Use of Affordance in Design Science Research: A Systematic Literature Review and Research Agenda

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Abstract

Design Science Research (DSR) focuses on creating artefacts to solve real-world problems and shares some common objectives with affordance for creating designs that are not only visually aesthetic but also user-friendly and practical. However, varying interpretations of affordance and lack of guidelines for its use with DSR have led to inconsistent findings and hindered the ability to draw meaningful conclusions. Considering the dearth of existing studies, we conducted a systematic literature review using the 'PRISMA' method to investigate trends, identify themes, gaps, and determine research agendas of relevant studies that uses affordance in DSR. We used four popular academic databases, and 21 research articles were finally selected through comprehensive screening criteria. The review identifies the findings, results and contributions that are helpful to researchers and practitioners through descriptive and thematic analysis using NVivo. It highlights the need for more interdisciplinary and cross-domain research to integrate affordance in DSR.

Keywords affordance, design science, SLR, research agenda, thematic analysis

1   Introduction

Studies in information systems (IS) are increasingly integrating affordance into their research (Wang et al., 2018). Gibson's original definition of "affordance" incorporates the potential actions an environment offers to animals, highlighting the critical connection between the environment and animals (Gibson, 1977). Norman (1999) expands the definition to a broader scope of Human-Computer Interaction (HCI) and helps to understand the potential interaction between users and technology or Information Systems (IS). Affordance is increasingly used in design studies as design itself is viewed as a process of searching for an artefact that possesses desired affordances to support desired behaviours (Maier & Fadel, 2009). The power of design lies in how well it can communicate affordance, making people understand the system's possibilities or how well affordance is perceived by users, bridging the gap between physical property and user's interpretation (Norman 1999). Thus, the importance of affordance in IS design or studies can be understood by its application across diverse domains such as healthcare, business, environment, sensemaking and other digital industries. The modern IS design should not only fulfil the functional requirements but also provide enhanced user experience, satisfaction, and engagement through well-designed affordance (Gregor & Hevner, 2013) and support broader goals. For instance, IS designed with easier navigation and reliable performance demonstrates higher user satisfaction and increased adoption (Zahedi et al., 2022).

Norman's interpretation of affordance is influential in areas such as HCI and DSR, where design heavily relies on user perception and interaction with the system to assess the possibilities. The concept of affordance is helpful in design as it considers not only artefacts but also the designers and users and the complex interaction between them (Maier & Fadel, 2009; Chaves et al., 2018). It helps integrate features according to user goals, enhances the experience, and informs and guides the design process (Lui et al., 2024).

Design science is concerned with designing, creating, and evaluating instances of the solution space in the form of innovative artefacts, exploring the problem space, and utilizing the interaction between users, designer, and system (Pan et al. 2020; Lui & Yoon, 2024); thus, affordance can inheritably play a crucial role as it shapes the design of system or products (Maier & Fadel, 2009). Affordance can be used in DSR to investigate IS and organisational practices (Seidel et al., 2018). The concept of affordance in design provides a powerful lens to understand how to utilise affordance for better system design and problem-solving. It can also demonstrate an IT artefact's possible uses and effects (Zhao et al., 2013) and enables an understanding of how the *material properties* of artefacts enable specific uses and create user-centred artefacts (Seidel et al., 2018).

Despite these recognitions of the need for the synergy among design, affordance and the DSR, the use of affordance in DSR is under-investigated, forming research gaps. The seminal DSR methods and principles lack interpretation or inclusion of how affordance can be integrated into the design to achieve goals or solutions. The lack of relevant studies and findings has led to using diverse methodologies, definitions, and varying interpretations, resulting in hindrances to drawing meaningful conclusions in DSR studies with affordance. The potential of using affordance with DSR in various domains remains unexplored (Wang et al., 2018), which calls for a systematic analysis. Most previous reviews in this area predominantly have focused on affordance from a design perspective rather than design science (Maier & Fadel, 2009; Stendal et al., 2016). So, this review aims to provide a holistic understanding of affordance in DSR for stakeholders through a systematic literature review (SLR), including thematic analysis from diverse perspectives, enhancing reliability and comprehensiveness. Most importantly, this research helps identify the gaps and limitations and formulate the research agenda in this area of interest and knowledge (Wang et al., 2018) and addresses the need to integrate affordance with DSR amidst the lack of studies in the area and changing user design interaction and expectations. To achieve this, we comprehensively reviewed research articles investigating affordance using DSR and apply descriptive and thematic analysis by seeking answers to the following research questions.

