelihood of adopting it increases significantly (Davis 1989a). According to Yadav, Sharma, and Tarhini (2016), perceived usefulness is the extent to which an application meets users' needs, integrates seamlessly into their existing workflows, and offers tangible

Table 1. Respondents' profile.

Participant number	Code	Gender	Position	Experience in the organisation
1.	K1	Female	Senior Aquarist	10 Year 9 Month
2.	K2	Female	Aquarist	2 Year 5 Month
3.	K3	Male	Senior Aquarist	9 Year 1 Month
4.	K4	Female	Senior Aquarist	10 Year 8 Month
5.	K5	Male	Aquarist	2 Year 6 Month
6.	K6	Female	Keeper 1	4 Year 1 Month
7.	K7	Female	Keeper 1	7 Year 4 Month
8.	K8	Female	Junior Keeper	1 Year 5 Month
9.	K9	Female	Senior Keeper	5 Year 9 Month
10.	K10	Male	Junior Keeper	1 Year 8 Month
11.	K11	Male	Keeper	12 Year 6 Month
12.	L1	Male	Animal Care Officer	5 Year 7 Month
13.	L2	Male	Deputy Head Aquarist	13 Year 6 Month
14.	L3	Male	Junior Animal Care Officer	7 Year 10 Month
15.	L4	Male	Head Keeper	23 Year 5 Month
16.	L5	Male	Assistant Curator	12 years and 1 month
17.	L6	Male	Curator	18 years and 10 months
18.	L7	Male	Curator	27 years and 6 months
19.	L8	Male	Curator	16 years and 8 months
20.	L9	Female	Assistant Curator	10 years and 9 months

Table 2. Main functions being commented on during the interview.

Function	Target users	Details of the function	Number of participants giving comments
Food and Beverage Menu	All employees	Allows all employees to browse the available food and beverage menu provided by the cafes.	20
Morning Checklist	Leaders	The Zoo has a practice where managers must brief staff on the safety protocols or highlight unique instances at the start of every work session. To digitalise this practice, the application includes a morning checklist function.	9
Enrichment Calendar	All	Keepers use the Application to develop, plan, and implement animal enrichment initiatives that are submitted it managers for review and approval. Once received the relevant managers review the enrichment application and provide feedback for amendment or approval by the keepers.	20

benefits that improve their efficiency and effectiveness in completing tasks. Our findings suggest that this perceived usefulness is primarily driven by three key factors: alignment with established work practices, facilitation of best practice sharing, and simplifying approval and tracking processes.

The first factor contributing to perceived usefulness is the Application's *alignment with existing work practices*, which refers to the degree to which the Application fits into users' current tasks and responsibilities without causing major disruptions (Kniffin et al. 2021). In this study, the Application's enrichment calendar function exemplifies such alignment. This feature was consistently recognised by users as useful because it integrates with their ongoing responsibilities related to the development, planning, and implementation of animal enrichment activities daily. It actively enhances users' ability to organise, plan, and execute their tasks efficiently.

> … It is not like we have to look up an Excel spreadsheet to see what enrichments we have done for these animals. [With this Application], it is easier to look back and see; it is not all over the place; it is the one Application. (Respondent K11)

> Ever since we have the enrichment calendar, we can plan [the enrichment activities] at the beginning of the month, such as fixing the days of giving enrichments for this animal. Like this day, we will do this one. We can follow the calendar to perform the enrichment. We will not forget about it. (Respondent K3)

The second factor that enhances usefulness is the *facilitation of best practice sharing*, which involves the Application's ability to support users in exchanging knowledge and effective methods. The Application's design encourages disseminating valuable practices among team members, fostering a collaborative learning environment. Section leads, for example, highlighted how the Application made extracting examples of successful enrichment strategies easier and sharing them with keepers. This capability enhances users' collective knowledge and encourages adopting best practices across the organisation. As a result, the Application

supports continuous learning and improvement, further reinforcing its perceived usefulness.

> Everyone using the Application can see all the different enrichments [from different sectors], avian or cortex. (Respondent L6)

> We can see what other enrichment that other sections have done, to share ideas. (Respondent K10)

> You can see everyone else's enrichment devices, and you can get certain ideas from that. (Respondent L3)

> I see [other department] doing this enrichment. We can get some idea about it. (Respondent L3)

The third factor is the *simplification of approval and tracking processes*. In this context, simplification refers to the reduction of time and effort required to manage and monitor workflow activities, such as obtaining approvals and tracking progress. Users found that the Application significantly reduced the administrative burden typically associated with these tasks. By providing an intuitive interface for managing approvals and tracking the status of enrichment programs, the Application helps eliminate common workflow bottlenecks. This, in turn, allows users to focus more on their core responsibilities, thereby increasing the Application's overall value.

