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# Two decades of design research on lessons-learned systems: a systematic review and future research agenda

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## Abstract

Lessons learned systems (LLS) are knowledge management systems (KMS) that collect, verify, store, disseminate, and enable the reuse of experiential knowledge created during the execution of organizational activities. Despite this promise, many scholars have noted that many LLS fail to properly manage their intellectual capital. While behavioral and organizational factors contribute to the success or failure of any IT system, their design is also a critical consideration. Here, a systematic literature review is helpful for understanding the current state of knowledge on LLS design research though to the best of our knowledge, none exists as past reviews have focused on behavioral or organizational factors around the use of KMS. Towards this knowledge gap and to guide future research, we performed a systematic literature review of LLS design research across two decades, finding that most designs employ web technologies, are largely designed for use by managerially- and technically oriented users in the construction context, and only support explicit and declarative knowledge. Based on these findings, we recommend that future research be directed at improving the projectability of design knowledge, supporting the transfer of LL across communities, and improving support for tacit and procedural knowledge.

**Keywords**: Lessons Learned, Knowledge Management Systems, Design Science

## Introduction

The practice of organizational knowledge management (KM) continues to be of critical importance for organizations of all sizes and sectors in the face of continued technological, economic, and societal disruptions that have complicated the operating landscape. In support of processes and mechanisms that enable the socialization, externalization, creation, and internalization of knowledge (Nonaka & Konno, 1998), the development of technology-based KM systems (KMS) continues to be of significant interest to both academics and practitioners alike (Becerra-Fernandez & Sabherwal, 2014; Manesh et al., 2021; Núñez et al., 2018). Numerous classes of KMS have been developed to support diverse types of knowledge, KM mechanisms, and processes, such as collaborative workspaces (Cavillier & Wieser, 2018; Li et al., 2007), web forums (Curado & Ramos, 2010; Sun et al., 2020), case-based reasoning systems (Wang & Takahashi, 2012), and enterprise social networks (Ali et al., 2024; Ladeg & Chalal, 2022).

This systematic literature review focuses on lessons learned systems (LLS), a class of KMS designed to capture experiential knowledge on the context, actions, and outcomes gained from carrying out various organizational processes and procedures that may help ensure success or prevent failure, or increase efficiency (Arditi et al., 2010; Secchi et al., 1999; Weber et al., 2001). These lessons learned (LL) can be leveraged by the organization to guide future activities, achieve or avoid certain outcomes, and support improvements to organizational performance organizational performance by ensuring that valuable, contextually specific experiential knowledge is available when and where it is needed (Eken et al., 2020; Weber et al., 2001).

The design of any IT system, including KMS, is a critical factor influencing their utility and acceptance. Unfortunately, many scholars have noted that poorly designed KMS have hindered KM efforts (Alves et al., 2022; Chión et al., 2019; Kim & Lee, 2006; Santos et al., 2012). LLS are not immune as most LLS have limited success in managing experiential knowledge due to factors related to their design (Badr & Ahmad, 2013; Liebowitz, 2009; Weber et al., 2001). Given the importance and value of experientially derived knowledge on organization processes, the design of LLS is of significant interest to practitioners and academics alike. Here, understanding the contemporary state of design research on LLS is helpful to guide the development of better-suited KMS and LLS, though to the best of our knowledge, none exists. Extant reviews have emphasized non-design aspects, such as KM practice in startups and small/medium size enterprises (Centobelli et al., 2017; Cerchione et al., 2016), or supply chains (Cerchione & Esposito, 2016). To complement these extant reviews on organizational and behavioral factors, we perform a systematic literature review of two decades of design research on LLS. To the best of our knowledge, our research is an initial foray towards this research gap and contributes novel knowledge on the state of LLS design research. Our study objectives are threefold: to summarize extant research on LLS; to identify limitations of current designs; and to propose a research agenda to guide the future of LLS design research. Toward these objectives, we investigate three research questions:

**RQ1.** *What technological artifacts have been proposed to manage lessons learned?*
**RQ2.** *What context are these artifacts designed and evaluated within?*
**RQ3.** *What types of knowledge are supported by these technological artifacts?*

The rest of this paper is organized as follows. First, we provide a brief theoretical background on key concepts related to knowledge, KM, and LLS. Following this, we present our research methodology and protocol. We then present our findings and propose a research agenda to guide the future of LLS design research, concluding with a discussion of limitations and future directions.

