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ACHIEVING SUSTAINABLE TRANSDISCIPLINARY RESEARCH IN CONSTRUCTION PROJECT MANAGEMENT: A BIBLIOMETRIC APPROACH

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ABSTRACT

Contemporary construction project management faces a significant challenge: the existing academic literature, spanning various disciplines, remains underutilised due to a lack of systematic integration for transdisciplinary collaboration. The primary purpose of this study is to forecast connected disciplinary thought through a novel bibliometric model, in the development of 'co-theory analysis', thereby identifying potential transdisciplinary collaboration gaps capable of effectively addressing transdisciplinary research in the field of construction project management through a theocratic lens of transdisciplinary perspectives. This novel method of exploring interdisciplinary theory utilises a detailed bibliometric analysis of project management literature from Scopus by identifying its interconnected relationship with construction project management, categorising papers by theory to reveal interdisciplinary intersections and potential collaborations. It statistically predicts research effectiveness, providing a roadmap for success across a series of disciplines. The analysis reveals significant, yet previously unexplored, theoretical intersections with a focus on construction project management and other co-keyword disciplines, cointegrated through theory to systematically map and analyse patterns in academic literature trends. These intersections suggest specific areas where collaborative research yields substantial potential advancements. Additionally, the study further identifies key institutions and academic experts whose combined expertise could be pivotal in bridging these identified research gaps. This novel bibliometric analysis method for statistical theory analysis is developed to enhance transdisciplinary collaboration and is a considerable contribution to the advancement of transdisciplinary research. Aligned with SDG 9, in addressing complex challenges and promoting sustainable industrialisation and innovation. It identifies key theories for use in construction project management, offering a framework for strategic academic transdisciplinary partnerships and targeted theoretical exploration for academics of any level.

Keywords: Bibliometric analysis, Cointegrating theory, Construction project management, Co-Theory, Model of Transdisciplinarity.

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INTRODUCTION

Hypotheses are nets: only he who casts will catch," Friedrich von Hardenberg, known as Novalis, poignantly captures the essence of intellectual pursuit.

Friedrich von Hardenberg, whose life spanned the late 18th to early 19th century, often delved into the realms of knowledge and understanding through his writings. His profound words echo a deep reflection on the significance of theory development, as in this case, the development of 'co-theory', both as a metaphysical exploration and a means to make sense of observable phenomena. It is in the weaving and casting of these 'nets' – the hypotheses – that gather insights, whether they pertain to the tangible world around us or the more elusive, abstract dimensions of reality. Novalis, in his time, underscored this timeless truth: that the quest for understanding is an active, dynamic process, requiring not just the creation but also the courageous deployment of theories to unravel the mysteries of both the seen and the unseen (Novalis et al., 1997).

Background

Construction Project Management: Co-Theory for SDG-Driven Sustainable Development

Interdisciplinary research merges diverse disciplines, offering holistic solutions to complex global challenges like climate change and socioeconomic disparities (Bernstein, 2015; Klein, 2008, 1990; Repko et al., 2019). Despite its importance in fostering innovation, its application, particularly in empirically understanding theory for problem-solving, remains underutilised (Adolfi et al., 2023). In sustainable development, integrating varied fields—from architecture and economics to public policy—is vital for addressing multi-faceted stakeholder engagement (Mewomo et al., 2022; Ndlovu and Simbanegavi, 2022; Weaich et al., 2023a). Such integration stimulates creativity, driving breakthroughs beyond the scope of isolated disciplines (Porter et al., 2006). The SDGs' interdisciplinary nature showcases the necessity of this approach to tackle issues like poverty, health, and environmental degradation within sustainability comprehensively (Lee et al., 2016). Yet, the slow permeation of interdisciplinary research across academic fields hinders SDG progress, as observed in South Africa's challenges in meeting the 2030 agenda (Barković, 2010; Dzebo et al., 2023; Statistics SA, 2019). Embracing 'co-theory collaboration' in construction project management is crucial for advancing SDG commitments, offering a more nuanced understanding, and informing policy to navigate the complexities of these global imperatives effectively.