1) What trends are evolving in use of affordance in DSR and how is affordance conceptualised or interpreted in such studies?

2) What are the significant themes, gaps, and opportunities identified in the literature on affordances in DSR, and what is the future research agenda in this area?

This paper is organized as follows. The next section introduces the background followed by the method of this review which explains the searching, selecting and analysing thematic analysis. The results of this search and review are presented in the following section. Discussion and future agenda sections aggregate and analyse the results to answer research questions. Finally, it is concluded with contributions and implications on the research topic.

2   Background

Gibson coined the initial concept of affordance as the actionable properties or potentials between the world and an actor. He argues that affordances are inherently available to individuals and tied to the environment irrespective of whether the actor recognises or utilises them. They can be perceived directly, regardless of prior synthesis and analysis (Gibson, 1977). Norman (1999), based on design and HCI, introduced the concept of "perceived" and "real" affordance, constraints arguing the importance of cues for actors to recognise or perceive the presence of the affordance before it can be utilised which in turn will also depend on various factors. Unlike Gibson's concept of universal availability of affordance, Norman argued that a system should be designed to make the perceived affordance intuitive, easy to identify, interact and use.

Design science aims to create artefacts that solve real-world problems, and user engagement plays a crucial role in DSR studies (Lui & Yoon, 2024). The goal is to design artefacts with intuitive features that can be utilised to solve various problems. The affordance theory provides a framework to understand how artefacts can support tasks by offering actionable properties, guiding goal-directed actors' actions and behaviour to achieve goals, and enriching the design process (Lui et al., 2024). Mikkelsen (2023, p. 17) argues '*affordance theory is a good supplement to ADR*'. The definition of affordance has continued to evolve with newer concepts such as the selection view, dispositional view stages of affordance actualisation, the trajectory of affordance or the idea of sequential affordances (Zhao et al. 2013). Introducing affordance in design helps the designer to anticipate how user will interact with artefacts and thus modify or enhance such artefacts to meet users' requirements and increase usability, providing cues to aid users' actions. Affordances can aid users make informed decisions about their system usage and behaviour (Seidel et al., 2018).

Similarly, affordance conceptualises the relation or interaction between the user and environments, listing the potentials and usability (Zhao et al., 2013; Pan et al., 2020); thus, the design science paradigm, which incorporates design and user engagement through its various phases, can provide an ideal method for investigating affordance. Humans rely on cues to perceive the affordance of digital elements, such as clickable, or draggable items, to convey the functionality offered by various aspects through their interface and behaviour, enabling interaction. Affordance-based design is helpful even in creating engaging and compelling user experiences (Johnson Glenberg, 2018; John et al., 2022).

3   Method

The research uses a systematic literature review (SLR) to examine affordance studies that use the DSR. SLR helps to identify, synthesise, and analyse existing information, reveals research gaps, and guides future research on a topic (Shafiee et al. 2019). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram, guidelines for systematic reviews and analyses, is used for this review for reliable information synthesis (Moher et al. 2009). The PRISMA Flow diagram from our study is shown below.
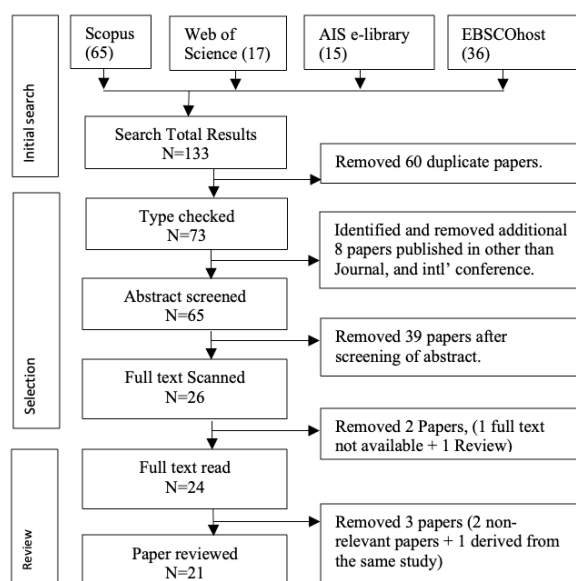

Figure 1: PRISMA Diagram

3.1 Data collection

The review was initiated by searching some popular databases, i.e., Scopus, EBSCOHost, Web of Science, and AIS e-library, to find the relevant articles. While searching, Boolean operators and search filters are used to list and limit accurate results, focusing on affordance and design science. The search was conducted in March 2024. For the search, the term 'affordance' in either the abstract OR keywords or the title OR with "AND" was used to join another query term, 'design science', in the title or abstract or keywords. After the search results were displayed, additional filters were applied to filter journal and conference papers. It produced 133 results, as shown in Figure 1 above. The Zotero application was used to collect all results, which allowed standardising the results from different databases into the same data fields or columns. Then, the results were exported to MS Excel in Comma Separated Value (CSV) format for processing.

