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How do Researchers (Re-)Use Design Principles: An Inductive Analysis of Cumulative Research

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Abstract. Accumulating prescriptive design knowledge, such as design principles (DP), is one of the fundamental goals in design science research projects. As previous studies have examined the use of DPs in practice to advance the development and communication of such principles, we argue that this attention also needs to be paid to how and for what researchers (re-)use DPs. Hence, this paper explores DP usage in cumulative (information systems) research based on the analysis and coding of a sample of 114 articles with 226 in-text citations. In doing this, we aim at contributing to the valuable discourse on DP reuse and accumulation by focusing on usage in research, present preliminary types of DP usage extracted from cumulative literature, as well as raise the awareness for guiding user and designer in how to (re-)use and how to allow for reuse of DPs.

Keywords: Design Principle, Reuse, Cumulative Research, Citation Analysis.

1 Motivation

The accumulation of design knowledge is the ultimate goal of design science research (DSR) [1] and necessary for a design to "[..] go far beyond a single success story" [2]. This accumulation requires the codification of design knowledge to make it reusable in different scenarios, by other users, and at another point in time [3]. Design principles (DP) are one of the most dominant mechanisms for codifying design knowledge [2].

The paramount position of reusability of DPs inevitably leads to the question of whether that happens [4]. Therefore, Chandra Kruse et al. hypothesized whether "[we] may expect that information system (IS) practitioners would use such design principles to produce reliable outcomes." [3] As the corresponding study and further discussions offer valuable insights into how practitioners use DPs and thereby advance the understanding of developing, evaluating, and communicating principles, we seek to complement this through a more research-driven perspective. Considering the emphasis on rigor from DSR we, in turn, question the level of rigor of which the literature has attained in reusing and codifying design knowledge within its own paradigm so far. This is important for the field of knowledge to evolve smoothly and gradually for new as

well as experienced DSR researcher's ability to ground, design, evaluate, and publish their research. To move towards an understanding of (re-)using DPs, we raised the following question: *What are the usages of design principles in cumulative research?*

In attempting to answer this, this research-in-progress makes three contributions as part of a more extensive study. First, it broadens the discourse on DP reusability onto the IS community by shedding light on the question of how and for what principles are (re-)used in research. Second, the paper provides preliminary types of DP usage—organized along with content-/methodology-driven usage—by employing citation analysis. Third, we discuss four main observations from our analysis, pointing to the need for guiding researchers and principle designers to leverage DP reuse in research. We believe that such guidance will potentially lead to supporting researchers in (re-)using, validating, and refining available principles as well as, from a designer perspective, in grounding [5, 6], positioning, and presenting [7] principles that allow for reuse.

2 Research Design: Identification of Cumulative Research

To disclose how and for what DPs are used by researchers, we performed a citation-driven content analysis, which qualitatively explores in-text citations, structured in three main steps: In **step 1**, we sought to obtain articles that propose DPs. We searched for the term "design principle" in the AIS Senior Scholars' Basket and leading IS proceedings using 'Publish or Perish'. We examined the top five-cited articles in each of the eight journals and determined whether they provide DPs or not. From those articles that provide DPs, we selected ten journal articles with the most citations. We also included three conference papers from ICIS, ECIS, and DERIST (see Table 1).

Table 1. Selection of top-cited articles that propose design principles (query in 02/2021).

ID	Reference	Citations	ID	Reference	Citations
J1	Markus et al. [8]	1.529	J8	Bygstad [9]	135
J2	Lindgren et al. [10]	560	J9	Seidel et al. [11]	86
J3	Gosain et al. [12]	550	J10	Corbett [13]	85
J4	Kohler et al. [14]	457	C1	Gnewuch et al. [15]	147
J5	Day et al. [16]	192	C2	Nærland et al. [17]	79
J6	Siponen & Ivari [18]	162	C3	El-Masri & Tarhini [19]	48
J7	Granados et al. [20]	147			

In step 2, to find papers that potentially (re-)use DPs for their research, we selected citing articles from the initial sample of 13 articles (see step 1). From each article, we again identified the ten most citing articles (amounting to 130 articles).

In **step 3**, from the 130 articles, we excluded non-English/non-German, duplicates, etc. The final sample contains 114 citing articles (available upon request), including a total number of 226 in-text citations (i.e., an article's sentence in which the primary DP article's citation appears). To analyze these in-text citation sentences, we employed a

coding schema—inductively specified after analyzing the first articles—that differentiates between binary categories (yes/no), which is as follows: *Content-driven usage* (e.g., citing for the specification of a domain or providing definitions for a particular field); *Methodology-driven usage* (e.g., citing for the adoption of their research design). Moreover, we qualitatively added codes, including reasons and comments of why a DP article was cited for creating more specific usage insights. Finally, the obtained codes were examined and clustered within the author team to arrive at initial usage types.

3 Results: Preliminary Types of Design Principle Usage

Based on our sample, we developed eight types of usage, among two major clusters. First, **content-driven usage** refers to authors who cite a DP article because they conduct research that is related to the phenomenon the principles address. We found 181 from the 226 in-text citations—143 from journals and 47 from conferences—that can be assigned to this cluster, including four different types of usage, for instance, articles that simply emphasize the availability of DPs for a particular field or articles that make use of DPs to instantiate their artifacts. Second, **methodology-driven usage** refers to authors that cite a DP article because they adopt methodological guidance from that article. Forty-nine in-text citations from our sample—46 from journals and three from conferences—can be classified into this cluster. Usually, authors use DP articles to adopt an article's research design or point out that DPs help to achieve specific goals.