## Background

Knowledge is commonly conceptualized as being valid relationships between concepts, often about procedures, facts, or ideas that can help guide future action (Alavi & Leidner, 2001; Becerra-Fernandez & Sabherwal, 2014; Davenport & Prusak, 1998). One common classification of knowledge considers whether it is tacit or explicit in nature. Tacit knowledge often takes the form of the insights, beliefs, and hunches held by individuals. As such, it is often more difficult to articulate and explicate (Davenport & Prusak, 1998; Polanyi, 1966). In contrast, explicit knowledge often takes the form of facts, statements, and rules that can be readily transferred and manipulated (Nonaka & Konno, 1998).

Another dimension considers whether the knowledge is procedural or declarative, where procedural knowledge refers to the “steps, procedures, sequences, and actions” required to complete a task while declarative knowledge refers to the facts, events figures, rules, relations, and concepts related to a given task (Cooke et al., 2000; ten Berge & van Hezewijk, 1999). The specificity of knowledge also varies. While general knowledge is broadly held, contextually and technically specific knowledge is relevant only to certain locations, situations, or specialized areas of practice (Becerra-Fernandez & Sabherwal, 2014). Organizations will select a KM strategy based on their intellectual capital and their KM needs (Hurnonen et al., 2015). For activities that rely more on tacit know-how knowledge, collaboration, training, and apprenticeships are commonly employed mechanisms to ensure that members of the organization have the requisite knowledge to execute tasks (Harlow, 2008; Yasuoka & Hirata, 2020), while the development of procedures, routines, and direction of work may be suitable for tasks relying more on explicit knowledge.

### Knowledge Management Systems

Throughout the years, various information technology (IT) based knowledge management systems (KMS) have been developed to facilitate KM processes across temporal and geographic boundaries (Becerra-Fernandez & Sabherwal, 2014; Chua, 2004). KMS supports key knowledge processes of socializing, externalizing, creating, and internalizing knowledge, often by creating *ba*, or spaces that allow for the creation, utilization, transference, and reuse of knowledge that can improve organizational performance (Nonaka & Konno, 1998; Ruggles, 1998). Often, organizations utilize a variety of KMS to fulfill their organization's knowledge needs as each KMS may be intended to support different knowledge mechanisms such as capturing, discovering, or applying knowledge (Becerra-Fernandez & Sabherwal, 2014; Keller & Clancy, 2002). A comparison of web forums and enterprise social networks (ESN) illustrates this point. Web forums provide a space in which experts of heterogeneous backgrounds can exchange knowledge, thereby allowing them to address complex, poorly structured problems in a conversational manner (Curado & Ramos, 2010; Sun et al., 2020). In contrast, ESN provides low-friction, cross-team communication that enables collaboration and knowledge sharing across the organization, allowing staff members to seek experts and social guidance (Ali et al., 2024; Bolisani et al., 2015; Ladeg & Chalal, 2022). Though both allow for communication across the organization, their intended purpose and thus, design differ. That is, the design of any KMS is guided by the knowledge and KM processes it is intended to support.

### Experiential Knowledge, Lessons Learned, and KMS

Secchi et al. (1999) defines lessons learned (LL) as *true and valid experiential knowledge on the positive or negative outcome of some activity that can inform design, future processes, and decision-making to induce or prevent some outcome*. LL are distinct from other forms of experiential knowledge as they don't describe a complete process, track both success and failure, and are oriented towards organizations rather than industries (Weber et al., 2004). To improve efficiency and organizational outcomes (Andrade et al., 2013; Carrillo et al., 2013), many organizations have implemented lessons learned systems (LLS) to facilitate the collection, verification, storage, dissemination, and reuse of knowledge (Badr & Ahmad, 2013; Chua, 2004; Fong & Yip, 2006; Keller & Clancy, 2002; Weber et al., 2004). While organizational factors (e.g., culture, resources, absorptive capacity) influence the success or failure of any KMS implementation effort (Cavillier & Wieser, 2018; Ladeg & Chalal, 2022; Rhodes & Dawson, 2013; Salmela & Happonen, 2007), the lack of appropriately designed IT systems can impede KM efforts. Scholars have noted that LLS often fail to accomplish their intended purpose of managing experiential knowledge due to design-related factors (Badr & Ahmad, 2013; Ferrada et al., 2016; Liebowitz, 2009; Núñez et al., 2018), suggesting that additional design research is warranted. To do so, it is necessary to first understand the available research; however, to the best of our knowledge, there is no extant systematic review of extant design research of LLS. As such, our research seeks to address this knowledge gap.

