

(Re)considering the Concept of Reproducibility of Information Systems Literature Reviews

Completed Research

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Abstract

Literature reviews play a key role in information systems (IS) research by describing, understanding, testing, and explaining the constructs and theories within a particular topic area. In recent years, various commentaries, debates, and editorials in the field's top journals have highlighted the importance of systematicity and transparency in creating trustworthy literature reviews. Although also recognized as being important, the characteristic of reproducibility of IS literature reviews has not received nearly the same level of attention. This paper seeks to contribute to the ongoing discussion on the elements required for high quality IS literature reviews by clarifying the role of reproducibility. In doing so, we find that the concept of reproducibility has been misunderstood in much of the guidance to authors of IS literature reviews. Based on this observation, we make several suggestions for clarifying the terminology and identifying when reproducibility is desirable and feasible within IS literature reviews.

Keywords

Literature review, reproducibility, systematicity, transparency, meta-analysis, IS research.

Introduction

Literature reviews provide a fundamental backbone to any academic field. By periodically examining the research that has been done in the past, scholars can cultivate valuable insights by describing a phenomenon (e.g., a narrative review), understanding a phenomenon (e.g., a scoping review), explaining a phenomenon (e.g., a realist review), or testing theory (e.g., a meta-analysis) (Paré et al. 2015; Rowe 2014; Templier and Paré 2018). In contrast to the conceptual foundations or background sections within traditional empirical papers, literature reviews in this context represent full-length, stand-alone academic studies.

A variety of influential commentaries have been published over the years to provide assistance to IS scholars who seek to publish literature reviews. Early guidance in the field is often traced to the creation of the MIS Quarterly Review department in 2001 and the advice of the first two senior editors of the section (Watson 2001; Webster and Watson 2002). During the past five years, the editors of other top IS journals have also weighed in with their views of literature reviews within IS, including at the European Journal of Information Systems (Rowe 2014) and the Journal of the Association for Information Systems (Leidner 2016). In addition, there have been a number of debates and commentaries published in top IS journals that examined emerging issues related to the practice of writing literature reviews. For example, in 2015, the Communications of the Association for Information Systems published a special issue on IS literature reviews, oriented towards advancing review methodologies, improving rigor, and providing practical guidance to authors (Tate et al. 2015). Similarly, a paper published in the Journal of Information Technology by Boell and Cecez-Kecmanovic (2015a) considered the concept of being systematic in literature reviews, which prompted a range of responses (Chiasson 2015; Oates 2015; Schultze 2015; Watson 2015), as well as a rejoinder from the original authors (Boell and Cecez-Kecmanovic 2015b). Finally, in addition to these important collections of opinions, several additional publications have provided valuable and

insightful views on IS literature reviews, including Paré et al. (2016; 2015), Schwarz et al. (2007), Sylvester et al. (2013), Templier & Paré (2018), and Wolfswinkel et al. (2013).

Taken as a whole, IS scholars have been provided with a range of opinions and suggestions on how to conduct literature reviews and why they are valuable. Although the advice has been contradictory at times (for example, refer to the discussion below on differing opinions related to systematicity), most would acknowledge the overall value that has emerged from the dialogue. Indeed, much of the focus of the recent guidance has been oriented around the characteristics that are inherent in trustworthy, rigorous literature reviews. In particular, a good deal of recent attention has been paid to the role of *systematicity*, which refers to literature reviews that are conducted in an organized and orderly manner (Paré et al. 2016), as well as *transparency*, which is achieved when the elements of the review process are explicitly detailed (Templier and Paré 2018). A variety of views on either systematicity, transparency, or both, have figured prominently in the recent IS literature review guidance of Boell & Cecez-Kecmanovic (2015a; 2015b), Paré et al. (2016), Rowe (2014), Templier & Paré (2018), and vom Brocke et al. (2015).

However, a third characteristic of trustworthy literature reviews, *reproducibility*, has also been frequently noted within these discussions, but has yet to be examined in as much depth as systematicity or transparency. Although reproducibility is acknowledged as being important (Leidner 2016; Paré et al. 2016; Templier and Paré 2018), the current literature is unclear on the core elements that make a review reproducible and what value this actually provides. The objective of this study is to clarify the role of reproducibility in the context of IS literature reviews by establishing what reproducibility actually means, as well as identifying when reproducibility is beneficial and what challenges it presents to researchers.