The Problem Statement: The Necessity of Interdisciplinary Approaches and Co-Theory Development in Construction Project Management

The Problem Paradigm: Transdisciplinary Theory in Sustainable Construction Project Management

Construction project management faces intricate challenges that extend beyond technical and managerial confines, encompassing socioeconomic and environmental considerations, which are integral to achieving the Sustainable Development Goals (SDGs) (Weaich et al., 2023a). Existing methods and theories within project management often operate in disciplinary isolation, lacking the integrated, cross-disciplinary viewpoint needed to tackle these complexities effectively. A glaring research gap persists in the empirical investigation of theory from an interdisciplinary standpoint (Adolfi et al., 2023). There is a critical need for a new bibliometric model to predict interdisciplinary connections and foster transdisciplinary collaborations, an approach that aligns with Popper's advocacy for systematic scientific exploration and rigorous theory evaluation (Donthu et al., 2021a; Mukherjee et al., 2022; Popper, 1959; Popper and Popper, 2008).

Aim: Crafting a Theocratic Bibliometric Framework for Transdisciplinary Progress in Construction Project Management

The 'End Goal': Transdisciplinary Bibliometric Modelling for Sustainable Development

This research endeavours to construct an innovative bibliometric model tailored to encourage transdisciplinary collaboration within construction project management, fostering sustainability across disciplines (Radakovic et al., 2022). Grounded in the systematic methodologies of scientific investigation championed by Aristotle and Karl Popper, the study focuses on the critical evaluation of interconnected theories and practices (Aristotle, 1994; Aristotle and Ross, 2009; Popper and Popper, 2008). It is this fusion of Aristotle's foundational insights and Popper's philosophical scientific rigour that informs the methodological approach of the study, driving the creation of a model that not only bridges disciplinary gaps but also formulates a comprehensive theoretical understanding of sustainability within a collaborative, transdisciplinary research framework.

Main Research Question

MRQ: How can a new bibliometric model, grounded in systematic methodology and collaborative focus, predict and weave interdisciplinary theories within a theocratic framework, uncover routes for transdisciplinary cooperation, and thereby strengthen methodological precision and innovation in scientific exploration to construct an overarching theory of sustainability achieved via transdisciplinary research in the field of construction project management?

Research Sub-Questions

To dissect the overarching **MRQ** on developing a bibliometric model for transdisciplinary sustainability in construction management, this study formulates three interrelated sub-questions:

R1: How does bibliometric analysis enable the systematic amalgamation of interdisciplinary theories, enhancing sustainability understanding in construction project management? **R2**: How can the bibliometric

model predict interdisciplinary integration, and how might this prediction aid in carving out opportunities for transdisciplinary collaboration within construction management? **R3**: In what ways does the co-theory approach, underpinned by bibliometric analysis, contribute to methodological precision, and drive scientific innovation, ultimately leading to a holistic theory of sustainability in construction management? These questions segment the **MRQ** into targeted inquiries that leverage bibliometric methods to evaluate research patterns, each probing a distinct dimension of the bibliometric model's utility in fostering a transdisciplinary sustainability framework.

Objectives

The study delineates its objectives for leveraging bibliometric analysis with the co-theory methodology to address the **MRQ**'s complexity:

O1: Utilise bibliometric analysis to systematically identify and synthesize diverse interdisciplinary theories within project management disciplines, enhancing the grasp of transdisciplinary sustainability in construction management. **O2:** Deploy the bibliometric model to forecast disciplinary interconnections and promote the discovery and advancement of transdisciplinary collaborative ventures in construction project management. **O3:** Implement a co-theory approach, anchored in bibliometric scrutiny, to augment methodological integrity and inspire scientific innovation, culminating in a comprehensive theory of transdisciplinary sustainability for construction project management. These objectives are crafted to methodically unravel the **MRQ**, facilitating a detailed and holistic evaluation of the bibliometric model's capacity to enrich the theory and application of transdisciplinary sustainability in the realm of construction project management.

Assumptions

The study's foundational assumptions, pivotal for its execution, are outlined as follows:

A1: The research posits that Scopus, being extensive and reputable, offers a complete and representative array of literature pertinent to construction management and sustainability, a cornerstone for the credibility of the bibliometric analysis. **A2**: It presumes the Scopus database's data integrity, where citations, authorship, and publication specifics are presumed accurate and uniform, crucial for the validity of identifying research patterns and connections. **A3**: The study is predicated on the validity of bibliometric indicators and metrics, including novel co-theory constructs and empirical methods like co-authorship networks, to effectively evaluate interdisciplinary engagements and transdisciplinary collaborations. These presumptions are integral to the research design, signifying reliance on Scopus for comprehensive data and trust in bibliometric techniques as instruments for dissecting and decoding academic discourse in sustainable construction project management.