## Methodology

We adopted the systemic literature review (SLR) method proposed by Kitchenham and Charters (2007). As our objective is to identify, summarize, and synthesize extant research on a topic, the selection of the SLR methodology is appropriate (Fink, 2019). We queried two databases: Clarivate's Web of Science (WOS), and IEEE Explore. We selected WOS given its broad indexing of other disciplines such as information science, business, etc., that may contain relevant articles. IEEE Explore was included given its focus on technical and engineering research. The search string ("*lesson* learned system* OR LLS AND knowledge management OR KM AND design OR architecture*") was developed from our research questions and executed in both databases at the end of September 2023 and repeated in the first week of February 2024 to collect articles captured between the initial query and the end of the study period.

### Inclusion and Exclusion Criteria

We developed inclusion and exclusion criteria (Table 1) to serve as a practical screen as the majority of articles found by the query are irrelevant to the study (Kitchenham & Charters, 2007; Okoli & Schabram, 2010). Given the goals and objectives of our research, we only considered primary research where the central focus was the design of technological artifacts or systems intended to support LL (i.e., LLS). As such, secondary research (e.g., systematic reviews) and research that focused on technological artifacts intended to support LL (e.g., rules-based systems) were excluded, along with studies that focused on non-design aspects (e.g., behavior, culture) or those that lacked a technological component.

Early on in our review process, we discovered that reports on lessons learned from projects (e.g., spaceflight, system deployment) were common but were not germane to our study and were excluded as well. Similarly, as knowledge management is a diverse, "diffuse and scattered" discipline (Scholl et al., 2004), we only considered research articles where the focus was on organizational knowledge management as opposed to personal knowledge management or education. We also excluded any articles published in languages other than English, published outside of the study period of 2003 to 2023, or were unavailable in full text.

**Table 1: Inclusion and Exclusion Criteria**

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| • Is primary research published in a peer-reviewed journal or conference<br>• The central focus of the research is on the design and evaluation of the artifact<br>• The artifact is technology related<br>• The artifact is intended to manage lessons learned<br>• The research is related to organizational knowledge management | • Is not written in English<br>• Is published outside of the 2003 to 2023 period<br>• Unavailable in full text<br>• Not related to KM<br>• Not a research article (e.g., grey literature, opinion piece, editorial) |

### Study Selection

Our study selection process is presented in the PRISMA format (Liberati et al., 2009) in Figure 1. The query returned a total of 736 articles across both databases. After identifying duplicates with automated procedures, we reviewed the titles and as necessary, the abstracts of each article and applied the inclusion and exclusion criteria, thereby excluding 670 articles. We then performed a full-text review of the remaining 24 articles which led to the removal of 13 articles for being duplicates or for their lack of relevance to the present study. Ultimately, 11 articles remained and were thus scored for quality.

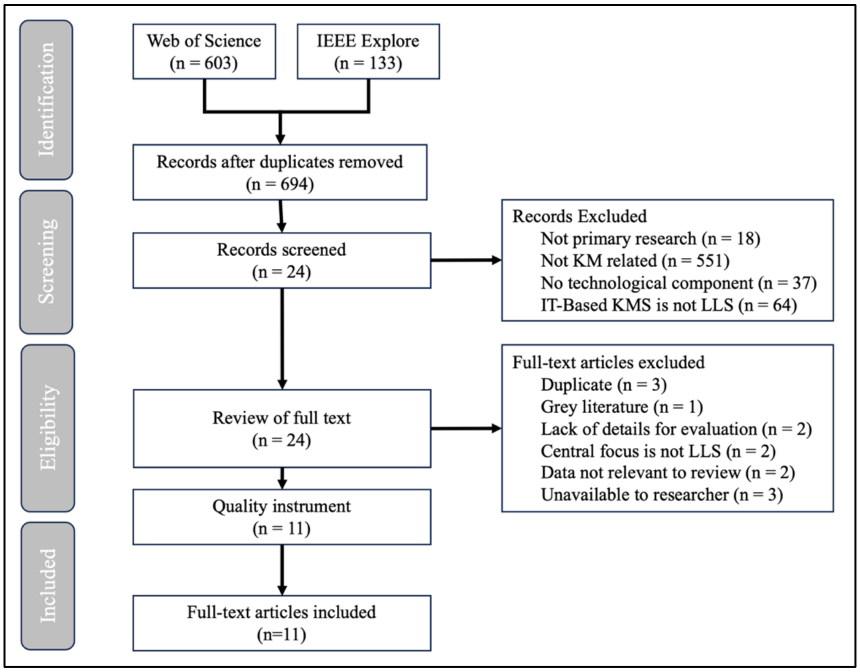


**Figure 1: PRISMA Statement Figure**

### Quality Instrument

We adapted the software engineering quality instrument (QI) proposed by Dybå and Dingsøyr (2008) by incorporating guidelines for design science research (DSR) proposed by Hevner et al. (2004). These selections were informed by the study of Venable (2010) which identified the most important guidelines for what the IS community considered to be good DSR. Table 2 details the items comprising our QI. Each item received a score of 1 (yes), 0.5 (partially), or 0 (no), and each article had to score at least 6 points to be included in our review.