3.2 Selection of Relevant Articles

The articles were included in the review based on explicit criteria to ensure quality papers were selected for the review. For Instance, articles published in the English language and peer-reviewed journals, international conferences were included, whereas book chapters, non-peer-reviewed articles and other review papers were excluded from the review. The studies that use design science as a methodology or paradigm to create some forms of artifacts were only included in the review.

The Zotero's browser plugin was used to download details of the articles and then exported to Microsoft Excel for further processing. However, for articles stored in AIS e-library each paper link was manually re-visited to extract abstracts of the papers. In the initial round of screening in Excel, 60 duplicate records were removed as some articles appeared across databases. The second round of additional screening was conducted, and eight papers were removed, as shown in the diagram. In the subsequent round, both authors screened all 65 articles abstracts independently, in Excel in which Author 1 selected 25 and Author 2 selected 27 papers with inter-rater reliability of around 92%. The two unmatched articles were then examined collaboratively, and an agreement was reached to include one and exclude one paper.

Many articles (N=39) were removed as they were unrelated to the affordance or Design Science but still included those in their abstracts. The 26 papers were finalised for the full paper review; however, one full paper was not available, and one article was removed as it was a review article. So, 24 articles were selected for the in-depth full paper review. After reading the articles, two articles which did not match with the objectives of this review were removed, as they focused on theorizing or reviewing rather than using the DSR paradigm in their study. Similarly, another paper by the same author who has derived the same study was also removed, providing a list of 21 final papers for the review. They were checked for missing information manually in the Excel sheet and processed for descriptive and thematic analyses.

3.3 Thematic analysis method

The research identifies the current themes of the problem investigated, contributions claimed, and definition orientation through thematic analysis using Braun & Clarke's (2012) six-phase framework as an inductive guiding theory. A codebook was developed for the problem investigated, and the contributions and definitions were included in the Excel sheet, importing relevant chunks of the text from each article. Then, those texts were imported to NVivo 12 for thematic analysis, forming three principal nodes, i.e., problem investigated, contribution claimed, and the way affordance used. Each node was analysed separately, and the steps below summarise the process for thematic analysis.

The first phase included re-reading text in NVivo to familiarise them with the data. The proposed initial descriptive and interpretive codes were generated through the 'open coding' principle. In the second phase, and a relevant chunk of the text was classified by creating code group. In the third phase, through an inductive process, code groups were reviewed for possible patterns and relations and merged, divided, or categorised under another code group. Following this process, themes were merged out if needed. Then, the codes in the group were examined to create a thematic map and ensure they followed a thematic pattern. Finally, each group/code was named/and renamed, providing summative indicators presenting codes based on the pattern. The processes were conducted independently for each principal node: 'problem investigated ', 'contribution claimed' and 'definition orientation' and are presented in 'Section 4.2'.

4   Results

The descriptive analysis was based on categorisation, and the thematic analysis was based on Braun & Clarke's (2012) six-phase framework (explained above in section 3.3) for qualitative analysis, which was carried out on the selected articles.

4.1   Descriptive Analysis

The timeline of the publication helps to identify the crucial points in the area. The trend suggests persistent interest in the area, as evidenced by the surge in publications in recent years, 4 each in 2018 and 2023.

Figure 1: Publication over the Years

Table 1 below shows that many studies relied on naturalistic evaluation with practical use cases, interviews and focus groups, whereas some focused on artificial evaluation (prototyping). Focus groups and interviews are mostly used for evaluation focusing on user-centred design. Some studies used semi-structured interviews and focus groups to get feedback and refine the artefact, whereas others implemented mixed methods. Many studies have multiple cycles for evaluation to ensure continuous improvement based on feedback, robust validation, and enhanced reliability (Seidel et al., 2018; Pan et al., 2020).