Hypotheses

In alignment with its objectives and under the premise of using Scopus-based bibliometric analysis to investigate transdisciplinary sustainability in construction project management, the study posits the following hypotheses for empirical testing:

H1: Bibliometric analysis applied to Scopus-sourced literature will uncover a substantive confluence of interdisciplinary theories in construction management, reflecting a shift towards a holistic methodology for transdisciplinary sustainability challenges. **H2**: The bibliometric scrutiny of project management texts will facilitate the prognostication of inter-disciplinary thought patterns, unveiling pivotal junctures for transdisciplinary cooperation vital for the progress of sustainable practices within the sector. **H3**: Implementing a co-theory modality, informed by bibliometric examination of Scopus data, will bolster methodological exactitude, and contribute to evolving a robust and all-encompassing theoretical construct for transdisciplinary sustainability in construction project management. These hypotheses are formulated to rigorously evaluate the bibliometric model's efficacy in detecting research directions, collaborative ventures, and theoretical innovations pertinent to transdisciplinary sustainability in construction project management.

LITERATURE REVIEW

Theoretical Literature Review: The Theory of Transdisciplinarity (ToT)

Transdisciplinarity Theory: Project Management Sustainability

To explain the study's phenomenon, which involves the integration of interdisciplinary theories and the identification of transdisciplinary collaboration in construction project management with a focus on transdisciplinary sustainability, the 'Theory of Transdisciplinarity' is selected for its core-tenets being in alignment with the study's hypotheses. This theory is rooted in the idea that complex problems, especially those related to sustainability, require insights and methodologies from multiple disciplines to be effectively understood and addressed (Hadorn et al., 2008; Lawrence and Després, 2004; McGregor, 2017; Nicolescu, 2002). The Theory of Transdisciplinarity, as it is understood in the context of addressing complex, real-world problems by transcending traditional academic disciplines, was developed, and significantly shaped by multiple scholars. However, one of the key figures in the development of this theory is Basarab Nicolescu. Nicolescu, a theoretical physicist, played a crucial role in articulating and promoting the concepts of transdisciplinarity, particularly through his work "Manifesto of Transdisciplinarity", (2002).

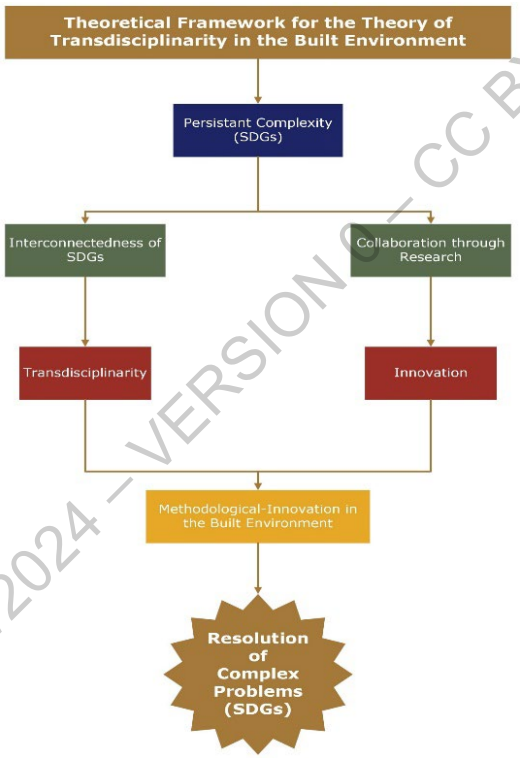
Core Tenets of the Theory of Transdisciplinarity in relation to development of the Co-Theory Bibliometric Model of Transdisciplinarity (BMT): A Basarab Nicolescu Perspective

To effectively explain the phenomenon, the study adapts the following core-tenets from the Theory of Transdisciplinarity to develop a model for it to test its Hypotheses in reality (**H1**, **H2** and **H3**):

