

Editorial

MEDIATION ANALYSIS ISSUES AND RECOMMENDATIONS

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ABSTRACT

This editorial outlines and responds to some of the most frequently asked questions regarding mediation analysis. Specifically, six key issues are addressed with reference to the state-of-the-art mediation literature. In doing this, we provide practical guidelines for researchers to successfully conceptualise, test and interpret mediation models. Recent references are also provided to discourage researchers from using outdated mediation approaches in their theses/manuscripts. It is our hope that this effort will clarify misconceptions regarding mediation analysis and provide up-to-date guidelines for researchers to make informed decisions and conduct the analysis appropriately.

Keywords: *Mediation analysis, Baron and Kenny, Preacher and Hayes, Malaysia, MySEM*

INTRODUCTION

Mediational designs are at the heart of social science and business research, often referred to as 'vital to theory development', 'important to the scientific status of the field' and an 'indispensable tool' to cultivate a better scientific understanding of the mechanisms which intervene the relationship between the exogenous and endogenous variables (Pieters, 2017; Rucker, Preacher, Tormala, & Petty, 2011; Wood, Goodman, Beckmann, & Cook, 2008). To illustrate, mediation is typically the standard technique and procedure to test theories in order to understand the causal relationship (Baron & Kenny, 1986; MacKinnon, 2008; Preacher & Hayes, 2004; Shrout & Bolger, 2002). Therefore, mediation model has become increasingly 'ubiquitous' and 'almost mandatory' in the contemporary literature and research endeavours (Bullock, Green, & Ha, 2010; Mathieu & Taylor, 2006).

Evidently scholars today are placing an increased emphasis on studying mediation models. Wood et al. (2008) reviewed five top management journals—*Journal of Applied Psychology*, *Organizational Behaviour and Human Decision Processes*, *Academy of Management Journal*, *Personnel Psychology* and *Administrative Science Quarterly*—over the past 25 years (1981–2005) and identified 409 studies that tested mediational relationships. Pieters (2017) observed that the majority of empirical articles in the *Journal of Consumer Research* used mediation analysis. Similarly, Rungtusanatham, Miller, and Boyer (2014) reviewed supply chain management articles which were published between 2008 and 2011 and found that supply chain management literature was/is increasingly interested in mediation effects. Additionally, mediation has progressively been noted in organisational psychology and organisational behaviour (Holland, Shore, & Cortina, 2016; James & Brett, 1984), marketing and consumer science (Pieters, 2017), school psychology (Fairchild & McQuillin, 2010), social psychology (Bullock et al., 2010; Rucker et al., 2011), social and behaviour sciences (Kenny & Judd, 2014), strategic management (Aguinis, Edwards, & Bradley, 2016), operations management (Malhotra, Singhal, Shang, & Ployhart, 2014), as well as clinical research (Hayes & Rockwood, 2016), thus confirming the popularity of mediation analysis/modeling in academic research.

Despite a growing body of literature on mediation (see Aguinis et al., 2016; Baron & Kenny, 1986; Green, Tonidandel, & Cortina, 2016; Hayes, 2013; MacKinnon, 2008; MacKinnon, Coxe, & Baraldi, 2012; Rucker et al., 2011; Shrout & Bolger, 2002; Zhao, Lynch, & Chen, 2010), researchers continue to use outdated methods of mediation (Aguinis et al., 2016; Rucker et al., 2011). Past studies (e.g., MacKinnon, 2008; Rucker et al., 2011; Wood et al., 2008) have long pointed out that a large number of studies have followed the causal steps approach suggested by Baron and Kenny (1986). Another essential issue highlighted by Miller, Triana, Reutzler, and Certo (2007) is that the vast majority of studies (77%) that examined mediation did not test the mediated effect itself. Unfortunately, this trend continues in recent research (Aguinis et al., 2016). Moreover, the reporting of mediation results was often inefficient and incomplete (Wood et al., 2008). Another important issue noted by Rungtusanatham et al. (2014) is that they found a high percentage of mediation articles (75%) which did not even hypothesise mediating effects despite invoking the mediation process in prose or in diagrammatic form.

Similar issues have been observed among researchers in Malaysia due to the lack of understanding of mediation analysis. Particularly, postgraduate researchers remain unclear of the requirements and considerations for analysing a mediation framework. Consequently, the use of outdated approaches is quite common among local researchers. This is apparent based on the number of inquiries and the type of questions we receive on a regular basis, be it personally or through *MySEM* group—a dedicated forum on structural equation modeling (SEM) and related methods. These perennial inquiries include issues pertaining to direct and indirect effect, number of hypotheses, interpretation of results, type of approach, and selection of appropriate analytical tools for mediation analysis. This editorial intends to address some of these issues.