**Table 2: Quality Instrument**

| # | Quality Item |
|---|---|
| 1 | Is the paper based on research (or is it merely a ‘‘lessons learned” report based on expert opinion)? |
| 2 | Is the problem the artifact seeks to address clearly defined? |
| 3 | Is the artifact clearly defined? |
| 4 | Is there an adequate description of the context in which the research was carried out? |
| 5 | Was the research design appropriate to address the aims of the research? |
| 6 | Was the artifact designed in a rigorous manner? |
| 7 | Was the data collected in a way that addressed the research issue? |
| 8 | Was the artifact evaluated? |
| 9 | Was the evaluation of the artifact appropriate and carried out in a rigorous manner? |
| 10 | Is there a clear statement of findings? |
| 11 | Are research findings communicated a way suitable for both management and technology-oriented audiences? |
| 12 | Is the study of value for research and practice? |

## Results

We present the findings of our study, starting with general results then present results by research question. The 11 articles included in the review are provided in Table 3. Each eligible article received at least at least 6 points on our quality assessment instrument (Table 2) and was eligible for inclusion in the study. Regarding the temporal distribution of publications during the study period, Figure 2 shows that most articles were published in the timeframe of 2011-2015 (n = 7) and that the periods of 2004-2011 and 2019-2023 had zero publications.

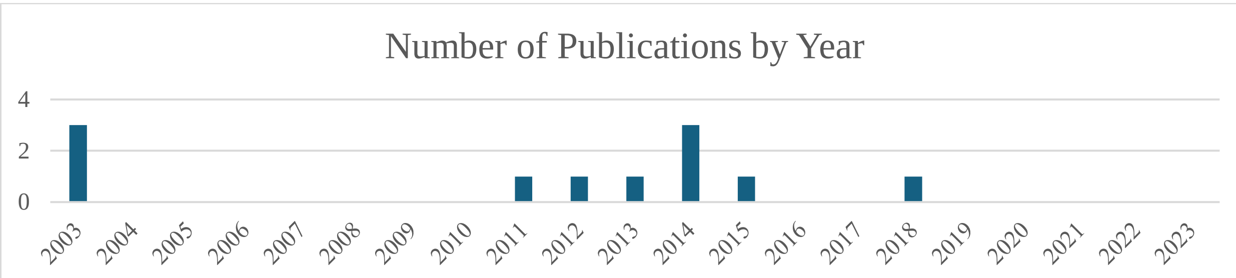


**Figure 2: Publications by Year Throughout Study Period**

### RQ1: What technological artifacts have been proposed to manage LL?

We adopted the typology of technological artifacts proposed by March and Smith (1995) and referenced Mijač (2019) who conceptualizes instantiations as prototypes, information and database systems, tools, components, services, libraries, software frameworks, and algorithms to obtain a less abstract definition of instantiation. In some studies, abstract artifacts were developed into prototypes or systems to enable their study which led us to track this. In terms of artifact types, we found that methods (n=4) were the most common type of artifact proposed, followed by instantiations (n=3), architectures (n=3), and models (n=1). Of the 11 artifacts proposed, 9 were instantiated, frequently taking the form of a web application.

**Table 3: Selected Articles**

| Year | Author | Article Title | Article Type |
|---|---|---|---|
| 2003 | Liszka et al. | A Collaborative Knowledge Management System for Concurrent Design and Manufacturing | Conference |
| 2003 | Soibelman et al. | Design Review Checking System with Corporate Lessons Learned | Journal |
| 2003 | Tacla and Barthès | A Multi-Agent System for Acquiring and Sharing Lessons Learned | Journal |
| 2011 | Cheah et al. | An Ontological Approach for Program Management Lessons Learned: Case Study at Motorola Penang Design Centre | Conference |
| 2012 | Andrade et al. | An Architectural Model for Software Testing Lesson Learned Systems | Journal |
| 2013 | Elkaffas and Wagih | Use Of Semantic Wiki as A Capturing Tool for Lessons Learned In Project Management | Conference |