> In the past, when the keepers gave us the enrichment for approval, we got to recall which keeper got approval for that enrichment before and search for the enrichment from [different sheets in] Excel and share samples with the new applicant. Now it is all streamlined. All the approvals go to the same Application, and [I] can see them all at the same time. (Respondent L5)

> After we get this Application, everything is in the Application. After [we] submit the thing, it is directly sent to our boss, and our boss will have to copy it. Because it is just everything in the Application. So that you know what is pending and what is approved. (Respondent K10)

5.3.2. Perceived compatibility with lifestyle

Compatibility with users' lifestyles was a recurring theme emphasised by interviewees, particularly its

support for professional and personal routines. According to Rogers (2003), compatibility is the degree to which an innovation is perceived as consistent with existing values, past experiences, and the needs of potential adopters. Technologies that better align with users' lifestyles, cultural practices, and work routines are more likely to be adopted rapidly and effectively.

Our results further confirmed this definition, demonstrating that compatibility extends to personal lifestyle factors, including generational differences and individual comfort with technology. Users' varying familiarity with digital tools and preferences for specific devices, such as computers over mobile phones, played a significant role in determining how the Application was received and utilised. Younger users were generally more open to adopting mobile-based workflows, while older employees sometimes found it challenging to adjust to smaller screens or mobile-specific tasks.

> In my section, a colleague did not use the Application at all because she is quite old. Also, she is not expected [to use it]. Everyone else has the Application. (Respondent K9)

> For me, I am not good at hand phones. If I need to type many things, I rather do that on the computer. For the Application, I do not even want to see [the small words on the small screen]. I see some of my colleagues are really good at iPads. However, they may struggle using the phone. (Respondent L2)

5.4. Perceived ease of use

Despite its usefulness, users pointed out key issues that further reinforce the importance of ease of use. The first issue is customisability, which refers to how well a technology is tailored to meet users' specific needs regarding data, functionality, and output (Venkatesh, Thong, and Xu 2012). Our results showed that a complex interface with too many functions did not allow the user to customise the display to their personal preferences, thereby deterring their intention of adoption. This is not surprising, considering that users find it challenging to locate the features that are useful for them, reducing the Application's ease of use.

> Sometime after we submit, we want to review what we have written, but there is no way for us to review it; you are not allowed to edit once submitting it. But I would prefer if I could review back what you have submitted; maybe I have left out something. (Respondent K3)

> I have a bunch of staff that have been working here for about five to ten years. They have gained the knowledge. So, I do not have to keep on telling them about safe working procedures (SWP), and all that we keep repeating [in the morning checklist] is unnecessary. (Respondent L4)

The second issue highlighted is *reconfigurability*. Reconfigurability refers to the extent to which a system can support iterative changes and adjustments to meet evolving needs throughout its use (Goyal, Jain, and Jain 2013). An application supporting reconfigurability in a work environment often facing dynamic changes becomes essential. It enables the system to be flexible and adaptable, allowing modifications without disrupting core functionalities or requiring extensive redevelopment (Savastano et al. 2024). Moreover, reconfigurability reduces the costs and complexities associated with system upgrades and maintenance. Instead of investing in entirely new systems or tools, organisations can update existing ones, ensuring sustainability and continued relevance in a rapidly evolving environment. In this regard, supporting reconfigurability in applications is crucial for technology acceptance. These are the same views expressed by the respondents.

> After submission, if it did one point wrong, then we need to resubmit. (Respondent K1)

> I cannot use someone else's enrichment. I have to recreate everything. I have to send it for approval and then do the whole process again. So then, that whole process just slows everything down. Then I have to do it by the end of this month to be used for next month. So, in that month, I cannot use it. (Respondent K8)

> I think that is because of this tedious process of getting it [enrichment approval] done, you know, submissions for approvals and all that, many keepers are not as keen to submit things. (Respondent L1)

5.4.1. Perceived security

The third factor influencing technological acceptance is perceived security. It is interesting to note that while respondents felt that it is justified to have security measures, their collective impact can lead to what is known as 'security fatigue', which occurs when users become overwhelmed by the complexity and frequency of security requirements (Nobles 2022). Security fatigue often manifests in users feeling exhausted by the constant demands to create unique passwords, manage multiple authentication steps, and stay vigilant against threats (H. Chen, Liu, and Lyu 2022). As these security requirements grow more intricate, users may develop a sense of helplessness or frustration, leading them to adopt unsafe practices, such as reusing passwords or avoiding updates and other essential protective behaviours. The paradox is that while security measures are designed to protect users, their excess can decrease user engagement with the technology and reduce compliance with necessary safety protocols.

