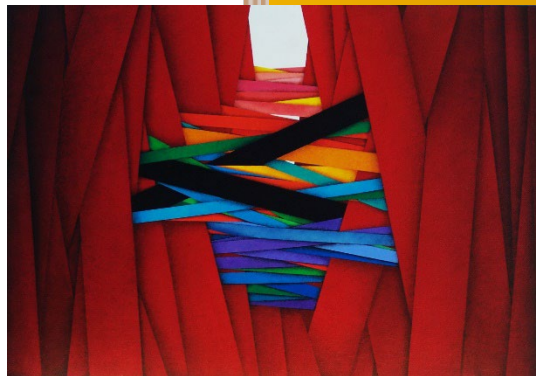


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Unraveling Endogeneity: A Systematic Review of Methodologies in Digital Leadership and Remote Work Research

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Abstract: In the evolving landscape of digital leadership and remote work, methodological challenges, particularly endogeneity, have emerged as significant concerns. Endogeneity, which arises when independent variables correlate with regression error terms, can introduce biases that compromise the validity of research findings. This systematic review examines the methodological underpinnings of research in digital leadership and remote work, focusing on how studies have addressed or overlooked the challenges posed by endogeneity. Drawing from 45 seminal articles published between 2019 and 2023, the review reveals a predominant preference for quantitative approaches, with a subset exploring qualitative narratives. While 15 studies directly tackled endogeneity using rigorous methodologies, 10 did not address it, indicating potential gaps in their investigative rigor. This study not only provides clarity and direction for future research endeavors but also supports the advancement of research methodology in business and management by emphasizing the need for methodological rigor in the study of digital leadership and remote work dynamics. By systematically evaluating the methods used to address endogeneity, this research advances the field of business and management research methodology by identifying best practices and highlighting areas for improvement. Specifically, it advocates for the adoption of advanced econometric techniques, such as instrumental variables and fixed effects models, to mitigate biases and enhance the reliability of research outcomes. Furthermore, this review underscores the importance of integrating both quantitative and qualitative approaches to capture the multifaceted nature of digital leadership and remote work, thereby contributing to a more comprehensive understanding of these domains. The study also highlights the influence of unobserved factors on outcomes such as employee productivity, leadership effectiveness, and team cohesiveness. In sum, this research provides a foundational framework for scholars aiming to enhance the robustness and validity of their studies in digital leadership and remote work, aligning with the broader goals of advancing research methodologies in business and management.

Keywords: Digital leadership, Remote work, Endogeneity, Methodological rigor, Systematic review

1. Introduction

In the contemporary professional milieu, significant transformations have been observed, most notably the ascendance of digital leadership and the proliferation of remote work as quintessential attributes of the present-day workplace (Kupiek, 2021). Such metamorphoses, underpinned by the confluence of technological innovations and salient global events, principally the COVID-19 pandemic, have engendered a comprehensive reconfiguration of organizational operations and leadership paradigms (Dirani *et al.*, 2020; Hitt, Holmes and Arregle, 2021). As delineated by Espina-Romero *et al.* (2023) and Luo, He and Li (2023), the exigencies placed upon contemporary leaders have undergone an augmentation. Beyond the realm of conventional managerial responsibilities, leaders find themselves navigating, with increasing alacrity, the intricacies of the digital domain.

Nevertheless, as the academic sphere penetrates deeper into these nascent dimensions, it persistently grapples with methodological conundrums, the preeminent of which is endogeneity (Shaver, 2020; Selezneva and Evdokimova, 2022). Endogeneity, manifesting when independent variables exhibit correlation with regression error terms, has the propensity to introduce profound biases into analytical frameworks (Jean *et al.*, 2016). Such biases jeopardize the veracity of scholarly interpretations by potentially obfuscating authentic relationships or inducing the perception of specious ones (Shaver, 2020). Ranging from simultaneity biases to challenges stemming from omitted variable concerns, these biases cast aspersions on the authenticity of academic conclusions (Jean *et al.*, 2016; Selezneva and Evdokimova, 2022).

The domains of digital leadership and remote work are particularly vulnerable to these analytical challenges due to their inherent complexities and rapid evolution (Banks *et al.*, 2022). Research on digital leadership often seeks to understand the impact of various leadership styles on remote team dynamics, encountering frequent methodological hurdles (Antonakis *et al.*, 2019). Similarly, studies on remote work may overlook individual

preferences for different remote work setups, inadvertently heightening bias risks (Banks *et al.*, 2017; Cooper *et al.*, 2020).

In response to the complexities posed by endogeneity and its related concerns, many scholars have turned to a variety of methodological tools and strategies. The use of instrumental variables, as discussed by Papies, Ebbes and Feit (2023), emerges as a strong approach to clarify causality issues. Guide and Ketokivi (2015) emphasize the importance of fixed effects models, which, by accounting for certain latent variables, increase the robustness and rigor of empirical designs. The advocacy for sophisticated econometric methodologies further strengthens the defense against challenges associated with endogeneity (Hill *et al.*, 2021; Li *et al.*, 2021). Notable scholars, including Banks *et al.* (2022) and Luu (2023), have highlighted the evolving dynamics of leadership in this digital era, underscoring both its promises and challenges. Despite this extensive body of knowledge, gaps remain, especially regarding methodological rigor and the problems associated with endogeneity.

Against this complex scholarly background, this manuscript identifies its focus. Our goal is to provide a detailed analysis of the methodological foundations in research on digital leadership and remote work, particularly how studies have either effectively addressed or overlooked the nuanced challenges posed by endogeneity. This involves examining various approaches used by researchers, such as the implementation of instrumental variables (Papies, Ebbes and Feit, 2023) and fixed effects models (Guide and Ketokivi, 2015), which have shown promise in mitigating endogeneity issues. By integrating these methodologies, scholars can enhance the robustness of their studies and better capture the realities of digital leadership and remote work dynamics. In undertaking this academic exploration, we aim to shed light on the current state of the field and pave the way for future research endeavors that are methodologically rigorous and relevant to the varied realities of this digital era. Our central question is: "How have scholarly efforts navigated the methodological intricacies, focusing on the pitfalls of endogeneity, in their exploration of digital leadership within the context of remote work?" With this analytical approach, we aim to provide clarity, academic coherence, and critical insight to a field that remains dynamic and essential.

2. The Review Methods

2.1 Eligibility Criteria

In conducting the systematic review, a rigorous methodology anchored by clearly defined eligibility criteria was crucial to ensure both precision and comprehensive coverage (McCrae, Blackstock and Purssell, 2015). The pivotal starting point was the decision to rely exclusively on the Elsevier database, a choice driven by its vast collection of scholarly content pertinent to the domains of interest (Ballew, 2009). However, such exclusivity presents a limitation, potentially overlooking seminal works available in other databases (Gusenbauer and Haddaway, 2020).

Transitioning from source selection to temporal scope, the period from January 2019 to September 2023 was chosen as the focus. This wasn't a random selection; there was a noticeable uptick in discussions surrounding digital leadership and remote work starting in 2019 (Sheninger, 2019; Gierlich-Joas, Hess and Neuburger, 2020). Nevertheless, this specific timeframe, while providing a contemporary perspective, may inadvertently omit relevant insights from earlier periods.

Moving on to language as a filtering criterion, the review honed in on English publications, a pragmatic choice ensuring consistent interpretation (Alexander, 2020). Yet, this linguistic limitation inevitably risks missing significant contributions from non-English scholarship (Walpole, 2019). Delving into the search mechanics, the central theme revolved around the interplay between leadership and the diverse world of remote work. To illustrate, a sample search in Elsevier included the query: (Leadership) AND ("remote work" OR "telework" OR "telecommuting" OR "virtual work" OR "work from home").

Set against the backdrop of Business, Management, and Accounting, clear boundaries for this exploration were drawn. However, defining inclusion also brings the challenge of exclusion into the spotlight. While thematic relevance remained paramount, a more nuanced evaluation was undertaken, considering methodological clarity and thematic depth. There was a clear preference for empirical studies, aiming to derive concrete insights, but this exists alongside an acknowledgment of the richness offered by theoretical works. To conclude this criterion description, the emphasis on peer-reviewed articles, while appearing restrictive, underscores a steadfast dedication to maintaining academic rigor, yet also acknowledges the potential value within the wider academic domain (Amir-Behghadami and Janati, 2020; Harari *et al.*, 2020).

2.2 Studies Selection

Initiating the research endeavor, a comprehensive search was conducted within the Elsevier database. This search yielded a total of 396 articles elucidating the intricacies of digital leadership and remote work. Given the substantial number of initial findings, it became imperative to employ a systematic filtration strategy. In the preliminary phase, titles and abstracts underwent rigorous screening to ascertain alignment with the research objectives. This critical process refined the pool to 76 pertinent articles.

In the subsequent selection phase, these 76 articles were meticulously examined in terms of their full texts. A particular emphasis was placed upon the robustness of their methodological constructs and their congruence with the theme of endogeneity in digital leadership, a central tenet of the current research. This rigorous assessment culminated in the isolation of 45 seminal articles, each published between 2019 and September 2023, and firmly anchored in the disciplines of Business, Management, and Accounting. Upholding a commitment to thoroughness, the reference lists of these 45 articles were scrupulously inspected to ensure that no pivotal works, potentially of significant contribution to the systematic review's narrative, were inadvertently omitted.

2.3 Data Collection Process

Upon commencing data extraction, it became evident that a structured and systematic approach was essential (Lunny *et al.*, 2017). This approach was established through a series of subsidiary research questions, each tailored to foster a deeper understanding of the topic. The primary focus was on methodologies, with the aim of determining their role in ascertaining causality within the realm of digital leadership in remote work environments. This investigation was prompted by the question: "Which specific methodologies have been commonly employed to ensure causality in studies of digital leadership in remote work contexts?" Such an assessment is vital because establishing causality provides a robust foundation for informed decision-making and policy development in the rapidly evolving domain of digital leadership in remote work settings (Antonakis *et al.*, 2014; Martin *et al.*, 2021).

As the analysis advanced, the emphasis transitioned towards assessing the methodological rigor of the chosen studies, especially concerning endogeneity. The guiding question at this point was: "To what extent have studies on digital leadership in remote settings employed experimental designs, instrumental-variable estimation, or other stringent methods?" Simultaneously, potential omissions of critical variables in some studies were examined to determine whether such lapses led to ambiguous or misleading outcomes. This evaluation provided a comprehensive view of the predominant methodologies and their potential limitations (Antonakis *et al.*, 2010; Boyd, Gove and Solarino, 2017; Cheng and Choi, 2022).

Beyond merely evaluating the current state of research, the process aimed to identify gaps and set the stage for future scholarly endeavors (Mengist, Soromessa and Legese, 2020). The examination focused on the most glaring gaps in the literature, particularly regarding methodological robustness, and made suggestions for forthcoming research.

To validate the accuracy of this extraction process, a pilot review was conducted on a sample of articles (Long, 2014). This preliminary step sets the standard for the comprehensive extraction process. Each article underwent a meticulous review concerning the subsidiary questions, with results systematically documented. To bolster the reliability of the review (Waffenschmidt *et al.*, 2019; Haby *et al.*, 2023), every fifth article was reevaluated by a separate reviewer, following consistent guidelines. Differences in interpretations were resolved by reaching a consensus or, if necessary, through third-party mediation.

3. Results and Analysis

3.1 Methodological Approaches and Endogeneity Concerns

The journey through the academic milieu of digital leadership and remote work began with an expansive collection of studies. Upon meticulous scrutiny, 45 pivotal studies were earmarked for their crucial insights and distinctive contributions (Flavian, Guinalíu and Jordan, 2019; Norman *et al.*, 2020; Leonardelli, 2022). Predominantly, the selected research landscape veered towards a quantitative approach, a choice evident in 33 studies. This suggests a marked emphasis on empirical evidence and quantifiable metrics in this realm (e.g., Bae, Lee and Sohn, 2019; Muttaqin, Taqi and Arifin, 2020; Allgood, Jensen and Stritch, 2022). However, an insightful subsection of 8 studies delved into the qualitative narrative, aiming to unearth the intricacies and lived experiences of individuals navigating the digital leadership and remote work ecosystems (e.g., Daraba *et al.*, 2021; Abalkhail, 2022; Ferreira, Pinto-Moreira and Larginho, 2023). An intriguing blend of both of these

paradigms was showcased by four studies, emphasizing the depth and breadth the mixed-method approach brings to the table (e.g., Johnson & Mabry, 2022; Leonard *et al.*, 2023; Mutha & Srivastava, 2023).

Endogeneity, a concern of paramount importance, garnered varied attention across the reviewed corpus (Cooper *et al.*, 2020; Hill *et al.*, 2021). A commendable 15 studies tackled it head-on, employing rigorous methodologies such as experimental designs or instrumental-variable estimation (e.g., Darics, 2020; Junça Silva, Almeida and Rebelo, 2022; Mohanan and Rajarathinam, 2023). An additional 20 studies acknowledged it partially, suggesting a cautious approach to the topic (e.g., Bhumika, 2020; Barhate, Hirudayaraj and Nair, 2022; Islam *et al.*, 2022). Surprisingly, 10 studies did not address this concern, indicating potential gaps in their investigative rigor (e.g., Günther, Hauff and Gubernator, 2022; Imhanrenialena *et al.*, 2023). Of particular note were studies that not only acknowledged endogeneity but also pioneered innovative techniques or applied especially rigorous methodologies to counteract its implications. Abalkhail (2022), for instance, stood out for its nuanced instrumental-variable approach, while Mohanan and Rajarathinam's (2023) employed panel data and fixed-effects models, offering a robust defense against potential endogeneity pitfalls. Likewise, Ferreira, Pinto-Moreira and Larginho's (2023) experimental design, meticulously crafted, serves as a beacon of methodological excellence in this arena.

Amidst these methodological nuances, certain thematic areas emerged prominently. Employee productivity in remote settings garnered significant attention (Choudhury, Foroughi and Larson, 2021; Straus *et al.*, 2023). Studies such as Liebermann *et al.* (2021), Sanhokwe (2022), and Santiago-Torner (2023) delved deep into the influencing variables and potential unobserved factors. Leadership effectiveness in digital contexts was another spotlight area, explored extensively by studies like Müller and Niessen (2019), Johnson and Mabry (2022), and Lee and Kim (2023). Additional domains, including team cohesiveness, employee well-being, and innovation in remote teams, were meticulously charted by studies such as those developed by Norman *et al.* (2020), Eichenauer, Ryan and Alanis (2022), and Pereira and Marcolino (2023).

In synthesis, while the selected studies span a diverse spectrum of methodological strategies, their collective approach to endogeneity highlights both the progress made and the challenges that persist in the rigorous study of digital leadership and remote work dynamics.

3.2 Outcomes and Potential Influences by Unobserved Factors

Delving into the myriad facets of digital leadership and remote work research derived from the compilation of 45 reviewed studies, several pivotal outcomes or dependent variables emerged as the cynosure of academic intrigue. First and foremost, a large number of studies, notably those exemplified by Müller and Niessen (2019), Islam *et al.* (2022), and Barhate, Hirudayaraj and Nair (2022), centered their investigations around the metrics of employee productivity in remote environments. It is crucial to underscore the lurking shadows of unobserved factors (Rutz and Watson, 2019; Li *et al.*, 2021). Individual motivation, inherent distractions in the home environment, or even the caliber of digital tools employed could potentially sway productivity readings. For instance, Islam *et al.* (2022) meticulously factored in the influence of individual motivation using control variables. In contrast, Barhate, Hirudayaraj and Nair (2022) seemed to give mere cursory acknowledgment to the potential perturbations caused by distractions in the home environment.

Leadership effectiveness in the digital medium, as focused upon in studies like Norman *et al.* (2020), Krehl and Büttgen (2022), and Mander and Antoni (2023), also garnered significant scholarly attention (Torre and Sarti, 2020; Tigre, Curado and Henriques, 2023). However, the uncharted waters of leaders' digital literacy, their antecedent rapport with teams, and adaptability to the digital metamorphosis could arguably modulate the findings (Bartsch *et al.*, 2021). In this context, Krehl and Büttgen (2022) provided an illuminating approach by incorporating leader adaptability as a moderator. Yet many studies frequently overlook the nuanced interplay of these unobserved elements.

Furthermore, the cohesive fabric of remote teams, often termed "team cohesiveness," (Palos-Sanchez, Baena-Luna and Silva-O'Connor, 2023) was the focus of seminal works such as Darics (2020), Sanhokwe (2022), and Nguyen and Tsang (2023). Nevertheless, the subterranean currents of pre-existing team dynamics, individual predilections towards remote work, or even the efficacy of communication tools, as delineated in the study by Darics (2020), might have an overarching influence on the observed outcomes.

Other salient outcomes such as employee well-being and mental health; innovation and creativity in remote teams; and organizational commitment and employee retention were also recurrent themes, explored in studies such as Daraba *et al.* (2021), Willermark and Islind (2022), and Ferreira, Pinto-Moreira and Larginho (2023), respectively. From the socio-emotional impact of global events on well-being, as marginally addressed in the

study by Daraba *et al.* (2021), to the intrinsic motivation of team members influencing innovation, the realm of unobserved factors is vast and often uncharted.

While the selected studies lay a robust groundwork in encapsulating the essence of digital leadership and remote work outcomes, the omnipresent and multifaceted unobserved factors pose both a challenge and an opportunity. It beckons researchers to not only recognize these lurking variables but to ingeniously integrate them into the research paradigm, paving the way for a more holistic understanding of the domain.

3.3 Identified Gaps and Shortcomings in the Literature

The scholarly pursuit of understanding digital leadership and remote work, as evidenced by the compendium of 45 reviews, has produced a breadth of knowledge. However, deep within these analyses, various methodological gaps and study shortcomings have emerged. While these gaps might be unavoidable in emerging research areas, they are crucial for the future direction of academic exploration in this field (Mukherjee, 2019).

A primary chasm in the methodological landscape pertains to the treatment of endogeneity. Endogeneity, the bane of causal inference, remains an under-addressed concern (Hill *et al.*, 2021), with a myriad of studies potentially skirting around its nuanced complexities. Take, for instance, Norman *et al.* (2020) and Krehl and Büttgen (2022). While both delve deep into the intricacies of digital leadership dynamics, neither appears to sufficiently address potential endogeneity issues, leaving the door open to potential biases in their conclusions. This lapse is of particular concern given the multifaceted nature of digital leadership, where omitted variables and reverse causality could play a significant role.

The tapestry of methodological gaps is further intensified by the noticeable reliance on convenience sampling, a method which has been criticized for its potential biases and limitations in ensuring representativeness (Emerson, 2021), in several studies including those by Hafermalz and Riemer (2020) and Johnson and Mabry (2022). By potentially targeting specific industries or geographical regions, these studies may inadvertently encase their findings within a bubble, limiting the broader applicability and generalizability of their results.

Cross-sectional designs, valuable for snapshot analyses (Spector, 2019), have also emerged as a prevalent shortcoming in investigations (Wang and Cheng, 2020) such as those by Miglioretti *et al.* (2021), Willermark and Islind (2022), and Susita *et al.* (2023). The ephemerality of these designs curtails the depth of insight, particularly in understanding the evolving dynamics of digital leadership and its long-term implications for remote work.

Adding to the litany of concerns is the propensity of certain studies (e.g., Kwon and Jeon, 2020; Eichenauer, Ryan and Alanis, 2022) to hinge predominantly on self-reported measures. Such measures, while valuable for capturing individual perceptions, have been noted for their potential to introduce biases and compromise the objectivity of results (Krohn *et al.*, 2013). In particular, an overreliance on self-assessment can lead to the introduction of certain biases, including the often-encountered social desirability bias, thereby potentially skewing the study's conclusions.

The reviewed literature also shows a tendency to overemphasize certain variables, often sidelining others (Wang and Eastwick, 2020). For instance, the allure of popular metrics such as productivity or well-being, as spotlighted in the work of both Liebermann *et al.* (2021) and Junça Silva, Almeida and Rebelo (2022), might have overshadowed other seminal facets of remote work, such as innovation or organizational commitment.

Lastly, a discernible neglect of cultural nuances, underscored by foundational work on the significance of cross-cultural considerations in leadership and remote work (Tahirkheli, 2022), is evident across these 45 studies. In an era where remote work often transcends borders, the potential lack of cross-cultural considerations in studies like Bhumika (2020) and Ferreira, Pinto-Moreira and Larguinho (2023) appears as a glaring omission. This oversight could be limiting our understanding of how cultural dynamics interplay with digital leadership practices.

In summation, while the tapestry of reviewed literature has undeniably enriched the discourse on digital leadership and remote work, the identified gaps and shortcomings serve as both a cautionary tale and a clarion call. They underscore the imperative for future research to weave a more intricate, holistic, and methodologically robust narrative that can stand the test of scrutiny in this ever-evolving domain.

3.4 Emerging Trends and Noteworthy Observations

In the intricate tapestry of research that focuses on digital leadership and remote work, certain discernible patterns and emergent trends have become evident (Pellegrini *et al.*, 2020; Karakose *et al.*, 2022). The past

decade, characterized by a surge in remote work dynamics, has seen the academic landscape adapt, innovate, and evolve in response to the shifting paradigms of leadership and digital workspaces (Bresciani *et al.*, 2021).

One conspicuous trend observed across the 45 reviewed studies is the increasing gravitation towards mixed-method research designs. Earlier, quantitative approaches held predominant sway, as evidenced by the prevalence of such methods in studies like those by Müller and Niessen (2019) and Chaudhuri *et al.* (2022). However, recent additions to the corpus, such as Mutha and Srivastava (2023) and Leonard *et al.* (2023), showcase an amalgamation of quantitative and qualitative insights. This hybrid approach suggests a broader recognition of the necessity to capture both statistical rigor and the nuanced human experiences inherent to remote work and leadership dynamics.

In this climate of methodological evolution, a handful of studies have carved a niche for themselves with groundbreaking methodologies. For instance, Allgood, Jensen and Stritch (2022) introduced an innovative use of machine learning algorithms to parse and understand the dynamics of digital leadership communications. This harnessing of technological expertise for academic inquiry signals a promising confluence of technology and the social sciences.

Equally noteworthy is the apparent shift toward addressing endogeneity concerns (Lu *et al.*, 2018). The specter of endogeneity has long cast a shadow over causal inferences in this domain (Güntner *et al.*, 2020). Early studies, like those by Norman *et al.* (2020) and Krehl and Büttgen (2022), revealed potential gaps in their treatment of endogeneity. Yet, a clear evolution is discernible in the more recent contributions to literature. Consider, for example, Pham *et al.* (2023), who employ instrumental-variable estimation, and Tworek *et al.* (2023), who adopt a propensity score matching technique. Both signify a growing awareness of and a concerted effort to grapple with the confounding intricacies of endogeneity.

Beyond the bounds of methodology, another emergent observation is the increasing focus on the psychological and emotional facets of remote work. While earlier studies might have been more oriented towards metrics of productivity and operational efficiency, works like those by Lee and Kim (2023) and Santiago-Torner (2023) underscore the emotional well-being, mental health, and intrinsic motivations of remote workers. This shift perhaps reflects the broader societal recognition of mental health's centrality in the contemporary work ecosystem (Stratton *et al.*, 2021).

The realm of academic inquiry into digital leadership and remote work, as exemplified by the reviewed studies, is neither static nor monolithic. It's a dynamic, ever-evolving landscape, shaped by technological advancements, societal shifts, and the inexorable march of time. The emerging trends and observations offer both a barometer of the current academic climate and a compass pointing towards future research horizons.