In doing so, we consider the various viewpoints on literature review trustworthiness, both in IS and in other fields, with a particular focus on reproducibility. We find that the scientific concept of reproducibility has been largely misunderstood in the published guidance to authors of IS literature reviews. In addition, we note that the current IS-specific guidance is confusing when discussing reproducibility alongside the other trustworthiness characteristics. In an effort to clarify the issue, we suggest that authors and journal editors reconsider what reproducibility represents, when it is feasible to pursue, and when other trustworthiness characteristics may be more appropriate objectives to pursue.

The remainder of the paper is presented as follows. First, an overview of the current opinions on IS literature review systematicity, transparency, and reproducibility is presented. This is followed by a discussion of the current issues related to reproducibility, their potential impact, and proposals for addressing the concerns. We conclude with considerations for future directions that can further aid the field in facilitating literature reviews that are increasingly reproducible in the future.

Characteristics of IS Literature Reviews

Undertaking an IS literature review can take several distinct paths, each of which has the potential of concluding with a trustworthy product. Past commentators have established a variety of frameworks and typologies that categorize these different approaches. For example, Rowe (2014) classifies IS literature reviews into four genres with respect to theory: describing, understanding, theory testing, and explaining. In comparison, Paré et al. (2015) propose a typology of nine ideal literature review types, consisting of narrative review, descriptive review, scoping/mapping review, meta-analysis, qualitative systematic review, umbrella review, theoretical review, realist review, and critical review. These types are distinguished by seven, first-order dimensions: overarching goal, scope of questions, search strategy, nature of primary sources, explicit study selection, quality appraisal, and methods for synthesizing/analyzing findings. In addition, Leidner (2016) suggests that review papers can be framed as either organizing reviews, assessing reviews, specific-theorizing reviews, or broad-theorizing reviews, depending on the review's focus and objectives.

What makes a literature review trustworthy?

Among the range of characteristics associated with trustworthy IS literature reviews, three are most commonly recognized within the recent commentaries (refer to Table 1)¹.

Systematicity

The first is systematicity, which refers to “...a disposition towards organized, methodic, and orderly inquiry that uses various methods and processes to search, screen, assess, analyze and interpret relevant information with a view to achieving a set of specific research goals” (Paré et al. 2016, p. 596, cf. Valanides & Charoula (2008) and Borko et al. (2007))². A common technique to demonstrate literature review systematicity is to follow a series of pre-determined, agreed-upon steps. One example in the recent guidance is Okoli’s (2015) eight steps of identifying the purpose, drafting a protocol and training a team, applying a practical screen, searching for literature, extracting data, appraising quality, synthesizing the studies, and writing the review. Another example is from Fink’s (2010) seven steps of selecting a research question, selecting sources, choosing search terms, applying practical screening criteria, applying methodological screening criteria, doing the review, and synthesizing the results.

Although systematicity in conducting IS literature reviews is generally seen to be a valuable objective, some commentators speak to the difficulties in actually being entirely systematic. For example, vom Brocke et al. (2015) suggest that there is no one-size-fits-all approach to the literature search, that literature searches often lead to unexpected results, and that it is not easy to tell when a literature search is finished. To that end, the activities required to conduct a literature review have at least some degree of variability, which may be seen to conflict with the concept of completely organized and orderly inquires.

Some commentators, such as Paré et al. (2016) argue that systematicity can be embedded within each step (i.e., developing a plan, searching the literature, selecting studies, assessing the quality of studies, extracting data, and analyzing/interpreting/synthesizing/formulating conclusions) of all review genres. However, others advocate for systematicity to be of varying importance depending on the review step or type of literature review. For example, Rowe (2014) argues that “systematicity, like perfect coverage, may not always be the most important quality elements of a literature review. In fact, higher systematicity does not help much ‘abstracting data’ from papers and synthesizing it. Systematicity is more and more important for the assessment of the material in the collecting stages and to some extent for the ‘doing the review’ stage, but it is more important for explaining and testing reviews rather than for understanding and viewing the landscape” (p. 247).

Transparency

The second characteristic is that of *transparency*, which refers to “...the extent to which the review process is made explicit” (Templier and Paré 2018, p. 504). Similarly, Paré et al. (2016) (cf. Shea et al. (2009) and Liberati et al. (2009)) define transparency as “...the completeness with which a review is presented and whether important methodological aspects about its design and execution are clearly or explicitly reported” (p. 497). From this perspective, quality is assessed based not only on completing the necessary literature review steps in an orderly way (i.e., systematicity), but by also clearly describing the literature review steps as well. Such details could include the activities undertaken to complete a thorough database search or assess the quality of the literature. By being transparent, it can allow for the strengths and weaknesses of a study to be evaluated (Liberati et al. 2009; Rowe 2014).