Yeah, to keep logging in to the Application, they must get the two authentication factors. That is, more steps to their workflow. (Respondent L5)

What I find troublesome is that we log in once, but sometimes, the next day, I want to log in, and it asks me [for authentication] again, although this Application is only used on my device. So, it is quite troublesome. (Respondent K3)

I think about security issues, there is two-factor authentication. So, we always get logged out, and then it takes you to key in your password [again] because they do not let you save your password. (Respondent L1)

5.4.2. Interoperability with other databases
Our findings revealed that interoperability with other databases is the fourth driver leading to technology adoption. Interoperability is the ability of two or more software components to cooperate despite differences in language, interface, and execution platform (Zeng 2019). In an increasingly interconnected digital ecosystem, the ability of new technologies to seamlessly interact with existing systems and databases is paramount. Organisations typically operate with diverse platforms, applications, and data storage systems, often needing to work together to ensure smooth and efficient operations. Therefore, when considering new technology, one of the main factors influencing its adoption is its interoperability with the organisation's existing databases and technological infrastructure. Technologies designed to be interoperable can easily communicate and share information across multiple databases, enhancing their value and ease of implementation. When a new system integrates effortlessly with established databases, it reduces operational friction, minimises disruption, and ensures continuity, making it much more likely that users will adopt it. In this regard, our results showed that the interoperability failure of the Application and earlier manual systems using Microsoft Excel creates an extra burden for keepers and managers to switch to the Application. As a result, many keepers chose to use Excel sheets when adopting enrichment.

Before this Application, we did populate the [enrichment] catalogue in [Excel]. So, I thought they would already be inside here so we do not have to redo everything again. Now that they are saying it [past enrichments] is not there. So, I think that guys have to go and redo everything again. So that is the tedious part. (Respondent L6)

5.5. Drivers for technology adoption – organisational support

Organisational support is critical in driving technology adoption among individuals within a company. When organisations provide adequate resources, training, and incentives, employees are more likely to embrace new technologies (Harunavamwe and Kanengoni 2023). Besides, organisational backing helps reduce employees' uncertainty and resistance towards adopting new technologies by fostering a learning culture and providing clear communication about the benefits of the technology. In the interviews, both section leaders and keepers reported that adopting the Application was not imposed but encouraged, and they experienced different forms of organisational support as illustrated below.

5.5.1. Co-creation culture
The results further highlight the importance of having a co-creation culture. Co-creation is the collaborative process between developers and end users to jointly design and refine products or services (Prahalad & Ramaswamy 2004). A co-creation culture is central to the organisation's approach to any technology adoption. In this case, the co-creation mechanism included pre-development consultations, small-scale pilot testing, and a structured feedback system. During the initial development phase, a subset of users was invited to share their preferences regarding the Application's functions and features. However, some participants in our study expressed that they were unaware of this consultation process, and none of the participants had been involved. As such, many felt that it did not adequately address their needs.

We are the end users. We are feeling the pain of using it at the moment. [The organisation should] ask the end users how they feel about the Application. What you guys [the organisation] need to do is have a brainstorming session, throw everything out there through whatever is unnecessary, whatever is rubbish. (Respondent L4)

5.5.2. Onboarding session
Our result found that onboarding is another critical factor in ensuring users transition smoothly from initial exposure to proficient and sustained use (N'Dri and Su 2024). Onboarding is a structured, ongoing process by which new users are introduced to and educated on a product or service (N'Dri and Su 2024). Effective technology onboarding involves orientation sessions, hands-on training, instructional materials, and ongoing support. A good onboarding program is expected to foster user engagement, increase confidence, and reduce barriers to effective usage. Our findings reiterated the importance of implementing onboarding as an ongoing engagement process. The evidence demonstrated a desire for continuous onboarding support through additional training sessions.

That time [At the first briefing session], I could not use my phone. So, I could not follow. Maybe there is another briefing also. But I do not know. Still, one briefing is not enough. (Respondent K11)

5.5.3. Ongoing technical support

Organisational support plays a crucial role in driving new technology adoption within a company, and one of the most critical aspects of this support is technical support. A well-established technical support system, including access to helpdesk services, troubleshooting, and expert guidance, can significantly reduce resistance to change (Ismatullaev and Kim 2024). It ensures that when issues arise, they are resolved quickly, allowing employees to continue their work without extended downtime. Moreover, technical support can help employees overcome the fear of adopting new tools by providing training and resources to build familiarity (W. Chen and Filieri 2024).

The contact person, Ms V, has been telling us if we face any difficulty using the APPs, we can directly contact her. (Respondent K3)

Yes. There is a way for us to get help [through Ms V] if we meet with technical issues on the Application. (Respondent K4)

5.6. Drivers for technology adoption – environmental factor

Environmental support refers to the external factors and conditions influencing an individual's decision to adopt new technologies (Ng, Lit, and Cheung 2022). These can include market trends, competitive pressures, industry standards, and regulatory requirements, creating a broader context in which technology adoption becomes essential (N'Dri and Su 2024). In rapidly evolving technological environments, organisations often face external pressure to adopt new tools, driven by the need to stay competitive, comply with regulations, and meet customer expectations.