Evaluation Method	Example Studies	Requirement Collection Tools
Focus groups and interviews	Bergman & Humble, 2022; Burton et al., 2021; Seidel et al., 2018; Chaves et al., 2018; Giesbrecht et al., 2015;	Interviews, Stakeholder workshops
Surveys and questionnaires	Mikkelsen et al., 2023; Giesbrecht et al., 2015; Rönneberg & Kettunen, 2023	Web-based surveys, Literature review
Experiments	Gao et al., 2023; Lui & Yoon, 2024; Zahedi et al., 2022;	Stakeholder interviews, Literature Review
Prototyping and iterative design	Schmitt, 2020; Schmit, 2021	Conceptual development, Iterative refinement
Data analysis and other methods	Zhao et al., 2013; Lienhard et al., 2017; Nouwens, 2021	Literature review, content and other analysis

Table 1. Analysis of method for evaluation and requirement collection

Many studies relied on qualitative methods for requirements collection and evaluation (Pan et al. 2020; Mikkelsen et al. 2023). For instance, some studies used interviews for requirement collection and also used interviews and focus groups for evaluation (Chaves et al., 2018; Bergman & Humble, 2022). Humble et al. (2023) used email interviews for requirement collection. Gao et al. (2023) used experiments for evaluation while they used interviews for requirement collections.

The analysis of the DSR theory or framework used in the article reveals frameworks such as Hevner et al. 2004 and Peffers et al. 2007 (Seidel et al., 2018; Giesbrecht et al. 2015; Lui & Yoon, 2024) are mostly used. Some studies have also used Action Design Research (Pan et al. 2020; Mikkelsen et al. 2023). The other DSR framework, such as Johannesson and Perjons (2014), is also used in some studies (Bergman & Humble, 2022; Humble et al., 2023).

In conjunction with DSR, several theories in addition to the affordance theory were also found to be used. The studies prominently incorporate theories on Knowledge management (Chaves et al., 2018), sensemaking (Seidel et al., 2018; Nouwens 2021), Human-Computer Interaction (HCI) and Emotional design (Humble et al., 2023; Bergman & Humble, 2022). Crowdsourcing and gamification theories are also utilised to design affordances that encourage collaboration and user engagement (Rönneberg & Kettunen, 2023). This diversity indicates the interdisciplinary nature of affordance studies in DSR and the multifaceted role of affordance in design. The compiled summary (Table 1 above) regarding evaluation and requirements methods provides valuable inputs for researchers while considering selection of methods or requirement collection instrument in DSR investigating affordance.

Category	Affordances	Sample Research
Technological and functional context	Technological, Action possibilities, Functional affordances	Seidel et al., 2018; Zahedi et al., 2022
Educational context	Learning, Instructional affordances	Humble et al., 2023; John et al., 2022
Organizational and business context	Knowledge and support affordances, Organizational affordances, Employee support affordance	Giesbrecht et al., 2015; Chaves et al., 2018; Schmitt, 2020
Social context	Social affordances, Collaborative affordances	Zhao et al., 2013; Goa et al., 2023; Rönneberg & Kettunen, 2023
Environmental context	Environmental affordances, Resource-saving affordances	Seidel et al., 2018; Burton et al., 2021; Pan et al., 2020
General design context	User interaction, User-satisfaction affordance	Chaves et al., 2018; Zhao et al., 2013

Table 2. Categories of context for affordances identified/discussed.

Table 2 above shows the identification of the categories of different context in which the affordances were investigated or identified. Technological context has been widely investigated. Several studies investigate organisational context, and communicative affordances are primarily explored in the social media context. The studies investigating eco-friendly affordance explores the interaction between artefacts and the environment (Seidel et al., 2018; Pan et al., 2020). The general design context includes usability and user satisfaction-related affordances (Zhao et al., 2013; Zahedi et al., 2022).

As mentioned in the introduction, there are variations in the interpretation of affordance. The interpretation in most studies adheres to core principles of affordance as "possibilities"; however, there are some differences in terms of conceptualisation of affordance in their research. For instance, Rönneberg & Kettunen (2023) conceptualise affordance in terms of features such as points and leader boards, whereas Seidel et al. (2018) conceptualise affordance as "*dispositional*" and "*relational*", which could be "*deliberately*" and "*purposefully*" designed (Seidel et al. 2018, p 225). We categorised the articles based on the orientation or interpretation of affordance use, and four categories were formed.