¹ We recognize that other characteristics of trustworthy literature reviews are noted in the literature, such as objectivity; however, we focus on those that have been most prominently discussed in the recent IS commentaries.

² We recognize, as pointed out by Paré et al. (2016), Schulze (2015), and vom Brocke et al. (2015), that the characteristic of being systematic differs from the genre of a systematic literature review, which refers to a specific method common in other fields, such as medicine. To that end, all literature reviews are at least somewhat systematic, even though all reviews are not ‘systematic literature reviews’.

Characteristic	Definition(s)	Reference(s)
Systematicity	“...a disposition towards organized, methodic, and orderly inquiry that uses various methods and processes to search, screen, assess, analyze and interpret relevant information with a view to achieving a set of specific research goals” (p. 596).	Paré et al. (2016), cf. Valanides & Charoula (2008) and Borko et al. (2007)
Transparency	“...the extent to which the review process is made explicit” p. 504. “...the completeness with which a review is presented and whether important methodological aspects about its design and execution are clearly or explicitly reported” (p. 497)	Templier & Paré (2018) Paré et al. (2016), cf. Shea et al. (2009) and Liberati et al. (2009)
Reproducibility	The methods used in a literature review could be reproduced by an independent party. An existing study, where the data is made available to others, is re-analyzed by an independent party in order to duplicate the results.	Paré et al. (2016); Templier and Paré (2018) Bollen et al. (2015), Cassey and Blackburn (2006), Goodman et al. (2016), and Peng (2011).

Table 1. Characteristics of Trustworthy IS Literature Reviews

Reproducibility

Finally, a third characteristic that is commonly recognized as part of the discussion on literature review trustworthiness is *reproducibility*. Paré et al. (2016) argue that reproducibility contributes to the credibility of the review by clarifying the reasonability of the research design, while Templier and Paré (2018) also suggest that reproducibility can enable future researchers to conduct updated reviews on a topic in the future. However, despite this recognition of importance, there are conflicting views as to what reproducibility actually means. From one perspective, reproducibility is closely connected with transparency in the sense that if a review is transparent (i.e., the review steps are explained), the authors’ methodological steps, such as the literature search, could be ‘reproduced’ in that they could be performed again by someone else (Paré et al. 2016; Templier and Paré 2018). For example, Paré et al. (2015) note that “reliability describes the reproducibility of the review process, which may be facilitated by a comprehensive documentation of the literature search process, extraction, coding and analysis performed in the review” (p. 192). It is important to note that this approach to reproducibility is clear to orient itself only around the reproducibility only of the methods and *not* the results (Templier and Paré 2018), on the basis that literature reviews “are a human-based activity, and the literature pool changes over time” (Paré et al. 2016, p. 497).

However, other perspectives, particularly those from the fields outside of IS, such as the natural sciences and medicine, focus not on the reproduction of methods, but instead on the results. From this perspective, reproducibility is achieved in an existing study when data is made available to an independent party to be re-analyzed in order to duplicate the results (Bollen et al. 2015; Cassey and Blackburn 2006; Goodman et al. 2016; Peng 2011). This ‘reproducibility of findings’ approach diverges significantly from the ‘reproducibility of methods’ approach advocated by Paré et al. (2016) and Templier and Paré (2018). This difference is further articulated by Boell & Cecez-Kecmanovic (2015a), who suggest that the rigor of IS literature reviews is, to a large part, assessed on the trustworthiness of the document search, while in other fields, rigor is more concerned with how comprehensive the literature is and the methodology of the selected studies, but “not how they are identified or whether the process of identifying them is reproducible by others” (p. 163).