4. Recommendations and Future Research

Upon meticulous examination of 45 scholarly studies, a detailed depiction emerges, highlighting the advancements made in the domain of digital leadership and remote work. These comprehensive analyses, while thoroughly detailing the known, also indicate areas yet to be fully explored. This presents potential avenues for deeper scholarly exploration in this emerging domain. Based on this synthesis, a trajectory is proposed, advocating for the combination of quantitative methodologies with the depth of qualitative research. Foundational works, such as those by Chaudhuri *et al.* (2022) and Müller and Niessen (2019), underscore the merits of quantitative designs. However, a thorough review of contemporary literature highlights the need for holistic approaches, as demonstrated by recent studies like Johnson and Mabry (2022) and Leonard *et al.* (2023). This suggests a harmonization where both statistical rigor and the nuance of human experiences come together, particularly in the context of remote work.

Furthermore, among these methodological considerations, literature emphasizes the importance of addressing endogeneity. Seminal methodologies, illustrated by studies such as Pham *et al.* (2023) with its instrumental-variable estimation and Tworek *et al.* (2023) using propensity score matching, emerge as standards for robust research designs. Therefore, subsequent research should clearly navigate causal relationships with methodological precision. At the same time, an evident trend underscores the dynamic nature of digital leadership and remote work, highlighting the need for temporal examinations. While cross-sectional studies offer specific advantages, there is a growing preference for longitudinal designs in the literature. These promise deeper insights into the changing dynamics of remote teams and leadership modalities.

Adding to this complex landscape is the integration of technology into traditional scholarly investigations. This intersection is exemplified by the innovative approach of Allgood, Jensen and Stritch (2022), where technological

advancements like machine learning and artificial intelligence merge with academic pursuits. This alliance indicates an expansive horizon ripe for future academic exploration. Moreover, the vast scope of the literature suggests numerous areas awaiting scholarly attention. Topics such as the role of trust in digital leadership, the complex interplay of creativity in remote environments, and the challenges of leading geographically dispersed teams remain relatively under-studied.

In addition to these methodological considerations, future research could benefit from a mixed methods approach to capture the nuances of digital leadership and remote work more effectively. Mixed methods research, which combines quantitative and qualitative approaches, offers significant advantages in studying complex phenomena. By integrating quantitative data with qualitative insights, researchers can address endogeneity and provide a more comprehensive understanding of the multifaceted dynamics in digital leadership and remote work. For instance, quantitative analysis could be complemented with qualitative methods such as interviews or focus groups to explore underlying reasons behind observed patterns, thereby enriching the findings and offering deeper insights.

In conclusion, the collective assessment of the literature suggests that while current studies provide a solid foundation, the academic exploration surrounding digital leadership and remote work is still evolving. The upcoming landscape promises a blend of methodological precision, innovative research approaches, and investigations into previously under-researched areas, all aiming to produce more nuanced, comprehensive, and impactful scholarly contributions.

5. Practical Implications

In today's organizational landscape, digital transformation and remote work have rapidly evolved from mere buzzwords to fundamental strategic considerations (Li, 2020). This shift emphasizes the urgent need to understand the intricacies and challenges these domains pose. Central to this understanding is decision-making, a foundational element of organizational strategy (Hanandeh *et al.*, 2023). Profoundly influenced by clear and rigorous research on digital transformation and remote work, our systematic review highlights the critical importance of addressing endogeneity. This phenomenon, in which certain variables might be correlated in ways that could skew research findings, is vital to comprehend (Cooper *et al.*, 2020; Hill *et al.*, 2021). Grasping this issue allows organizations to base decisions on a solid academic foundation, yielding more informed and effective strategies.

Moreover, as we traverse the intricacies of the digital world, the significance of leadership development becomes apparent (Cortellazzo, Bruni and Zampieri, 2019). Tailored training, such as programs that focus on digital communication tools, virtual team dynamics, and the nuances of remote team motivation, emerges as an essential requirement for today's leaders (McCauley and Palus, 2021). This focus on leadership is deeply intertwined with broader organizational dynamics. Beyond leadership, the formulation of effective remote work policies is vital (Wang *et al.*, 2021). An in-depth grasp of individual preferences, technological tools, and potential distractions is crucial. By integratively considering these factors, organizations can develop policies that harmoniously balance productivity with employee satisfaction.

On the technological side, while digital tools are indispensable in this era, they also present unique challenges (Marion and Fixson, 2021). Drawing on specific insights from our review, like the effectiveness of particular digital tools and platforms, organizations can realize tangible benefits (Hanelt *et al.*, 2021). Informed technological investments ensure organizations utilize tools that genuinely amplify digital leadership and remote work capabilities.

6. Conclusion

The meticulous analysis of 45 pivotal studies within the realm of digital leadership and remote work unveils a detailed matrix of research trends, methodologies, and emergent themes. This investigation reveals a predominant reliance on quantitative approaches, with approximately one-third of the examined studies prioritizing this method. However, a notable subset has gravitated towards the depth of qualitative insights, or the equilibrated viewpoint proffered by mixed methods designs. For example, studies like Müller and Niessen (2019) and Islam *et al.* (2022) employed control variables to account for individual motivation and home environment distractions.

A central finding is the varied treatment of endogeneity, a foundational concern in such explorations. While 15 studies demonstrated diligent efforts to navigate potential methodological pitfalls through the use of instrumental variables and fixed effects models, an additional 20 studies only partially addressed these issues,

and 10 studies did not address them at all. This inconsistency highlights significant gaps in the robustness of research designs in the field, underscoring the need for more stringent methodological rigor.

Transitioning to the pivotal issue of endogeneity, a foundational concern in such explorations, it is observed that it has been addressed with differing levels of rigor. For instance, Krehl and Büttgen (2022) provided an illuminating approach by incorporating leader adaptability as a moderator. However, many studies frequently overlooked the nuanced interplay of unobserved elements, such as leaders' digital literacy and adaptability. Studies like Norman *et al.* (2020) and Mander and Antoni (2023) did not fully consider these factors, which could significantly influence leadership effectiveness in digital contexts. A commendable proportion of studies have demonstrated diligent efforts to navigate potential methodological pitfalls. However, a significant segment seems to have either inadequately addressed or altogether bypassed this crucial facet, thereby casting potential aspersions on the robustness of their conclusions.

Further analysis of the studies reveals a gamut of primary outcomes. These span considerations from gauging employee productivity in remote settings and assessing the efficacy of digital leadership to delving into the intricacies of team cohesion, employee well-being, and organizational commitment within digital contexts. For example, studies like Darics (2020) and Sanhokwe (2022) highlighted the importance of pre-existing team dynamics and communication tools. However, the potential influence of unobserved variables, such as individual preferences for remote work, remained under-explored. Simultaneously, the latent influence of unobservable variables on these outcomes repeatedly emerges, underscoring the multifaceted nature of such investigations.

The literature also tacitly reveals methodological gaps, suggesting avenues for enhanced rigor. Challenges related to sampling biases, the prevailing dominance of cross-sectional designs, and an exacerbated reliance on self-reported measures pinpoint critical areas necessitating methodological fortification in subsequent research endeavors. Studies such as Hafermalz and Riemer (2020) and Johnson and Mabry (2022) illustrate the reliance on convenience sampling and self-reported measures, potentially limiting the generalizability and objectivity of their findings. Conversely, certain emergent trends augur well for the domain's trajectory, with select studies elucidating pioneering methodologies and innovative paradigms that bode well for future scholarly pursuits.

A key finding of this study is the importance of integrating more advanced analytical methods to enhance the understanding of digital leadership and remote work dynamics. Methods such as structural equation modeling, longitudinal studies, and mixed methods can provide deeper insights into the causal relationships and process dynamics that are often complex and multifaceted. Additionally, incorporating graphical representations, such as digraphs, can offer a more intuitive understanding of the interconnections and processes involved in digital leadership and remote work. Although not explicitly mentioned in the existing literature, these tools can be a valuable addition to future research methodologies.

At the heart of this research lies an unwavering emphasis on methodological rigor. Given that digital leadership and remote work manifest as dynamic and intricate constructs, they indubitably necessitate research methodologies adept at capturing their nuances while upholding analytical validity and reliability. The researchers posit that addressing endogeneity extends beyond academic convention; it stands as an imperative to ensure causal relationships are discerned, devoid of underlying variables potentially distorting outcomes.

Although the extant literature on digital leadership and remote work is both expansive and enlightening, it mirrors a goldmine replete with myriad untapped avenues. To unearth its full potential and further scholarly understanding, it is crucial to employ diverse and robust methodologies, including advanced statistical techniques and graphical analysis tools, which can highlight the complex interplay of factors influencing digital leadership and remote work. The imperatives for fellow researchers stand clear: maintain unwavering methodological rigor, accord primacy to endogeneity considerations, and remain committed to innovative approaches, thereby enriching the nuanced discourse on leadership and remote work in this digital epoch.

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Developing a Directed Graph Analysis Framework as a Method to Analyse and Present Complex Datasets: A Case Study in Tax Compliance

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Abstract: Directed graphs are often used as graphical representations of interrelationships between entities. In many fields of research besides the STEM fields, datasets containing complex qualitative interrelationships are challenging to represent graphically in traditional line graphs, bar graphs, or pie charts. In addition, if quantitative data needs to be presented on top of the qualitative relationships, graphical representation becomes even more complex. As a result, datasets of this nature are often tabulated or presented in text since graphical representation is considered difficult or impractical. This paper presents a *Directed Graph Analysis Framework* that may be used to develop graphical illustrations of such complex datasets. A PhD study in employer tax compliance undertaken by the principal author is utilised as a case study in this paper (Van der Walt, Z., 2024). The framework is then used to develop a *variable interrelationship and compliance decision flow diagram* to present employer tax compliance decisions in graphical form. It is demonstrated that the method is suitable to produce a single graphical representation of a large number of variables and sub-variables, displaying the relevant qualitative and quantitative information in an easy-to-understand way. The proposed method may be applied to other fields of research where similarly complex datasets are presented.

Keywords: Directed graph, Digraph, Graphical analysis, Grounded theory, Data analysis, Tax compliance

1. Introduction

Research results are often presented in tables and graphs in fields of study such as engineering and science. A graphical presentation enables the reader to grasp the essence of the results within seconds by merely observing the trends displayed by the graphical presentation. The reader may then further observe the specific quantitative results of the research if interested in any particular values or limits. In fields of study other than STEM, such as the social sciences, it is often more challenging to analyse and present the research results in an informative and concise manner. While tables may be used to present such results, graphs are not often used since the results may not present themselves in ways readily plottable on a traditional line graph, bar graph or pie chart.

This paper presents an adaptation of directed graphs, commonly abbreviated as *digraphs*, by developing a *digraph analysis framework* (DAF) that not only presents relationships between datasets or variables - the typical use of digraphs - but also assists in analysing each of the variables in isolation to simplify the analysis procedure before combining the influences of all variables into a single graphical representation. The framework then enables the user to display the quantitative results of the variables in a clear and simple graphical manner. The proposed framework involves a four-step procedure where (1) the variables involved in the study are identified, (2) each variable is analysed in isolation with regard to its influences, outcomes, results or effects, (3) the combined effects of all the datasets or variables are calculated, and (4) the combined effects of all the datasets or variables are presented graphically and quantitatively to form a combined variable interrelationship diagram. The framework not only allows the researcher to display interrelationships but also to rank different interrelationships relative to quantitative importance.

As an example of a real-world complex dataset that can be analysed using the *Digraph Analysis Framework*, the principal author conducted a tax psychology study of small to medium-sized employers' (SMEs) tax compliance concerning their employees' wages. The datasets have been slightly modified and adapted to illustrate better the development and use of the proposed *Digraph Analysis Framework*. The paper assumes the datasets without a detailed consideration of the reasons, methodology, and background regarding how the information was obtained.

2. Literature Review of Digraphs and Other Graphical Methods

A definition of a digraph is given by Metcalf and Casey (2016):

"A directed graph is a graph where the relationship between two vertices is a one-way relationship."

In contrast, an undirected graph lacks the directional constructs of a directed graph. An example of a simple digraph is shown in Figure 1 below:

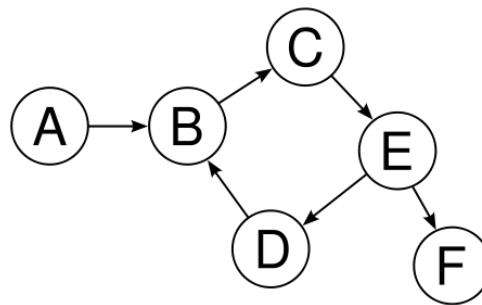


Figure 1: A simple digraph

Digraphs are graphical representations of relationships between entities, concepts, or variables. The terms *directed graph* and *digraph* appear to have been coined by Frank Harary (1955). Several variations on this theme seem to exist. *Directed Acyclic Graphs* (DAGs) have been used in many applications, including medical diagnoses (Shrier et al., 2008). DAGs represent a series of activities in such a fashion that no cyclic activity occurs. This contrasts with the cyclic activity B-C-E-D in Figure 1 above. Bang-Jensen and Gutin (2018) published a book containing many digraph types and examples. A development of digraphs presented by Gansner et al. (1993) allows for the ranking of vertices, which is closer in intent to the *digraph analysis framework* presented in this paper.

Van Rensburg (2018) employed digraphs to analyse the constraints of South African households' discretionary savings and investment habits. In her thesis, the principal author of this paper has adapted and significantly modified the digraph analysis model used by Van Rensburg to include not only relationships but also indications of the relative importance of each relationship. Furthermore, both variables and sub-variables (categories) are considered in the proposed framework.

Another related graphical method is *structural equation modelling* (SEM). SEM is often used in behavioural sciences, epidemiology (Boslaugh & McNutt 2008), business (Shelley 2006) and other fields. SEM models could use graphical representations similar to digraphs to indicate the causal connection of one phenomenon to others. Alternatively, the relationships may be represented using equations. SEM models come in two variants: covariance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM). CB-SEM is primarily used to test and confirm theories (Hair et al. 2021) and is analogous in some respects to the *digraph analysis framework* proposed in this paper, albeit significantly more complex.

A summary of the graphical methods related to digraphs considered during the study and the development of the Digraph Analysis Framework presented in this paper is given in Figure 2:

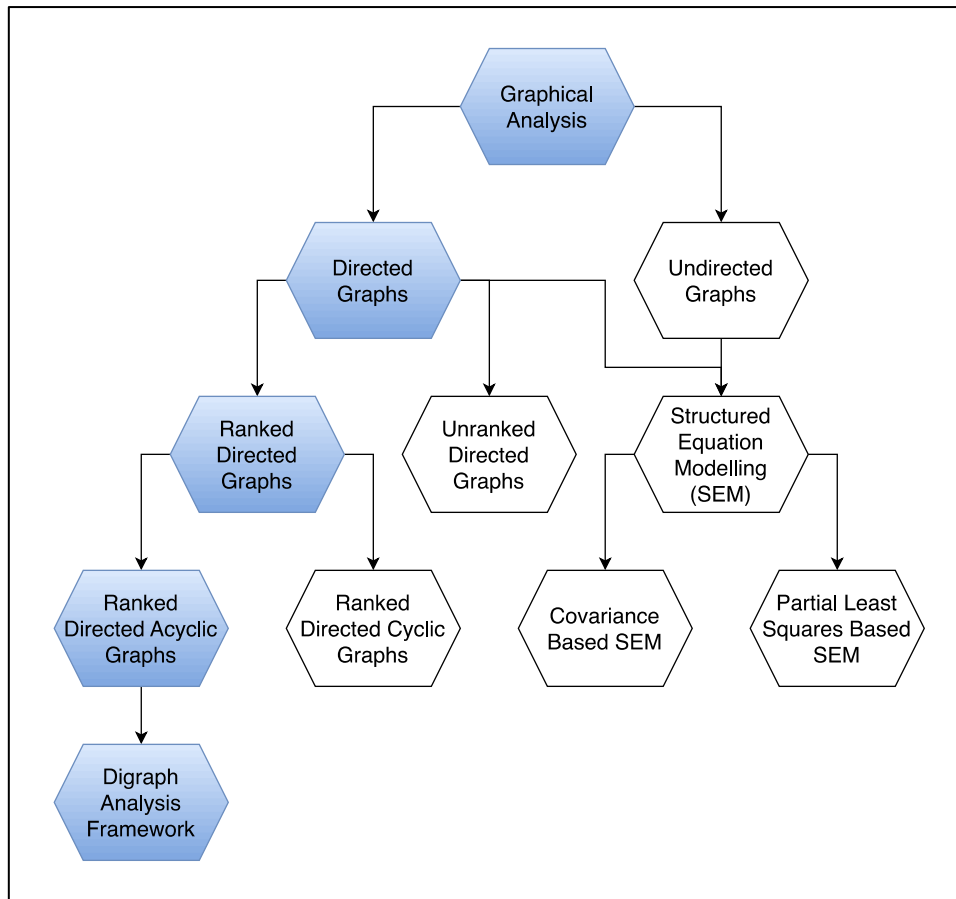


Figure 2: Graphical methods and the development of the Digraph Analysis Framework

A simple ranked acyclic digraph can thus be extended to indicate the interrelationships and decision flows between the factors identified as influencing tax compliance. Furthermore, the digraph can be adapted to assist with data analysis and to display the relative importance of the variables presented in graphical form.

3. The Data to be Analysed

The original study aimed to determine the main factors influencing employers' decisions to comply with taxation regulations regarding PAYE deductions from their employees' remuneration. A grounded theory (GT) approach was used to collect the information. In short, this approach conducted interviews with a large group of employers without a predetermined set of questions on tax compliance. As the interviews progressed, answers and comments provided by the interviewees led the discussion in new and unforeseen directions, with the variables governing their compliance decisions emerging. Three rounds of interviews were ultimately conducted.

The variables governing the compliance decisions were identified by coding the responses obtained. The number of times a specific variable was mentioned during the interviews indicated its relative importance. For example, an unfavourable view of the tax authorities was one such variable. The more frequently an interviewee mentioned their negative sentiments toward the tax authority as a reason for possible non-compliance, the more prominently this variable will feature in the analysis.

Seven such variables were distilled as most critical in the study. Many more variables could have been listed, but the seven identified represented the most significant contributors to the decision regarding tax compliance. Without delving into why these seven variables were recognised as the most important, this paper assumes the data as given.

Figure 3 below presents the findings of the study:

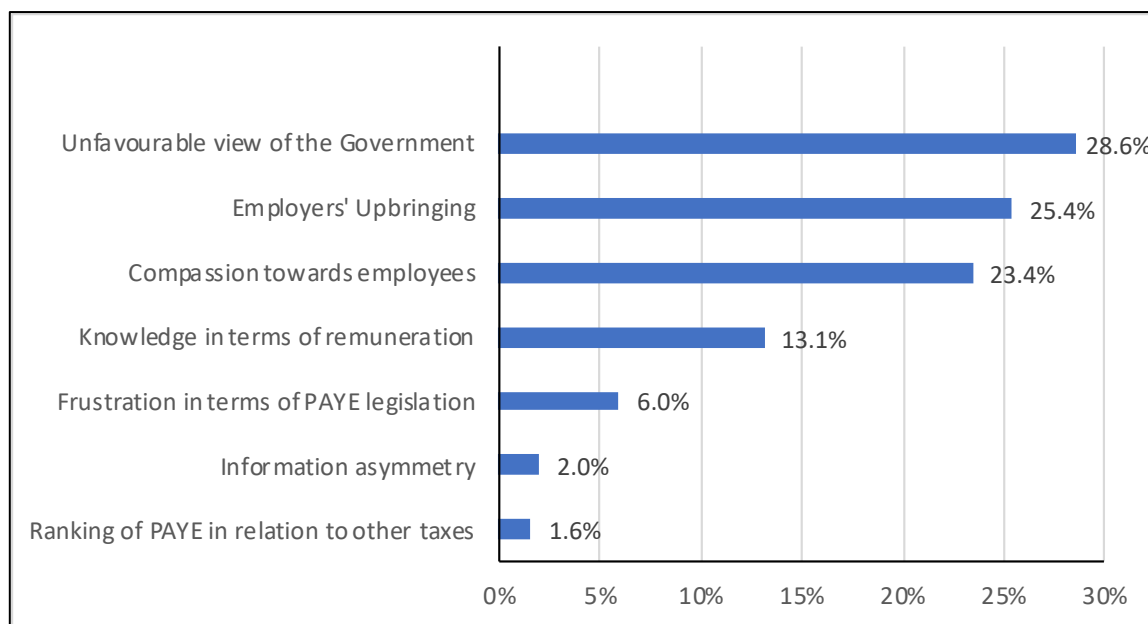


Figure 3: Compliance decision variables (in percentages)

The percentages indicate the frequency at which each variable manifested itself during the interviews relative to the other identified variables.

For clarity, the identified variables are presented in small caps in this paper. Interviewees may not necessarily mention a variable, such as an UNFAVOURABLE VIEW OF THE GOVERNMENT in precisely those terms. Instead, interviewees may remark that they perceive the tax officials as corrupt, exhibit a bad attitude towards employers, are incompetent, or cannot account for national funds, which is then assumed to be embezzled. Thus, all such expressions, called *categories* (or sub-variables, in essence), may be collected under a single *variable*, an UNFAVOURABLE VIEW OF THE GOVERNMENT in this case. This paper presents categories, or sub-variables, in italicised small caps.

Each compliance decision variable is therefore governed by one or more categories (sub-variables) underlying that variable. These categories or sub-variables explain the compliance decision in more detail. Analysing all the categories for all the variables displays the relative importance of each variable in the decision-making process. For the case study presented, the relative importance of the categories and variables (i.e., in relation to all the others) is illustrated in Figure 4 below.

Finally, with its underlying categories, each variable results in one of three outcomes: NON-COMPLIANCE, ENFORCED COMPLIANCE, or VOLUNTARY COMPLIANCE. The data analysis needs to show how each variable and its categories influence the employer's decision to either comply or not comply with the tax legislation.