The purpose of this editorial is to advance our understanding of mediation analysis so as to help the local researchers. In doing so, we review state-of-the-art literature, clarify misunderstandings and highlight issues regarding the use of mediation analysis. In addition, drawing on past literature, we outline how to deal with these issues and recommend methodological guidelines to successfully conceptualise, test, interpret and report mediation models. Furthermore, this editorial echoes Guide and Ketokivi (2015) work by discouraging researchers from using outdated approaches in their theses/manuscripts. The whole idea is to provide a practical, easy-to-follow guidelines which would help expedite the journey of every researcher, especially the emerging ones, in conducting mediation analysis.

BASIC MEDIATION MODEL

Before discussing the issues related to mediation analysis, we outline a basic mediation model that we will refer to and discuss throughout this editorial. A mediator (M) is a third variable that explains how or why two other variables (i.e. X and Y) are related. A simple mediation model consists of at least three variables: one independent variable (X), one mediator (M) and one outcome variable (Y). The model is adopted from Holland et al. (2016). Figure 1 shows the relationship between X , M and Y .



Figure 1. A simple mediation framework.
 Source: Holland et al. (2016)

ISSUES AND RECOMMENDATIONS

Issue 1: Preparation for mediation analysis

Question 2: What should I do prior to running a mediation analysis?

Recommendation: This is one of the fundamental questions that everyone should consider before doing a mediation analysis. Using multiple mediators to make a model complex and introducing a mediator to see how it works are neither a good advice nor practice. Focusing solely on statistical issues and data analysis tools is also not sufficient to justify a mediation study. The significance of a mediation model mainly depends on the design decisions that should be considered before any analysis and even before the research is conducted (MacKinnon et al., 2012). Simply stating that M will mediate the relationship between X and Y neither justifies the role of mediator nor contributes to the advancement of theory building. The need of a mediator in a model must be explicitly raised and justified up front by responding to two key questions: 1) why a mediator is needed and 2) which variable should be considered the mediator, and why? The conceptualisation of a mediation relationship needs forethought about the relationships between the variables of interest and the theoretical meaning behind those relationships (MacKinnon et al., 2012). Also, the researcher must hypothesise explicitly for mediation effects ‘to formally engage in a theorizing exercise to formulate hypotheses about mediation effect before proceeding to test and draw conclusion about it’ (Rungtusanatham et al., 2014, p. 106). Among other issues, reliability and validity of the instrument, sample size to detect required effects, selection of appropriate software application and basic understanding of available approaches for mediation testing including their strengths and weakness are the key issues one must be aware of before conducting a mediation analysis. A brief discussion on the issues before, during and after mediation analysis is provided in MacKinnon et al. (2012). Moreover, reading classical work on mediation by Baron and Kenny (1986) and James and Brett (1984), ground-breaking papers by Preacher and Hayes (2004, 2008), Hayes (2009) and recent masterpieces by Aguinis et al. (2016), Rungtusanatham et al. (2014), and Schoemann, Boulton, and Short (2017) can be good references to understand the fundamentals of mediation effects and how they work. We would also recommend the works of Aguinis, Ramani, and Alabduljader (2017), and Green et al. (2016) as well as our recent paper Memon, Ting, Ramayah, Chuah, and Cheah (2017) as a good start to understand the general methodological issues and potential remedies related to mediation analysis.

Issue 2: Number of hypotheses

Question 2: How many hypotheses should be developed for a mediation effect?

Recommendation: This is one of the most frequently asked questions about mediation. Rungtusanatham et al. (2014) clarified the issue of how formal hypotheses for mediation effects are developed and articulated and recommended two major approaches: segmentation and transmittal approaches. When adopting the *segmentation approach*, three hypotheses should be developed: H1) independent variable (X) effects mediator (M), H2) mediator (M) effects outcome variable (Y) and H3) mediation effect (e.g. M mediates the relationship between X and Y). Papers using the segmentation approach include Zhou, Benton, Schilling, and Milligan (2011), Paulraj (2011) and Wu, Choi, and Rungtusanatham (2010). The *transmittal approach*, in turn, requires a single hypothesis stating that mediator (M) mediates the relationship between X and Y without delving into hypotheses relating X to M and M to Y , as summarized in Table 1. Rungtusanatham (2001) and Sarkis, Gonzalez-Torre, and Adenso-Diaz (2010) are some of the examples for theorising mediation models using the transmittal approach. We would strongly recommend researchers to read Rungtusanatham et al. (2014) as it will help them articulate mediational hypotheses. A detailed discussion on this matter is also provided in the 2nd edition of our PLS manual (Ramayah, Cheah, Chuah, Ting, & Memon, 2018).