| Year | Author | Article Title | Article Type |
|---|---|---|---|
| 2014 | Deshpande et al. | A Framework for A BIM-Based KM System | Journal |
| 2014 | Jung et al. | Development of a Water Infrastructure Knowledge Database | Conference |
| 2014 | Yildiz et al. | A Knowledge-Based Risk Mapping Tool for Cost Estimation of International Construction Projects | Journal |
| 2015 | Huang et al. | A Semantic-Based Visualized Wiki System (SVWKS) For Lesson-Learned Knowledge Reuse Situated in Product Design | Journal |
| 2018 | Núñez et al. | A User-Centered Mobile Cloud Computing Platform for Improving Knowledge Management in Small-To-Medium Enterprises in the Chilean Construction Industry | Journal |

**RQ2: What context are these artifacts designed and evaluated within?**

We identified the organizational context (i.e. sector, or activity) and intended user for each proposed artifact. Given that the inner design or environment of artifacts is influenced by the outer environment, understanding these factors is critical (Simon, 1996). Regarding organizational contexts, we found that the most frequent class of proposed artifacts (n=5) are designed to manage LL in architecture, building engineering, and construction (AEC). While some artifacts are broadly oriented at the AEC sector (Deshpande et al., 2014; Elkaffas & Wagih, 2013; Soibelman et al., 2003), others are more narrowly scoped to address specific concerns such as the management of LL in resource- and bandwidth-constrained environments (Núñez et al., 2018), and risk management for international projects (Yildiz et al., 2014). Following AEC, we find that product design and development was the second most frequent context (n=3). Here, artifacts support the capture of LL in product design project management (Cheah et al., 2011), and product design knowledge by supporting the capture and identification of relevant LL with wikis (Elkaffas & Wagih, 2013; Huang et al., 2015). Concerning intended users of proposed artifacts, we found that most users had a technical (e.g., engineers, experts) or managerial orientation in that they either managed projects or were responsible for the design of products or services.

**RQ3: What types of knowledge are supported by these artifacts?**

We classified the knowledge supported by each proposed artifact (Table 5) based on three dimensions of knowledge: tacit-explicit, procedural-declarative, and specificity (general, contextually- or technically-specific), finding that most artifacts are designed to support explicit knowledge (i.e., text-based) rather than tacit knowledge. While some artifacts allow for multimedia content in the form of pictures or associated digital building objects with knowledge which may confer tacit forms of knowledge (Deshpande et al., 2014; Núñez et al., 2018), the principal form of the knowledge captured was text-based explicit knowledge. Regarding whether the LL was procedural or declarative, we found that all but one artifact was designed to support declarative knowledge with the sole exception being Andrade et al. (2013) proposing an architecture to capture LL for software testing by capturing and disseminating procedural knowledge. Turning to the specificity of knowledge, we found that all proposed artifacts were intended to work with either contextually- or technically-specific knowledge, with one exception where the proposed artifact supported both (Deshpande et al., 2014).

**Table 4: Artifact Classes and Description**

| Author | Artifact Type | Description | Instantiated | Instantiation Type |
|---|---|---|---|---|
| Andrade et al. | Architecture | Schema for capturing LL in software testing | Yes | Web Application |
| Cheah et al. | Model | Ontology used to capture LL knowledge | Yes | Spreadsheet |
| Deshpande et al. | Method | Method for using building-information management software to track LL | No | |
| Elkaffas and Waigh | Method | How to use semantic tagging to better capture and related LL | Yes | Wiki |
| Huang et al. | Method | How to automatically identify topics and their semantic relationships | Yes | Wiki |
| Jung et al. | Method | How to develop a national web-based database of water-utility knowledge, LL, and community of practice | Yes | Web Application |
| Liszka et al. | Instantiation | Web application to capture and share knowledge on producing complex glass-metal seals | Yes | Web Application |
| Núñez et al. | Architecture | Architecture for capturing construction LL in internet-poor areas with mobile devices | Yes | Application Platform |
| Soibelman et al. | Instantiation | Web-application supporting design checking and capturing LL | Yes | Web Application |
| Tacla and Barthès | Architecture | Multi-agent system that automatically identifies, captures, and circulates LL | No | |
| Yildiz Et al. | Instantiation | Risk-management tool with lessons-learned management capabilities | Yes | Computer Application |