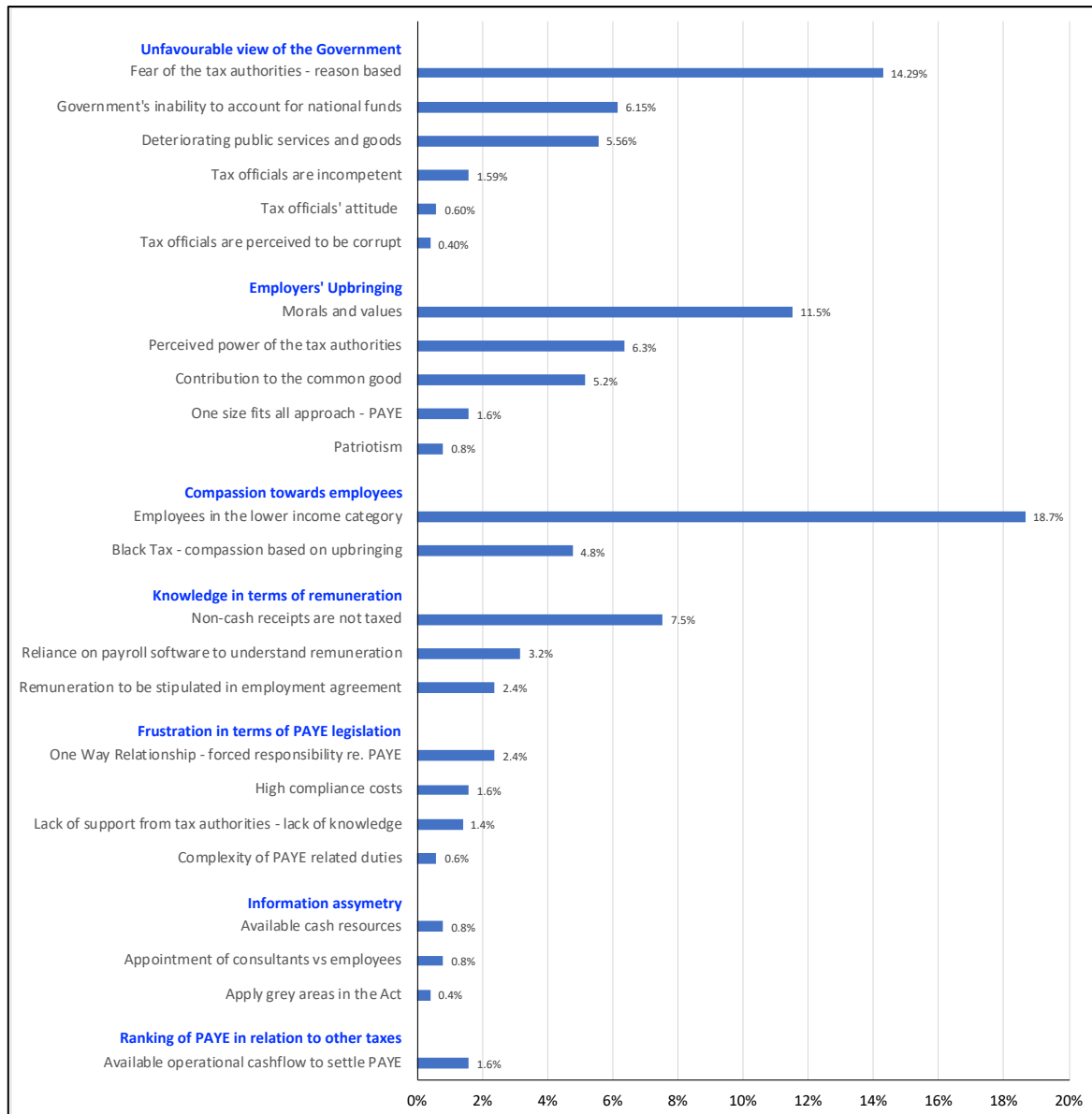


Figure 4: Compliance decision variables and categories (in percentages)

4. Development of the Variable Interrelationship and Decision Flow Digraph Using the Digraph Analysis Framework

To establish the interrelationships and decision flows between the seven identified decision-making variables, each variable and its underlying categories were individually considered in relation to each of the other variables. These interrelationships then determined the flow of decisions in the compliance or non-compliance options of the interviewed employers.

To provide the reader with maximum clarity, each variable and its associated categories are analysed one at a time in this section, each under its own subheading. Although this results in a rather long Section 4, it provides a clear progression of the analysis process of all the variables, first from simple variables, then progressing to quite complex ones. The graphical analyses of each of the seven variables are presented in Sections 4.1 to 4.7.

Furthermore, the analysis is divided into four distinct steps or procedures spanning across Section 4 and Section 5:

- Step One: Listing of all variables (Section 4 below).
- Step Two: Analysis of the influence of each variable (one at a time) on all other variables (Sections 4.1 to 4.7).

- Step Three: Calculation of the combined influences of all the variables considered (Section 5).
- Step Four: Graphical presentation of the combined influences of all variables considered (Section 5).

Using the DAF, the **first step** of the procedure is to create a graphical presentation listing all the variables and outcomes, as shown in Figure 5 below. This case study has seven variables and three outcomes.

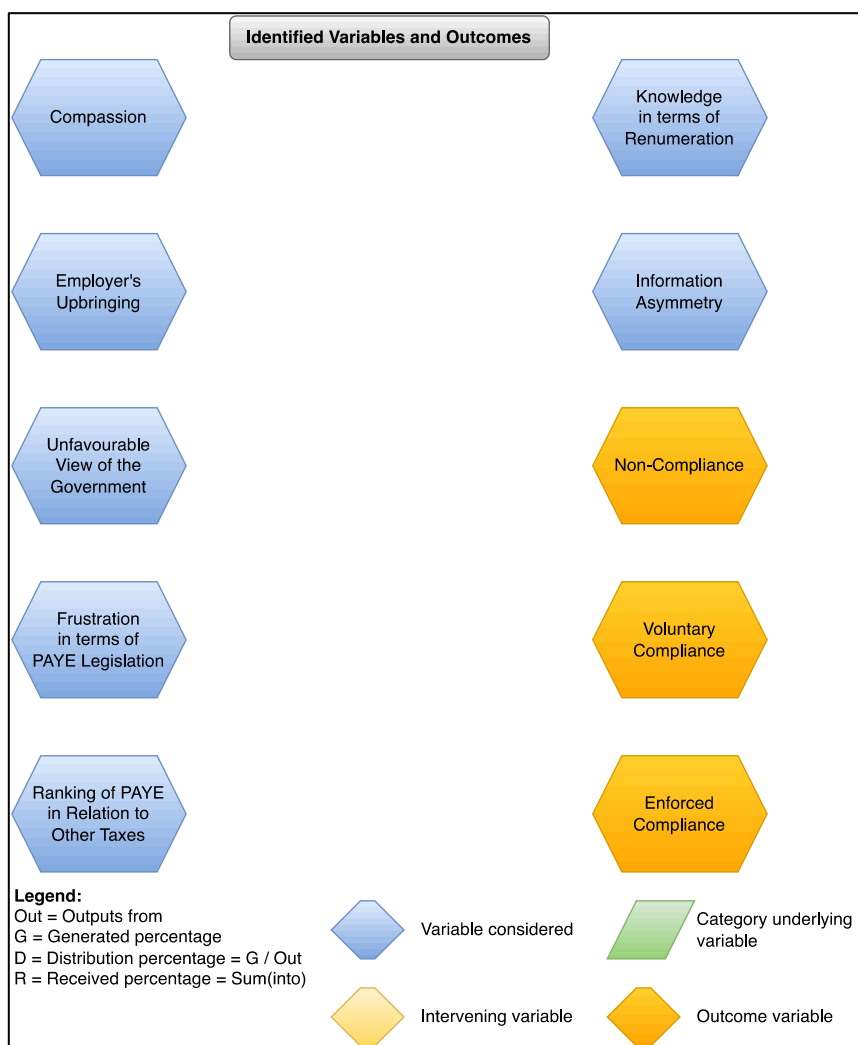


Figure 5: Placing the variables and outcomes on an empty digraph

In the **second step** of the DAF procedure, each variable, with its underlying categories, is plotted against the appropriate outcome or intervening variables. This is done one variable at a time to carefully calculate and assign the generated frequencies as percentages, and distribution decisions as percentages and receipt percentages. To demonstrate this, we will first analyse a straightforward variable, for example, the employer's ranking of the importance of PAYE to other taxes such as VAT, and so on.

Figure 6 illustrates the effect of the perceived importance of the PAYE legislation relative to other taxes (the variable being considered) which the employer must deal with. Suppose an employer concludes that PAYE is not of primary importance and that this employer happens to be experiencing operational cash flow constraints. Such an employer may be tempted to explore non-compliance opportunities and ultimately may not comply with regulations.

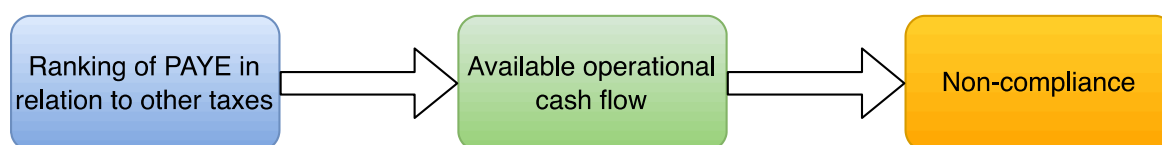


Figure 6: Influence of perceived PAYE ranking on compliance

In the following sections, each identified variable, as shown in Figure 5 above, with its associated categories, will be plotted and analysed relative to all the other variables.

4.1 RANKING OF PAYE IN RELATION TO OTHER TAXES as a variable in the compliance decision

From Figure 4, the variable RANKING OF PAYE IN RELATION TO OTHER TAXES had an interview occurrence frequency (i.e., the number of times this variable was activated during the interview via its associated categories) of 1.6%. The interview occurrence frequency is displayed as the *Generated frequency percentage* (G) on the digraph shown in Figure 7 below for this variable.

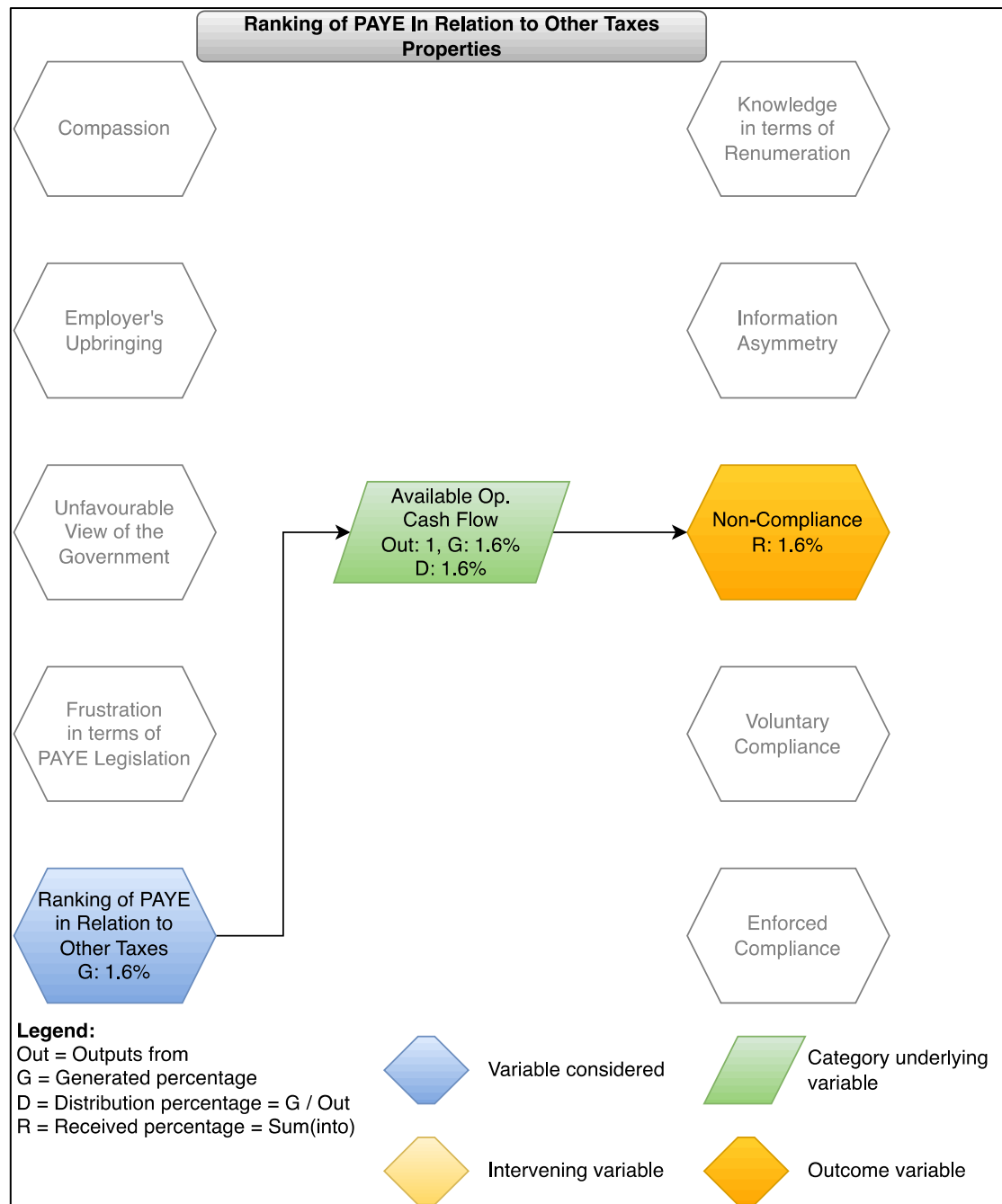


Figure 7: The RANKING OF PAYE IN RELATION TO OTHER TAXES as a variable in the compliance decision

The variable under consideration, RANKING OF PAYE IN RELATION TO OTHER TAXES, exists because employers' comment on the option not to comply with tax regulations due to a lack of available operational cash flow in the company. Hence, the category *AVAILABILITY OF OPERATIONAL CASH FLOW* represents 1.6% of the total compliance or non-compliance decision.

The figure shows that this category generated (G) 1.6% of the compliance decision. Since this category is the only one linked to the associated variable, this variable is therefore also assigned a generated percentage (G) of 1.6%. Lastly, since the category under discussion also has only one output to a single recipient variable, this recipient variable is allocated a received decision (R) percentage of 1.6%.

However, variables are often associated with several categories and more than one recipient variable. We discuss such cases below.

To be clear, the categories, and not the variables, generate the frequency percentages. The sum of the generated percentages is then assigned to the associated variable and distributed to the receiving variables, as will be shown in subsequent variable analyses.

4.2 EMPLOYERS' FRUSTRATION WITH PAYE LEGISLATION as a Variable in the Compliance Decision

From Figure 4 above, the variable FRUSTRATION WITH PAYE LEGISLATION has a generated frequency percentage (G) of 6.0%. This sum-total is comprised of four identified categories as shown in Figure 8 below: *ONE-WAY RELATIONSHIP* between the tax authorities and employers in their role as tax agents (2.4%); *HIGH COMPLIANCE COSTS* (1.6%); *LACK OF SUPPORT FROM THE TAX AUTHORITIES* (1.4%); and the *COMPLEXITY OF PAYE-RELATED DUTIES* (0.6%).

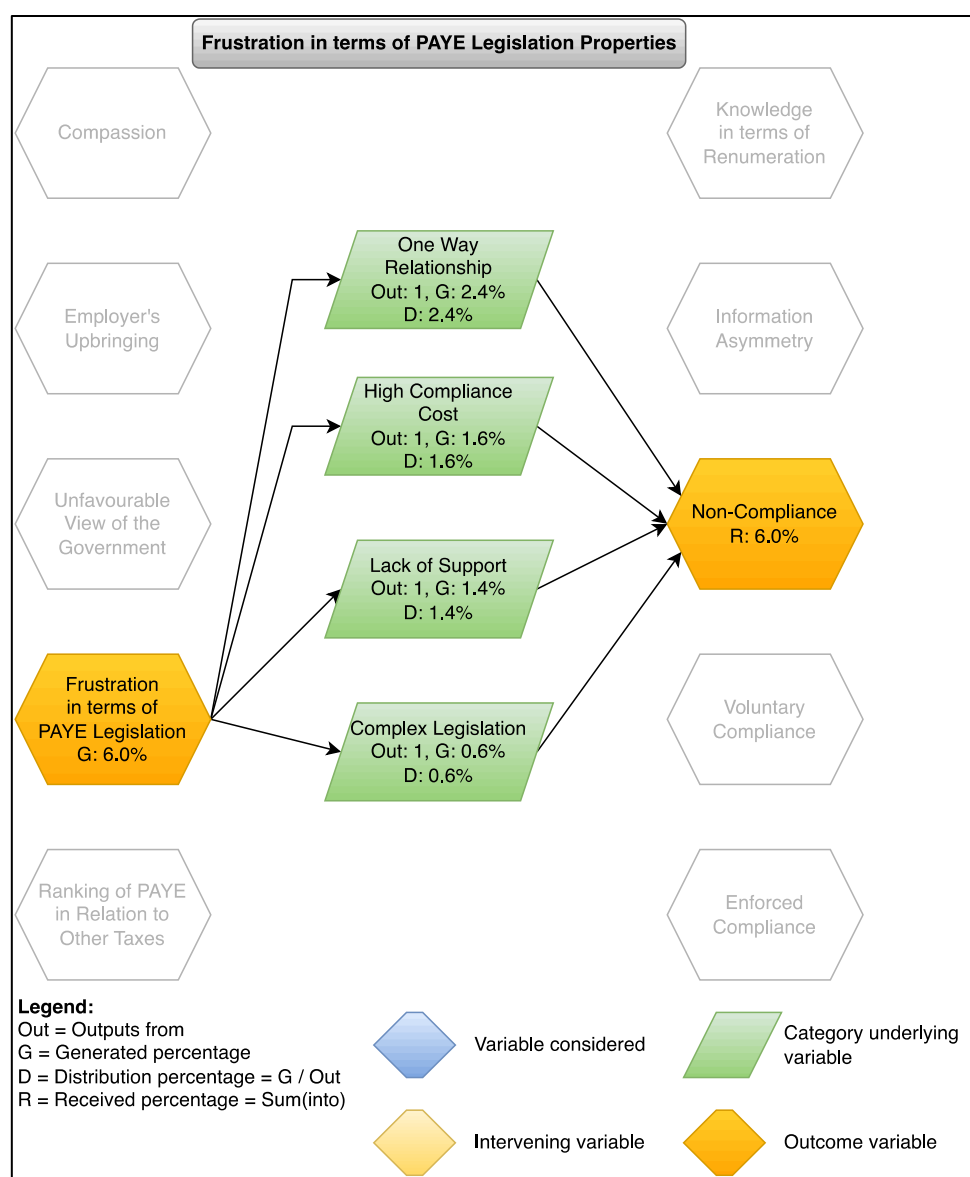


Figure 8: EMPLOYERS' FRUSTRATION WITH PAYE LEGISLATION as a variable in the compliance decision

During the interviews, the category *ONE-WAY RELATIONSHIP* was cited 2.4% of the time as a reason for non-compliance. Thus, that category generated (G) 2.4% of the frustration the employer mentioned. Since this

category has only one link (Out: 1) to the outcome variable NON-COMPLIANCE, it *distributes* the complete 2.4% (D: 2.4%) to the recipient variable.

In this simple example, the sum of the generated frustrations of the four categories equals the 6% indicated in the considered variable on the left-hand side. Furthermore, since all four categories contribute to the same outcome variable, NON-COMPLIANCE on the right-hand side, its *received* percentage (R) also equals the total of the categories.

An example of a slightly more complex variable, the EMPLOYER'S UPBRINGING, is discussed next.

4.3 EMPLOYERS' UPBRINGING as a Variable in the Compliance Decision

As shown in Figure 4, the variable under consideration, the EMPLOYER'S UPBRINGING, consists of five categories, as depicted in Figure 9 below. It had a generated frequency percentage (G) of 25.4% and is comprised of the categories *MORALS AND VALUES* (11.5%), *CONTRIBUTION TO THE COMMON GOOD* (5.2%), *PATRIOTISM* (0.8%), *ONE-SIZE-FITS-ALL APPROACH IS INAPPROPRIATE* (1.6%), and *FEAR OF THE TAX AUTHORITIES* (6.3%).

This variable and its categories are different from the variables discussed above in terms of the output distribution of the categories. Each category still has only one output, therefore the generated percentage (G) and the distributed percentage (D) in each category are equal in all cases. The difference, however, is that the five categories do not all contribute to the same outcome variable. Each outcome variable receives a percentage from one or more categories. These percentages are then summed and reflected as the received percentage (R), as shown in Figure 9.

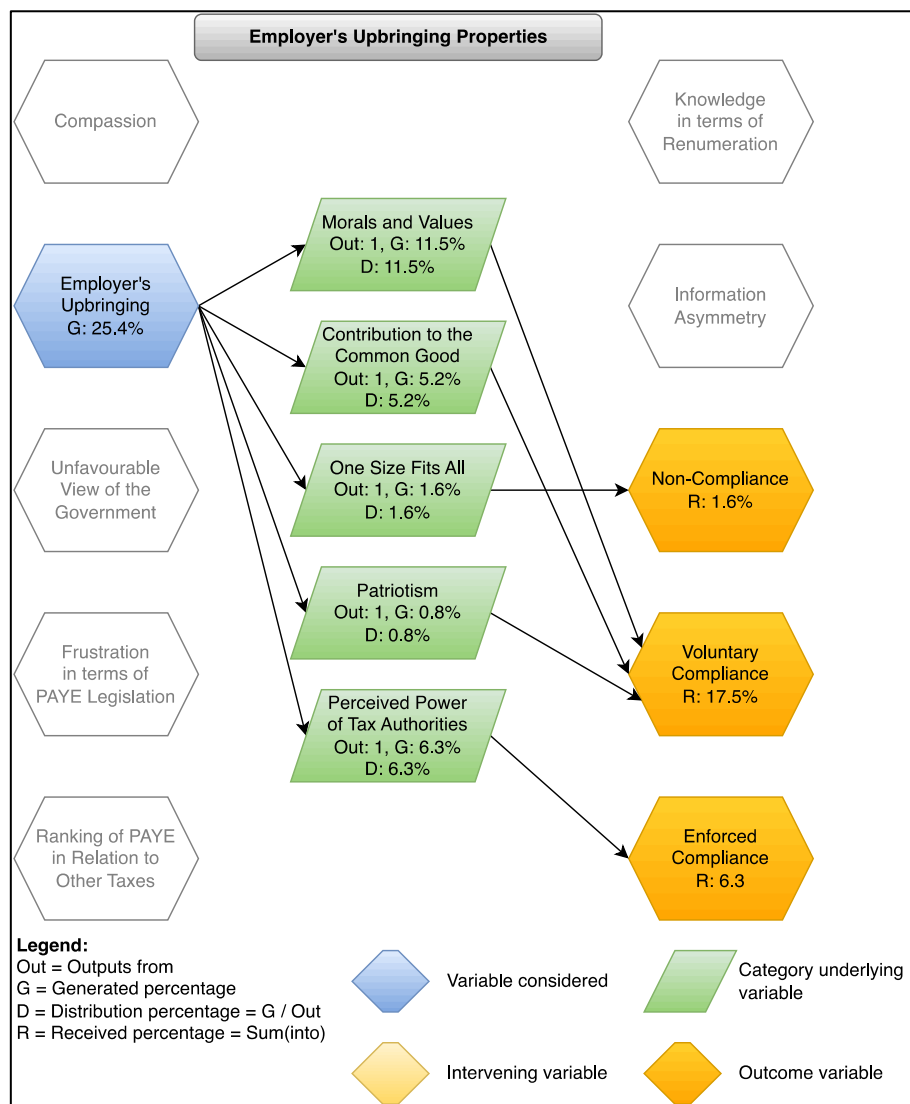


Figure 9: UPBRINGING as a variable in the compliance decision

4.4 INFORMATION ASYMMETRY as a Variable in the Compliance Decision

In Figure 4 above, the variable INFORMATION ASYMMETRY generated a frequency percentage (G) of 2.0%. The variable is also described by the categories of AVAILABILITY OF CASH RESOURCES (0.8%), THE APPOINTMENT OF CONSULTANTS VERSUS EMPLOYEES (0.8%), and THE APPLICATION OF GREY AREAS IN THE ACT (0.4%).

This variable and its associated categories are straightforward, and the related digraph analysis is shown in Figure 10 below. Information asymmetry is when the employer, as a tax agent of the tax authorities, does not share all information with the tax authorities.