5.6.1. Societal expectation

The societal expectation is an environmental factor that drives technology adoption (Tang, Wei, and Chen 2024). In today's increasingly digital and interconnected environment, individuals and organisations must adopt the latest technologies to stay relevant, efficient, and responsible (Ismatullaev and Kim 2024). Society's expectations often pressure individuals within organisations to adopt technologies that promote sustainability, inclusivity, or efficiency (Tang, Wei, and Chen 2024). For example, there is a heightened awareness of digital

transformation and its role in driving progress and improving outcomes in many industries (N'Dri and Su 2024). Another example is the rise of remote work, where societal demands for flexibility and accessibility encourage the adoption of digital collaboration platforms (Smite et al. 2023). In this way, societal expectations are an external force shaping how individuals perceive and engage with technology in their professional environments.

We are doing it for the sake of just being technologically savvy and trying to go forward and tell [the stakeholders] that we are doing all these fantastic stuff. (Respondent L4)

5.7. Outcomes for adopting

5.7.1. Theme 1. Organisational level outcomes

5.7.1.1. Increased perceived efficiency at the operations level. Differentiated responses were received when asked about the perceived efficiency before and after adopting the Application. The curators and keepers reported efficiency improvement in general, while section leads reported the opposite, as shown in Table 3.

From the curators' and keepers' perspective, it is apparent that the Application improves work efficiencies by automating routine administrative tasks and streamlining operational processes, allowing users to focus on higher-value activities. For example, automated systems can manage feeding schedules, environmental controls, or animal health monitoring, significantly reducing users' time on these manual tasks. This increased efficiency allows staff to allocate more time to tasks that require critical thinking, problem-solving, and creative input, such as developing enrichment activities or innovating care routines. Although they also find that the use of the Application can be burdensome, such as spending time recreating the enrichment activities that are available in the previous Excel spreadsheet, respondents see the benefits outweighing the cost, resulting in a positive outcome in terms of their overall productivity improvement at work.

Table 3. Perceived efficiency before and after adoption of animal care application.

	Pre-App	With App	% Change
Curators	4.2	7.1	↑29%
Section Leads	5.25	4.5	↓7.5%
Keepers	5.5	5.85	↑ 3.5%

Notes: (1) These are the perceived efficiencies where all participants were asked to rank their work efficiency with a scale from 1 to 10, with 1 being the least efficient and 10 being the most efficient. (2) The scores are averaged out based on the number of respondents in a similar functional role.

It's easier to like you submit the enrichment, then [once approved], you can do that enrichment. And once you done it, you can go to the day of the enrichment, and then submit [updates on the outcomes of it]. (Respondent K11)

I think is more systematic. In a sense, because it's just everything in the Application. So that you know, what is pending? What was approved? And so, we can see other, what other enrichment that other sections have done, to share ideas. Previously, the process is kind of the same, but it's in the Excel file. And you have to like, share the Excel file … and have to [input the detials] in manually. (Respondent L4)

5.7.1.2. Better animal care.
A key outcome of the interviews is that integrating digital technologies within zoological institutions and conservation centres is transforming the animal care industry. Institutions can improve animal care quality and consistency by leveraging tools such as mobile applications. These technologies enable keepers to optimise feeding and enrichment schedules, track health metrics, and ensure that each animal's unique needs are met promptly. Real-time monitoring systems, for instance, can alert staff to changes in an animal's behaviour, weight, or activity levels, facilitating early interventions and improving overall well-being. For example, as shared by keepers and section leaders,

I know the Application has other departments sharing the enrichment items for exchange. Sometimes I go to see the idea that comes from other sections or departments that can be useful for the aquatic section [to improve the well-being of our aquatic animals]. (Respondent K8)

We have a link to an animal assessment form [in the Application], which indicates who is responsible for which animals and [we can update] the outcome for the animals. (Respondent K1)

When keepers submit an animal assessment form, section leaders could give timely feedback and comments to help ensure the well-being of the animals under their care.

[Keepers can] put their safety concern [in the Application] for us to comment on. [In a] recent case, [I found that] some [keepers] had gone too aggressively with the enrichment. I was concerned that [the] disease might get transmitted through the chain [of the animal]. So, I put in a comment, [suggesting them] try placing a PVC pipe over the chain, so [the] animals will not get caught with the disease. (Respondent L6)

5.7.1.3. Fostering a learning environment for innovation.
Innovation within organisations is driven by a learning environment that allows for process improvement, adapts to changing environments, and stays competitive. However, the success of innovation, particularly the adoption of digital technologies like mobile applications, is not always guaranteed (Moghavvemi et al. 2021). Innovation through the adoption of mobile technologies often stems from the need to enhance operational efficiency, streamline processes, and adapt to changing organisational demands (Tan, Leong, and Richter 2024a). Taking our earlier arguments together, we can infer that the Application can foster innovation by creating a learning environment.