**Table 5: Classification of Knowledge Supported by Reviewed Systems**

| Article | Tacit or Explicit | Procedural or Declarative | Specificity |
|---|---|---|---|
| Andrade et al. | Explicit | Procedural | Technically Specific |
| Cheah et al. | Explicit | Declarative | Contextually Specific |
| Deshpande et al. | Explicit | Declarative | Contextually and Technically Specific |
| Elkaffas and Waigh | Explicit | Declarative | Contextually Specific |
| Huang et al. | Explicit | Declarative | Contextually Specific |
| Jung et al. | Explicit | Declarative | Contextually Specific |
| Liszka et al. | Explicit | Declarative | Technically Specific |
| Núñez et al. | Explicit | Declarative | Technically Specific |
| Soibelman et al. | Explicit | Declarative | Technically Specific |
| Tacla and Barthès | Explicit | Declarative | Contextually Specific |
| Yildiz Et al. | Explicit | Declarative | Contextually Specific |

## Discussion

We reviewed two decades of LLS DSR research to understand which technological artifacts have been proposed during the study period, understand the contexts and users of these proposed artifacts; and assess the types of knowledge supported by these artifacts. One finding of this study is that DSR on LLS appears to be limited with most studies having been performed between 2010 and 2015, with the last study published in 2018. While this may be due to some limitations of this study (e.g., search terminology), it is also likely that academic attention has turned towards other research areas such as artificial intelligence where the number of research publications has grown geometrically over the past decade (De la Vega Hernández et al., 2023; Gao et al., 2021). Further, KMS research has received much academic attention over the years and much of the problem- and solution-domain space may have been covered (Gregor & Hevner, 2013). Consequently, DSR investigating KMS and LLS may fall under the routine design paradigm, particularly in project-oriented industries (e.g., construction). However, opportunities to investigate the design of KM, KMS, and LLS in other contexts remain, particularly in less conventional contexts such as craftworks and art where tacit knowledge is critical (see Manfredi Latilla et al., 2018; Yasuoka & Hirata, 2020).

Regarding our first research question, we found that methods and instantiations were the most frequently proposed class of artifact. Further, most artifacts were instantiated and typically employed web technologies, allowing geographically and temporally distributed teams to create and access LL (Chua, 2004). Wiki-based approaches were frequently employed and included functionality to tag, relate, and group LL to better support its reuse (Elkaffas & Wagih, 2013; Huang et al., 2015), though custom web applications were also developed (Andrade et al., 2013; Jung et al., 2014; Núñez et al., 2018; Soibelman et al., 2003). Three artifacts did not adopt this web-centric paradigm, relying on local computer applications such as BIM software (Deshpande et al., 2014), Microsoft Excel (Cheah et al., 2011), or custom-developed software (Yildiz et al., 2014). Considering that these artifacts are intended to be research prototypes rather than production systems, this decision is understandable though worth noting that the design of some artifacts or methods may change to support multiple users across time and space.

Regarding our second research question on the contexts and users of artifacts, we find that DSR on LLS has concentrated in limited contexts with relatively homogenous intended users. Specifically, the intended users are managerial or technically oriented (MTO), and many LLS are intended to support construction project management, building design, and risk assessment (Deshpande et al., 2014; Elkaffas & Wagih, 2013; Núñez et al., 2018; Yildiz et al., 2014). Though the project-based orientation is not unexpected, especially given the temporary nature of project teams within organizations, the paucity of diversity in research contexts suggests that there is a significant gap in design knowledge in other contexts. Such emphasis on certain contexts is not novel to the field of KM research as scholars have previously noted that most studies have focused on large enterprises rather than small and medium enterprises (Nunes et al., 2006). While research on KM within SMEs has improved dramatically over the past decade (Durst et al., 2023; Durst & Runar Edvardsson, 2012), our findings corroborate Badr and Ahmad (2013), suggesting that design research on LLS has continued to be limited over the past decade. The emphasis on MTO users suggests that designers may have not considered the knowledge needs of other users such as construction workers or technicians who may have different needs for accessing, capturing, and creating knowledge. Further, the emphasis on MTO users suggests an underlying assumption that individuals can internalize and explicate knowledge created by others. As scholars have noted, transferring knowledge between differentiated communities of practice is significantly more challenging (Carlile, 2002, 2004). Although the use of KMS can support knowledge transfer (Kanwal et al., 2019), effectively transferring knowledge remains a challenge deserving of further study (Cerchione et al., 2020).