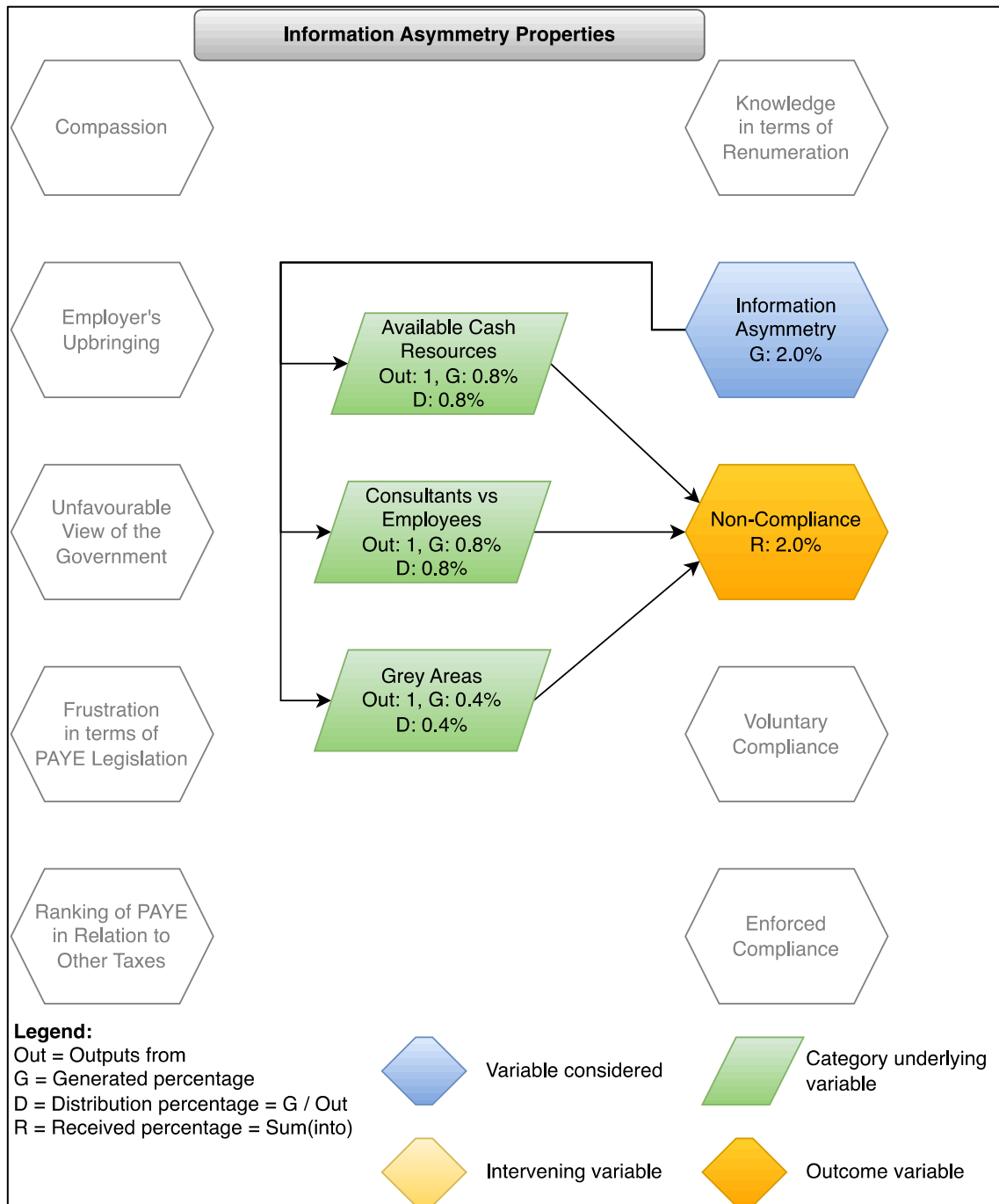


Figure 10: INFORMATION ASYMMETRY as a variable in the compliance decision

4.5 EMPLOYERS' COMPASSION FOR EMPLOYEES as a Variable in the Compliance Decision

From Figure 4 above, the variable EMPLOYERS' COMPASSION FOR EMPLOYEES generated a frequency percentage (G) of 23.5%. The variable is described by the categories: *COMPASSION FOR EMPLOYEES IN THE LOWER INCOME CATEGORIES* (18.7%) and *BLACK TAX* (4.8%), as shown in Figure 11 below.

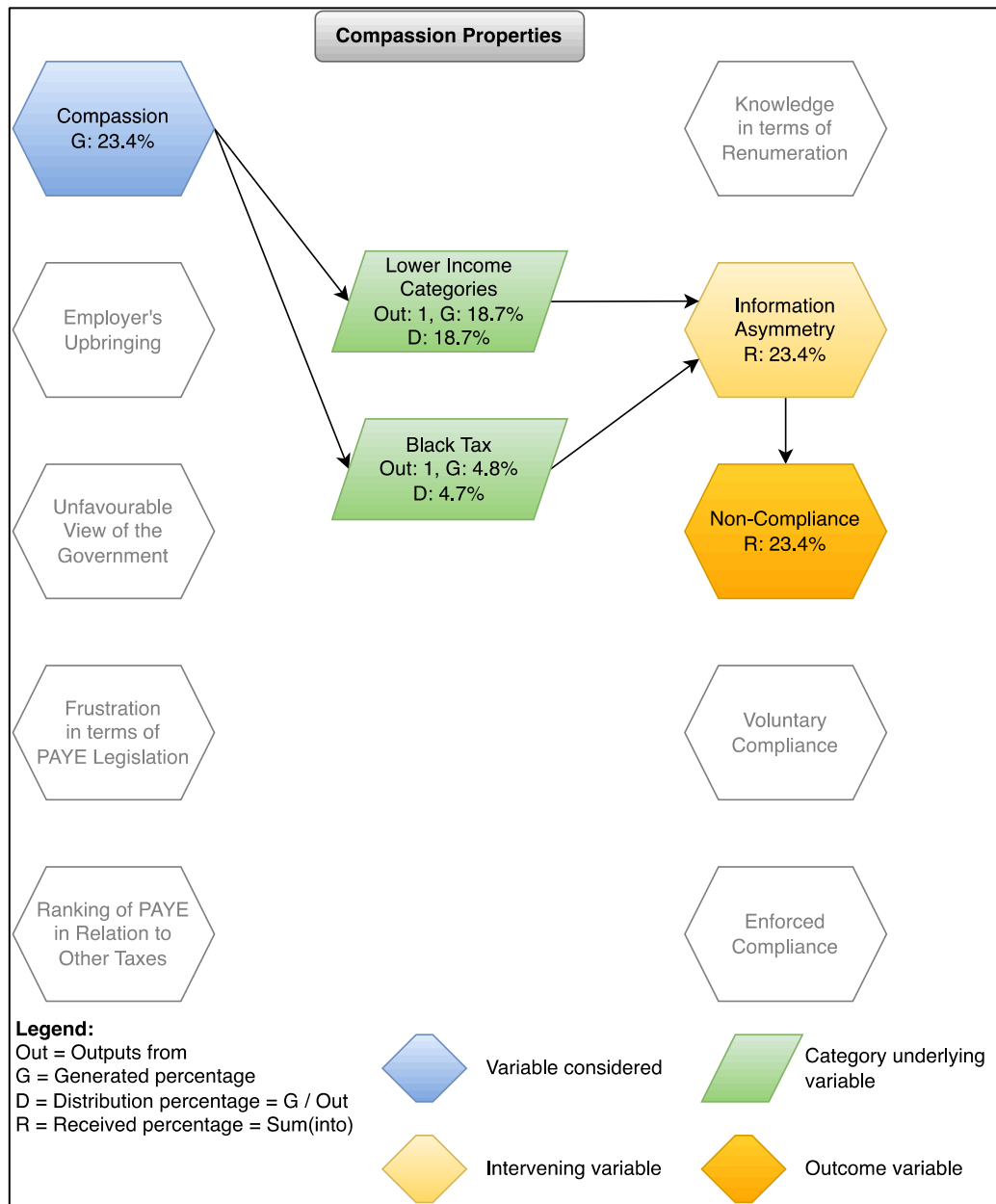


Figure 11: COMPASSION FOR EMPLOYEES as a variable - interrelationships and decision flows

However, both categories cause an INFORMATION ASYMMETRY between the employer and the tax authorities since the tax authorities are not informed about the compassionate behaviour of the employer who pays the taxi fares of a low-income worker in cash, for example. In the case of the COMPASSION variable, therefore, the two associated categories result in non-compliance via INFORMATION ASYMMETRY. In this example, INFORMATION ASYMMETRY is an *intervening variable* that generates no compliance decision percentage. Instead, it combines and transfers the decision percentages of the preceding categories to the recipient variable, NON-COMPLIANCE, as shown in Figure 11.

4.6 UNFAVOURABLE VIEW OF THE GOVERNMENT as a Variable in the Compliance Decision

From Figure 4 above, the variable UNFAVOURABLE VIEW OF THE GOVERNMENT generated a frequency percentage (G) of 30.2%. The variable is comprised of the categories: *TAX OFFICIALS ARE INCOMPETENT* (1.6%), *TAX OFFICIALS' ATTITUDE*

(0.6%), TAX OFFICIALS ARE PERCEIVED TO BE CORRUPT (0.4%), DETERIORATING PUBLIC SERVICES AND GOODS (5.6%), INABILITY TO ACCOUNT FOR NATIONAL FUNDS (6.1%) and FEAR OF THE TAX AUTHORITIES (14.3%).

Each underlying category has one connection with the variable under consideration, to which it assigns the generated percentage (G). However, each category may contain multiple outputs to different recipient variables (R).

As shown in Figure 12 below, only one category, *FEAR OF TAX AUTHORITIES*, directly results in a compliance decision (ENFORCED COMPLIANCE). The remaining categories contribute to intervening variables, all analysed as independent variables in the preceding paragraphs. Variables such as *COMPASSION* therefore act as *driver variables* and as *intervening variables*. Driver variables cause decisions to be taken and thus generate a decision percentage. Intervening variables collect the generated decisions of driver variables and then distribute them to outcome variables.

Figure 12 shows that the category of *INCOMPETENT OFFICIALS* contributes to the intervening variables of *INFORMATION ASYMMETRY* and *FRUSTRATION IN TERMS OF PAYE LEGISLATION*. This category has a generated decision percentage (G) of 1.6%. Due to a lack of more detailed low-level information in this study, it was assumed that an equal split of decision percentages (0.8%) would flow to each intervening variable. If more research had been conducted on the specific importance of each split, different percentages could have been assigned to each intervening variable.

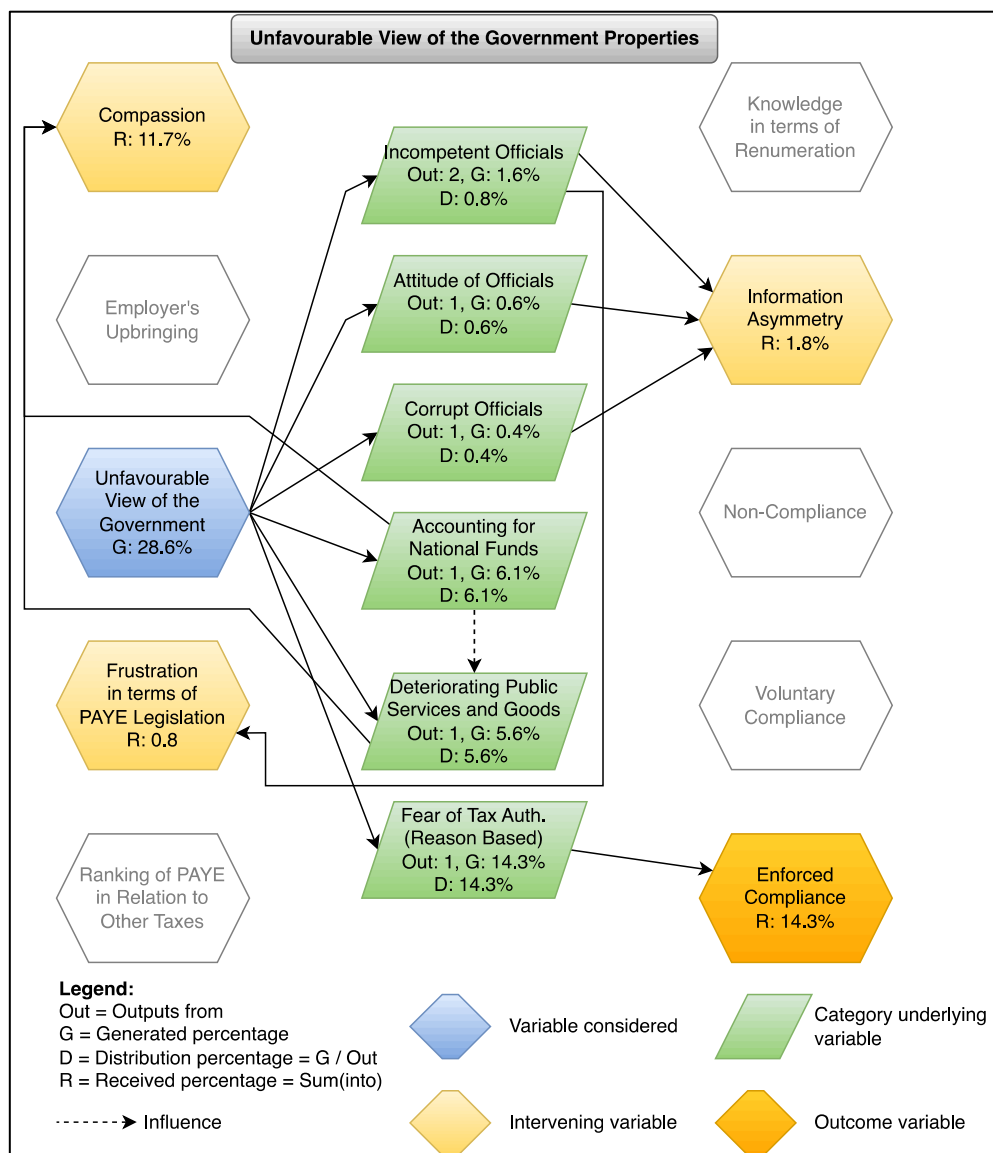


Figure 12: UNFAVOURABLE VIEW OF THE GOVERNMENT as a variable: interrelationships and decision flows

4.7 KNOWLEDGE OF REMUNERATION as a Variable in the Compliance Decision

From Figure 4 above, the variable KNOWLEDGE OF REMUNERATION generated a frequency percentage (G) of 13.1%. The categories that further describe the variable are *NON-CASH RECEIPTS* (7.5%), *RELIANCE ON PAYROLL SOFTWARE AS A MEANS TO ENHANCE KNOWLEDGE* (3.3%) and *VIEW THAT REMUNERATION SHOULD BE STIPULATED IN THE EMPLOYMENT AGREEMENT* (2.3%).

These straightforward results are shown in the associated digraph in Figure 13 below.

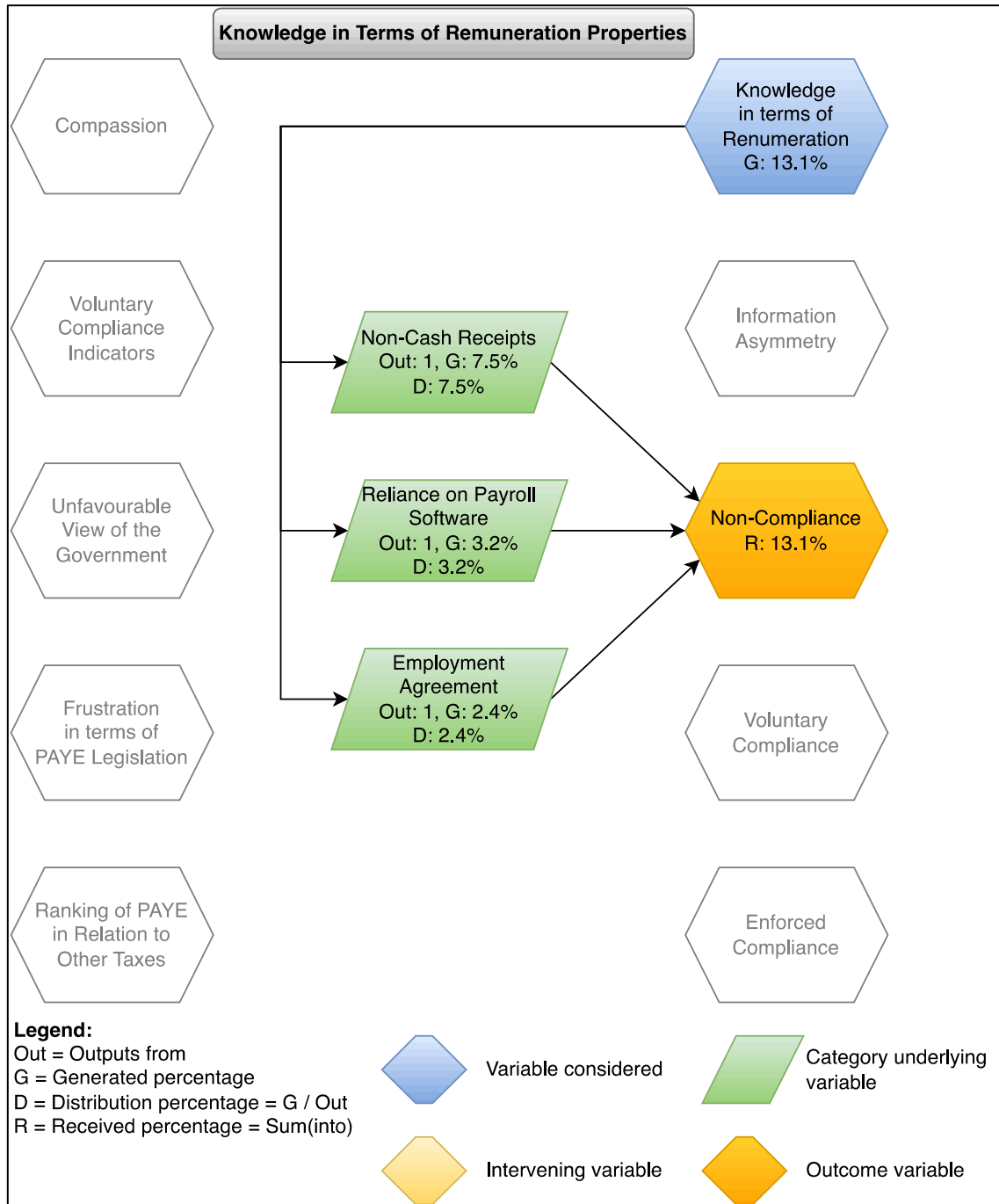


Figure 13: KNOWLEDGE OF REMUNERATION as a variable in the compliance decision

5. Results Assembly

The **third step** of the DAF procedure is to calculate the combined influence of each variable on all the other variables. This calculation was performed in a spreadsheet, and its outcomes are presented in Figure 14 below. As analysed from Figure 7 to Figure 13, the variables are listed on the left (*Variables Generating Influence*). The

intervening and outcome variables receiving influence are listed in the top row. The influence of each variable in the column on the left on each of the other variables can be seen by following its row horizontally to the right to the cell where the two variables concerned intersect. For example, COMPASSION has an influence of 23.4% on INFORMATION ASYMMETRY. The right-most column reflects the total influence each of the influence-generating variables in the left-most column has on all receiving variables, and this total is equal to the generated percentage (G) of the variable on the left. The first grey row at the bottom (Percentages Received - R) shows the inputs into each intervening or outcome variable.

Figure 11 shows that COMPASSION results in NON-COMPLIANCE via the intervening variable *INFORMATION ASYMMETRY*. This result is also reflected in Figure 14 below. Similarly, the variable UNFAVOURABLE VIEW OF THE GOVERNMENT contributes to both INFORMATION ASYMMETRY and COMPASSION. Since INFORMATION ASYMMETRY leads to NON-COMPLIANCE, the generated percentages 11.7% and 25.2% are combined (36.9%) in the second grey row at the bottom of the table.

The third grey row combines all the generated percentages G into the three outcome variables. Since INFORMATION ASYMMETRY (36.9%) only leads to NON-COMPLIANCE, INFORMATION ASYMMETRY (36.9%) and NON-COMPLIANCE generated from other variables (25.1%) are combined to result in the total NON-COMPLIANCE output variable (62.0%).

Variables Generating Influence	Intervening Variables							Outcome Variables			Percentages Generated (G-values)
	Ranking of PAYE re Other Taxes	Frustration re PAYE Legislation	Employer's Upbringing	Unfavourable View of the Government	Compassion	Information Asymmetry	Knowledge re Remuneration	Non-Compliance	Voluntary Compliance	Enforced Compliance	
Ranking of PAYE re Other Taxes								1.6			1.6
Frustration re PAYE Legislation								6.8			6.8
Employer's Upbringing								1.6	17.5	6.3	25.4
Unfavourable View of the Government					11.7	1.8				14.3	27.8
Compassion						23.4					23.4
Information Asymmetry								2.0			2.0
Knowledge re Remuneration								13.1			13.1
Percentages Received (R-values)					11.7	25.2		25.1	17.5	20.6	100
Combining Receiving Variables (R-values)						36.9		25.1			
Total Compliance Outcome Values (O-values)								62.0	17.5	20.6	100

Figure 14: Variables and Outcomes Results

The **fourth and final step** of the *DAF* procedure is to combine the digraphs developed from Figures 7 to 13 and the total percentages calculated in Figure 14 into a single *Variable interrelationship and decision flow digraph*. This digraph shows not only the relationships between all the variables but also the flow of the compliance decision-making process, thus resulting in an estimate of percentages for the *outcome variables*: NON-COMPLIANCE, VOLUNTARY COMPLIANCE, and ENFORCED COMPLIANCE. This combined *Variable interrelationship and decision flow digraph* is shown in Figure 15

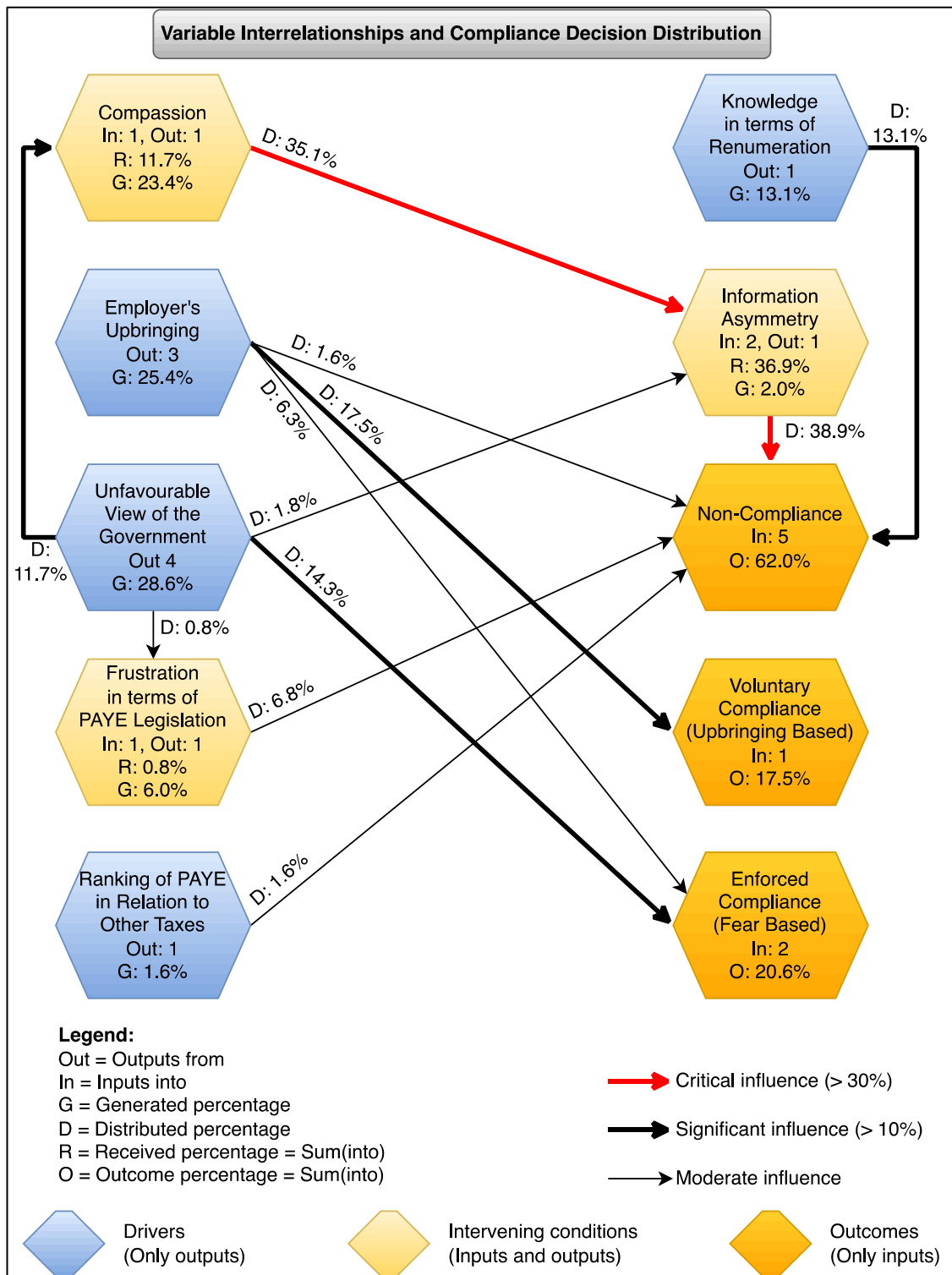


Figure 15: Variable interrelationships and compliance decision flow diagram

Variables with no inputs, i.e., variables not influenced by other variables, are *Drivers*. On the other hand, variables that only have inputs are *Outcomes*. Variables that have both inputs and outputs are *Intervening variables*.

