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Editor's Introduction to a Debate on Proper Use of Partial Least Squares (PLS) Analysis in Information Systems

John R. Venable

Abstract:

This debate addresses an issue that has divided the Information Systems research community for years. Partial Least Squared (PLS) has both strong advocates and strong critics. In this debate, two prominent PLS critics (Jörg Evermann and Mikko Rönkkö) make a set of 14 evidence-based recommendations for how and when PLS may be appropriately used. Six different responses were received, some supportive, some critical, and some making further suggestions. Significantly, even those critical responses did not make arguments against the recommendations. As such, these recommendations should serve as current recommendations for best practice for quantitative researchers as well as reviewers and editors of work making use of PLS.

Keywords: Partial Least Squares, PLS, Quantitative Research, Research Methods in Information Systems.

This manuscript underwent editorial review. It was received in 2023. Fred Niederman served as Associate Editor.

1 Introduction

When Partial Least Squares (PLS) came onto the scene as a tool for research in Information Systems (IS), there was much excitement about it. Together with increasingly easy-to-use mathematical software (e.g. SmartPLS, WarpPLS), PLS promised advantages (some well-founded and others unfounded) including building and analysis of structured equation models (PLS-SEM) including latent variables, use of both reflective and formative constructs, flexibility of data types, lower requirements for sample sizes (supposedly), suitability for “exploratory research”, applicability to non-normal data, and ease of building models using graphical modelling. Compared to the then more established use of ordinary linear regression and covariance-based structured equation modelling (CBSEM), the touted advantages were very attractive and PLS has been widely adopted in quantitative IS research.

Indeed, as a then (relatively) young supervisor of PhD students, I had students who had identified PLS as an appropriate approach for their planned theorizing, data collection, and data analysis. In my own meagre PhD training in statistical research methods (focusing more on qualitative methods, but also including ordinary regression, which I also taught), I struggled somewhat to learn PLS-SEM and how to apply it, but more importantly was perhaps ill-prepared to consider questions of whether PLS *should* be used in the research situations into which my students entered. In addressing those challenges, I drew heavily on basic materials about PLS, including statistical analysis software manuals. Rarely did these address topics of critical thinking about appropriate (and inappropriate) PLS usage.

However, as a co-chair of the research methods track at ECIS 2012, we received a submission that provided a strong analysis and critique of PLS. Rönkkö, Parkkila, and Ylitalo (2012) provided an analysis that showed that previously published SEM models could be arrived at (i.e. converged upon with significant relationships indicated) using PLS, even if one substituted *random* data for the data of one of the constructs in the SEM model. In dialog with the authors, we learned that they were having difficulty publishing papers that were critical of PLS, which by then had received widespread acceptance in the IS field. We accepted the paper and were proud to see it presented at ECIS in 2011.

Since then, there have been many publications both critical of PLS and how it is used in the IS field (e.g. Rönkkö and Evermann (2013)) and strongly advocating its use for IS research (e.g. Hair, Ringle, and Sarstedt (2011)), which continues to this day.

Based on this ongoing disparity of views within the IS research community, a critical examination of the topic of the appropriate use of PLS seemed like a very appropriate topic for a formal debate within the pages of *Communications of the Association for Information Systems* (CAIS).

As the CAIS debate section editor, I asked Jöerg Evermann and Mikko Rönkkö whether they would be willing to write a piece setting out their views of when and how PLS can or should be appropriately used for IS research. I am immensely pleased with the outcome (Evermann & Rönkkö, 2023), which is up-to-date (as of the date of acceptance) and evidence-based and provides a clear set of 14 specific recommendations for when and how PLS can or should be used appropriately for drawing valid conclusions in IS research.

After Evermann and Rönkkö (2023) provided a position for the start of a debate, we then asked a number of experts on PLS to provide their reactions to the initial recommendations. Some of the response authors had previously been critical of PLS while others had advocated for the use of PLS.

Edward Rigdon has previously argued (Rigdon, 2016) that neither support for small sample size nor conducting “exploratory research” are appropriate justifications for the use of PLS, which he reiterates in his response (Rigdon, 2023). He further supports Evermann and Rönkkö (2023) in their stance against polemic pieces and arguments *ad hominem* (as does this editorial). However, Rigdon also suggests the use of generalized structured component analysis and regression component analysis rather than PLS.

In Kock (2023), Ned Kock, the developer of WarpPLS, provides a response supporting the position of Evermann and Rönkkö (2023) and focusing on the relationship of the debate piece and its recommendations toward various further suggestions for enhancements supported by WarpPLS.

Dale Goodhue, Will Lewis, and Ron Thompson, in their response (Goodhue et al, 2023) support the views of Evermann and Rönkkö (2023), provide further argument explaining the limitations of PLS, and discuss from a historical perspective the adoption and popularity, as well as consequences, of PLS within the field of IS. They close with a recommendation that the IS field either stop using PLS or limit its use to summed

scale scores. Failing that, they recommend that editors or major IS journals assemble a task force (including independent, non-IS statistical experts) to come up with recommendations for how the IS community should address open issues with PLS.