Table 1. Hypotheses for Mediation Analysis

Segmentation Approach (Rungtusanatham et al., 2014)	
H1	The effect of X on M Example: There is a positive effect of X on M
H2	The effect of M on Y Example: There is a positive effect of M on Y
H3	Mediation effect Example 1: M mediates the relationship between X and Y Example 2: X has an indirect effect on Y through M
Transmittal Approach (Rungtusanatham et al., 2014)	
H1	Mediation effect
	Example 1: M mediates the relationship between X and Y
	Example 2: X has an indirect effect on Y through M

Source: Ramayah et al. (2018)

Issue 3: Using Baron and Kenny’s (1986) approach

Question 3: Can I use Baron and Kenny’s (1986) approach for mediation analysis?

Recommendation: The Baron and Kenny’s causal-steps¹ approach is widely recognised and cited, achieving more than seventy thousand citations to date. It is still a good reference and one of the most read papers to understand the mediation theory. Nevertheless, recent development in mediation literature unequivocally discourages researchers from using Baron Kenny’s approach because of its severe limitations (Aguinis et al., 2016; Green et al., 2016; Guide & Ketokivi, 2015; Hayes, 2009; Rucker et al., 2011). These limitations include: 1) low statistical power, 2) not directly testing the significance of a specific indirect effect, 3) neither quantifying the magnitude of the mediation effect, nor accommodating models with inconsistent mediation (Hayes, 2009; MacKinnon, 2000; MacKinnon, Lockwood, Hoffmann, West, & Sheets, 2002; Rungtusanatham et al., 2014). Considering these limitations, ‘using Baron and Kenny’s approach might produce misleading results, refute potentially significant theoretical relationships, and in turn damage future theory building’ (Rungtusanatham et al., 2014, p. 131).

¹ Baron and Kenny (1986) causal-steps for mediation analysis: 1) X must have related to Y , 2) X must have related to M , 3) X and M must have related to Y , and 4) The effect of X on Y shrinks upon inclusion of M .

There are also clear recommendation to abandon this approach to test for mediation effects (Rucker et al., 2011; Rungtusanatham et al., 2014). Guide and Ketokivi (2015) explicitly advise that following Baron and Kenny (1986) was fine in the 1980s; however, researchers need to be cautious with it today. For advanced approaches and a better understanding of the issues related to the Baron and Kenny's approach and the efficacy of other methods, one should look at Aguinis et al. (2016), Rucker et al. (2011), Hayes (2009), Hayes (2013) and Rungtusanatham et al. (2014).

Issue 4: Testing the relation between antecedent (X) and outcome (Y)

Question 4: Should I test the relationship between X and Y when testing mediation?

Recommendation: Although we have already covered this issue (see Issue 3) and discussed the limitations of the causal step approach, we wish to further explain here why one should not test X and Y when testing for a mediation effect. Testing the relationship between X and Y for mediation analysis is the first condition of Baron Kenny's causal-steps approach. Historically, because of such a condition and the steps, several mediating relationships were rejected and prematurely ended (Hayes, 2009). The practice of testing direct effects violates the basic principle of parsimony and prompts researchers to examine models that are not aligned with theory (Aguinis et al., 2016). Thus, a mediation analysis does not require an association between X and Y (Hayes, 2009; MacKinnon, Krull, & Lockwood, 2000; Preacher & Hayes, 2004; Rucker et al., 2011; Rungtusanatham et al., 2014; Shrout & Bolger, 2002; Zhao et al., 2010). To illustrate, the relationship between X and Y 'needs not be considered when determining whether M mediates the effect of X on Y because that path is not part of mediated effect' (Aguinis et al., 2016, p. 12). Testing the significance of $X \rightarrow Y$ before or after examining a mediation effect is outdated and unnecessarily restrictive. If theory suggests the presence of mediation, researchers should test it regardless of the significance of the relationship between X and Y . This does not mean that researchers should stop testing the direct relationship between X and Y . However, taking into account the discussion above, it is suggested that testing $X \rightarrow Y$ with the purpose to confirm a simple mediation effect is rather unnecessary and a hindrance to theory building. We recommend some articles on the subject matter, including the works by Aguinis et al. (2016), Rungtusanatham et al. (2014) and Rucker et al. (2011), Zhao et al. (2010), and Hayes (2009). Also, a brief explanation of such an issue is detailed in Ramayah et al. (2018).