The G-values shown in the variables in Figure 15 indicate the percentage of the occurrence (generated) frequency during the interviews. Similarly, the R-values represent the sum of all the G-values received into the particular recipient variable. The label *In* indicates the number of transfers into a variable, and the label *Out* shows the number of transfers out of the variable. At the start of each transfer arrow, the numeric value

indicates the percentages transferred or distributed (D-value) to the recipient variable. Recipient variables show the sum of all received percentages as R-values. The sums of the inputs into the *Outcomes* are shown as O-values.

In the *Variable interrelationship and decision flow digraph*, Figure 15, red arrows indicate critical drivers exceeding a specific limit (30% selected in this case). Thick black arrows indicate significant drivers in the decision-making process (exceeding 10% in this case). Standard black arrow lines denote moderate influences (10% and less). The limits selected for these levels of influence are arbitrary and are set by the researcher to best reflect the data being analysed.

6. Data Analysis

Analysing the data presented in the final *Variable interrelationship and decision flow digraph*, as shown in Figure 15, immediately reveals the following significant trends:

- INFORMATION ASYMMETRY contributes to 38.9% of non-compliance decisions, as indicated by a thick red arrow.
- COMPASSION considerations alone contribute to 35.1% of the decisions to exploit non-compliance opportunities, also indicated by a thick red arrow.
- The UNFAVOURABLE VIEW OF THE GOVERNMENT variable increases compassionate action by a significant 11.7%, indicated by a thick black arrow.
- An EMPLOYER'S UPBRINGING contributes 17.5% to VOLUNTARY COMPLIANCE, also as indicated by a thick black arrow.
- An UNFAVOURABLE VIEW OF THE GOVERNMENT (fear of the tax authorities' power) may contribute to 14.3% of ENFORCED COMPLIANCE (thick black arrow).
- The contribution of LACK OF KNOWLEDGE, i.e., employers not complying with the tax law simply because they misunderstand the law, is 13.1%, as shown by the last thick black arrow.
- All the other influences may be considered moderate or minor (thin black arrows).
- Finally, the *Outcomes* are illuminating. They indicate that respondents are 62% likely not to comply, with VOLUNTARY COMPLIANCE at only 17.5% and ENFORCED COMPLIANCE similarly low at 20.6%.

If the tax authorities wanted to improve compliance, they would be well advised to focus on resolving the critical and significant influences resulting in non-compliance.

7. Conclusion

This paper presented a *Directed Graph (digraph) Analysis Framework (DAF)*, which may be used to analyse and graphically display complex datasets that include both qualitative and quantitative information and cannot easily be presented using traditional graphing methods. In the STEM fields, simple line graphs, more advanced 3-D surface plots, radar plots, bar graphs and pie charts may suffice; however, in many other fields of research, such as the humanities and other fields such as the tax psychology case study presented in this paper, none of these traditional graphing methods would suffice. Numerous other fields of research outside the traditional STEM fields, such as the humanities, may benefit from this approach, especially where a combination of qualitative and quantitative data needs to be presented graphically.

A four-step method was presented that allows several interdependent variables, each with associated sub-variables (categories), to be analysed against all other variables and plotted graphically.

The four-step method is summarised as follows:

Step 1: Create a graphical presentation listing all the variables and outcomes.

Step 2: Plot each variable, with its underlying categories or sub-variables, against the appropriate outcome or intervening variables.

Step 3: Calculate the combined influence of each variable on all the other variables.

Step 4: Combine all the digraphs developed in Step 2 and the total percentages calculated in Step 3 into a single variable interrelationship and decision flow digraph.

The final *Variable interrelationship and decision flow digraph*, as shown in Figure 15, displays the information obtained in the case study. The interrelationships are clearly demonstrated using arrow lines. The level of

importance of these relationships is visually presented in terms of the colours and thicknesses of the arrow lines. The three variable types used in this case study, *Driver*, *Intervening* and *Outcome*, are visually distinguished by using different colours. Should the reader need a more precise data resolution, the percentages generated for each interrelationship are also shown on the arrow lines.

This case study presented the analysis of seven variables and twenty-four sub-variables. The influence of each of the variables on all others was analysed using a simple procedure and combined into a relatively simple and understandable graphical representation, as shown in Figure 15. It is unlikely that a traditional graphing solution could be used to present the qualitative and quantitative interrelationships of a total of thirty-one variables and sub-variables in the clear and concise manner as presented in this paper.

The *Digraph Analysis Framework* (DAF) may be modified and extended to suit many other types of datasets that researchers may encounter.

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The Role of Training in Big Data Analytics Adoption: An Empirical Study of Auditors Using the Technology Acceptance Model

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Abstract: This study investigates the impact of training on auditors' intention to adopt Big Data Analytics (BDA) in auditing processes, using the Technology Acceptance Model (TAM) as a theoretical framework. This study seeks to fill the gap in research on the impact of training in the adoption of BDA in audit procedures. While most existing studies have concentrated on the general benefits and challenges of BDA in auditing and other business sectors, they have largely overlooked the specific influence of training as an external factor on the use of BDA in auditing processes. Moreover, there is a significant research gap concerning the application of BDA in developing countries, including Palestine. A census survey of 94 auditors from Big Four accounting firms in Palestine was conducted, with an 86% response rate. Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis revealed that training positively influences perceived usefulness ($\beta = 0.658$, $p < 0.001$) and perceived ease of use ($\beta = 0.616$, $p < 0.001$) of BDA tools. Perceived usefulness significantly affects behavioral intention to adopt BDA ($\beta = 0.532$, $p < 0.001$), while perceived ease of use does not. Behavioral intention positively impacts actual use of BDA tools ($\beta = 0.481$, $p < 0.001$). Based on these findings, audit firms should focus on strategies to translate positive intentions into actual usage. This can be accomplished through ongoing support and resources, such as regular training programs and showcasing success stories that highlight the practical advantages of BDA tools. By fostering an environment that actively supports and encourages the use of BDA, audit firms can ensure that their auditors not only intend to use these tools but also integrate them into their daily auditing practices. This paper contributes to understanding BDA adoption in auditing, particularly in developing countries, and provide insights for audit firms in designing effective training programs to enhance BDA adoption.

Keywords: Big data analytics, Behavioral intention, Perceived ease of use, Perceived usefulness, Technology acceptance model, Training

1. Introduction

Utilization of Big Data Analytics (BDA) in the financial reporting and accounting field is increasing across various sectors; thereby, professionals in these fields are increasing their interest in such tools to enhance their analytical capabilities to be up to date with the latest technologies (Idil and Akbulut, 2018; Austin et al., 2018). BDA is found to be an effective technique in enhancing the understanding of business operations and the complexities of accounting treatments, in addition to offering opportunities for real-time process analysis, which reinforces the adoption of new technologies in financial accounting and reporting (Idil and Akbulut, 2018).

Audit firms, mainly the Big 4, are investing heavily in BDA, integrating it into their audit methodologies to provide auditors with the knowledge required for applying the BDA tools in their auditing processes (Kapoor, 2020). Examples of these BDA tools that are continually updated and developed by these firms include digital working papers, smart forms, templates, and checklists (Pedrosa, Costa, & Aparicio, 2020). However, the adoption of these tools by auditors varies from one to another although they are available and accessible to them; thus, the journey towards digital audit transformation represents a major challenge for these audit firms. This paper focuses on clarifying the influence of one of the audit firms' characteristics, represented by the level of provided training, that may motivate auditors to use BDA.

Despite the availability and accessibility of BDA tools, their adoption levels in auditing remain inconsistent. Some auditors use BDA tools extensively, while others use them minimally or not at all. This inconsistency can be attributed to various factors, including the size of the audit firm, the strategic orientation, and the technological capabilities of the organization. Large audit firms are more likely to adopt BDA due to their ability to invest in the necessary tools and resources. However, the adoption is generally limited by the quality and comparability of data, as well as the availability of qualified data analysts. Additionally, the extent of BDA usage is often influenced by the engagement partner or manager, and many audit firms have not made it mandatory to use or

test advanced BDA tools. The application of BDA in auditing is still in its early stages, with many firms exploring its potential benefits and challenges. This inconsistency highlights the need for research to identify the barriers to adoption and the factors that can enhance the uptake of BDA tools (Krieger, Drews, & Velte, 2021; Eilifsen et al., 2020).

This study aims to address the gap in the impact of training in adopting BDA in audit procedures, as most existing research has focused on the general benefits and challenges of BDA applications in the auditing field and across various other business sectors. The specific effect of external factor represented by training on the use of BDA in performing audit procedures has been ignored. Additionally, there is a significant gap regarding the lack of focus on BDA applications in developing countries including Palestine.

Adopting the Technology Acceptance Model (TAM), as developed by Davis, Bagozzi, & Warshaw (1989), as a framework would help in understanding auditors' attitudes and interactions towards such technologies. This model is specifically designed to examine the behavior associated with the adoption of information technology. It revolves around two key beliefs: perceived usefulness (PU) and perceived ease of use (PEU) (Davis, Bagozzi, & Warshaw, 1989). According to Davis (1986, p.26), PU is defined as "the degree to which an individual believes that using a particular system would enhance his or her job performance," while PEU is defined as "the degree to which an individual believes that using a particular system would be free of physical and mental effort". Consequently, PU and PEU influence the user's intention and attitude towards the acceptance and utilization of new technology. Venkatesh, Davis, & Morris (2007) highlight that numerous researchers have examined the reliability and validity of the TAM by applying it to various technologies with different methodologies and at different times. Despite the existence of several models, such as Innovation Diffusion Theory and Theory of Planned Behavior which were used to study technology acceptance behavior (Oliveira and Martins, 2011), TAM is widely regarded as the most significant and effective model for interpreting technology acceptance behaviors and attitudes (Marangunić & Granić, 2015). This research makes two significant contributions. Firstly, it addresses the topic of BDA in auditing within a developing countries context, as this paper is one of the few in Palestine examining BDA in the auditing field. Secondly, it extends the scope of research on how external factors affect PU and PEU in auditing by adding a specific external variable related to audit firms (training) and assessing their effect on auditors' perceptions regarding BDA tools.

The paper aims to achieve the following objectives:

- To assess the degree of impact of training on auditors' PEU and PU of BDA tool.
- To examine the relationship between the PU and PEU of BDA tools on auditors' BI to adopt these tools.
- To explain how auditors' BI to adopt BDA tools translate into actual use (AU) in the audit process.

The structure of the remaining parts of this paper is as follows: Section 2 reviews the literature on firms' specific attribute (training), TAM, and BDA, in addition to hypothesis development. Section 3 introduces the paper's framework. Section 4 addresses the methodology adopted in the paper. Section 5 covers the data analysis and results. The last sections (Sections 6 & 7) present the discussion and conclusion, summarizing the results, limitations, and the recommendations for future studies.

2. Literature Review

TAM provides a theoretical framework for analyzing technology adoption tendencies, focusing on two main factors: PU and PEU. These variables influence the attitudes of users, especially professionals like auditors, towards the acceptance or rejection of new technology (Davis, Bagozzi, & Warshaw, 1989). In their study, (Hwa, Hwei, & Peck, 2015) examined how users' BI to adopt web-based e-learning systems are influenced by their PU and PEU. The researchers found that the users' perception of the user-friendly and the expected benefits of these systems directly influenced their desire to use them, resulting in an increase in AU. Grimaldo and Uy (2020) found a strong and direct correlation between people's favorable attitude towards using job search sites and online recruitment tools, and their desire to use and then AU.

Davis and Venkatesh (1996) developed their TAM model (Figure 1 (a)) on the assumption of the existence of specific external variables that would impact the PU and PEU. Tarabasz and Poddar (2019) noted that external variables have a significant role in interpreting why PU and PEU impact the decision regarding the adoption or rejection of new technology, thus, they concluded that external variables would directly impact the PU and PEU of new technology. Although limited research was conducted on the impact of external variables on PU and PEU, some scholars like Davis, Bagozzi, & Warshaw (1989); Sharma and Mishra (2014); Grimaldo and Uy (2020)

addressed some examples of external variables that might impact the PU and PEU, such as trust, support and documentation. In our study, we will focus on the training as one of the key variables to assess its impacts on PU and PEU.

This study employs the TAM to examine auditors' intentions to adopt BDA tools developed by their companies for use in auditing processes. Furthermore, we focus on external factor that have been previously identified in the literature as being directly related to the characteristics of auditing firms. Among these is training. The potential influence of training on auditors' assessments of the usefulness and ease of BDA technology use is what drives the investigation of this variable.

2.1 Impact of Training on PU and PEU

The acceptance of new technologies and the efficient use of such technologies inside businesses are both significantly impacted by training. It acts as a way to equip users with the essential skills and knowledge for the exploitation of technology, hence increasing the PU and PEU of the technology (Valenstein-Mah et al., 2020). In-person, online, and self-guided training can help professionals clarify questions and integrate technology into daily operations by building confidence and understanding (Valenstein-Mah et al., 2020; Shatri, 2020). Organizations struggle to develop successful training programs despite the advantages. Developing training programs involves creating ones that fit individual learning styles and encourage involvement. The complexity of the technology and training approach impacts training effectiveness, which may require customized programs to meet individual needs (Schröder et al., 2022; Al-Rahmi et al., 2019).

In order to get a better understanding of the role of training in increasing the perception of new technology adoption, other factors may be considered such as e-learning, training duration, learning style, and the use of interactive tools. These factors supposed to positively increase the benefits of training programs and then increase their adoption (Šumak et al., 2011; Al-Azawei, Parslow, & Lundqvist, 2017). Recognizing these matters raises the need to customize training programs to learners' needs and the specific requirements of the technology (Buchanan, Sainter, & Saunders, 2013; Al-Azawei, Parslow, & Lundqvist, 2017).

Major auditing firms acknowledge the significance of training in supporting their efforts toward a complete shift to digital audit transformation. Since this shift is essential for these firms' strategy to maintain a competitive advantage in the market, they are motivated to use advanced technology like BDA to enhance audit efficiency and quality. Consequently, these firms develop related training programs to prepare their auditors to utilize these newly developed technologies. Auditors perceive the usefulness and ease of use of BDA tools positively, following the increasing their knowledge and skills resulted from these training programs (Eilifsen et al., 2020; Buchanan, Sainter, & Saunders, 2013; Adrianto, 2018).

2.2 BDA and TAM

Recently, there has been a significant increase in studies dealing with the adoption of BDA. These studies addressed the benefits and issues related to the adoption of BDA, and focused on identifying the best theory that can be adopted to examine BDA adoption and use. Although many barriers could impact the adoption of BDA, such studies on big data adoption emphasized the importance of adopting BDA in organizations across different industries and economies (Olufemi, 2018; Brock and Khan, 2017; Verma, Bhattacharyya, & Kumar, 2018).

Biucky et al., (2017) provided a conceptual model based on TAM to explore factors impacting internet users' adoption of new technology represented by social commerce. They found that using TAM helps in interpreting the end users' intention to adopt a new IT system. Brock and Khan (2017) noted that the adoption of TAM was a critical factor in the study of the adoption of BDA. In addition, they also noted that TAM explains people's motivations for adopting the system. However, they also found that TAM does not consider the practical side of system adoption. Sharma and Mishra (2014) noted that technology adoption may require more than behavioral intention and technical knowledge; thus, they identified various factors such as trust, social influence, and numerous facilitating conditions. Meanwhile, Olufemi (2018) found that TAM does not consider technology cost, management support, and entities' environment and culture in the intention to adopt new technology. The user experience of big data was also addressed by some scholars to assess its impact on technology adoption. Müller and Jensen (2017) selected companies with previous experiences and knowledge in big data to investigate the application of big data among Danish SMEs. Li and Lai (2011) noted that experienced users feel more confident regarding the technology's ease of use than inexperienced users, recommending that experience is an external factor that impacts technology adoption behavior.

The common conclusion among most scholars is that the external variables have an effect on PU and PEU, and the PU and PEU themselves are considered the main TAM factors that can influence users' behavioral intentions to accept and adopt new technology, including BDA (Davis, 1989; Brock & Khan, 2017; Razmak & Bélanger, 2018; Bayraktaroglu et al., 2019).

2.3 BDA in Auditing

BDA helps professionals to understand companies' perceptions of business expectations. The need for understanding complex accounting standards increases the motivation to adopt new technologies in financial accounting and reporting, and the emergence of BDA helps to gain better chances of capturing real-time processes. This has led companies to invent new techniques and technologies to understand the role of BDA in accounting, but they should ensure that actual practices of BDA are aligned with the formally and publicly pronounced processes (İdil & Akbulut, 2018).

Gepp et al. (2018) found that big data offers an opportunity to analyze large volumes of data, sort information, and provide new insights. Auditing would benefit from adopting such big data approaches to enhance the efficiency of financial analysis and detect fraud. This complies with auditing standards that encourage the use of big data techniques, even for smaller data sets, to provide additional insights. BDA in external auditing is the process of inspecting and transforming big data to seek the efficiency and effectiveness of auditing and enhance the decision-making process (Dagilienė & Klovienė, 2019). Though auditors work with financial data, the volume and complexity of business require continuous analysis of non-financial data from both internal and external sources, demanding the use of BDA tools and changes in the audit processes (Dagilienė & Klovienė, 2019).

Eilifsen et al. (2020) identified some limitations and concerns represented by the evaluation of audit evidence collected through data analytics by regulatory bodies. Furthermore, auditing through data analytics is limited as supplementary evidence despite a global strategy concerning data analytics usage and the auditors' positive attitude towards its use. Its scope of use shall be limited until it is incorporated by clients, supported by regulators, and proves efficient and effective to gather evidence in the audit process. Auditing through BDA is extended by developing instructions and guidelines for substantive tests of details (No et al., 2019), and for fraud detection (Austin et al., 2018; Tang & Karim 2019). Several data analytics approaches were identified for auditors to effectively perform substantive tests of details (No et al., 2019) and for better fraud detection (Austin et al., 2018). The extent of applying BDA is determined by assessing the audit risk and materiality, also by the degree of understanding gained by the audit team about the nature, time, and extent of audit procedures designed to test accounts through BDA (No et al., 2019).

The benefits of using data analytics exceed challenges and costs, driving companies and audit firms towards the effective execution of data analytics, making it possible to analyze 100% of the journal entries, and potentially improving audit quality. Thus, data analytics is a transformative tool driving audit efficiency, adopted by various audit firms, especially Big Four firms, knowing that audits conducted by larger audit firms differ significantly in terms of BDA used in the financial reporting and audit process (Austin et al., 2018). An efficient audit with fewer expenses is the main purpose that audit firms are currently seeking. While companies expect their auditors to use BDA in the audit, disagreement about whether and how it affects audit fees is a concern among auditors, who have made a large investment in new BDA technologies. Therefore, many audit firms have called for the necessity of changing the audit fees in response to the implementation of BDA in the audit process (Austin et al., 2018).

2.4 Hypotheses Development

Auditors at top audit companies, like the "Big Four," gain from learning a lot about BDA technologies. This experience makes them much better at using BDA tools, which makes the move easier and helps them understand how BDA apps work. This kind of setting makes it less likely that auditors won't want to use BDA in their work.

Training turns out to be a key factor in how useful and easy to use new tools are seen to be. It is very important to give people full training when new technology is introduced so that it can be used and integrated well. This training help not only makes professionals more comfortable using the technology, but it also makes it more likely that it will be adopted (Valenstein-Mah, et al., 2020). Training also helps people understand the technology better, which can help clear up any misunderstandings or doubts that might stop people from using it (Shatri, 2020). Major auditing firms acknowledge the significance of training, instituting programs to equip their teams with the skills necessary for data analysis (Eilifsen et al., 2020). Buchanan, Sainter, and Saunders (2013) advice for concentrated training programs to enhance the supposed benefits and simplicity of use of new technologies,

therefore promoting their adoption. Based on these discussions, we formulate the following hypotheses to investigate the impact of training on the PU and PEU:

H1a: *Training has positive effect on the PU of BDA tools.*

H1b: *Training has positive effect on the PEU of BDA tools.*

The finding as presented in the literature review section provides support that the PU and PEU affect the user's intention toward the acceptance and usage of a particular technology (Davis and Venkatesh, 1996). This intention leads to the actual use and adoption of technology (Diop, Zhao, & Duy, 2019). PU and PEU are considered the most significant TAM variables that affect the BI of users to adopt actual technology (Davis & Venkatesh, 1996). Some of the previous studies emphasized the importance of understating the PU and PEU that affect the technology adoption behavior (Al Amin et al., 2020; Cabrera-Sánchez & Villarejo-Ramos, 2019; Olufemi, 2018). Hwa, Hwei, & Peck (2015) investigated the role of PU and PEU on BI to adopt web-based e-learning systems, and they found that PU and PEU, have a significant relationship to predicting users' BI to adopt web-based e-learning systems. Grimaldo and Uy (2020) concluded that the perception of usefulness and ease of use of technology has a positive and direct relationship with the intention to use them. BI is the tendency to implement certain behaviors in the future and is also a predictor of the adoption of new technology; thus, the intent and need to use new technology ultimately led to its actual use (Shahbaz et al., 2019).