A further point of confusion when considering literature review reproducibility is its ambiguous association with the other related trustworthiness concepts. For example, Bandara et al. (2015) state that “the value of IS literature reviews and, indeed, literature reviews in any field can thus be significantly enhanced through greater accuracy and comprehensiveness in the review process and through better justification and legitimization of choices. The review becomes not only more useful to the field but also more replicable and transparent” (p. 155). Similarly, Templier & Paré (2018) suggest that “...reproducibility of the review process also provides guidance with respect to future research. For positivist reviews, transparency mainly serves as a platform for an updated review on the same topic some years later. For interpretive reviews, transparency can help teach students and scholars how to go about similar research in other topic areas with no thought of replication of findings” (p. 504). Additionally, Paré et al. (2015) note that “the quality of a review is...reflected by the thoroughness of the documentation of the search and synthesis process, and the soundness in the choice of the approach used. At any point in time, a researcher interested in replicating a review should have all the information needed to complete the process” (p. 192). As well, systematicity and reproducibility are seen as being connected. Rowe (2014) argues that “the quality of a literature review depends on its systematicity, to an extent, which, as we will see, is a function of the theoretical review goal, since systematicity implies reproducibility through documenting the search process and potentially indicates comprehensiveness” (p. 246). Similar to the concept of reproducibility, replicability has an established definition in other fields. Specifically, in the natural sciences and medicine, replicability is distinct from reproducibility in that rather than using the original data (as is done with reproducibility), the data are independently re-collected and then re-analyzed by an independent party in order to duplicate a study’s results (Peng 2011).

A final point of contention is the division of opinions on the desirability and feasibility of achieving reproducibility in the first place. For example, Leidner (2016) suggests that writing a literature review is an iterative process, which (at least in some types of reviews) is not compatible with reproducibility. She notes that “I have seen authors obsess over reproducibility and have enjoyed some lively debates about creativity versus reproducibility. The process of conducting a review, to me, is as much an art as a science” (p. 562). Similarly, Boell & Cecez-Kecmanovic (2015a) argue that at least some genres of literature reviews contain too many subjective decisions (e.g., determining quality criteria) that can’t be replicated or even adequately explained. They argue that even if a description of the tasks can be articulated (e.g., the quality of the collected manuscripts were assessed), it is much more difficult to enable those tasks to actually be performed by others. This distinction seems to be somewhat consistent with the past conceptualizations of the differences between explicit versus tacit knowledge (Nonaka 1994).

In general, the concern raised within this line of argument is that the act of recording the steps undertaken that are required to make a literature review reproducible may be disruptive and distracting to the creative process (Boell and Cecez-Kecmanovic 2015a; Leidner 2016). For example, Chiasson (2015) notes that excessive focus on the mechanics of the literature review methods “is a warning to pay attention to the increasing use of methodological checklists in IS research arising out of wholesale methodological absorption” (p. 175) and that such checklists can restrict “the ability of the authors to pursue alternative means and ends” (p. 175).

From a feasibility perspective, the concept of reproducibility can also be questioned in terms of the continually changing pool of literature that is available for review. When reproducibility is used in this context, concerns have been raised in the recent commentaries regarding potential challenges in re-performing database searches (Boell and Cecez-Kecmanovic 2015a).

Potential Impacts of the Identified Reproducibility Issues

As described above, the IS discipline currently faces three broad issues associated with IS literature review reproducibility: competing reproducibility definitions, ambiguous terminology, and questions related to the desirability/feasibility of reproducibility. Refer to Table 2 for a summary of these issues. Before considering what could be done to address these concerns, it is worthwhile to first consider the potential impacts.

From a terminology perspective, the unique application of the concept of reproducibility in IS (oriented around methods reproducibility) relative to other scientific disciplines (that focus on findings reproducibility) could lead to misunderstandings both within the field and from other disciplines in terms of the methodological activities that were undertaken during a literature review. Additionally, the ambiguity of the concept of reproducibility relative to systematicity, transparency, and replicability further

complicates the various elements that contribute to trustworthiness. Where authors, reviewers, and editors are unclear what reproducibility actually refers to, it becomes increasingly challenging to attain the objective. Finally, the differing views by recent commentators on the overall desirability and feasibility of reproducibility introduces even more doubt into the literature review writing process in terms of the potential trade-off between creativity and trustworthiness. In response to these concerns, we suggest a series of potential avenues in the following section.