Issue 5: Complete or full mediation

Question 5: Should I conclude a mediation effect as a complete mediation?

Recommendation: Contemporary literature on mediation advocates that complete (also called full) and partial mediation concepts have little value and should be abandoned (Hayes, 2013; Hayes & Rockwood, 2016; Rucker et al., 2011). Full mediation implies that a researcher has completely explained the process by which X influences Y and no additional research is needed to search for further mediators (Hayes & Rockwood, 2016). The reality is that to claim full mediation, one would have to have confidently measured all possible mediators and suppressors without error. Nevertheless, measuring variables without error in social science and business research is practically impossible. Hence, 'one cannot ever claim to have established complete mediation' (Rucker et al., 2011, p. 369). Moreover, scholars have recently advocated that claiming a complete mediation would likely discourage researchers from examining other theoretically driven mediators, which in turn can unnecessarily constrain theory development (Hayes, 2009; Rucker et al., 2011; Rungtusanatham et al., 2014). Suffice it to say researchers should avoid using the terms complete and partial mediation when developing a mediation hypothesis or interpreting mediation effects (Hayes, 2013; Hayes & Rockwood, 2016; Rungtusanatham et al., 2014). We also recommend researchers to read Zhao et al. (2010) to know more about competitive and complementary mediation.

Issue 6: Analysing mediating effect

Question 6: How do we confirm that there is a mediation effect between X and Y?

Recommendation: The central consideration of mediation analysis is that there is a significant relationship between the independent variable (X) and outcome (Y) through the mediator (M). Researchers should follow Preacher and Hayes's (2004, 2008) approach and bootstrap the sampling distribution of the indirect effect. Specifically, bias-corrected bootstrapping is considered a powerful method to detect mediation. A statistically significant indirect effect (z -value > 1.96 , two-tailed, $p < 0.05$) should be taken as an evidence for mediation (Preacher & Hayes, 2004; Zhao et al., 2010). Additionally, evaluating confidence intervals is another important condition to confirm a mediation effect. If the confidence interval for the indirect effect does not straddle a zero in between, this supports the presence of mediation effect (and vice versa). Statistical programmes such as PROCESS, SmartPLS, WarpPLS, ADANCO and AMOS help authors to estimate a bootstrap confidence interval for the models with indirect effects. However, when analysing models with multiple mediators, researchers must estimate *specific indirect effects*, instead of *total indirect effects*. SmartPLS 3.0 (Ringle, Wende, & Becker, 2015) and WarpPLS6.0 (Kock, 2017) can estimate specific indirect effects, thus making the assessment of models with multiple mediators easier. Researchers are also encouraged to explore other methods of mediation analysis, for example Monte Carlo simulation (MacKinnon, Lockwood, & Williams, 2004; Preacher & Selig, 2012), and Bayesian estimation (Yuan & MacKinnon, 2009). For more information, articles by Preacher and Hayes (2004, 2008), and Hayes (2013) for mediation analysis using PROCESS macro should be referred to. Cepeda, Nitzl, and Roldán (2018), Nitzl, Roldan, and Carrion (2016) and Kock (2014) can also be a good start to know more about mediation analysis using PLS-SEM. For a practical explanation and step-by-step guidelines, we strongly recommend the PLS Primer by Hair, Hult, Ringle, and Sarstedt (2017) and PLS manual by Ramayah et al. (2018) to assess mediation in SmartPLS 3.0. Well-researched explanation and guidelines on mediation analysis can also be found in materials using other languages, such as Chinese (Shiau, 2017) and Indonesian (Ghozali & Latan, 2015).

CONCLUSION

Notwithstanding brief, we believe we have provided a concise explanation and guidelines to conducting mediation analysis in this Editorial. It is hoped that researchers in Malaysia, including supervisors and postgraduate students, would take heed of our advice to move away from what they knew and heard in the past and get into the current development of mediation analysis. Reading selectively and conducting analysis based on what we know conveniently have been our conundrum. However, with all the literature and resources (such as *MySEM* Facebook group) available at our disposal, there is simply no excuse to not update ourselves with any methodological advancement and changes. With that being said, it is also our hope that this Editorial contributes to improving researchers' understanding and use of mediation analysis.

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