C1: Embracing Complexity and Multidimensionality: The study leverages the transdisciplinary acknowledgment of the world's complexity and various levels of reality, recognising that the multifaceted nature of construction project management, spanning technical, economic, and social aspects, will be evident through bibliometric analysis (Aristotle and Ross, 2009; Nicolescu, 2002; Weaich et al., 2023a). **C2: The Logic of the Included Middle**: Aligned with Nicolescu's 'included middle', the study posits that its bibliometric approach will forecast and discern the potential for transdisciplinary collaborations, transcending dichotomous thinking (Kaatz et al., 2005; Nicolescu, 2002). **C3: Transcending Disciplines**: Transdisciplinarity's imperative to go beyond disciplinary confines is mirrored in the study's ambition to cultivate a methodologically robust and encompassing theoretical framework through a co-theory approach

(Nicolescu, 2002; Weaich et al., 2023a). **C4: Stakeholder Participation**: The study's methodology inherently involves diverse stakeholder insights, a testament to transdisciplinarity's principle of inclusive knowledge production (Ndlovu and Simbanegavi, 2022; Nicolescu, 2002). **C5: Fostering Novelty and Innovation**: Consistent with the principle that transdisciplinarity sparks new knowledge, the study provides a clear path to contribute novel models and theoretical advances targeting the SDGs within construction project management (Nicolescu, 2002; Weaich et al., 2023b; Zartha Sossa et al., 2021). The Theory of Transdisciplinarity, particularly Nicolescu's perspective, fortifies the study's conceptual foundation, aligning with the hypotheses to transcend conventional disciplinary approaches and tackle construction management's complexities for sustainable development.

Framework 1: Adapting the Theory of Transdisciplinarity: A Theoretical Framework



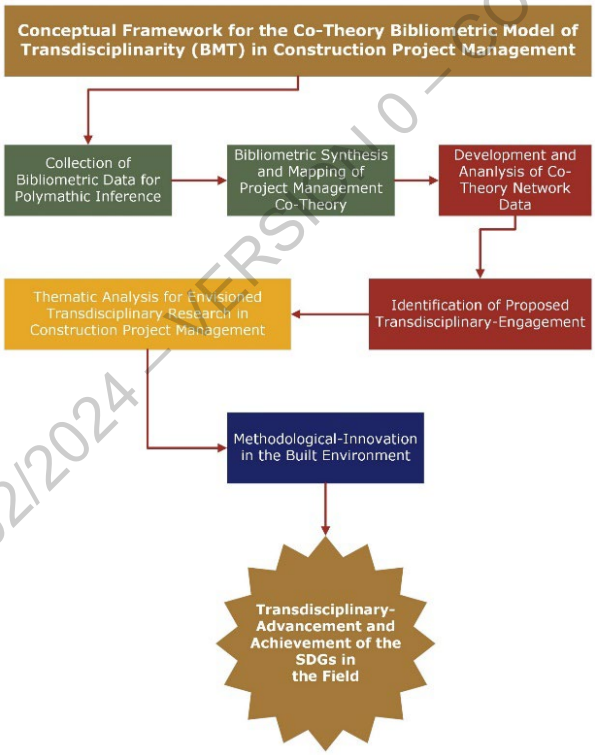
Adapting the tenets of the Theory of Transdisciplinarity in relation to development of the Co-Theory Bibliometric Model of Transdisciplinarity (BMT): An Aristotelian Polymathic Perspective

The Bibliometric Model of Transdisciplinarity **(BMT)** harnesses the **(ToT)**, guided by an Aristotelian ethos, to navigate the complex landscape of sustainable construction project management. This innovative approach:

T1: Integrates Diverse Disciplines, advocating for a synthesis that extends beyond traditional multidisciplinarity, embracing a holistic transdisciplinary sustainability perspective (Aristotle and Ross, 2009; Nicolescu, 2002). **T2**: Addresses complex problems through a polymathic lens, recognising the inadequacy of single-discipline solutions for the multifaceted challenges inherent in sustainable construction,

which spans technical, environmental, economic, and social concerns (Aristotle and Ross, 2009; Lawrence and Després, 2004; Nicolescu, 2002; Weaich et al., 2023a). **T3**: Encourages stakeholder participation, integrating insights from academics, practitioners, policymakers, and communities, thereby enriching the analysis with diverse, qualitative insights for a comprehensive understanding (Aristotle and Ross, 2009; Donthu et al., 2021b; McGregor, 2017). **T4**: Promotes methodological innovation, applying bibliometric analysis to foster new pathways for understanding and addressing the SDGs through the development of specific metrics and indexes (Aristotle, 1994; Hadorn et al., 2008; Weaich et al., 2023a). **BMT**, therefore, represents a significant step forward in the quest for transdisciplinary sustainability within construction management. It systematically synthesises interdisciplinary knowledge, offering effective strategies and policies to overcome the sector's complex challenges. This model not only marks a methodological leap in scientific inquiry but also aligns with the broader goals of achieving sustainability through collaborative, transdisciplinary research.