(Re)considering the Concept of Reproducibility

Several avenues (see Table 2) may be helpful in moving towards a resolution to the concerns associated with reproducibility in the previous section. The first step is to clarify the definition of reproducibility and how it relates to other terms. A key proposal stemming from this research is to adjust the terminology pertaining to reproducibility to be increasingly consistent with other scientific fields. Specifically, we suggest that the use of the term reproducibility in the context of methodological steps that can be re-performed by others, (e.g., Paré et al. (2016) and Templier and Paré (2018)) be modified to *repeatability*. The concept of repeatability is established in the scientific literature and can be achieved in cases where, “from the information presented, a third party must be able to perform a study using identical methodological protocols and analyze the resulting data in an identical manner” (Cassey and Blackburn 2006, p. 958). This view of repeatability is consistent with the concept of methods reproducibility currently employed within the IS literature. By taking this approach, the concept of reproducibility (of findings) could be then applied within IS in a manner consistent with other scientific fields, as the situation where data is made available to others and is re-analyzed by an independent party in order to duplicate the results (Bollen et al. 2015; Cassey and Blackburn 2006; Goodman et al. 2016; Peng 2011).

This proposal achieves two objectives. First, it maintains the recognition of valuable observation made by Paré and colleagues related to the importance of being able to independently complete the methodological steps that the authors of a review have conducted (i.e., repeatability). However, secondly, it distinguishes this activity from the concept in reproducibility, in terms of findings that can be duplicated by an independent party, based on provided data (e.g., Bollen et al. 2015; Cassey and Blackburn 2006; Goodman et al. 2016; Peng 2011). By adopting this proposal, literature review authors can be increasingly clear as to what they did (or did not) do, while maintaining consistent terminology with scholars in other fields.

Current Issue	Examples	Potential Impact	Proposal
Competing reproducibility definitions	Paré et al. (2016) and Templier and Paré (2018) view reproducibility in terms of methods versus other scientific fields that view reproducibility in terms of findings, such as Bollen et al. (2015), Goodman et al. (2016), and Peng (2011).	A different use of terms in IS compared to other fields could lead to misunderstandings both within the field and from other disciplines in terms of the methodological activities that were undertaken in a study.	Modify IS terminology to be consistent with other fields. For example, adapt the ‘reproducibility of methods’ terminology used by Paré et al. (2016) and Templier and Paré (2018) to <i>repeatability</i> . Cassey and Blackburn (2006) explain that repeatability is achieved where, “from the information presented, a third party must be able to perform a study using identical methodological protocols and analyze the resulting data in an identical manner” (p. 958).
Ambiguous application of the term reproducibility, compared to systematicity,	Reproducibility is not always clearly differentiated from systematicity (Rowe 2014), transparency (Templier and Paré	Without a clear view on what is unique about the concept of reproducibility, it could be difficult for authors to undertake the	Researchers should be increasingly mindful of the key elements of <i>repeatability</i> (presenting sufficient information for a third party to perform the same methods), <i>reproducibility</i>

transparency, and replicability	2018), and replicability (Bandara et al. 2015; Paré et al. 2015; Templier and Paré 2018).	necessary activities and for reviewers to evaluate if those steps have been adequately completed.	(presenting the data to a third party, such as a journal, so that they could duplicate the results), and <i>replicability</i> (a new study that collects its own data in order to corroborate the results of a previous study) (Peng 2011).
Disagreements on the desirability and feasibility of reproducibility	Competing opinions on whether reproducibility is desirable and/or feasible (Boell and Cecez-Kecmanovic 2015a; Chiasson 2015; Leidner 2016).	For authors, attempting to achieve reproducibility could inadvertently reduce creativity, but ignoring reproducibility could reduce the trustworthiness of the study.	Highlight the cases where reproducibility is actually valuable (e.g., where can results actually be reproduced, where is creativity not impeded). For those that don't meet the criteria, reviewers and editors could focus on other trustworthiness criteria instead.

Table 2. Current Issue on Reproducibility in IS Literature Reviews

A second avenue is to carefully consider when reproducibility can add value to the trustworthiness of a review and when it cannot. That is, in what scenarios might the achievement of reproducibility be valuable and when might reproducibility be less desirable?³ In order to address this question, we considered past work on systematicity and replicability by Paré et al. (2015; 2016) in terms of the different types of the steps undertaken when conducting a literature review (Table 3) and the different genres of literature reviews (Table 4). When considering the six generic review steps that comprise a literature review (Paré et al. 2016), the methodological elements that would appear to pertain to our proposed application of the repeatability definition include developing a review plan, searching the literature, selecting studies, assessing the quality of studies, and extracting data or key aspects from the included studies. It would also include the analysis of the data, but would not go so far as to require the repeatability of findings or conclusions (see definition in Table 2). In comparison, under the proposed definition of reproducibility, the only step that would be relevant would be that the activity related to analysis, interpretation, and/or data synthesis, including the formulation of conclusions, as reproducibility is only concerned with the duplication of results, based on the provided data. Finally, from the perspective of replicability, all six steps would need to be sufficiently articulated to allow an independent party to both collect the data and then duplicate the results.