Based on the discussion regarding the impact of PU and PEU on the BI to use BDA and its actual use, we propose the following hypothesis:

H 2a: *PU has a positive effect on the BI to adopt BDA technological tools in the audit process.*

H 2b: *PEU has a positive effect on the BI to adopt BDA technological tools in the audit process.*

H 2c: *BI to adopt BDA technological tools in the audit process has a positive effect on the actual use of these tools.*

3. Model Development

The study model is based on an examination of the impact of training on the PU, PEU, and consequent adoption of technology. The TAM serves as the theoretical foundation for this analysis. This framework visually represents the interconnections among the variables and factors of the study, expanding upon the foundational principles of Davis's TAM (as shown in Figure 1 (a)). It accepts the proposition put forth by Davis and Venkatesh (1996) that perceived utility and simplicity of use are substantially influenced by specific external factors. This paper elucidates a certain external factor—specifically, training—that may influence auditors' perspectives on the utility and navigability of BDA technological tools, as revealed through a review of the relevant literature.

PU and PEU stand as cornerstone variables within TAM, critically influencing the BI of users towards embracing new technologies (Davis and Venkatesh, 1996). The significance of these variables in determining technology adoption behaviors has been addressed in previous studies (Al Amin et al., 2020; Cabrera-Sánchez & Villarejo-Ramos, 2020; Olufemi, 2018), in which the researchers highlighted their connections in predicting the intention towards new technology adoption (Grimaldo & Uy, 2020).

Furthermore, the developed research model suggests a direct pathway started from the external variables, then the auditor's perception of the usefulness and ease of use of BDA, which further linked to their intention to employ BDA tools in their work and ultimately resulted in their practical and actual application (Davis and Venkatesh, 1996; Shahbaz et al., 2019). Many scholars have given some examples of the output of this practical utilization of BDA by auditors, such as templates, checklists, and digital working papers (Pedrosa, Costa, & Aparicio, 2020; Knechel, 2007; Hurtt et al., 2013). Figure 1 (b) presents the conceptual framework that was built based on the literature review of the main research topics along with the related theoretical discussion. The model translated the above-mentioned linkage between the main areas of this study (external variables, PU, PEU, BI, and AU of BDA tools). This framework summarizes the decision-making process by auditors to adopt or reject BDA in their work to balance the pressure from their firm to apply it, discontinuing the traditional audit methods, and their perception of the ease and usefulness of these tools.

The research model presented in figure 1 (b) has two essential features: it integrates and elaborates on training as one of the external factors identified in the literature as influencing PU and PEU, thereby offering a comprehensive view of the elements affecting the adoption of data analytics. Furthermore, it investigates

whether the training provided by audit firms might enhance auditors' perceptions of BDA tools and whether this enhanced perception could lead to a broader adoption of BDA tools in auditing practices.

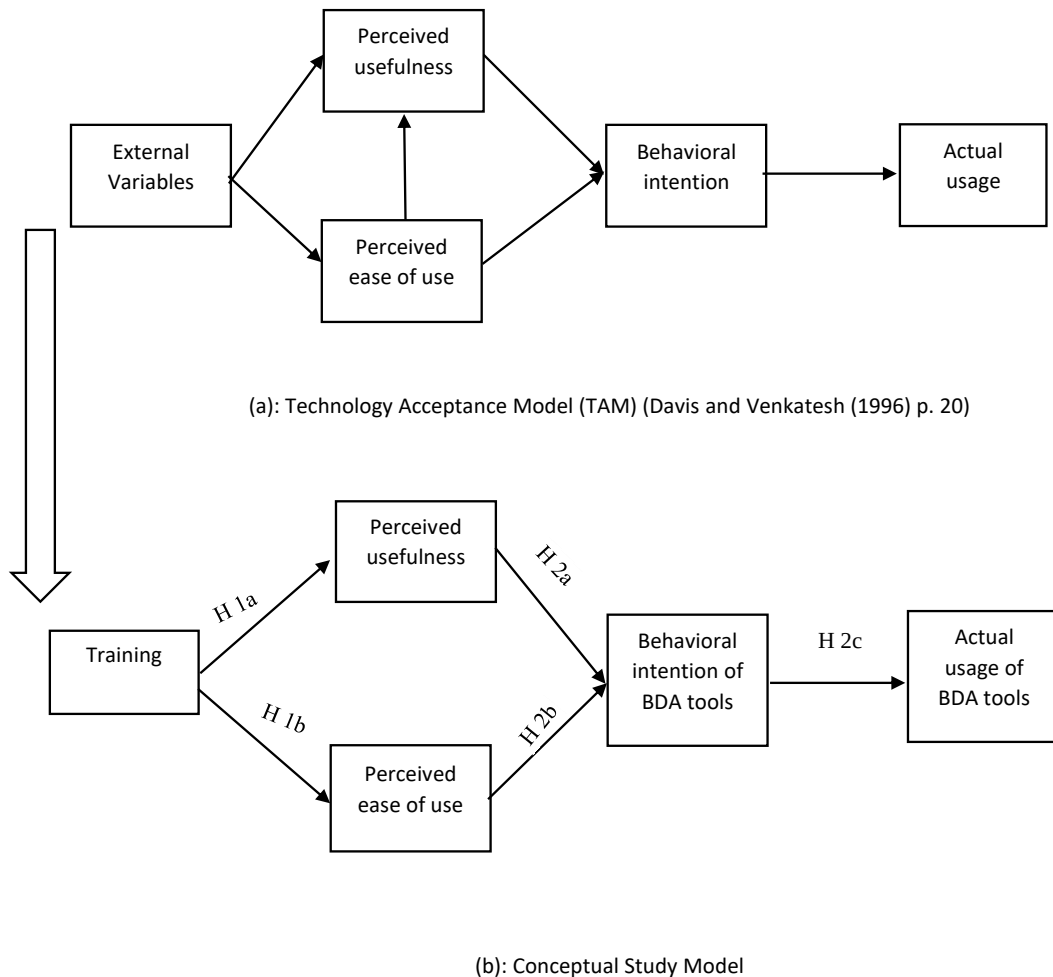


Figure 1: Models Contributing to the Development of the Study Framework

4. Method

4.1 Research Design

The purpose of this study is to determine whether relationships exist between the study's independent and dependent variables across its three stages. In the first stage, the external variable, represented by the training, will serve as independent variables, while PEU and PU will be the dependent variables. In the second stage, PEU and PU will function as independent variables, with the practicing auditors' BI to adopt BDA in auditing as the dependent variable. This is followed by the third stage, in which BI is treated as the independent variable and AU as the dependent variable.

The study adopts quantitative research method by relying on the survey technique for data collection, as this method is effective for interpreting correlations and predicting the value of a specific variable based on another's value (Khaldi, 2017; Reio, 2016). The data gathered from the questionnaire were analyzed using SMARTPLS4.

Path analysis was utilized to investigate the connections between the research's independent and dependent variables (Loehlin, 2004).

4.2 Population and Sample

The study population consisted of practicing auditors working at the big four auditing firms in Palestine at the time of data collection. The sample selection method for this research was the census approach, where the entire population also represented the sample (Levy & Lemeshow, 2013; Gibbins, Salterio, & Webb, 2001). This method is effective when dealing with smaller population, such as when the total population is fewer than 100 units (Levy & Lemeshow, 2013; Vinzi et al., 2010). Out of 105 auditors in the Big Four firms in Palestine, 11 with less than one year of experience were excluded, reducing the survey population to 94. The survey received 81 responses, yielding an 86% response rate. Less experienced auditors were excluded to ensure the reliability of audit judgments, as research indicates that experience enhances auditors' ability to identify risks and inconsistencies (Sayed Hussin et al., 2017; Pagalung & Habbe, 2017).

4.3 Questionnaire Design

The questionnaire was designed to collect the main demographic information about the participants. Additionally, the questionnaire includes three main sections with a total of 29 statements as follows: The first section contains 7 statements related to the training factor. The second section contains 14 statements to determine whether PEU and PU impact auditors' BI to adopt BDA. The last section, consisting of 8 statements to measure the AU of BDA technological tools. The questionnaire items in all sections (except for the demographic part) were measured using a 7-point Likert scale, ranging from 1 ('strongly disagree') to 7 ('strongly agree'). This scale is commonly used to examine participants' perceptions, attitudes, and opinions when a questionnaire is employed to assess specific subjective matters (Schrum et al., 2020).

The Training factor is based on the research of Al-Azawei, Parslow, and Lundqvist (2017) which includes question from TG1 to TG7. In TAM section, Davis's (1989) TAM questionnaire was employed to measure the independent variables of PEU and PU, encompassing questions from PU.1 to PU.6 and PEU.1 to PEU.6. Davis developed a measurement scale for these variables to assess user acceptance of new technology. However, since Davis's 1989 model did not include the dependent variable of BI to use, the work of Davis and Venkatesh (1996) will also be referenced, as they incorporated this aspect into the TAM framework (questions BI.1 and BI.2). Finally, AU section of the questionnaire is designed to assess the AU of BDA technological tools, addressing questions from AU.1 to AU. 8. The focus here is on measuring the independent variable of the AU of these tools. This part is adopted from Janvrin, Bierstaker, & Lowe (2009), who explored auditors' use of computer-assisted audit techniques (CAATs) within the audit process. Some modifications Janvrin, Bierstaker, & Lowe (2009)' instrument was made to better align with the focus of this questionnaire section.

5. Data Analysis and Results

5.1 Questionnaire Analysis

To achieve the study' objectives and test the related hypotheses, SmartPLS 4 software was used. Two vital methodological elements were considered: the measurement model and the structural model. Currently, Path analysis and PLS-SEM techniques are broadly used as the primary statistical approach in various research fields. (Hair et al., 2010, 2016; Kline, 2023).

Table 1 presents the means and standard deviations for each of the constructs. We grouped the responses collected on the seven-point Likert scale into three categories: 'low' for ratings from 1 to less than 3, 'medium' for ratings from 3 to less than 5, and 'high' for ratings from 5 to 7. This division was intended to yield uniform and dependable feedback from the auditor participants. The analysis indicated that all the constructs scored within the 'high' category. This suggests a positive reception towards the technology among the auditors. Furthermore, training influences the implementation of the technology, underscoring the significance of this external factor in facilitating the adoption and effective utilization of the technology in audit firms.

Table 1: Level of implementation of the external variables, TAM, and AU

	Mean	Standard Deviation	Level of Implementation
Training	5.50	0.95	High
Perceived usefulness	5.42	1.02	High
Perceived ease of use	5.16	0.94	High
Behavioral intention	5.44	1.07	High
Total for TAM	5.31	0.89	High
Actual use	5.14	1.07	High

5.2 Assessment of the Measurement Model

The measurement model was assessed to establish the reliability and validity of the constructs (Table 2). First, the factor loading of all the items in the model exceeded the minimum acceptable value of 0.50 (Hair et al., 2010). Although factor loading over 0.70 is recommended (Vinzi et al., 2010), researchers in social science studies often encounter lower loading (less than 0.70). Instead of immediately deleting these indicators, their effects on composite reliability, content validity, and convergent validity shall be examined. Items with outer loadings from 0.40 to 0.70 should be considered for removal only if their deletion increases of composite reliability or average variance extracted (AVE) above the recommended value (Hair et al., 2016). In this paper, removing the item (TG5, loading = 0.639) would not have significantly increased the composite reliability and AVE, as the values were already above the threshold. Additionally, evaluating the confidence interval of the loading revealed that none included zero. Hence, no items were removed from the study for further analysis.

Table 2: Reflective constructs measurement properties

Reflective constructs	Construct items	Items loading	CR	AVE	Reference
Training	TG1	0.789	0.930	0.657	Al-Azawei, Parslow, & Lundqvist (2017)
	TG2	0.830			
	TG3	0.850			
	TG4	0.803			
	TG5	0.639			
	TG6	0.886			
	TG7	0.852			
Perceived Usefulness	PU1	0.930	0.977	0.874	Davis (1989)
	PU2	0.964			
	PU3	0.949			
	PU4	0.947			
	PU5	0.899			
	PU6	0.920			
Perceived ease of use	PEU1	0.868	0.961	0.804	Davis (1989)
	PEU2	0.903			
	PEU3	0.944			
	PEU4	0.922			
	PEU5	0.898			
	PEU6	0.841			
Behavioral intention	BI1	0.976	0.976	0.954	Davis & Venkatesh (1996)
	BI2	0.977			

Reflective constructs	Construct items	Items loading	CR	AVE	Reference
Actual use	AU1	0.857	0.958	0.742	Janvrin, Bierstaker, & Lowe (2009)
	AU2	0.858			
	AU3	0.908			
	AU4	0.806			
	AU5	0.845			
	AU6	0.881			
	AU7	0.839			
	AU8	0.895			

Reliability was assessed using Cronbach's alpha, rho-a, and composite reliability; statistics for both were greater than the recommended value of 0.700 (Wasko & Faraj, 2005). The rho-a value returned was between the Cronbach's alpha and composite reliability (Sarstedt, Ringle, & Hair, 2017), it was also more than 0.70, thereby indicating high reliability (Henseler et al., 2016). Additionally, convergent validity was acceptable since the AVE was more than 0.500. Moreover, the verification of discriminant validity is essential for confirming the uniqueness of the measurement tools associated with different factors. This process checks that the square root of the AVE for each construct is greater than the inter-construct correlations, as proposed by Fornell and Larcker (1981). Table 3 presents the results of applying the Fornell-Larcker criterion to our study's model, which indicating compliance with this validation standard.

Table 3: The measurement model discriminant validity- Fornell-Larcker criterion.

Constructs	Actual Use	Behavioral Intention	Perceived Ease of Use	Perceived Usefulness	Training
Actual Use	0.862				
Behavioral Intention	0.481	0.977			
Perceived Ease of Use	0.615	0.631	0.897		
Perceived Usefulness	0.650	0.712	0.710	0.935	
Training	0.728	0.481	0.616	0.658	0.810

Additionally, the model's discriminant validity was evaluated using the heterotrait-monotrait ratio (HTMT) of correlations (Ab Hamid, Sami, & Sidek, 2017). An HTMT ratio should be less than 0.90 to achieve adequate discriminant validity between the constructs. We presented all of results from HTMT assessment in Table 4, where each recorded value is below the 0.90 threshold, thereby confirming the discriminant validity of the model.

Following the compilation of results from the study's measurement model evaluation, Figure 2 depicts the finalized research model that was explored.

Table 4: Heterotrait-Monotrait Ratio (HTMT)

Constructs	Actual Use	Behavioral Intention	Perceived Ease of Use	Perceived Usefulness	Training
Actual Use	-				
Behavioral Intention	0.493	-			
Perceived Ease of Use	0.646	0.661	-		
Perceived Usefulness	0.673	0.739	0.738	-	
Training	0.781	0.511	0.648	0.695	-

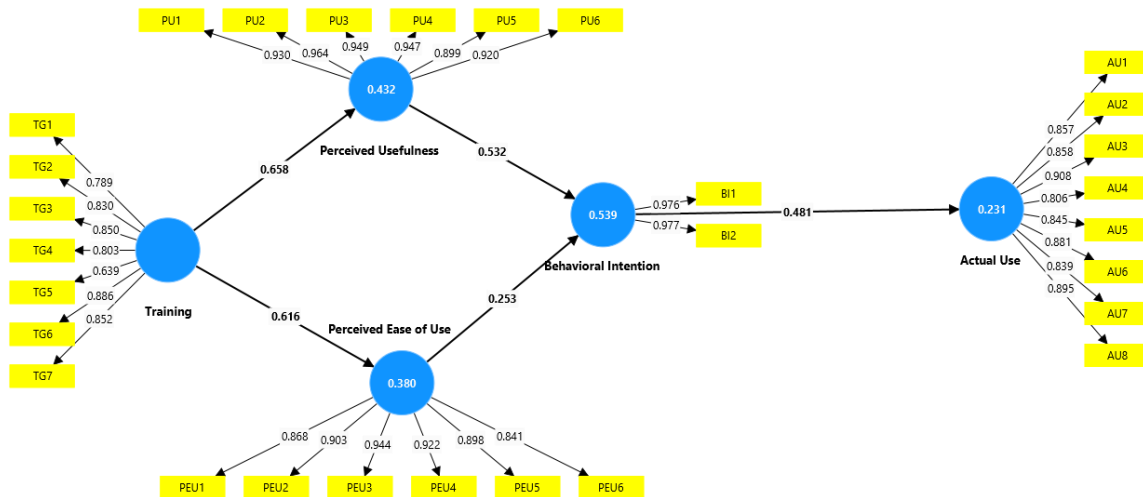


Figure 2: The measurement model

5.3 Assessment of the Structural Model

The next step in the study was to examine the structural model to determine its predictive accuracy and explore the interactions among the constructs, as well as the model's robustness and coherence. This phase was important for verifying the study's hypotheses. The analysis used a bootstrapping procedure and focused on several key indicators: the coefficient of determination (R^2), path coefficients (β values), T-statistics, the effect size (f^2), and the model's predictive relevance (Q^2). R^2 values are considered high at 0.75, moderate at 0.50, and low at 0.25 (Hair et al., 2010). In this paper, the R^2 values are considered moderate. The Q^2 values act as markers of the model's predictive capacity, with the results affirming the model's effectiveness in forecasting outcomes.

Crucially, for a model to demonstrate sufficient predictive relevance, the Q^2 values must surpass zero, confirming that the external constructs possess predictive utility for the internal constructs, following the guidance of Hair et al. (2010). Table 5 outlines the cross-validated redundancy values for AU, BI, PEU, and PU, documented at 0.264, 0.214, 0.369, and 0.415, respectively. The effect size (f^2) measures the influence of each external latent variable on an internal latent variable, enabling an assessment of how well the structural model accounts for the variance in internal latent variables.

Adhering to Cohen's (1988) framework, f^2 values of 0.02, 0.15, and 0.35 are categorized as indicative of small, medium, and large impacts, respectively. The data presented in Table 5 indicate that the f^2 effect sizes range from a minimal impact, with a value of 0.069 for PEU on BI, to a significant impact, with a value of 0.762 for training's effect on PU. In addition, the Q^2 values for the internal constructs all exceeded 0, thus confirming the structural model's predictive relevance.

Table 5: R^2 , communality, and redundancy

Construct	R^2 adj	Q^2	f^2 Perceived Ease of Use	f^2 Perceived Usefulness	f^2 Behavioral Intention	f^2 Actual Use
Training	-	-	0.613	0.762	-	-
Actual Use	0.222	0.264	-	-	-	-
Behavioral Intention	0.527	0.214	-	-	-	0.301
Perceived Ease of Use	0.372	0.369	-	-	0.069	-
Perceived Usefulness	0.425	0.415	-	-	0.305	-

Moreover, the study engaged in the use of Path Coefficients to scrutinize the proposed relationships among variables. The findings, elaborated in Table 6, adhere to the approach recommended by Hair et al. (2016), which involves the application of the bootstrapping method. This procedure produced key statistical figures such as beta coefficients, standard errors, t-values, and p-values.

Table 6: Hypothesis testing results

Hypothesis	Beta coefficients	Standard deviation	T statistics	P values	Decision
H 2c Behavioral Intention -> Actual Use	0.481	0.114	4.236	0.000	Supported
H 2b Perceived Ease of Use -> Behavioral Intention	0.253	0.150	1.688	0.091	Rejected
H 2a Perceived Usefulness -> Behavioral Intention	0.532	0.142	3.760	0.000	Supported
H1b Training -> Perceived Ease of Use	0.616	0.080	7.680	0.000	Supported
H1a Training -> Perceived Usefulness	0.658	0.080	8.219	0.000	Supported

Table (6) and figure (3) provided offers a detailed examination of the relationships among various constructs, with each hypothesis clearly numbered for enhanced clarity. The analysis begins with a compelling validation of the impact of BI on AU (hypothesis 2c), as evidenced by a robust beta coefficient of 0.481, a T statistic of 4.236, and a p-value of 0.000. This significant finding highlights the critical influence of BI on AU.

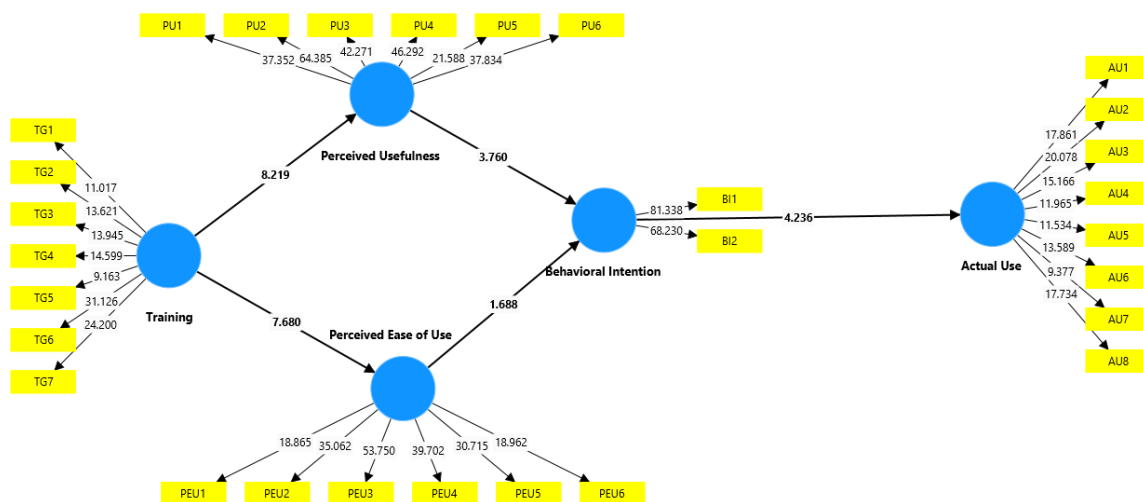


Figure 3: PLS Bootstrapping (t-values) for the study model

The study also demonstrates the significant influence of the PU on BI (hypothesis 2a), with beta coefficients of 0.532, T statistics of 3.760, and p-values of 0.000. This finding emphasizes the important role of PEU in influencing BI. Conversely, the hypothesis regarding PEU's impact on BI (hypothesis 2b) did not achieve statistical significance (beta coefficient: 0.253, T statistic: 1.688, and p-value: 0.091), resulting in its rejection.

The study also demonstrates the significant influence of the training on PEU (hypothesis 1b) and PU (hypothesis 1a), with beta coefficients of 0.616 and 0.658, T statistics of 7.680 and 8.219, and p-values of 0.000 and 0.000, respectively. These findings highlight the importance of training in shaping PU and PEU.

Collectively, these refined results detail the relationship between constructs such as BI, PU, PEU, and training. These findings offer insights for future research and practical applications, particularly on the effect of one of the external factors related to audit firm attributes represented by training on technology adoption behaviors.

6. Discussion

The Findings of this study provide insights into the influence of training on PU and PEU, and their collective impact on BI to adopt BDA tools, and how these intentions translate into actual usage. Training was found to have a positive effect on PU and PEU of BDA tools (H1a and H1b). These findings are similar with finding of some of previous studies, such as Valenstein-Mah et al. (2020) who emphasized that detailed training programs enhance users' understanding and confidence in new technologies. Shatri (2020) also found that training help professionals integrate technology into daily operations by building confidence and understanding. Other studies, like Buchanan, Sainter, & Saunders (2013), and Adrianto (2018), also highlight the importance of training in technology adoption; they found that effective training programs customized to the users or learners' need significantly enhance the PU and PEU of new technologies, motivating their adoption. These findings indicates that Auditing firms should invest in good training programs specified to the needs of their auditors. Such

programs should be designed to address the different learning styles and ensure that auditors are comfortable and confident in using BDA tools. This approach not only facilitate the adoption of new technologies but also enhance the overall quality and efficiency of the audit process.