Orientation	Example Definition	Sample Research
Action possibilities and potentials	Affordance as the potential for behaviours tied to the environment	Lienhard et al., 2017; Bergman & Humble, 2022; Gao et al., 2023; Humble et al., 2023
Perception and Actualization	Affordance as what an object offers the user, based on the user's capabilities and the object's properties."	Zhao et al., 2013; Giesbrecht et al., 2015; Mata et al., 2018; Zahedi et al., 2022
Relational aspects and interaction with the environment	Affordances as dispositional and relational properties that define an object's use.	Chaves et al., 2018; Seidel et al. 2018; Pan et al., 2020;
As a function or features	Affordance as a features or functionality	Nouwens, 2021; Schmitt, 2020; Rönneberg & Kettunen 2023

Table 3. Affordance' definition orientation.

As shown in Table 3 above, most of the studies have interpreted affordance based on Gibson's initial conceptualisation of affordance, whereas other studies have interpreted and used the concept of affordance from a "perception" and "actualisation" process. Some studies have interpreted or emphasised affordance from relational and dispositional perspectives, while some studies have interpreted affordance more from a features or functionalities perspectives.

4.2   Results of thematic analysis

Table 4 below shows the categorisation of problems investigated, which provide an overview of what kind of challenges are being investigated in this area. Most studies aim to analyse user interaction and behaviour challenges. Some examine affordance related to adoption or barriers in the education or learning process. Many studies investigate organisational and collaboration problems. Sustainability-related challenges have also been investigated in some studies.

Theme	Example Studies	Example Codes
User interaction & engagement challenges	Zhao et al., 2013; Goa et al., 2023	Challenges in user interactions, Usability issues, User interface design
Adoption and implementation barriers	Pan et al., 2020; Schmitt, 2020; Schmitt, 2021; Zahedi et al., 2022;	Barriers to adoption system for sustainability, identify shortcomings
Educational and learning gaps	John et al., 2022; Humble et al., 2023	Gaps in educational goals, Interactive learning environments
Organizational efficiency and Knowledge management	Chaves et al., 2018; Nouwens, 2021	Inefficiencies in organizational practices, Knowledge sharing and management
Sustainability and eco-friendly practices	Seidel et al., 2018; Pan et al. 2020; Burton et al., 2021; Schmitt, 2021;	Sustainable packaging practices, Environmental sustainability challenges, inefficiencies in planning
Collaboration and communication improvement	John et al., 2019; Rönneberg & Kettunen, 2023	Collaboration challenges, Digital communication, Team dynamics

Table 4. Themes for the problem investigated.

The analysis of the contributions claimed by the papers (Table 5 below) shows that most studies contribute to enhancing systems and design, implementing user-centred design, and integrating technology, which is critical to affordance. The studies using affordance in DSR claim to contribute to diverse domains, from sustainability to knowledge management. In line with the DSR principles, many studies contribute by producing artefacts such as frameworks and models.

Theme	Description	Example Studies
Creation of user-centric and improved design	Contribute by enhancing user experiences and skills through effective design	Bergman & Humble, 2022; John et al., 2021
Contribution to sustainability	Contribute by creating artefacts promoting sustainability	Burton et al.,2021, Pan et al., 2018; Seidel et al., 2018;
Efficient technology integration and management	Contribute by integrating technology to enhance management	Mikkel et al.,2017; Pan et al.,2018; Gao et al., 2023,
Creation of frameworks and models	Contribute by developing and evaluating of frameworks and models for various domains	Burton et al., 2021; Gao et al., 2023
Knowledge management and innovation	Contribute by advancing knowledge management and innovations	Giesbrecht et al., 2015; Schmitt, 2020; Mikkelsen et al., 2023;

Table 5. Themes for Contribution Claimed.

The themes presented in table 6 (below) presents a summative view of limitations and challenges faced on studies investigating affordance using DSR. The constraints related to size or scope of sample, and the context of research have been reported as limitations by most studies, which impacts the generalisation of the study. The lack of longitudinal studies and instantiations for validation are also reported by many studies which indicate the need for more instantiations in the future, as the actualisation of affordance could be better measured over time by implementing it through some real-world applications.