Literature Review Step	Repeatability	Reproducibility	Replicability
1. Developing a review plan	X		X
2. Searching the literature	X		X
3. Selecting studies	X		X
4. Assessing the quality of studies	X		X
5. Extracting data or key aspects from included studies	X		X
6. Analyzing, interpreting, and/or synthesizing data, and formulating conclusions	(Data analysis, but not results or conclusions)	X	X

Table 3. Distinguishing Between Repeatability, Reproducibility, and Replicability in IS Literature Reviews (Adapted from Paré et al. (2016))

³ In making this argument, we assume that both systematicity and transparency are necessary to enable the achievement of reproducibility.

Applying this line of thinking to the broader context of the nine literature review genres proposed by Paré et al. (2015), we considered the feasibility of repeatability, reproducibility, and/or replicability (see Table 4). For *repeatability*, our view here is consistent with that of Paré et al. (2015) in that narrative reviews are recognized for having shortcomings related to explanations of how the review process was conducted. However, each of the remaining eight genres have the potential to detail their methodological procedures to allow for a third party to re-perform them. For *reproducibility*, the only literature review genre that could broadly be expected to have an independent party duplicate the results of a previous study is a meta-analysis, due to the reliance on standardized statistical techniques. Similarly, for *replicability*, only the results from a meta-analysis could be reasonably be expected to be duplicated by a third party that is also responsible for re-collecting the data.

Literature Review Genre	Repeatability	Reproducibility	Replicability
Narrative review			
Descriptive review	X		
Scoping review	X		
Critical review	X		
Meta-analysis	X	X	X
Qualitative systematic review	X		
Umbrella review	X		
Theory development review	X		
Realist review	X		

Table 4. Repeatability, Reproducibility, and Replicability in IS Literature Review Genres (Adapted from Paré et al. (2015))

Future Considerations

Several important issues remain unaddressed that pertain to reproducibility. One relates to the elements other than the data that would need to be provided to allow for reproducibility. Goodman et al. (2016) note that reproducibility requires “...at minimum, the sharing of analytical data sets (original raw or processed data), relevant metadata, analytical code, and related software” (p. 1). In addition to the technical (e.g. infrastructure) and logistical challenges that could arise in authors sharing large quantities of data with reviewers and editors (Peng 2011), we also anticipate barriers in terms of sharing access to the software used to perform a meta-analysis.⁴ Although some authors may design their own tools to perform a meta-analysis based on accepted statistical procedures (e.g., Lipsey and Wilson 2001) that could be easily shared, others use tools that are difficult to obtain, such as the customized software for the Hunter-Schmidt methods (Schmidt and Le 2014) or expensive commercial tools such as Comprehensive Meta-Analysis. Difficulty in supplying broad access to these tools could impede reproducibility.

Another area of concern relates to the volatility of literature databases and several commentators have raised issues with the database search process (e.g., Boell and Cecez-Kecmanovic 2015a; vom Brocke et al. 2015). As new journals and conferences are added or removed from databases and the search algorithms are adjusted over time, an identical search conducted at two separate times may not always generate the same output. Although transparency may still be feasible even with this volatility by clearly articulating the search terms, justifying search decisions, and testing search parameters (vom Brocke et al. 2015), it may not be possible at a later date to repeat the same search steps in order to generate the same search results. Similarly, a common technique in literature reviews, particularly meta-analyses, is to collect unpublished studies so as to minimize the risk of publication bias (Rothstein et al. 2005; Schmidt and Hunter 2015).

⁴ We focus on meta-analysis in this argument, as it is the sole literature review genre that clearly links with our application of reproducibility terminology.

This activity may involve the authors contacting a large pool of researchers to determine if they have any unpublished studies they are willing to share, but the results of such an activity in terms of who responds are highly variable. Although authors can be transparent in explaining the process they employed, repeating that process at a future time is much more difficult.