Daniel Russo and Klaas-Jan Stol recently published a paper encouraging the use of PLS within Software Engineering, a sibling research discipline of Information Systems (Russo & Stol, 2021). In responding to Evermann and Rönkkö (2023), they critique their analysis of the limitations of PLS, argue that some of their 14 recommendations are overly strict, ignoring philosophical and practical differences in PLS use (e.g. recommendations unsupported by statistical tools), recommend that a more nuanced and balanced debate is needed, and suggest that IS and related research fields should not discard PLS based solely on its limitations.

Florian Schuberth, Sam Zaza, and Jörg Henseler, in their response to Evermann and Rönkkö (2023) (Schuberth et al., 2023) in some ways mirror three of the four options for the IS field presented by Goodhue et al. (2023) by dividing the IS field's current reaction into three groups – (1) those continuing to use PLS while ignoring criticisms of PLS and its limitations, (2) those rejecting and abstaining from the use of PLS, and (3) those attempting to improve PLS to address its limitation and allow unproblematic use (which they use to characterize the work of Evermann and Rönkkö (2023)). Schuberth et al. (2023) support the views of Evermann and Rönkkö (2023), providing further explanation and making an additional (i.e. 15th) recommendation. In particular, they draw attention to the use of PLS in PLS-SEM (for structured equation modelling) and the need to follow the steps of SEM, regardless of which estimation technique is used.

Finally, Pratyush Sharma, Benjamin Liengard, Marco Sarstedt, Joseph Hair, and Christian Ringle (Sharma et al, 2023) in their response provide a strong critique of portions of Evermann and Rönkkö (2023), especially noting that any one study (e.g. using PLS) is not the be-all and end-all of research on a topic, with theoretical models needing (and getting) confirmation (or rejection) over time. Importantly, they do not quarrel with any of the recommendations made by Evermann and Rönkkö (2023). They suggest that not all is doom and gloom with PLS and that, similar to Russo and Stol (2023), a more balanced and positive perspective is needed on the debate. Importantly, they also note that the near-constant flow of improvements to PLS makes it difficult for reviewers and editors (let alone the poor researchers) to keep up with recent developments, yet it is precisely these gatekeepers who have the responsibility of ensuring that publications meet current standards of best practice.

Following the receipt, review, revision, and acceptance of all of the above six responses, Evermann and Rönkkö (2023) provided a rejoinder discussing each of the six responses described above. They addressed each of the six responses in turn, highlighting points of agreement and disagreement. They further provide an analysis of CAIS papers published during 2016-2021 that used PLS, critiquing the extent to which those papers followed (or rather reported following) various practices recommended at the time, highlighting potential inadequacies. Importantly, *none* of the six responses to Evermann and Rönkkö (2023) gave Evermann and Rönkkö (2023) cause to retract any of their 14 recommendations for the proper use of PLS. As such, they suggest that their recommendations should serve as a guide for researchers in planning and conducting PLS analyses and for reviewers and editors in evaluating the rigor and validity with which PLS analyses have been conducted. Also importantly, they note that extant PLS statistical analysis tools already support reporting on all of their 14 recommended practices *now*, so barriers to adoption of their recommendations in practice should be few.

Research methods, techniques, and tools are all purposeful artefacts, designed to achieve particular goals held by stakeholders in research, including researchers themselves, but also other research participants, reviewers, editors, publishers, and the ultimate users of the knowledge obtained through research. Designing research methods, techniques, and tools does not guarantee that they will work even if used properly (efficacy) or that they will be used properly in practice (effectiveness) to obtain knowledge. As my colleague Richard Baskerville and I noted in Venable and Baskerville (2012), as designed artefacts, research methods, techniques and tools need to be evaluated to determine whether and/or how well they work (or not) to achieve their stated goals and the kinds of situations in which their use is appropriate. I note that the work presented in this debate has actually focused on *efficacy* (i.e. the appropriate (and ideal) conditions in which PLS may and can produce valid analyses). That said, there also remains an issue of valid and valuable use in practice (i.e. evaluation of the *effectiveness* of PLS in practice). This remains an open issue. Are researchers (whether novice or experienced) able to assimilate all of the recommendations and apply them correctly? Will reviewers and editors take up the task of evaluating evidence of the proper application of PLS? While Evermann and Rönkkö (2023) have provided many

useful recommendations in this debate, it remains to be seen whether the IS field will answer these last two questions in the affirmative.

Finally, it is important to note that the field of research methods, techniques, and tools continues to evolve, so the recommendations arising from this particular debate cannot be seen as final. Research method specialists (and the researchers who apply them) are constantly working to improve the methods, techniques and tools at hand. The only constant in research (and perhaps everything else) is change. But when is a new, evolved, and/or (or hopefully) improved research method, technique, or tool evaluated enough to provide evidence that it can reliably produce rigor? When does the status of how to use it become standard and required rather than just emerging? Under what conditions should its status become “you *may* use it” (optionally) and (possibly) change to “you *should* use it” (recommended or even required)? Finding that “sweet spot” (not too soon and not too late) in the adoption of new, evolved, and/or (or hopefully) improved research methods is a topic for another time.

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