Theme	Example Studies	Sample Codes
Limited sample and generalisation constraints	Giesbrecht et al., 2015; Seidel et al., 2018; Bergman & Humble, 2022; John et al. 2022; Zahedi et al. 2022; Humble et al., 2023;	Limited type of participants, Limited scope, small sample size; problem with generalizability of results
Context related constraints	Giesbrecht et al., 2015; Lienhard et al., 2017; Burton et al., 2021; Zahedi et al., 2022; Rönneberg & Kettunen, 2023	Constraints related to domain; constraints related industry, Problem related to context.
Lack of Instantiation	Schmit, 2020; Schmit, 2021; Bergman & Humble, 2022	No instantiation, prototype creation in progress
Methodological and data quality constraints	Lui & Yoon, 2024; Mata et al., 2018; Mikkelsen et al., 2023; Pan et al. 2020	Limited availability of data, quality of data available; technical knowledge of participants, non-diverse participants
Validation constraints	Zhao et al., 2013; Chaves et al. 2018; Gao et al., 2023; Rönneberg & Kettunen, 2023	Further validation required, Preliminary results, lack of longitudinal study; single method validation; short duration evaluation.

Table 6. Themes for Limitations reported.

These descriptive and thematic analyses provide valuable insights to researchers and practitioners to understand the overall status of affordance studies in DSR.

5 Discussion

The concept of affordance is intertwined with design by the notion of how *material properties* enable uses (Seidel et al., 2018) and create purposeful design in terms of utility (Schmitt, 2020). Affordance can enable designs that are functional, intuitive, and satisfying to use. The review shows that the current discourse on using affordance in design science research is progressing; however, there are gaps, requirements, and opportunities for future study.

The analysis of the publication reveals growing recognition and interest, particularly in recent years. The selected articles investigated some prominent discussions related to affordance, such as perceived affordance, whether affordance is an implicit phenomenon or if it can be deliberately designed, the stages of affordance and the interplay between perception and actualization. The review of methods used shows the array of methodologies and theories adopted; however, the findings are fragmented due to insufficient justifications in their studies. Most of the articles have not extensively discussed the justification behind using design science and why design science is suitable for the study. Though many studies have also used theories other than affordance theory, two studies justified the suitability of affordance theory in their DSR (Seidel et al. 2018; Zahedi et al. 2022). Similarly, many studies also lack justification for selecting a requirement collection or evaluation method. Some studies have proposed the evaluation cycle as a part of future studies (Humble et al., 2023) and emphasised the need for more validation (Schmitt, 2021). Moreover, most studies do not analyse or evaluate how affordance is actualised over time. Some studies have highlighted the limitations and practical constraints while investigating and evaluating affordance (Gao et al., 2023; Rönneberg & Kettunen, 2023).

Only few papers in the review claimed to contribute to DSR's integration of affordance with design science. Moreover, the artefacts created are predominantly models, with only a few studies instantiating them. Instantiation and practical testing help ensure that theoretical artefacts are grounded in real-world evidence (Chaves et al., 2018; Burton et al., 2021). Most instantiations are web-based applications or prototypes (Mata et al. 2018; Seidel et al. 2018; Pan et al. 2020; Zahedi et al. 2022). Some studies

produced actionable prescriptive knowledge such as design principles for sustainability using sensemaking (Seidel et al. 2013), environment sustainability and wildlife (Pan et al. 2020), mixed reality technologies (John et al. 2022), counselling affordance (Giesbrecht, 2015), and live streaming (Gao et al. 2023).

The review of evaluations used reveals that many studies are limited to lab or artificial environment evaluation, and lacks user participation, or are based on theoretical discussions, indicating the need for greater rigour and validation for the reliability and generalizability of the findings. Though some studies use questionnaires and experiments, the evaluations use qualitative methods predominantly, and there is a lack of standardization and validation for the methodology selection. Consequently, due to the predominant use of qualitative methods and artificial evaluation, most studies have indicated small sample sizes or limited cases as the limitation of their study (Pan et al., 2020; Mikkelsen et al., 2023).

Most researchers have investigated the potential of affordance-based designs in a technological or organisational context to optimise business processes. Studies have investigated affordance in education (John et al. 2022, Humble et al. 2023), knowledge management (Schmitt 2020; Schmitt 2021), mapping (Rönneberg & Kettunen, 2023), social media (Zhao et al. 2013; Chaves et al. 2018) and health (Lienhard et al., 2017; Zahedi et al. 2022); however, some other sectors such as tourism, banking where user satisfaction and interaction among users, environment, and intuitive design play a crucial role have not been explored. Though some studies have discussed the affordance using DSR leveraging innovative concepts such as Augmented Reality (AR) (John et al.,2022), the possibility of using newer advancements such as Artificial Intelligence (AI), blockchain, and Internet of Things (IoT) has not been fully explored. The review shows studies are centralised in the developed economies, highlighting the need for diversification, such as more studies in developing economies where user interaction with a system and the ability to perceive and actualise affordance may differ. Such diversification will enrich the discourse in the area and external validity of the studies and produce findings that cater for a more diverse range of users. As the concept of affordance revolves around how a user is linked to their environment; some studies have explored sustainability or green IS issues such as encouraging eco-friendly practices, like energy consumption displays and recycling prompts with sensemaking (Seidel et al., 2018), environmental sustainability in the context of wildlife (Pan et al., 2020), sustainable packaging decisions (Burton et al., 2021) and "*desirable sustainability vision*" (Schmitt, 2021).