Conclusion

The objective of this paper was to further the dialogue on trustworthiness in stand-alone IS literature reviews by considering the field's current views on the role of reproducibility. Although reproducibility is generally acknowledged as an important characteristic, alongside systematicity and transparency, it has yet to receive as much attention. In response, we examined the recent commentaries, editorials, and debates within the field in order to clarify how the concept of reproducibility was perceived and if there were any differences of opinion. We noted three issues: competing definitions of what reproducibility means, an ambiguous application of those terms compared to other trustworthiness concepts, and disagreements related to the desirability and feasibility of reproducibility. In response, we suggest that IS scholars employ the concept of reproducibility in a manner that is consistent with other scientific fields, in addition to more frequently pursuing the alternate objective of repeatability. In doing so, authors in IS may be more likely to pursue literature reviews that fulfill the objectives of systematicity, transparency, and repeatability, but that may not be reproducible. We believe that such reviews should still be perceived within the field as trustworthy, based on the awareness that it may not be desirable or feasible to achieve reproducibility for all genres of literature reviews in IS. One exception to this view may be in the case of meta-analyses, which are more consistent with the general tenets of reproducibility. Overall, we hope that this paper aids in continuing the rich discussion in the field as to how authors can continue to contribute valuable and meaningful insights through their literature review articles.

REFERENCES

- Bandara, W., Furtmueller, E., Gorbacheva, E., Miskon, S., and Beekhuyzen, J. 2015. "Achieving Rigor in Literature Reviews: Insights from Qualitative Data Analysis and Tool-Support," *Communications of the Association for Information Systems* (34:8), pp. 154-204.
- Boell, S.K., and Cecez-Kecmanovic, D. 2015a. "On Being 'Systematic' in Literature Reviews in IS," *Journal of Information Technology* (30:2), pp. 161-173.
- Boell, S.K., and Cecez-Kecmanovic, D. 2015b. "Debating Systematic Literature Reviews (SLR) and Their Ramifications for IS: A Rejoinder to Mike Chiasson, Briony Oates, Ulrike Schultze, and Richard Watson," *Journal of Information Technology* (30:2), pp. 188-193.
- Bollen, K., Cacioppo, J.T., Kaplan, R., Krosnick, J., and Olds, J.L. 2015. "Social, Behavioral, and Economic Sciences Perspectives on Robust and Reliable Science," National Sciences Foundation, Arlington, VA.
- Borko, H., Liston, D., and Whitcomb, J.A. 2007. "Genres of Empirical Research in Teacher Education," *Journal of Teacher Education* (58:1), pp. 3-11.
- Cassey, P., and Blackburn, T.M. 2006. "Reproducibility and Repeatability in Ecology," *BioScience* (56:12), pp. 958-959.
- Chiasson, M.W. 2015. "Avoiding Methodological Overdose: A Declaration for Independent Ends," *Journal of Information Technology* (30:2), pp. 174-176.
- Fink, A. 2010. *Conducting Research Literature Reviews: From the Internet to Paper, 3rd Edition*. Thousand Oaks: SAGE.
- Goodman, S.N., Fanelli, D., and Ioannidis, J.P.A. 2016. "What Does Research Reproducibility Mean?," *Science Translational Medicine* (8:341), pp. 1-6.
- Leidner, D.E. 2016. "Review and Theory Symbiosis: An Introspective Retrospective," *Journal for the Association for Information Systems* (19:6), pp. 552-567.
- Liberati, A., Altman, D.G., Tetzlaff, J., Mulrow, C., Gøtzsche, P.C., Ioannidis, J.P.A., Clarke, M., Devereaux, P.J., Kleijnen, J., and Moher, D. 2009. "The Prisma Statement for Reporting Systematic Reviews and Meta-Analyses of Studies That Evaluate Health Care Interventions: Explanation and Elaboration," *PLoS Medicine* (6:7), pp. 1-28.
- Lipsey, M.W., and Wilson, D.B. 2001. *Practical Meta-Analysis*. Thousand Oaks: SAGE Publications.