However, not all attempts at innovation succeed. Our results show that users may hesitate to alter established routines, especially if they perceive new technologies as complex or disruptive. In other words, if the technology is not designed with usability in mind or if adequate training and support are lacking, users may disengage from the innovation process, leading to poor adoption.

I think that is because of this tedious process of getting, you know, submissions for approvals and all that, a lot of keepers are not as keen to submit new enrichments. (Respondent L1)

If I have to get the approval for some new enrichment, I rather do some existing enrichment that is already approved. (Respondent K7)

5.7.2. Theme 2. Individual level outcomes
5.7.2.1. Enhanced autonomy.
Our results show that the availability of real-time data and analytics through digital platforms empowers the keepers by giving them greater autonomy in their decision-making processes. For instance, staff can access up-to-date information on animal health, behaviour patterns, and environmental conditions, enabling them to make more informed decisions. This fosters a sense of ownership and responsibility among users, making them feel more connected to the outcomes of their actions. As users are directly involved in shaping care strategies and routines, they will experience higher levels of autonomy and competence (Tummers and Bakker 2021)

Now with this Application, [I am] speaking to [the colleagues] to know [their] enrichment [in the Application], I have the freedom to suggest improvement on my enrichment, so it is a good platform. (Respondent K9)

5.7.2.2. Improved competence.
Our results also demonstrated that implementing mobile applications in zoological institutions and conservation centres significantly contributes to enhancing the competence of staff

members. With the adoption of mobile applications, data management systems, and other digital platforms, users can access and share information more effectively, improving their skills, knowledge, and decision-making capabilities. These tools provide staff with immediate access to animal health records, care protocols, and best practices, which fosters a deeper understanding of each animal's unique needs and enables more informed and accurate care decisions. At the same time, mobile applications can provide opportunities for continuous learning and professional development (Benitez, Ruiz, and Popovic 2022). This is especially true when the mobile application acts as a repository for learning best practices, enabling users to innovate their practices.

> Sometimes the enrichment we see [on the Application], we can [learn and] use it for other our animals. (Respondent K11)

> Because we can see [the enrichment] of animals … we can learn the ideas and we are able to create for my own. (Respondent K10)

> Because that's how you can improve your enrichments. And then, when you learn from others, you also know that this could be effective. (Respondent K5)

5.7.2.3. Enhanced relatedness through collaboration and communication.

Our results demonstrated that all respondents agreed that the Application enhances communication and collaboration across different teams, departments, or locations. As highlighted by Bök and Micucci (2024), applications on cloud-based platforms ensure that real-time information is available to everyone who needs it, allowing users to instantly share updates, notes, and data about animal health, behaviour, or care routines. This improved communication ensures that all team members are aligned and informed, fostering a collaborative work environment.

> It could be because you can see everyone else's enrichment [plans], and you can [contact others] to discuss the ideas. (Respondent L3)

> I know the [Application] has other departments sharing the enrichment items to exchange. Sometimes, I go in [the Application] to see any ideas I can get from other sections or departments that could be useful for the aquatic section. It can exchange resources, which helps me get to know others better. (Respondent K1)

5.8. Challenge/hindrance appraisal and in(voluntary) adoption

Individuals who perceived the Application as having enhanced their job performance and workplace well-being in various ways viewed the technology as a positive challenge, which led to a strong willingness and commitment to adopt it voluntarily. This was further supported by managers' feedback, noting the frequent use of the enrichment calendar by their staff:

> I think one of my staff submitted maybe about 15 or 20 enrichment. (Respondent L7)

> [For my team], I think around ten [of my staff have submitted enrichment for approval]. (Respondent L8)

In contrast, the low ease of use, lack of organisational support and perception that the organisation adopts the technology solely to meet societal expectations led some employees to believe the Application increases their workload, such as imposing unnecessary administrative tasks on managers and requiring extra time for keepers to obtain approvals for enrichment activities.

> [Using the Application is] just like a normal routine. I go and click, click, and submit. I do not even read inside [contents]. The Application is [supposed] to help our work, not to make our work more. (Respondent L2)

This resulted in frustration and a hindrance appraisal, due to which some employees adopted the Application reluctantly, reflected in its infrequent use or use merely for compliance.

6. Discussion

The findings are summarised in Figure 1, highlighting a detailed examination of the drivers and outcomes associated with technology adoption, particularly within organisational environments. The identified technological reasons for adoption align closely with established technology adoption frameworks, focusing primarily on perceived usefulness and perceived ease of use. Perceived usefulness results from aligning the Application with existing working practice and lifestyle, facilitating knowledge sharing and simplifying administrative processes. Perceived usefulness thus serves as a challenge stressor, pointing to instrumental motivation, with users voluntarily adopting technologies due to practical rewards such as improved knowledge sharing, reduced administrative burdens, and better decision-making capabilities. This echoes studies such as Orji, Chan, and Orji (2025), where factors such as perceived usefulness are a dominant predictor of adoption.