The studies produce diverse findings and re-iterate the need to improve design through user engagement and feedback (Mata et al. 2018) and the role of affordance (Humble et al. 2023). Some studies claim to contribute by designing, developing, and validating the artefacts, integrating or enabling achievement of study goals, interpreting associated affordance, and providing novel perspectives or insights (Schmitt, 2020; Zahedi et al., 2022). Seidel et al. (2013) argued that while affordance can drive users to certain behaviours and highlight potential, it is challenging to design a universally perceived and actualised design. Some studies investigated how to integrate affordance in the DSR paradigm to create guidelines for DSR to design intuitive artefacts, naturally affording their perceived uses.

Most studies have based the identification of affordance and relevance cycle on the findings from the literature review, interaction with the system, observation of related practice and process and environment. The studies have identified and discussed various affordances in their research context such as counselling affordance (Giesbrecht et al. 2015), social affordance (Goa et al. 2023), innovativeness (John et al. 2022), mixed reality affordances (John et al., 2022), personalised knowledge management affordance (Schmitt, 2020), disruptive ambiguity and surprise, noticing and bracketing, open and inclusive communication (Seidel et al. 2018), trust, convenience, telepresence (Zahedi et. 2022), perceived physical, cognitive, affective and control affordance (Zhao et al. 2013) and reflective disclosure, democratization, and live decision affordance (Burton et al., 2021). In the absence of longitudinal studies, most of the studies have examined the actualization of affordance through evaluation cycles using features in prototypes. Their results are presented based on validations such as successful perception of affordance, improvement in processes based on affordance, positive users' feedback or increase in user's satisfaction, or by examining proof of use or how design features linked to affordance lead to intended behaviour (Pan et al. 2020; Rönneberg & Kettunen, 2023; Seidel et al., 2018; Zahedi et al., 2022).

These analyses and the discussion provide the answers to the first research question (RQ1).

6   Formulating the Future Agenda

This comprehensive review synthesises the existing studies investigating or using affordance through DSR with the aim of answering the research question (RQ2). It has identified various areas of research

or several agendas for future studies. These agendas are based on identified gaps and limitations will aid expanding the exploration for researchers and practitioners.

Despite the lack of a consensual or universal understanding of affordance, there is significant variation in its use or interpretation, and future research could work to bring possible standardisation, making efforts to reconcile the confusion. Similarly, the review reveals great discrepancies in methods used to solve similar problems, identification of affordance, and how design science has been integrated, which hinders understanding the nuances of user interactions in design studies. Similarly, qualitative methods dominate the problem-framing or identification and evaluation processes. So, to add rigour to the results and contribute to methodological advancements embracing the dynamic nature of affordance, future studies should aim to bring some standardisation to adopt a balanced approach by providing guidelines and efficient evaluation processes and helping researchers select or adapt frameworks for DSR involving affordance.

The review reveals a limited geographical coverage and domain. So, future studies should investigate affordance in industries such as tourism, banking, where user engagement and satisfaction are critical. More interdisciplinary and cross-domain research is needed to investigate affordance from a holistic perspective. Similarly, to solve the problem of using single cases and investigating problems based on unilateral angles using limited methods, future research should explore wider triangulation to enrich the results. The objective of DSR is to create artefacts to solve real-world problems. So, to increase the impact on users, usability, and reliability, the studies should carry out comprehensive problem formulation and evaluation involving real-world people and naturalistic scenarios beyond lab settings. This also invites researchers to test their propositions and theories in varied sectors and geographic regions. The actualisation of affordance and the results related to its outcome may not be apparent immediately, and it is not a short-term phenomenon. So, longitudinal studies with adequate sample sizes are necessary to yield higher results and examine how these affordances change, impact, or are utilised over time.