- Nonaka, I. 1994. "A Dynamic Theory of Organizational Knowledge Creation," *Organization Science* (5:1), pp. 14-37.
- Oates, B.J. 2015. "On Systematic Reviews for Evidence-Based Practice," *Journal of Information Technology* (30:2), pp. 177-179.
- Okoli, C. 2015. "A Guide to Conducting a Standalone Systematic Literature Review," *Communications of the Association for Information Systems* (37:43), pp. 879-910.
- Paré, G., Tate, M., Johnstone, D., and Kitsiou, S. 2016. "Contextualizing the Twin Concepts of Systematicity and Transparency in Information Systems Literature Reviews," *European Journal of Information Systems* (25:6), pp. 493-508.
- Paré, G., Trudel, M.-C., Jaana, M., and Kitsiou, S. 2015. "Synthesizing Information Systems Knowledge: A Typology of Literature Reviews," *Information & Management* (52:2), pp. 183-199.
- Peng, R.D. 2011. "Reproducible Research in Computational Science," *Science* (334:6060), pp. 126-127.
- Rothstein, H.R., Sutton, A.J., and Borenstein, M. 2005. "Publication Bias in Meta-Analysis," in *Publication Bias in Meta Analysis: Prevention, Assessment, and Adjustments*, H.R. Rothstein, A.J. Sutton and M. Borenstein (eds.). West Sussex, UK: Wiley, pp. 1-7.
- Rowe, F. 2014. "What Literature Review Is Not: Diversity, Boundaries and Recommendations," *European Journal of Information Systems* (23:3), pp. 241-255.
- Schmidt, F.L., and Hunter, J.E. 2015. *Methods of Meta-Analysis: Correcting Error and Bias in Research Findings (3rd Ed.)*. Thousand Oaks, CA: Sage Publications.
- Schmidt, F.L., and Le, H. 2014. "Software for the Hunter-Schmidt Meta-Analysis Methods, Version 2.0." University of Iowa, Department of Management & Organizations.
- Schultze, U. 2015. "Skirting Slr's Language Trap: Reframing the 'Systematic' Vs 'Traditional' Literature Review Opposition as a Continuum," *Journal of Information Technology* (30:2), pp. 180-184.
- Schwarz, A., Mehta, M., Johnson, N., and Chin, W.W. 2007. "Understanding Frameworks and Reviews: A Commentary to Assist Us in Moving Our Field Forward by Analyzing Our Past," *The DATA BASE for Advances in Information Systems* (38:3), pp. 29-50.
- Shea, B.J., Hamel, C., Wells, G.A., Bouter, L.M., Kristjansson, E., Grimshaw, J., and Boers, M. 2009. "AMSTAR Is a Reliable and Valid Measurement Tool to Assess the Methodological Quality of Systematic Reviews," *Journal of Clinical Epidemiology* (62:10), pp. 1013-1020.
- Sylvester, A., Tate, M., and Johnstone, D. 2013. "Beyond Synthesis: Re-Presenting Heterogeneous Research Literature," *Behaviour & Information Technology* (32:12), pp. 1199-1215.
- Tate, M., Furtmueller, E., Evermann, J., and Bandara, W. 2015. "Introduction to the Special Issue: The Literature Review in Information Systems," *Communications of the Association for Information Systems* (37:5), pp. 103-111.
- Templier, M., and Paré, G. 2018. "Transparency in Literature Reviews: An Assessment of Reporting Practices across Review Types and Genres in Top IS Journals," *European Journal of Information Systems* (27:5), pp. 503-550.
- Valanides, N., and Charoula, A. 2008. "An Exploratory Study About the Role of Epistemological Beliefs and Dispositions on Learners' Thinking About an Ill-Defined Issue in Solo and Duo Problem Solving Contexts," in *Knowing, Knowledge and Beliefs*. Netherlands: Springer, pp. 197-218.
- vom Brocke, J., Simons, A., Riemer, K., Niehaves, B., and Plattfaut, R. 2015. "Standing on the Shoulders of Giants: Challenges and Recommendations of Literature Search in Information Systems Research," *Communications of the Association for Information Systems* (37:9), pp. 205-224.
- Watson, R.T. 2001. "Introducing Misq Review - a New Department in Mis Quarterly," *MIS Quarterly* (25:1), pp. 103-106.
- Watson, R.T. 2015. "Beyond Being Systematic in Literature Reviews in IS," *Journal of Information Technology* (30:2), pp. 185-187.
- Webster, J., and Watson, R.T. 2002. "Analyzing the Past to Prepare for the Future: Writing a Literature Review," *MIS Quarterly* (26:2), pp. xiii-xxiii.
- Wolfswinkel, J.F., Furtmueller, E., and Wilderom, C.P.M. 2013. "Using Grounded Theory as a Method for Rigorously Reviewing Literature," *European Journal of Information Systems* (22:1), pp. 45-55.