In 192 in-text citations, however, authors use DPs neither content-wise nor methodology-wise (citing a DP article not for the principles *per se*). We do not consider these relevant for our study. Table 2 summarizes the eight types of usage that have been extracted from our sample, citing DP articles.

Table 2. Types of design principle usage in cumulative literature.

Type of usage		Description of type and example from our sample
Content	Availability of principles	Authors highlight the availability of DPs in a certain domain/field. In doing this, they mostly refer to principles but do not directly build upon them. *For example,* [21] *referred to and listed* [11]*'s DPs on sensemaking within their literature review on Green IS.*
	Implementation of principles	Authors use available DPs to implement and/or instantiate their design knowledge/artifact. *For example,* [22] *derived a set of four DPs for Blockchain technology and implemented one of these principles by reusing* [17]*'s practices on reducing Blockchain risks*.
	(Meta-) Requirements	Authors refer to (meta-)requirements underpinning DPs to stress their availability and compare their insights with existing knowledge. *For example,* [23] *analyzed Chabot projects and compared their observations with* [15]*'s issues and requirements for service bots.*
	Instantiation	Authors refer to a specific instantiation that has been developed based on DPs. *For example,* [24] *described* [8]*`s tool 'TOP Modeler' to illustrate that artifact instantiation help demonstrating the feasibility of the design process and the design product.*

Methodology	Development methods	Authors adopt the methods for developing DPs. *For example,* [14] *used* [10]*'s work to indicate the suitability of action design research for the development of DPs.*
	Development steps	Authors adopt the steps for developing DPs. *For example,* [25] *described* [11]*'s procedure for the development of DPs. Thereby, they used* [11] *as an illustrative example for their design instantiation.*
	Theoretical lens	Authors reuse an underpinning (kernel) theory that is appropriate for a certain domain. *For example,* [21] *stressed that Affordance theory provides a useful theoretical lens and referred to* [11]*'s work.*
	Positioning and formulation	Authors position their DPs with regard to design theories. *For example,* [26] *referred to* [8]*'s work in order to state that DPs are an important component of design theories.*

Other types—which do not meet this study's goals—are citing articles exclusively for the phenomenon captured by a DP article (e.g., citing [15] for conversational agents) or for methods used within a DP article (e.g., citing [16] for performing interviews).

4 Discussion, Conclusion, and Future Research

From analyzing DP (re-)use in cumulative literature, four main **observations** emerged.

- First, there are only a few articles in our sample that directly build upon available DPs, which is crucial to support knowledge accumulation—see also knowledge production modes for 'building on and contribution to design theory' from [1].
- Second, we observed an inconsistent use of DPs and different purposes for citing DP articles ranging from referring to a specific instantiation to abstract (meta-)requirements. Hence, there seems to be a need for additional guidance on particular *design knowledge movements* [1] for DPs, such as instantiating, advancing, and extending them. Enabling rigor in the use of DPs will potentially lead to more validation, for instance, through peer reviews and internal validation through the IS community.
- Third, some articles in our sample developed design knowledge by grounding it on available DPs. In general, to enable knowledge reuse, DSR projects need to be transparent regarding their *grounding* [1]. Since DPs can be classified as 'nascent design theory' [27], reusing them would especially contribute to the *theoretical grounding* in which "we are justifying the practical knowledge of the design theory with theoretical knowledge" [5], corresponding to the concept of 'kernel theories' [6].
- Fourth, we observed that articles presenting DPs as their primary contribution are more frequently used for the principles themselves. Those articles that propose, for instance, a design theory, are cited more frequently for other reasons than the DPs.

Drawing on these preliminary observations, we asked ourselves 'why there is scarce usage?' This could be attributed to the fact that DPs are intended to primarily help practitioners in instantiating artifacts. To investigate this, **further research** might shed light on the following questions: What are *other usage* types? (content/methodology);

What are the actual *target user* groups of DPs? (practice vs. academia); How to facilitate the *evolution* of DPs? (e.g., integrating underpinning development steps for reviewing available DPs, [27]); What are possible *types/knowledge movements* of DP reuse?; How to *communicate* DPs to enable reuse in academia? (visual tools [28])

In **summary**, our work contributes to the core of the 'practical ethos' of DSR that requires its products to be reusable [4] by broadening the scope of reusability onto the academic domain and aim for a fruitful discussion on how to grow the body of prescriptive design knowledge. We outline our initial findings that conceptualize types of how others can use DPs to enhance their effectiveness and maturity. Overall, we argue that the limited and inconsistent (re-)use of DPs in research indicates a need for further guidelines that help to leverage the full potential of design knowledge reuse. Our future work will focus on (1) further synthesizing good practices. Since we concentrate on top-cited journals, the next steps should also examine random, up-to-date, and top-cited articles. Also, we plan to include outlets beyond the top-ranked ones as they might have more applied/domain-specific research (re-)using available DPs. Moreover, we (2) plan to verify and refine our preliminary types of DP usage (e.g., by means of Q-sorting) and seek to develop guidelines for reusing such principles in research.

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