While perceived low ease of use serves as a bottleneck, creating hindrance appraisal and resistance among employees to voluntary technology adoption. In this study, particularly frontline staff, such as animal keepers, found the Application added complexity to their day-to-day tasks rather than simplifying them. First and foremost, low customisability and
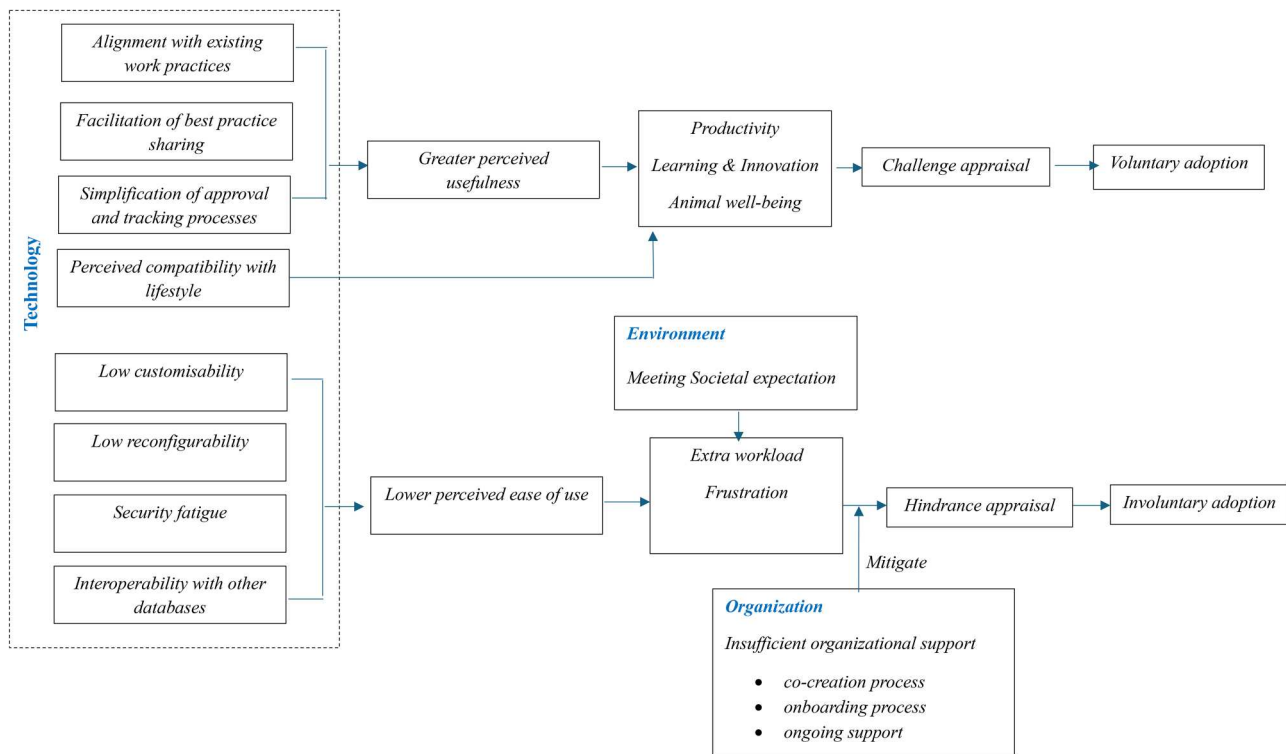
Figure 1. Findings.

compatibility featured by unadjustable layout, rigid approval and submission protocols, and a lack of interoperability with the legacy Excel systems increased the complexity of using the Application. It hence produced frustration and hindrance appraisal among users. Another source of hindrance appraisal relates to the security protocols that require two-factor authentication and frequent re-logins. Such a result aligns with prior studies that revealed that perceived ease of use is a bottleneck for users' adoption of technologies (Foroughi et al. 2024). For these results, it is essential to note that the keepers' daily routines must be adaptive to animals' changing behaviours and needs, and inflexible systems may disrupt rather than support care workflows. This underlines the need for system reconfigurability and backwards compatibility when designing technologies for animal-focused work.

Moreover, this study highlights the critical role of organisational support in mitigating the hindrance appraisal and fostering technology adoption. Adequate support practically enables smoother implementation and serves as a strong signal of digital leadership – a subtle yet powerful driver of adoption within institutions. In this study, both digital leadership and organisational support are evident across all levels.

At the ground level, leaders – particularly those in supervisory or managerial roles – act as intermediaries between organisational goals and frontline realities.

Importantly, none of the section leaders imposed the use of the Application on their keepers. Instead, they incorporated the Application into their daily routines, setting an example and encouraging adoption through practice rather than directive. As highlighted by Tang, Wei, and Chen (2024), when leaders are visible champions of technology, regularly using the tools themselves and reinforcing their benefits, they build a greater sense of legitimacy and trust around the innovation.