Turning to research question 3, we found that research has primarily focused on the design of artifacts that support explicit and declarative knowledge. Despite the importance of tacit knowledge on organizational performance, we find that all artifacts were intended to manage text-based explicit knowledge. Interestingly, some of the early research on LLS has identified the textual representation of knowledge as a barrier to effective KM and the integration of knowledge into procedures (Weber et al., 2001). This lack of support for non-text knowledge is limiting as pictures and videos can be an effective method for both capturing and socializing such knowledge on highly tacit processes (Le Bellu, 2016; Yasuoka & Hirata, 2020; Zappavigna-Lee & Patrick, 2009). While bandwidth and internet connectivity present challenges for storing, accessing, and disseminating such forms of knowledge, particularly in resource-constrained contexts (Ferrada et al., 2016; Núñez et al., 2018), this constraint is far from universal, particularly in more well-resourced organizations or nations. The omission of support for the management of tacit forms of knowledge also suggests an underlying assumption that tacit knowledge held by the staff can be easily explicated and converted into text-based formats effectively and accurately. Such an assumption may be challenging for effective management of tacit, experiential knowledge as the transfer and internalization of tacit knowledge is best facilitated by experience and time rather than written or spoken word (Dalkir, 2017; Davenport & Prusak, 1998). Thus, explication of tacit experiential knowledge by individuals belonging to a different community of practice may result in codified knowledge that is less meaningful and reusable, thereby limiting the use of the KMS for supporting unambiguous and straightforward organizational activities, which limits the competitive advantage afforded to the organization (Butler, 2003).

The emphasis on declarative over procedural knowledge is expected given that the objective of LL management is to ensure that experiential knowledge in the form of situations, actions, and outcomes are captured to inform future decision-making (Weber et al., 2004). However, the study of Andrade et al. (2013) demonstrates the utility of LLS for managing procedural knowledge for improving organizational performance. While procedural lessons learned (PLL) could be regarded as best practices, the latter are more abstract and lack important contextual knowledge that influences decision-making. In an increasingly competitive and resource-scarce operating landscape, organizations are looking to improve on knowledge-intensive business processes (KIBP) that rely on human knowledge, experience, and creativity (Marjanovic & Seethamraju, 2008). As such, the need for effective management of procedural knowledge may grow over time as organizations seek to optimize non-traditional organizational processes.

## Research Agenda

As the rate of technological, societal, and economic disruption continues to increase in the modern era, information systems researchers have an important role in building and evaluating new technological artifacts that enable more effective management of experiential knowledge as organizations adapt to new technologies and processes (Scholl et al., 2004; Tuomi, 2002). To understand the status of research on LLS, we performed a systematic review of design research on LLS over the past two decades. Our research has identified three knowledge gaps, limitations, and themes that warrant future investigation.

### Improving Projectability of Design Research

Our findings suggest that extant research has been narrowly scoped in terms of contexts and intended users, aligning with Kainova and Volkova (2023) who call for further research in new industries and national contexts. Moreover, several studies have a monolithic scope seeking to develop a solution for a problem faced by a single organizational unit. As the objective of DSR is to create design knowledge on classes of artifacts that solve important problems, this narrow focus presents a challenge for reusing design knowledge in new contexts given the limited breadth of the problem, evaluation, and solution space. While this monolithic scope is not new in DSR in IS, such narrow scopes of research greatly limit the projectability of design knowledge from one context or organization to another, thereby reducing the utility of design knowledge and its applicability to different real-world challenges (Brocke et al., 2020). Towards this challenge, we recommend that DSR be performed within new, hitherto understudied contexts to better evaluate how extant knowledge on the design of LL artifacts projects into new problem spaces. Similarly, we also recommend that future research considers the needs of non-managerially and technically oriented users. Researchers should consider how the needs of these types of users may differ in terms of how they capture, access, and employ lessons learned in the execution of their work, and how to design systems that suit their unexplored needs. In a similar line, we suggest that future research emphasizes the development of solutions for a class of problems rather than focusing on a specific problem faced by one organizational unit. In doing so, the design of the artifact encompasses a broader problem, solution, and evaluation space, thereby improving the projectability and summative validity of design knowledge.