Framework 2: Co-Theory Bibliometric Model of Transdisciplinarity (BMT): A Conceptual Framework



Empirical Literature Review: A Bibliometrics as a Tool for Achieving Transdisciplinarity

Garfield's Bibliometric Legacy: Achieving Transdisciplinary in Project Management

Eugene Garfield significantly contributed to bibliometrics, creating the Science Citation Index (SCI) and establishing a new paradigm for academic literature analysis (Garfield, 1955). This methodology underpins the bibliometric model for transdisciplinary collaboration (BMT) in construction project management,

facilitating the integration and assessment of interdisciplinary research. Garfield's innovation allows for the quantitative evaluation of knowledge proliferation across various disciplines, addressing sustainability within construction management by identifying key trends, influential research, and collaboration opportunities (Anninos, 2014; Debackere and Glänzel, 2004; Olawumi and Chan, 2018). Bibliometrics, leveraging Scopus's extensive database, offers insights into the interdisciplinary nature of sustainable construction project management, revealing patterns of collaboration and theoretical integration crucial for advancing transdisciplinary sustainability (Hood and Wilson, 2001; Leydesdorff and Rafols, 2009). This approach highlights the necessity of a systematic, objective analysis to navigate the complexities of sustainability challenges, aligning with the study's aim to explore the potential of bibliometric analysis in fostering methodological rigour and innovation in scientific inquiry (Bornmann and Mutz, 2015; Zupic and Čater, 2015). However, the methodology is not without limitations, such as potential biases in citation practices and the risk of overvaluing quantitative measures, which often relegates the importance of theory to develop metrics to assess author and academic performance. Despite these challenges, the application of bibliometrics in research evaluation, policy-making, and strategic R&D decision-making underscores its versatility and impact across various fields, from healthcare, academic grant funding and environmental science policy (Budler et al., 2021; Kokol et al., 2021; Mukherjee et al., 2022; Vinayavekhin et al., 2023). BMT, informed by Garfield's bibliometric principles and integrated with the philosophical underpinnings of Popper and Aristotle, provides the foundation required to encapsulate, and advance the understanding of transdisciplinary sustainability in construction project management. This model will provide the necessary tools to bridge disciplinary divides, highlighting the critical role of bibliometric analysis in synthesising interdisciplinary knowledge and fostering collaborative innovation towards achieving the SDGs within the construction industry.

Syllogistic Summary for Empirical Validation of Hypotheses in Sustainable Construction Project Management as a Phenomenon in Reality

Bibliometrics: A Syllogistic Approach to Transdisciplinarity in in Sustainable Construction Project Management Research

This summary distils empirical evidence into syllogisms, underpinning the application of bibliometrics for transdisciplinarity in sustainable construction project management:

First Syllogism: Enhancing Understanding and Policy through Bibliometrics:

Major Premise: Bibliometric analysis quantitatively assesses academic research's impact, facilitating the evaluation of scholarly work (Garfield, 1955). **Minor Premise**: In sustainable construction project management, understanding research impact is essential for integrating diverse disciplines and shaping effective policies. **Conclusion**: Thus, bibliometric analysis in sustainable construction project management is pivotal for enhancing interdisciplinary understanding and informing policymaking.

Second Syllogism: Advancing Knowledge via Trend Identification:

Major Premise: Bibliometric analysis provides insight into research trends and developments, highlighting emerging areas of study (Zupic and Čater, 2015). **Minor Premise**: In the context of sustainable construction project management, pinpointing trends and gaps is vital for knowledge progression. **Conclusion**:

Consequently, bibliometric analysis is crucial for propelling sustainable construction project management knowledge by spotlighting pivotal trends and filling existing gaps.