Regarding Hypothesis (H2a), the results showed that PU has a positive effect on the BI to adopt BDA tools, which aligns with the findings of Davis and Venkatesh (1996) and Hwa, Hwei, & Peck (2015). Grimalso and Uy (2020) also concluded that the perception of usefulness has a positive relationship with the intention to use technology. Furthermore, Cabrera-Sánchez and Villarejo-Ramos (2019) and Al Amin et al. (2020) emphasized the importance of PU in expecting users' behavioral intention to adopt new technologies. Their studies indicate the importance role of PU in driving technology adoption behaviors and attitudes. Accordingly, auditing firms should focus on highlighting the benefits of BDA tools to their auditors. Conducting training courses including on the job training on BDA applications would help these firm to demonstrate how these tools can enhance audit efficiency and quality. This can reinforce a positive perception of their usefulness and ultimately encouraging adoption.

On the other hand, while the study found that PEU has a positive impact on BI, this was not statistically significant (H2b). This suggest that while ease of use is important, the PU of the new technology play a more critical role in shaping auditors' intentions to use BDA. This finding is opposite to the conclusion of Davis and Venkatesh (1996), who empathized on the significant role of PEU in technology adoption. However, Sharma and Mishra (2014) noted that technology adoption may require more than just ease of use to include other factors such as trust and social influence, which may also play a role. This may explain the lack of a significant impact of PEU on BI in our study. Although simplifying the user interface and ensuring that BDA tools are easy to use is important, audit firms should primarily focus on proving the benefits of these tools. Emphasizing the practical advantages of BDA tools in improving audit efficiency and quality can more effectively increase adoption.

Furthermore, BI to adopt BDA tools was found to have a positive effect on the actual use of these tools (H2c). The study validates that BI significantly influences AU, supporting the framework proposed by Davis and Venkatesh (1996). External auditors who intend to use BDA tools are more likely to use them in performing their audit procedures. This finding is consistent with the TAM model and emphasizes the importance of increasing willingness towards new technologies to ensure their practical application. Previous studies, such as Diop, Zhao, & Duy (2019) and Shahbaz et al. (2019), also support the significant relationship between BI and AU. These studies highlight that a BI is a predictor of actual technology use. Based on these findings, audit firms should implement strategies to convert positive intentions into actual usage. This can be achieved through continuous support and resources, such as regular training programs, and success stories cases that present the practical benefits of BDA tools. By creating an environment that supports and encourages the use of BDA, Audit firms can ensure that their auditors not only intend to use BDA tools but also integrate them into their daily audit practices.

The above findings provide insights particularly relevant for audit firms in developing countries, where the adoption of advanced technologies like BDA is still in early stages. By addressing one of the critical external factors, represented by training, that is expected to influence technology adoption, firms can better navigate the challenges associated with digital transformation and improve their overall audit quality and efficiency.

7. Conclusion

7.1 Implications for Practice

This study demonstrates the significant role of training in shaping auditors' perceptions and adoption of BDA tools in Palestine. Our findings reveal that training positively influences both PU and PEU of BDA tools, with PU being a key driver of BI to adopt BDA. The strong link between BI and AU underscores the importance of fostering positive attitudes towards BDA among auditors.

These results have important implications for audit firms, particularly in developing countries. They suggest that investing in comprehensive BDA training programs can significantly enhance auditors' willingness to adopt these tools, potentially leading to improved audit quality and efficiency. However, the lack of significant impact of PEU on BI indicates that firms should focus on demonstrating the utility of BDA tools rather than just their user-friendliness. This finding is particularly relevant in the context of training, as it suggests that training programs should not only make BDA tools easier to use but also emphasize their practical benefits and how they can improve audit processes.

The conclusions of this study specifically address the three objectives laid out at the end of the introduction:

1. To examine the effect of training on PU and PEU of BDA tools: The study found that training has a positive effect on both PU and PEU, highlighting the importance of comprehensive training programs tailored to the needs of auditors.
2. To investigate the relationship between PU, PEU, and BI to adopt BDA tools: The results indicated that PU has a significant positive impact on BI, while PEU, although important, was not statistically significant. This underscores the need for training programs to focus on demonstrating the practical utility of BDA tools.
3. To explore the impact of BI on the actual use of BDA tools: The study confirmed that BI significantly influences AU, supporting the importance of fostering positive behavioral intentions through targeted training and support.

In summary, while ease of use is a critical factor, the perceived usefulness of BDA tools plays a more decisive role in their adoption. Therefore, audit firms should design their training programs to not only simplify the user experience but also highlight the tangible benefits of BDA tools in enhancing audit efficiency and quality. By doing so, they can more effectively drive the adoption and integration of these tools into daily audit practices, ultimately improving the overall audit process. Furthermore, while this study was based on a specific sample of external auditors in Palestine, the implications for practice can be generalized to other developing countries facing similar challenges in adopting advanced technologies. The insights gained from this research suggest that investing in training programs tailored to the unique needs of auditors can support the adoption of BDA tools and improve audit quality and efficiency.

7.2 Limitations

Despite its practical implications, this study has two main limitations. The first limitation arises from the study's focus on external auditors employed by the Big four auditing firms in Palestine. Excluding the remaining auditors from small firms may limit the generalizability of the findings to other regions or auditors from local firms. Second, adopting the TAM as a theoretical framework may not address all aspects related to impact of training on BDA utilization.

7.3 Future Research

Future research may consider expanding the geographical scope and auditing firm size by including auditors from different countries and firms of various sizes to enhance generalizability. Additionally, exploring other theoretical frameworks or models to assess the impact of training on BDA utilization could offer new perspectives.

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Appendix A: Details of Instrument Items

Variable	Instrument item
A. Demographics Variables Section	
Demographics Variables	• Age • Gender • Academic degree • Current job position • Years in the audit profession
B. External Variable Section	
Training	• Training on big data analytics tools improves my performance in using these tools. • Training on big data analytics tools increases my scientific performance in auditing. • Training on big data analytics tools enhances my learning effectiveness. • The training on using big data analytics tools is clear and understandable. • Interacting with the training programs on big data analytics tools is mentally easy. • I find that the training makes using big data analytics tools easy. • The types of training on big data analytics tools make them easy to use.
C. Technology Acceptance Model (TAM) Section	
PU	• Using big data analytics tools in my job would enable me to accomplish tasks more quickly. • Using big data analytics tools would improve my job performance. • Using big data analytics tools in my job would increase my productivity. • Using big data analytics tools would enhance my effectiveness on the job. • Using big data analytics tools would make it easier to do my job. • I would find big data analytics tools useful in my job.
PEU	• Learning to operate big data analytics tools would be easy for me.

	• I would find it easy to get big data analytics tools to do what I want them to do. • My interaction with big data analytics tools would be clear and understandable. • I would find big data analytics tools to be flexible to interact with. • It would be easy for me to become skillful at using big data analytics tools. • I would find big data analytics tools easy to use.
Intention to use	• Assuming I had access to big data analytics tools, I intend to use them. • Given that I had access to big data analytics tools, I predict that I would use them.
D. Actual Use Section	
Actual use of BDA tools	• While working on the audit of that assignment, I used the big data analytics tools when evaluating fraud risk. • While working on the audit of that assignment, I used the big data analytics tools for sample selection. • While working on the audit of that assignment, I used the big data analytics tools when identifying journal entries to be tested. • While working on the audit of that assignment, I used the big data analytics tools when evaluating and testing the control effectiveness. • While working on the audit of that assignment, I used the big data analytics tools for performing IPE (Information Produced by the Entity) test. • While working on the audit of that assignment, I used the big data analytics tools in the substantive testing of balance sheet accounts. • While working on the audit of that assignment, I used the big data analytics tools in the substantive testing of income sheet accounts. • While working on the audit of that assignment, I relied on big data analytics tools in performing overall analytical procedures.

Testing the List Order Response Effect Among Respondents With Cognitive Sophistication: Experimental Evidence in Management Information Systems Research

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Abstract: Questionnaires constitute a valuable data-collection tool in Management Information Systems (MIS) research. However, MIS researchers have identified various biases in the design and implementation of questionnaires. This paper focuses on the bias resulting from the order of items in the answer choices, called list order bias. Such bias is described through a framework of cognitive theories, including the cognitive elaboration model, memory limitation hypothesis, and satisficing theory. Previous literature has proved that satisficing theory is superior in explaining list order bias; therefore, such theory is adopted for this study. Satisficing theory posits that respondents provide a satisfactory rather than an optimal answer when a survey question requires cognitive effort. Previous research has shown that satisficing is triggered by respondents' cognitive abilities to complete the questionnaire and, therefore, it is predominant among less educated respondents. However, the extent to which satisficing behaviors could occur, even among respondents with higher education and cognitive abilities, still needs to be ascertained. This is particularly important for MIS studies that investigate information systems' adoption at the organizational level because they rely mostly on respondents who are information technology (IT) managers. Therefore, this study adopts the satisficing theory to examine the list order response effect among cognitively sophisticated respondents in the MIS field. The authors selected and manipulated a question from the Society for Information Management's (SIM) IT Trends Study web-based questionnaire to conduct such an analysis. The SIM IT Trends Study survey questions offer a lengthy list of answer options to SIM members who are IT managers inside organizations that operate in various business sectors. The authors created two types of the same list question: one provided the list options in alphabetical order and the other provided the list answers in reverse-alphabetical order. The findings show statistically significant empirical evidence for list order bias by revealing that, despite their cognitive sophistication, respondents were more likely to choose the first available answer, especially in the case of reverse-alphabetical order. In light of these findings, the authors propose remedies to decrease the satisficing behaviors of such respondents. In particular, researchers could break questions with long lists into several questions with short lists and then combine those responses into the answer selection list of a final question. Researchers could also provide the answer selection lists to half of the sample alphabetically and the other half in reverse order and then combine the two subsamples into the final possible responses. Alternatively, researchers could use "trigger" or "priming" statements before displaying the question and its answer selection list to reduce the questionnaire's difficulty. In summary, this study addresses the list order response bias among respondents with cognitive sophistication in MIS research, explains why this bias occurs by employing satisficing theory, and provides remedies for reducing the relevant occurrence. Hence, this manuscript contributes to MIS research by providing insights to improve the quality of questionnaires by minimizing satisficing behaviors that lead to list order bias, and it makes MIS practitioners aware of the possible influence of question design when they respond to questionnaires.

Keywords: Answer selection list, List order bias, Order effect, Question and questionnaire design, Satisficing theory

1. Introduction

Questionnaires are a well-established means of data collection for conducting empirical research as a method of scientific inquiry in many fields, such as sociology, social psychology, education, political science (Giddeon,

2012), and management information systems (MIS) (Olszak, 2016). Therefore, the design and quality of questionnaires are crucial to the reliability of questionnaire results in such fields. Question formats defined as "closed-ended" provide relevant response categories (Lavrakas, 2008), and some can even offer a list of items as responses to reduce time and response fatigue (Dashen et al., 2001). Because of these advantages, MIS studies have extensively used "closed-ended" questions with an answer selection list of items (Curry and Stancich, 2020; Taskin, Verville, and Keskin, 2014; Galup, Gary, and Jiang, 2008; Choudrie and Dwivedi, 2005), primarily to conduct research that investigates phenomena at the organizational level. For example, "closed-ended" questions were used to study the role of firm size in the adoption of enterprise information systems (Trigo et al., 2015). Also, the Society for Information Management's (SIM) IT Trends Study has relied, since its inception in 1980, on "closed-ended" questions to investigate the major information technology (IT) trends and issues in the market (Kappelman et al., 2014). However, the order of the answer options in answer selection lists can influence respondents to choose a specific answer based on its position in the list, leading to the so-called ordering response bias (Bhattacharjee, 2012).

Previous methodological studies have analyzed ordering response bias by drawing mostly on satisficing theory (Revilla and Couper, 2017; Roberts et al., 2019). Specifically, satisficing theory posits that "when optimally answering a survey question would require substantial cognitive effort, some respondents simply provide a satisfactory answer instead" (Krosnick, 1991, p.213). In the case of survey questions with a list of response alternatives, many respondents will select the first response alternative that they consider reasonable or acceptable. For example, respondents may select a response alternative presented early in the list, and, in this case, the respondents' satisficing behavior leads to the so-called "primacy effect." Alternatively, respondents may select a response alternative presented later in the list, and, in this case, the respondents' satisficing behavior leads to the so-called "recency effect."

Previous research has shown that satisficing is predominant among less educated respondents (Holbrook et al., 2007; Krosnick et al., 2002), but several studies have also considered satisficing and its influence on surveys in relation to the length of response alternatives and response scales among respondents who are university students (Oppenheimer, Meyvis, and Davidenko, 2009), members of various panels (Bishop and Smith, 2001; Robmann Gummer, and Silber, 2017), and respondents recruited through crowdfunding platforms (Paas and Morren, 2018).

However, there is a lack of research investigating the existence of satisficing behaviors among highly cognitively sophisticated respondents. This investigation is particularly important for MIS studies because they mostly examine information systems' adoption at the organizational level and rely extensively on respondents who are information technology (IT) practitioners with a high level of cognitive sophistication. Cognitive sophistication is the collection of abilities that individuals use to retrieve information from their memory and integrate this information into expressed decisions (Krosnick, 1991). More specifically, indicators of cognitive sophistication are respondents' level of education, number of years of education, cognitive skills, and age (Roberts et al., 2019). Satisficing is triggered by the respondents' cognitive abilities to complete the survey, and, therefore, it is expected to occur among respondents with low cognitive sophistication (Krosnick, 1991). However, suppose it could be shown that satisficing occurs even among respondents with high cognitive sophistication. In that case, researchers should consider other issues, such as the difficulty of the questionnaire and motivation to complete it. Therefore, researchers should develop strategies that address the above issues rather than simply focus on the respondents' abilities. Using an alphabetical or a reverse alphabetical list could be one of those strategies because it could decrease the questionnaire's difficulty, by minimizing the respondents' fatigue in evaluating response alternatives.

Overall, because previous studies have shown that list order effects such as primacy and recency effects can be the result of satisficing behaviors that are mostly applicable to long answer selection lists among respondents without cognitive sophistication (Krosnick, 1991; Smyth et al., 1987) and it was confirmed that task difficulty increases these behaviors (Krosnick, 1991), this study investigates the following research problems: (i) the quality of the survey instrument undermined by list order bias in case of long answer selection lists provided to respondents with high cognitive sophistication because their satisficing behaviors and (ii) the use of an alphabetical or reverse alphabetical list as an effective way to reduce those satisficing behaviors. More specifically, this study addresses the following research questions:

RQ1: *Does the length of selection lists trigger ordering bias because of satisficing behaviors among respondents with high cognitive sophistication?*

RQ2: *Does an alphabetical or a reverse-alphabetical list effectively reduce satisficing behaviors?*

To answer the above questions, the authors carried out an experiment on the web-based questionnaire conducted among the Society for Information Management (SIM) members, who are IT practitioners. The authors selected a question from the questionnaire of the Society for Information Management's (SIM) IT Trends Study that provides a lengthy list of answer options (Kappelman et al., 2014). Moreover, to effectively test the existence and the severity of the list order effect and to investigate possible methods to reduce it, the authors created two different types of the same list question: one list provided the answer options in alphabetical order, and the other list provided the answer options in reverse-alphabetical order. The authors randomly assigned participants to one version or the other. The findings from this experiment show a significant response bias resulting from the order of the answer options presented to the respondents. These findings can be generalized and employed across different disciplines and among different respondents with cognitive sophistication; therefore, in light of these findings, the authors investigate possible methods to decrease the satisficing effects.

This paper is unique in (i) explaining list order bias among respondents with high cognitive abilities and as a function of the list length by employing satisficing theory and (ii) assessing whether using an alphabetical list or a reverse alphabetical list can be an effective method to reduce satisficing.

This paper's main theoretical contribution is to understand whether cognitively sophisticated respondents exhibit satisficing behaviors and which strategies should be adopted to mitigate the effects of these behaviors. Indeed, the design and quality of questionnaires are crucial to preserve and guarantee the reliability of questionnaire results in the MIS field and the rigor of business research (Andrieux et al., 2024). Therefore, the importance of this study relies on analyzing how to minimize the effects of satisficing among respondents with high cognitive abilities, to increase the rigor of the survey instrument. The remainder of this paper is organized as follows: Section 2 reviews relevant prior literature and develops our hypothesis, Section 3 reports our data collection methodology, Section 4 analyzes the relevant results, Section 5 discusses such results, and Section 6 provides recommendations to improve questionnaire design to mitigate list order bias and offers suggestions for future research.

2. Literature Review and Hypothesis

Previous studies focusing on research methodologies showed that questionnaire-based survey methods are used more than other research methods in the MIS field (Grover et al., 1993). However, the popularity and the increasing use of this methodology has led to studies that investigate factors affecting the "quality" of the survey instrument (Alwin, 1989; Sivo et al., 2006; King et al., 2007; Hamby, et al., 2016). Specifically, recent MIS research has investigated possible factors that may undermine the accuracy of the responses: subconscious evaluations that influence respondents unconsciously, called "implicit attitude" (Serenko and Turel, 2019; Serenko and Turel, 2020; Serenko, 2022), or desirable or undesirable behaviors that distort respondents' self-reporting, called "social desirability bias" (Kwak, Ma, and Kim, 2021; Kwak Holtkamp, and Kim, 2019). Previous MIS studies have also proposed possible remedies and techniques to measure and control the effects of the above factors on questionnaire results, such as mixed-mode surveys or a multi-methods approach (Serenko, 2022; Serenko and Turel, 2019; Serenko and Turel, 2020; Kwak, Ma, and Kim, 2021; Kwak Holtkamp, and Kim, 2019).

However, the quality of questionnaires can also be undermined by order biases (Malhotra, 2008; Balkan and Kholod, 2015). Order biases occur when the respondents' answers are affected by, for example, the sequence of questions (Perreault Jr., 1975; Khorramdel, Kubinger, and Uitz, 2014), the number of answer categories (Asensio and Revilla, 2022), the scale direction (Höhne and Krebs, 2018), and the order in which a list of multiple responses is provided (Mathews, 1929; Hensley, 2000). Previous studies have attempted to propose possible solutions to overcome the response order bias that arises from questions with a list of possible answers. For example, Mathews (1929) suggested that individuals answer those questions using "a word or symbol" rather than being provided with a list of printed items. More recently, MIS research has employed methodological research tools such as the "Delphi method," which consists of an iterative process that collects responses from experts using questionnaires and feedback from the facilitators to reach convergence on a topic. Although the iterative nature of this method provides improvements to "traditional" survey methods (Okoli and Pawlowski, 2004; Parè et al., 2013), the "Delphi method" has raised methodological rigor issues related, for example, to its complexity and the lack of clarity in MIS research (Reeb, 2023; Alarabiat and Ramos, 2019). Other studies have proposed using shorter answer lists with only five or ten answer options (Couper, 2008; Dillman, 2014; Callegaro, Manfreda, and Vehovar, 2015). Although such a solution could be ideal, it is not always practical because answer options need to be exhaustive. In other words, shorter answer lists could not render meaningful insights possible in studies that need to capture the complexity of business realities. Indeed, business studies, particularly MIS

research, have extensively relied over the years on questions with various list alternatives to investigate phenomena related to technology adoption issues at the organizational level, as shown in Table 1.

Table 1: MIS Studies Surveys with Response List Alternatives

MIS Study	Number of Response List Alternatives
Caudle, Gorr, and Newcomer 1991	37
Leitheiser, 1992	54
Thong, 1999	8
Gholami et al., 2013	8
Trigo et al., 2015	12
Kappelman et al., 2019	41
Palvia et al., 2021	14

In an attempt to provide further solutions to the list order effect, previous studies have developed several approaches to explain the relevant causes: the memory limitations hypothesis (Smith, 1994), the cognitive elaboration model (Schwarz, Hippler, and Noelle-Neumann, 1992; Malhotra, 2008), and satisficing theory (Krosnick, 1991), as described below.

2.1 Cognitive Elaboration Model

The cognitive elaboration model considers three factors leading to response order bias: "the serial position, the presentation mode, and the plausibility of response categories" (Höhne and Lenzner, 2015, p.364). The serial position refers to the display of the response alternatives at the beginning, middle, or end of a list; the presentation mode refers to the format of the questionnaire, i.e., auditory, face-to-face, or visual; the plausibility of response categories refers to response alternatives that elicit agreeable or disagreeable thoughts (Bishop and Smith, 2001).

Given the combination of those three factors, the cognitive elaboration model predicts (i) primacy effects in a visual presentation format and in an auditory format where the response alternatives at the end are implausible and (ii) recency effects in an auditory presentation format and in a visual presentation format where the response alternatives at the beginning are implausible.

However, the cognitive elaboration model does not explain if and how primacy effects and recency effects can depend on factors such as "memory limitations, the complexity of response categories, and the cognitive ability and motivation of respondents" (Bishop and Smith, 2001, p.482). For example, the cognitive elaboration model cannot explain the occurrence of primacy and recency effects related to the behaviors of respondents who choose specific items from the top or the bottom of the list because of the difficulty of retrieving information from memory among the answer options or the difficulty of comparing all the different items and making a judgment among them.

2.2 Memory Limitations Hypothesis

The memory limitation hypothesis posits that response list order bias occurs because respondents cannot remember all the response alternatives. Specifically, respondents select subsequent response options rather than initial ones due to short-term memory and, therefore, recency effects occur. Recency effects are particularly expected when questions are in an auditory format without visual aids, such as phone surveys. This is because when the interviewer reads response alternatives, respondents will mostly remember the last options and select one of them.

However, a drawback of the memory limitation hypothesis is the inability to explain primacy effects because these effects depend on long-term memory, while the memory limitation hypothesis considers effects that are only dependent on short-term memory (Bishop and Smith, 2001). In other words, employing the memory limitations hypothesis makes the cause of primacy effects unclear. It does not explain why items at the beginning of a list and stored in long-term memory are sometimes more easily selected with respect to items at the end of the list and stored in short-term memory. Therefore, only recency effects play a significant role in the memory limitations hypothesis because this approach can only explain the response behavior of selecting among the last-mentioned response options.

2.3 Satisficing Theory

Satisficing theory explains order response bias by claiming that such bias occurs because of the satisficing behaviors of the respondents (Krosnick, Narayan, and Smith, 1996). These behaviors described in the work of Krosnick, Narayan, and Smith (1996) as "weak satisficing," consist of selecting the "first satisfactory or acceptable response alternative" (Bishop and Smith, 2001, p.483) rather than choosing the optimal response. An answer is considered optimal when it is provided through "four stages of cognitive processing": interpretation of the question, searching memories, integration of information into judgments, and reporting such judgments clearly and precisely (Krosnick, 1991). Specifically, Krosnick, Narayan, and Smith (1996) posit that in the case of response alternatives to closed-ended questions presented in a visual format, primacy effects are likely to occur because the fatigue in evaluating the above alternatives will lead respondents to select those presented early in the list. However, in the case of response alternatives to closed-ended questions presented in an auditory format, recency effects are more likely to occur because respondents do not have the opportunity to recall the earlier alternatives fully (Krosnick, Narayan, and Smith, 1996). Overall, the factors that foster satisficing are identified as the task's difficulty, respondents' ability, and respondents' motivation to perform the task. Because satisficing theory considers all the above factors together, it can provide better insights, with respect to the cognitive elaboration model and the memory limitation hypothesis, into when respondents will choose a response strategy that does not lead to the optimal answer but just to a satisfactory answer.