Digital leadership also manifests through structured, bottom-up initiatives to facilitate technology adoption. These include a co-creation culture, practical onboarding sessions, and continuous technical support – all present in this study. On one hand, such support structures ensure that users feel involved in the development process, are well-trained, and receive the assistance needed to navigate challenges. This aligns with the findings by Tan et al. (2024b) and Tang, Wei, and Chen (2024). These support structures reflect senior leaders' commitment to fostering a positive climate for digital innovation. By providing training, technical support, and open channels for feedback, leaders help maintain momentum for change while addressing implementation fatigue. Our findings reinforce this perspective and contribute new insights by showing that digital leadership aligned with change management principles is equally essential even in non-corporate, animal-focused environments.

These insights are particularly relevant within the zoological context, where digital technologies intersect with highly specialised animal welfare practices. For instance, the findings revealed that perceived usefulness was driven by the Application's enrichment calendar, which reflects the importance of precise and routine planning for animal enrichment activities. This is especially so where such planning is critical for animal stimulation and complying with specific animal welfare standards and accreditation requirements. In other words, this feature of the Application directly enhanced the operational and ethical outcomes of the zookeepers. Similarly, the emphasis on interdepartmental visibility – where keepers could access enrichment activities from other teams – reflects the sector's collaborative ethos and the need for standardised yet creative approaches to care. To this end, while Clay et al. (2011) found that digital tools have the potential to improve zoological institution operations, our findings value-add to the literature by highlighting that such tools must not only be functional but also embedded within the daily operational processes to have a more tangible impact.

In terms of outcomes, our results aligned with Chiu (2021), showing that adopting digital technologies with the relevant support systems increased employee productivity, improved competence, and ensured better collaboration across teams, all contributing to enhanced animal care and improved animal well-being. These findings align with Tan, Leong, and Richter (2024a) arguments that when digital systems are perceived as supportive rather than intrusive, they can reinforce employees' autonomy and decision-making confidence.

7. Implications

7.1. Theoretical implications

This study contributes theoretically by enabling a dual-level analysis. At the organisational and contextual level, the TOE framework allows for a systematic identification of external enablers and bottlenecks, such as technological complexity, environmental pressures, and internal readiness (including leadership support and digital infrastructure). At the individual level, the CHSF lens brings to light the cognitive and emotional appraisals that shape whether users respond to new technologies with openness and engagement – or with resistance and compliance. In doing so, the integrated model explains not just whether adoption occurs, but how and why adoption unfolds in different forms (e.g. voluntary vs. involuntary), depending on the interplay between contextual factors and users' subjective experiences.

As such, we have advanced the theoretical understanding of technology adoption as a dynamic, non-linear process, shaped by both environmental structures and personal meaning-making. Unlike linear models that focus solely on system characteristics or organisational readiness, our approach foregrounds the role of employee perception and psychological engagement throughout different phases of adoption – from awareness and consideration to pilot use and sustained support. This allows for a more realistic and human-centered portrayal of digital transformation, particularly in contexts where frontline staff face high-stakes responsibilities, unpredictable work conditions, and varying levels of digital literacy, such as in zoological institutions.

Seeing from this light, this study contributes to ongoing debates in organisational behaviour, occupational psychology, and information systems research. It provides an empirical foundation for future studies seeking to unpack the subtle tensions between formal adoption policies and lived user experiences – a gap that often leads to implementation failure or underutilisation of digital tools.

7.2. Managerial implications

From a managerial perspective, this study offers several implications for practitioners implementing digital tools in complex operational settings, such as zoological institutions. Drawing on the T-O-E and CHSF frameworks, the findings emphasise that successful adoption depends not only on technological functionality but also on how well the application aligns with users' work routines, the organisational environment, and technological readiness. Rather than viewing adoption as a one-time event, it should be understood as a phased process – moving through awareness, consideration, and adoption – each with distinct goals, as outlined in the Technology Adoption Map (Figure 2).