Similarly, instantiation is integral to DSR. However, many studies are limited to theoretical analysis without empirical validation and instantiation, which impacts the outcome. So, studies should aim to instantiate their model, framework, or other artefacts to solve the real-world problems identified through the relevance cycle for broader applicability of contributions. Few studies have created design principles or guidelines as artefacts, so future research can emphasise producing DP to provide prescriptive knowledge for practitioners and stakeholders. Considering the dynamic nature of affordance, emerging technologies such as AR, IoT, and blockchain can not only identify and evaluate novel affordances but also provide innovative perspectives that contribute to the body of knowledge and potentially uncover unique affordance dynamics. So, future research should involve these innovative technologies in the investigation to yield their benefits.

The review based on the findings, comprehensive analysis and correlation with limitations indicates the necessity for a holistic approach for advancing affordance studies conducting rigorous DSR studies with more robust, mixed-method approaches, broader validation of methodologies to enhance the reliability of findings across diverse contexts that could significantly elevate the reliability and applicability of findings. The identified gaps call for methodological enhancement, unveiling critical gaps in research rigour. There is a need to move beyond descriptive studies and develop predictive models that can guide practical design implementations that emphasise the translational aspect of research yet focus on real-world problems and bridge the gap between theory and practice. More studies are needed to examine the nature of affordances, providing deeper insights that can inform future innovations and policymaking using the DSR paradigm.

7 Contribution and implications of the review

This review provides several novel academic and practical contributions by synthesising and identifying gaps and themes, highlighting best practices and agenda for future investigation through a comprehensive analysis. Considering the dearth of such review in this discourse, the study is highly relevant. Examining the definitions and interpretations of affordance in DSR provides a thorough understanding of how affordance is used with DSR, consolidating the knowledge for a cohesive theoretical foundation. It shows how affordance is being conceptualised and investigated in different domains and provides consolidation and critiques aiding methodical improvement for the DSR framework and affordance theory. The series of analyses provide a deeper understanding of the patterns, valuable inputs, highlighting the problems and potentials to consolidate research aims, methods and design more rigorous and comprehensive studies. The issues identified remind researchers to address such concerns by focusing on concrete methods and rigorous evaluations. Future researchers

investigating this area can build on the foundations of this review. It reveals affordance across various domains and unveils the areas where affordance research can significantly impact and where future studies are needed.

It provides several practical contributions by unveiling various actionable insights to enhance user experience and satisfaction through affordance-based designs. It will encourage designers to create intuitive designs utilising affordance. It helps to understand the use of affordance across various industries. The findings present various affordances that businesses can leverage to optimise their communication process and stakeholder relations. It shows affordance and DSR can benefit from insights across various fields such as psychology, education, business, and technology.

This review of the fusion of affordance and design science study helps to bridge between theory and practice, providing a holistic view. The review offers a distinct way and encourages researchers to investigate and translate theory into practice. The problem identified by the review of limitations in the selected studies serves as a call for action for researchers and motivates to conduct studies integrating affordance. It unveils several gaps and the need for more rigour and validation, providing a detailed agenda for future research enabling more comprehensive and impactful research outcomes for research investigating affordance using DSR.

Though a comprehensive review is conducted, there are some limitations. It used only four popular academic databases; and the terms "design science" and "affordance" were used for the search in title, abstract and keywords. The other terms closely related to those terms may yield more results. Due to technical differences among databases, researchers have tried their best to mimic searches as filtering differs across various databases. Google Scholar was excluded as it did not allow users to search based on abstracts, and advanced search based on title did not yield many results.

8   Conclusion

The review provides a nuanced understanding of the current state of affordance research in DSR. The review is highly relevant as it helps to identify various patterns and themes considering the multifaceted nature of affordance and design science research. The review shows the field is still evolving; however, many researchers contribute to this field of interest and knowledge and enhance the practical application of affordance. The review is original in the research area and its approach by adopting a comprehensive thematic analysis, identifying gaps and state-of-the-art, and unveiling areas requiring further exploration.

A clear understanding of how affordance can be used with DSR seems lacking. The insights revealed would be unique and valuable for researchers and practitioners, ensuring that affordance-based designs are theoretically sound and practically beneficial. Researchers can aim to address identified gaps, leverage information yielded by the review, and theoretically and practically use affordance to follow more rigour and valuable outcomes and contribute to a more robust and reliable body of knowledge, bridging the gap between theory and practice in the knowledge discourse.

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