Table 2 presents a framework to summarize the peculiarities of each approach and shows that satisficing theory is superior in explaining list order bias. Indeed, previous studies have mostly used satisficing theory to evaluate the quality of survey data. Specifically, the recent systematic review of English journal articles analyzed by Roberts et al. (2019) from 1987 to 2015 shows that methodologist studies have drawn primarily on satisficing theory to assess list order response bias (Roberts et al., 2019).

Table 2: Framework of Cognitive Theories

Theory	Assumption	Primacy and Recency Effects	Effect/Bias
Satisficing Theory (Krosnick, 1991)	The difficulty of the task, respondents' cognitive abilities, and their motivation lead to weak satisfaction, i.e., providing rapid answers without fully understanding them. Weak satisficing leads to a primacy effect, i.e., the selection of answer options at the beginning of an answer list, or to a recency effect, i.e., the selection of answer options at the end of an answer list.	Both primacy and recency effects are explained. Task difficulty, respondent ability, and respondent motivation are the causes of primacy and recency effects.	Satisficing leads to response order effects that make questionnaire responses order-dependent.
Cognitive Elaboration Model (Schwarz, Hippler, and Noelle-Neumann, 1992)	Primacy effects are predicted in visual presentation format. Recency effects are predicted in auditory presentation format.	Both primacy and recency effects are explained. Primacy and recency effects depend on the serial position, the presentation mode, and the plausibility of response categories.	The position of a response item and the presentation format lead to response order effects.
Memory limitation hypothesis (Smith, 1994)	Respondents are not able to remember all responses - alternatives.	Only recency effects are explained. Recency effects are dependent on short-term memory.	Memory limitations generate response order effects.

Following satisficing theory's assumptions, the authors believe that response effects such as primacy and recency effects result from satisficing behaviors that mainly occur with long answer selection lists. This reasoning

is confirmed by prior studies, which show that shorter surveys decrease satisficing (Krosnick, 1991). In other words, a positive relationship exists between the length of a survey and satisficing (Galesic and Bosnjak, 2009; Gibson and Bowling, 2019; Schmidt, Gummer, and Rossmann, 2020) because long surveys reduce respondents' motivation (Herzog and Bachman, 1981). While researchers speculated about the possible cognitive burdens stemming from the order of answer selection items in questionnaires, no literature empirically investigated this type of bias among respondents who belong to professional associations. Previous studies examined satisficing effects among respondents who are university students (Oppenheimer, Meyvis, and Davidenko, 2009), members of specific panels, such as the Gallup Panel that selects households (Bishop and Smith, 2001), the panel of the Respondi AG that selects the German electorate (Robmann Gummer, and Silber, 2017), and respondents with and without a higher education degree (Terentev and Maloshonok, 2019) or recruited through crowdfunding platforms, such as SmartSurvey and MTurk (Paas and Morren, 2018). However, further research is needed to examine satisficing behaviors among respondents with cognitive sophistication because business research, including MIS, relies on such respondents. Indeed, most MIS studies examine technology adoption issues at the organizational level and respondents are mainly IT managers.

Therefore, this research investigates satisficing behaviors among respondents with cognitive sophistication, i.e., individuals with cognitive abilities to contribute meaningfully to problem-solving and decision-making processes, such as those IT practitioners who are members of a professional association such as SIM. Indeed, suppose list order response bias caused by satisficing also occurs in the case of respondents who should have cognitive sophistication. In that case, other issues are also likely, such as task difficulty and motivation to perform the task. Therefore, researchers should focus on proposing strategies to address the above issues rather than focusing on respondents' abilities. In this respect, scholars (e.g., Krosnick and Alwin, 1987; Schuman and Presser, 1981) have confirmed that minor or seemingly trivial alterations of the questions' framing and/or context could significantly affect the results of questionnaire-based studies. However, previous literature did not explicitly investigate the difference in the degree of such effects among alternative versions of the same question. The authors conducted such an investigation by modifying a question in the SIM IT Trends Study and using an alphabetical versus a reverse-alphabetical order answer option list. The authors selected the question on the "most important or worrisome IT management issues" in the SIM questionnaire that contains a long list of answer options. This SIM's survey question was used to address this study's research questions (RQ1 and RQ2) by first investigating the relationship between the questionnaire responses with answer selection lists and the length of the available answer options. Given that previous studies have shown that the number of answer categories triggers order bias (Asensio and Revilla, 2022), the authors examine if this finding can be explained by the existence of satisficing behaviors. Then, because previous literature confirmed that task difficulty increases these behaviors (Krosnick, 1991), the authors investigate if alphabetical or reverse-alphabetical order represents a method to reduce them. Therefore, the authors formulate the following null and alternative research hypotheses:

H₀: *The length of the answer selection list in alphabetical versus reverse-alphabetical order does not lead to satisficing behaviors and does not affect responses about the most important or worrisome IT management issues.*

H_a: *The length of the answer selection list in alphabetical versus reverse-alphabetical order leads to satisficing behaviors and affects responses about the most important or worrisome IT management issues.*

3. Methodology

Data was collected among the members of the Society for Information Management's (SIM) through a random sampling technique. SIM is an American professional organization composed of senior IT employees of organizations, companies, or divisions of larger organizations who pay to be members. SIM organizations are mostly based in the United States, operate in various business sectors, and have revenues ranging from \$5 million to \$100 million. Each SIM member was provided one copy of the questionnaire of the SIM IT Trends Study to complete the sponsored survey (Kappelman et al., 2014). The authors distributed 4,612 questionnaire requests, and 1,002 were returned, leading to a response rate of 21.4%. Since its inception in 1980, the SIM study has been a collaboration of academics and practitioners to investigate the practices, concerns, and demographics of senior IT leaders and their organizations (Ball and Harris, 1982). Specifically, the authors use the questionnaire and data from the SIM IT Trends Study because it is highly regarded and cited among MIS scholars. Indeed, given that it has been published since 1980 in one of the leading MIS journals, MISQ Executive, it has proven to be a well-validated instrument. Moreover, its research rigor is well documented in the study's Appendix, "Research Methods, Design," which explains the study's research methodology. To test the research

hypotheses, the authors modified the "most important or worrisome IT management issues" question. This question has been part of the SIM study since its inception, and it asks respondents to "pick up to three" answers from the list of 40 answer options (see Appendix A for the complete list). The authors selected such a question with a lengthy list of answer options because it is more likely to trigger the list order response bias (Asensio and Revilla, 2022). The authors modified the "most important or worrisome IT management issues" question by creating two versions: one with the answer items in alphabetical order (as shown in Appendix A) and the other with the answer items in reverse alphabetical order. Participants were randomly assigned to one version or the other. In all, 717 respondents answered the "most important or worrisome IT management issues" question: 360 using the alphabetical order list and 357 using the reverse alphabetical list. Each respondent is a senior-level IT professional member of the Society for Information Management (SIM) and a senior IT employee from a different organization.

4. Analysis and Findings

The authors conducted a Kolmogorov-Smirnov Goodness-of-Fit Test (Lilliefors, 1969) carried out with SPSS (Statistical Program in Social Sciences) to check the normal distribution of the study's sample. The data did not fit a normal distribution because the authors found a significance (p) of less than 0.05 and, therefore, they rejected the assumption of normality. Since the Kolmogorov-Smirnov test showed the sample is not normally distributed ($p < 0.05$), the authors used the non-parametric Chi-square test for homogeneity. The Chi-square non-parametric test was used because the authors were concerned to obtain a goodness of fit of the responses to a uniform distribution, for which the Chi-square is the appropriate test (Conover, 1999). This tests whether the responses of the two groups, alphabetical and reverse-alphabetical, share the same distribution across the list of answer options. For analysis purposes, the authors ordered alphabetically the reverse-alphabetical group's responses, and they divided the 40 answer options from both lists into four identical quadrants of 10 items each (as shown in Appendix B). The division into four quadrants allows for examining the effect of items at the front or end of the list versus the larger middle 50%. This approach looks at the location of items in groups and provides better information about location than examining the distribution of the individual items. Table 3 shows the observed frequencies and expected frequencies for the alphabetical and reverse-alphabetical groups. Multiplying the total number of selections in each quadrant by the percentage of the 2051 total number of items selected by the respondents in each group (i.e., 50.463% alphabetical, 49.537% reverse-alphabetical) provides the expected cell frequencies.

Table 3: Observed and Expected Item Selection Frequencies

Item Quadrant	Respondent Group				Total
	Alphabetical		Reverse-Alphabetical		
	N = 360		N = 357		
	Observed	Expected	Observed	Expected	
1 (Alignment to Enterprise Architecture)	324	(259.4)	190	(254.6)	514
2 (Global IT to IT Disaster Recovery)	207	(174.6)	139	(171.3)	346
3 (IT Efficiency to IT Value Proposition)	266	(294.2)	317	(288.8)	583
4 (Knowledge Mgmt. to Vendor Mgmt.)	238	(306.8)	370	(301.2)	608
Total	1035		1016		2051

The calculated χ^2 is 81.24 with three degrees of freedom and a p-value of less than 0.0000 (1.66 e-17). Since the p-value is less than the 0.05, or 0.01 critical value, the authors infer that the null hypothesis is likely false and that the answer selection list order matters. Notice that although the authors assigned the same number of participants to each group, 19 (or 1.87%), more respondents in the group that had the answer options list ordered alphabetically completed the question. On average, each respondent in the alphabetical group selected 2.875 items, while the reverse-alphabetical respondents selected 2.846 items, about 1% less. Both these findings suggest the possible effect of the likely increased cognitive burden for the reverse-alphabetical group. More importantly, the authors observed an uneven distribution of item selections between the two groups across the four quadrants. In both groups, respondents selected more items in the first quadrant presented. In the alphabetical group, more items were selected from the beginning of the alphabetical list (Quadrant 1). Similarly,

the reverse-alphabetical group selected more items from the beginning of the reverse-alphabetical list (Quadrant 4), as shown in Table 3 and Figure 1.

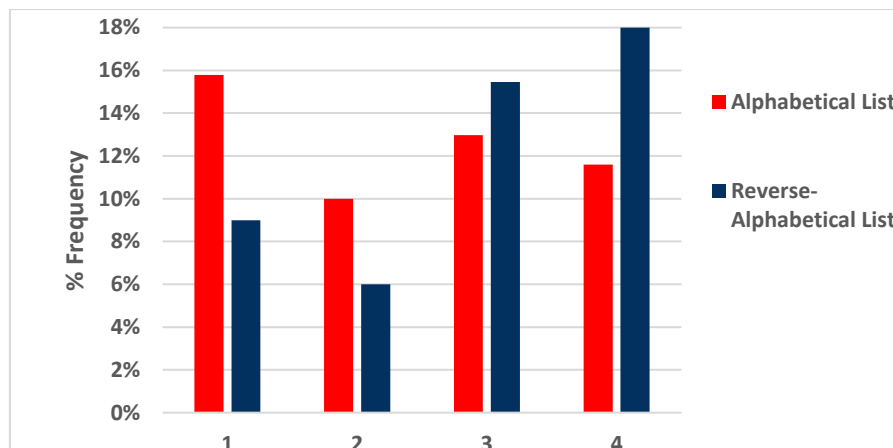


Figure 1: Alphabetical and Reverse-Alphabetical Item Selections by Quadrant

The number of selections in each quadrant varied based on the presentation of the options in alphabetical or reverse-alphabetical order. When the list was presented in alphabetical order, the respondents appeared to favor those items listed early, and they chose 324 options from Quadrant 1, while the respondents who were provided the reverse-alphabetical order chose only 190 from Quadrant 1. Further evidence of the list order influence is observed by examining the responses in Quadrant 4, where the respondents who received the reverse-alphabetical order list chose 370 items, while the group that received the alphabetical list chose only 238 items from Quadrant 4. Overall, the alphabetical group selected 531 items from the first two quadrants (or 51.3% of the 1035 answer items they selected), while the reverse-alphabetical group selected 687 items from the last two quadrants (or 67.6% of the 1016 answer items they selected). Table 4 shows that post-hoc examination of the Chi-square analysis supports these findings as it indicates that the largest deviations from a uniform distribution occurred in Quadrants 1 and 4. The positive standardized residual in the alphabetical respondent group's Quadrant 1 (3.262, p -value = 0.001) indicates that the actual selection frequency is significantly greater than the expected selection frequency ($\alpha = 0.05$).

By contrast, the negative standardized residual (-3.323, p -value = 0.001) in Quadrant 1 for the reverse-alphabetical respondent group indicates an actual selection frequency significantly lower than expected ($\alpha = 0.05$). Similarly, the positive standardized residual (3.358, p -value = 0.001) in Quadrant 4 of the reverse-alphabetical respondent group indicates an actual selection frequency significantly greater than the expected selection frequency ($\alpha = 0.05$). The negative standardized residual (-3.297, p -value = 0.001) in Quadrant 4 of the alphabetical respondent group indicates that the actual selection frequency is significantly lower than expected ($\alpha = 0.05$).

Table 4: Standardized Residuals for Alphabetical and Reverse-Alphabetical Respondents

Item Quadrant	Respondent Groups	
	Alphabetical	Reverse-Alphabetical
1 (Alignment to Enterprise Architecture)	3.262	-3.232
2 (Global IT to IT Disaster Recovery)	1.893	-1.928
3 (IT Efficiency to IT Value Proposition)	-1.368	1.393
4 (Knowledge Mgmt. to Vendor Mgmt.)	-3.297	3.358

When the order of the list was alphabetical, the top five items selected by the respondents as "the most important or worrisome IT management issues" all came from the first thirteen items of the list (i.e., from the first and second quadrants and the first 32.5% of the 40-item list), specifically from "Alignment" to "Innovation." When the order of the items was reversed, five of the top six items selected by the respondents as most important or worrisome came from the first 12 items presented (i.e., from the third and fourth quadrants and the first 30% of the 40-item reverse-alphabetical list), specifically from "Velocity of Change in Business" to "IT Time-to-Market." Among the top 10 items identified by each of the two groups of respondents, only six are in

both groups' responses, and they are in the opposite ranked order. Overall, there is strong empirical evidence that the length of the answer selection list in alphabetical versus reverse-alphabetical order leads to satisficing behaviors. Therefore, we reject the null hypothesis and accept the alternative hypothesis.

5. Discussion

Our findings confirm that respondents choose answers from the top of a list rather than searching the entire list for the most appropriate or "best" selection(s). The study's results are consistent with the findings of previous literature, which has shown the existence of a positive relationship between lengthy surveys and satisficing (Galesic and Bosnjak, 2009; Gibson and Bowling, 2019; Schmidt, Gummer, and Rossmann, 2020). In other words, increasing a survey's length by displaying a long list of answer items can lead to satisficing behaviors. Therefore, the results appear consistent with the satisficing effect as theorized by Krosnick (1991). When responding to a question requires substantial cognitive effort, as in this study in which respondents were asked to select up to three answers from a list of 40 items, many respondents simply provide a satisfactory answer rather than an optimal answer to reduce their effort (Krosnick, 1991).

Moreover, the modification of the survey questions utilized in our research (i.e., alphabetical versus reverse-alphabetical order of the answer list) and the analyses presented here suggest that the "satisficing" effect on respondents is somewhat more prominent in the reverse-alphabetical group. In other words, displaying the response alternatives in alphabetical order can mitigate satisficing behaviors by decreasing the mental fatigue of respondents in reading the answer options. As a result, presenting response alternatives in alphabetical order can be considered an efficient mechanism to reduce satisficing behaviors compared with a reverse-alphabetical order presentation. This reasoning is supported by previous satisficing studies, which have demonstrated that reducing the task's difficulty through survey questions that are less cognitively demanding can minimize satisficing behaviors (Krosnick, 1991; Blazek and Siegel, 2023).

Overall, the findings in this research make a new contribution because they show that (i) the length of the list of items in a questionnaire plays a significant role in the answers selected by the respondents because they are likely to engage in "satisficing" when the list is long, (ii) satisficing behaviors are more prominent when answer selection lists are in reverse alphabetical order, and (iii) respondents belonging to professional associations such as SIM take satisficing behaviors in spite of their high level of cognitive sophistication to answer survey questions.

Despite such a contribution, this study has several limitations. First, the sample is composed of IT practitioners who are members of a professional association based in the U.S., and a replication of the experiment among different practitioners who belong to professional associations located in other countries has not been performed by the authors. Second, the SIM IT Trends Study is conducted through an online survey; therefore, our findings could not be applicable in the case of telephone or face-to-face surveys. Third, the authors could not assign respondents to specific devices, for example, smartphones versus personal computers; therefore the authors did not investigate whether the type of device used could affect the results.

6. Recommendations and Future Research

There are significant theoretical and methodological implications for this study's results, which can be applied among respondents with cognitive sophistication beyond the MIS discipline. From a theoretical point of view, the authors believe that because satisficing behaviors still occur in the case of an answer selection list in alphabetical list order among respondents with advanced cognitive abilities, researchers should attempt to reduce the effects of the other conditions that foster satisficing, such as the difficulty of the questionnaire and respondents' motivation to complete the questionnaire.

From a methodological point of view, the findings stress that when practitioners and academics want to use questionnaire-based results as input for their decision-making, question design parameters such as answer selection list length and list order, i.e., reverse-alphabetical versus alphabetical, should be considered more carefully. Most importantly, researchers who value questionnaires as a tool for research are advised to design their questionnaires with extra care and a keen awareness of the possible response biases in order to limit potential bias effects as much as possible and to receive the fullest potential benefit from questionnaire-based research.

Also, when practitioners respond to questionnaires, they need to be aware of the possible influence of question design, cognitive load or burden, and satisficing behavior. This awareness is critical to providing "optimal" answers rather than "satisfactory" answers and avoiding possible response biases, especially to questions requiring substantial cognitive effort. A lack of response biases is particularly important, for example, for the

business community. Indeed, research questions addressed by business scholars tend to focus on issues that have implications and are of primary importance for practitioners, particularly chief information officers (CIOs). Future studies may, for example, investigate research topics based on the answers provided by CIOs to question 40 of the SIM IT Trends Study, which asks about the "most important or worrisome IT management issues." The risk is that the influence of the response order effect on the CIOs' answers to the above question, as shown in this research, may guide future studies to focus on research topics that do not accurately reflect issues of primary importance to IT managers.

Several mechanisms are available to address the list order bias issues identified in this study. The use of short lists in alphabetical order is ideal. Indeed, shorter lists in alphabetical order decrease the mental fatigue of respondents and encourage them not to simply choose the first satisfactory items on the list. Unfortunately, these options are often not possible. When researchers cannot use shorter lists in alphabetical order, the authors suggest breaking questions with long lists into several questions with short lists and then combining those responses into the answer selection list of a final question. For example, it is possible to divide the 40 items used in this research into four or five questions of eight or ten options each, allow two or three selections in each sub-question, and then combine those responses in a concluding question from which to choose the final answers. Because our analysis shows that the alphabetical group selected more items from the beginning of the alphabetical list (Quadrant 1) and, similarly, the reverse-alphabetical group selected more items from the beginning of the reverse-alphabetical list (Quadrant 4), the 40 items appear to present an issue that could be mitigated by dividing the list into shorter subsets. Such subdivision is best accomplished if rational subgroups are possible. This approach should be used carefully and according to the circumstances. It is practical in shorter questionnaires with few questions or where respondents are required to spend the time needed to complete the questionnaire. However, such a multi-part question will likely require considerable time in longer questionnaires. Finally, a multi-part question may reduce the accuracy of responses if, for example, a respondent's three best answers are all in one of the sub-questions but only two can be selected from each sub-question. Other viable suggestions include the following:

- Providing the answer selection lists to half of the sample in alphabetical and the other half in reverse-alphabetical order, and then combining the two subsamples in a final set of results that would lead to a mix of alphabetical and reverse-alphabetical items at the top, in the middle, or at the bottom of the list (Heyman and Sailors, 2016). This was the approach used in the 2014 SIM IT Trends Study (Kappelman et al., 2014), whereby both alphabetical and reverse-alphabetical versions of potentially problematic questions (i.e., those with long lists of options from which to choose answers) were used and then combined into the final possible responses.
- Using "trigger" or "priming" statements before displaying the actual question and its answer selection list. For example, with the "most important or worrisome IT management issues" question used in our research, a statement such as "before proceeding to the next question, please take a moment to think about your organization's most important or worrisome IT management issues" could be beneficial. Using a priming statement could reduce the possible effects of list order response biases by minimizing the task's difficulty and increasing respondents' motivation to complete the questionnaire.

Overall, this research provides insights into the optimal design of questions and survey instruments. The role of list length, the interaction of list length and order, and the number of selections required and/or allowed are worthy of future investigation. Specifically, future research is necessary to reduce response bias by manipulating the above parameters and survey design to reduce satisficing behaviors.

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Appendix A: Question no. 40

“Most important or worrisome IT management issues” with questionnaire list of IT management concerns/issues in alphabetical order In each column, please select up to three (3) concerns or issues.

1. Alignment
2. Business Cost Reduction Controls
3. Business Agility/Flexibility
4. Business Continuity
5. Business Process Management
6. Business Productivity
7. Bring Your Own Device (BYOD)
8. CIO Leadership
9. Compliance and Regulations
10. Enterprise/IT Architecture
11. Globalization of IT
12. Infrastructure Capability
13. Innovation
14. Insourcing of Previously Outsourced IT
15. Integration
16. IT Agility
17. IT Change Management
18. IT Cost Reduction
19. IT Credibility
20. IT Disaster Recovery
21. IT Efficiency
22. IT Governance
23. IT Operations/ITIL/IT Service Delivery
24. IT Organization Design / Structure
25. IT Performance Measures
26. IT Reliability / Quality / Availability
27. IT Strategic Planning
28. IT Talent / Skill Shortage / Human Resource

29. IT Time-to-Market
30. IT Value Proposition in the Business
31. Knowledge Management
32. Prioritization Process for IT Projects
33. Project Management
34. Revenue Generating IT Projects
35. Risk Management
36. Security/Privacy
37. Shadow IT / Rogue IT
38. Velocity of Change in Business
39. Velocity of Change in IT
40. Vendor Management

Appendix B: Questionnaire List of IT Management Concerns/Issues in Quadrants for Analysis

Group 1	Group 3
1. Alignment	21. IT Efficiency
2. Business Cost Reduction Controls	22. IT Governance
3. Business Agility/Flexibility	23. IT Operations/ITIL/IT Service Delivery
4. Business Continuity	24. IT Organization Design / Structure
5. Business Process Management	25. IT Performance Measures
6. Business Productivity	26. IT Reliability / Quality / Availability
7. Bring Your Own Device (BYOD)	27. IT Strategic Planning
8. CIO Leadership	28. IT Talent/Skill Shortage/Human Resource
9. Compliance and Regulations	29. IT Time-to-Market
10. Enterprise/IT Architecture	30. IT Value Proposition in the Business
Group 2	Group 4
11. Globalization of IT	31. Knowledge Management
12. Infrastructure Capability	32. Prioritization Process for IT Projects
13. Innovation	33. Project Management
14. Insourcing of Previously Outsourced IT	34. Revenue Generating IT Projects
15. Integration	35. Risk Management
16. IT Agility	36. Security/Privacy
17. IT Change Management	37. Shadow IT / Rogue IT
18. IT Cost Reduction	38. Velocity of Change in Business
19. IT Credibility	39. Velocity of Change in IT
20. IT Disaster Recovery	40. Vendor Management