In the Awareness Phase, managers should translate the application's capabilities into tangible benefits that align with staff priorities, such as improving animal welfare, enhancing team communication, or reducing time-consuming documentation. By doing so, animal care staff may be more receptive when they see how the system could be embedded into their work process. At the same time, managers should encourage users to give a thorough thought on whether if there could any blind spots that the design team could have overlooked. To make this phase successful, managers should provide a psychologically safe and low-pressure environments for staff to voice concerns or aspirations. Hence, having small group discussions, hands-on demonstrations, or
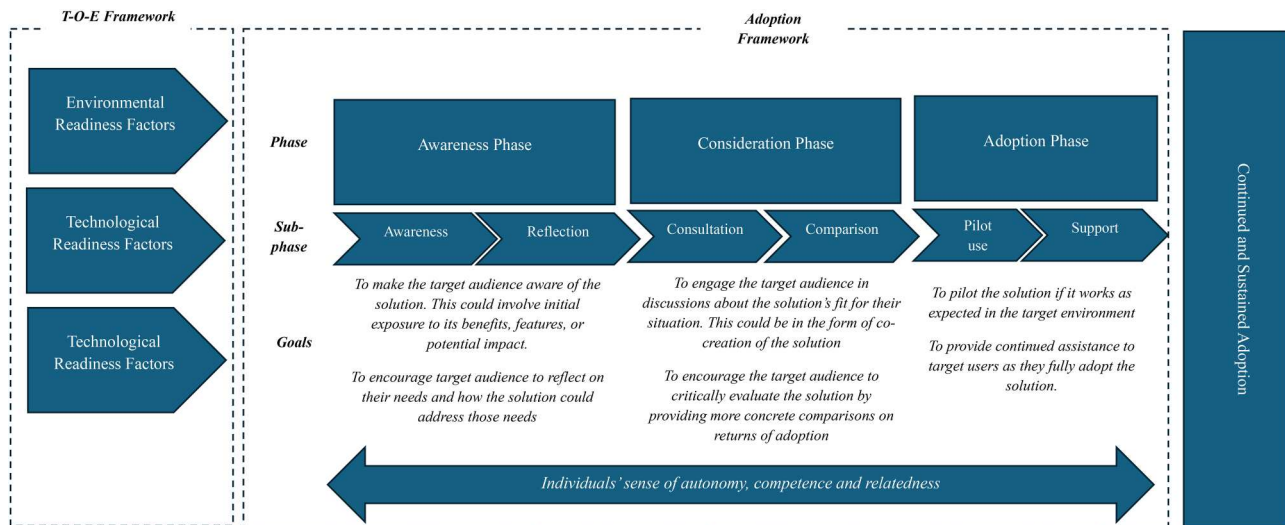
Figure 2. Technology adoption map.

team huddles are some ways towards fostering a more meaningful engagement at this stage.

In the Consideration Phase, managers should involve frontline staff to co-create the solution by shaping workflows, naming interface elements, or refining notification settings ensures that the final tool resonates with the realities of their work. This is particularly relevant in unpredictable environments like zoological institutions, where staff must juggle urgent care tasks, unpredictable animal behaviour, and environmental factors such as weather or visitor traffic. At the same time, managers should provide employees the chance to compare their current practices with projected gains from the new system, This can be in the form of case studies, or mini simulations. Doing so helps reveal friction points, such as overly complex approval chains or redundant data entry requirements, that may otherwise go unnoticed until post-implementation.

In the Adoption Phase, managers should pilot the system to refine workflows and identify friction points in real time. At the same time, managers should provide support mechanisms such as accessible training, peer champions, and responsive feedback loops, which are crucial in transitioning into full deployment.

Across all phases, leadership plays a key role. During the early stages, leaders should focus on building trust, clarifying the purpose and benefits of the application, and fostering openness to change. In later stages, leadership should reinforce commitment through visible engagement – such as actively using the tool themselves, allocating protected time for staff training, and celebrating incremental progress. Examples of effective leadership behaviours include modelling proper use of the application, linking small successes to broader animal

welfare outcomes, and maintaining an open feedback loop to respond to staff concerns.

7.3. Limitations and future research directions

Despite contributions, this study is not without its limitations. First, this study was conducted in a single zoological institution in Southeast Asia, with a relatively small sample size of 21 participants. While this allowed for in-depth qualitative insights, it limits the generalisability of the findings to other contexts or regions. Future research could broaden the scope by including multiple institutions across different geographic regions to better capture a broader range of perspectives and adoption experiences. Secondly, this study focuses on a specific form of application, which allows for a detailed exploration of its acceptance. However, it may not account for the nuances of adopting other technologies in similar environments. Future studies could explore replicating this study across other digital tools to identify if similar findings can be obtained. Finally, there is a lack of a quantitative dimension that could offer statistical validation of the findings. Naturally, future researchers could incorporate mixed methods, combining qualitative interviews with surveys to obtain a more holistic understanding of technology adoption. Similarly, future researchers can consider using an experimental approach to measure within-person or between-person differences to have a different perspective on technology adoption.

8. Conclusion

In conclusion, the technology adoption journey is like navigating an evolving landscape of opportunities and

challenges. As new technologies emerge, organisations are constantly faced with the question of how best to embrace these innovations without losing their way in the complexities they bring. This study advances a nuanced understanding of technology adoption by integrating the TOE and CHSF frameworks, revealing how contextual enablers and psychological appraisals jointly shape adoption behaviours. This study serves as a map for that journey, combining the broad perspectives for organisations to navigate the path of adoption of technology with a clearer understanding of where the roadblocks might be and how to successfully integrate innovations into the fabric of organisational life.

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Data availability statement

Data would be made available upon reasonable request from the corresponding author.

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