### Supporting Management of Lessons Learned Across Communities

Forming teams of experts from different communities of practice or backgrounds can be an effective means for organizations to execute KIBP and create innovative solutions for complex problems (Datta, 2007; Tiwana & McLean, 2005). Effective communication and collaboration across disciplinary boundaries and expertise levels are key for effective problem-solving (Natek & Lesjak, 2021) but codifying explicit and tacit knowledge across these complex barriers remains a challenge. While technology can play an important role in facilitating organizational innovation and problem-solving (Fox, 2011), the inability to develop a common technical language by individuals of heterogeneous backgrounds serves as a barrier to effective knowledge management (Santos et al., 2012). Although our study did not directly investigate the diversity of the intended user base, upon examination it is evident that most proposed LL artifacts are intended for use by relatively homogenous types of users (e.g. engineers, project managers). As domain complexity continues to grow and as teams of individuals with heterogeneous expertise continue to collaborate, the challenge of successfully managing both tacit and explicit experiential knowledge magnifies. In a similar line, the advent of new technologies, such as the internet of things (IoT) and generative artificial intelligence stands to radically alter the operating landscape, leading to significant academic interest in understanding how to share knowledge between humans and machines (Manesh et al., 2021). As such, we call for further design research on technological artifacts that are better suited for managing valuable LL knowledge produced by teams of heterogeneous experts as well as considering how to manage experiential knowledge in an IOT/machine-centric paradigm environment.

### Improving Support for the Management of Tacit and Procedural Knowledge

Our review reveals a lack of support for tacit and procedural knowledge. As organizations look to improve the execution of non-standard, complex, knowledge-intensive business processes that rely on human creativity, effective management of tacit knowledge is of critical importance (Butler, 2003; Hurnonen et al., 2015; Marjanovic & Seethamraju, 2008). Although tacit knowledge has a critical role to play in facilitating organizational processes and improving performance (Harlow, 2008), research on the design of KMS to support tacit knowledge remains limited (Natek & Lesjak, 2021). Given the need for further research on supporting the conversion of tacit knowledge into explicit knowledge (Yepes & López, 2021), future research efforts should be directed at designing technological artifacts that are better suited for capturing, representing, and applying tacit forms of knowledge in other forms than text, such as images, videos, graphs, and other virtual formats (Nemati et al., 2002). Future research should also focus on improving support for procedural knowledge. Although Weber (2004) argues that lessons-learned systems do not provide knowledge on complete procedures (i.e. process knowledge), the study of Andrade et al. (2013) suggests that capturing lessons learned on ideal procedures for executing organizational activities is beneficial. However, while research on LLS for procedural knowledge seems limited at this time, the need for effective management of such knowledge is becoming urgent given the increase in the frequency and complexity of human-machine interaction (de Giorgio et al., 2020; Manesh et al., 2021). Overall, as organizational processes become increasingly complex and integrated, reliance upon experiential knowledge, education, and creativity to address modern challenges will only increase, necessitating the development of KMS and LLS that are better suited for KM needs in this new era.

## Conclusion

We performed a systematic literature review covering two decades of research articles on LLS investigating the types of technological artifacts proposed, the contexts and users for which they have been designed, and the types of knowledge supported by these artifacts. We find that LLS frequently takes the form of web-based instantiations supporting KM in the context of construction, building management, and architecture, and have typically been designed for use by managerially- and technically oriented staff. Further, we find that these artifacts principally deal with explicit, declarative knowledge. We suggest future research that improves the projectability of design knowledge by exploring new contexts and focusing on classes of problems. In addition, we propose that future research be directed at supporting knowledge transfer across diverse communities of practice and differing levels of expertise. Last, researchers should consider how LLS may be designed to support tacit and procedural knowledge to enhance the capabilities of LLS.

This research has several limitations to discuss. First, although we attempted to control for bias by developing a rigorous protocol and providing details on our procedures, subjectivity remains in that a single researcher applied the inclusion and exclusion criteria. Second, while we queried two databases with broad indexing of academic journals (Web of Science and IEEE Explore), other databases may contain relevant publications not indexed by these databases. Our study has found that there is much interest in LLS design research in the construction and building management context, which suggests querying industry-specific journals may be fruitful.

Similarly, this study only considers research publications and does not consider industry or grey literature that may provide additional information relevant to this study. Fourth, our search query could be refined further to include more synonyms (e.g., tool) and to better delineate between lessons learned systems and knowledge management systems. For example, we cite the study of Eken et al. (2020) but did not include it in our analysis as our query did not capture this article.

Despite these limitations, our research contributes to the current understanding of extant research on LLS and proposes an agenda to guide the future of LLS design research. As organizational challenges continue to increase in complexity, IS researchers have a major role in developing and studying technologies, including novel KMS and LLS that improve the practice of KM and enable organizations to overcome novel challenges. The design of a new generation of LLS to support knowledge management for new types of knowledge for disparate users across various disciplines continues to be of critical importance and we hope that future researchers address the research agenda we have laid out.

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