Third Syllogism: Fostering Transdisciplinary Collaboration through Bibliometrics:

Major Premise: Bibliometrics reveals interdisciplinary collaboration's scope by analysing citation patterns and co-authorship networks, offering a theoretical perspective on the application of theory (Leydesdorff and Rafols, 2009). **Minor Premise**: Addressing sustainability's complex challenges in construction project management necessitates interdisciplinary collaboration. **Conclusion**: Hence, bibliometric analysis plays a key role in promoting transdisciplinary collaboration, crucial for surmounting sustainability challenges in construction project management.

These syllogisms articulate the empirical basis for utilising bibliometric analysis in the study, highlighting its utility in evaluating research impact, uncovering trends and gaps, and catalysing transdisciplinary collaboration within sustainable construction project management.

METHODOLOGY

Achieving Transdisciplinary: A Philosophical Perspective on Aristotelianism

A Bibliometric Approach: Philosophies and Quantitative Analysis in Sustainable Construction Management

This study embodies a hybrid of positivist and epistemological philosophies, advocating for the pragmatic application of diverse theories to decode complex real-world issues. Through bibliometric analysis, it objectively assess' theory usage and dissects data to construct a co-theory paradigm rooted in a rich history of academic discourse over the last five years. This blend of philosophies is instrumental in navigating the study's transdisciplinary scope, enabling the seamless fusion of multiple methodological and theoretical landscapes (Saunders et al., 2019). Methodologically, the research adopts a quantitative lens, leveraging Scopus's extensive academic publication database to perform bibliometric analysis. This approach quantifies academic literature patterns, facilitating a nuanced understanding of transdisciplinary sustainability in construction project management through deductive reasoning (Saunders et al., 2019). An exploratory polymathic strategy guides the inquiry, to illuminate the interplay of interdisciplinary knowledge and its influence on sustainable construction project management methodologies. This strategy, reflective of the study's innovative ambitions, is particularly apt for crafting the Bibliometric Model of Transdisciplinarity (BMT), marrying diverse knowledge spheres to spur methodological and theoretical advancements (Aristotle, 1994; Aristotle and Ross, 2009). The research employs deductive-objective reasoning to forge new theoretical insights from empirical data, aligning with the transdisciplinary ethos by testing and refining the BMT within this context (Aristotle, 1994; Popper and Popper, 2008; Saunders et al., 2019). A cross-sectional bibliometric analysis frames the study's temporal approach, pinpointing literature at a specific moment to gauge prevailing trends and identify research lacunae. This meticulous examination draws from Scopus, focusing on sustainability-centric terminology within construction project management, and employs network analysis to decode patterns of collaboration and theoretical discourse (Saunders et al., 2019). Despite its rigorous philosophical foundation, the study acknowledges a philosophical void in adequately capturing

transdisciplinary sustainability. It offers a pathway bridge this gap, albeit recognising that a comprehensive philosophical solution to sustainability's multifaceted challenges remains elusive, marking a fertile ground for future scholarly exploration.

DATA

Data Processing

Structured Bibliometric Approach: Transdisciplinary Sustainability in Project Management

The tabulation of the bibliometric data process for modelling an interdisciplinary network offers a structured overview of the actionable steps, along with considerations in the data handling process, streamlining the action of conducting a bibliometric study in the field of sustainable construction project management, introducing a 'co-theory' metric to achieve transdisciplinarity. The Boolean statements used in this study are designed to be broad enough to capture a wide range of relevant literature while being specific enough to focus on the intersection of project management as a discipline, construction project management as a sub-discipline, sustainability as a cointegrating factor and the use of theory as a discerning factor for potential transdisciplinary breakthroughs. **Selecting Data Sources with Specific Criteria**: Identifying suitable databases (e.g., Web of Science, Scopus, Google Scholar) that offer comprehensive metrics for citation analysis, content analysis, co-citation analysis, co-authorship analysis, and co-theory analysis. Chosen databases that encompass journals and publications pertinent to sustainable construction project management, ensuring alignment with the study's theoretical focus. Scopus was selected for its robust capabilities in fulfilling the study's requirements, providing a wide array of scholarly materials relevant to both construction project management and sustainability. **Developing a Boolean Search Strategy**: The study crafted a search strategy using keywords and Boolean logic to precisely target relevant literature. It refined search terms based on initial searches to achieve a balance between the scope of search results and the specificity needed for the study's focus. **The search strategy implemented**: First search operation: ("construction project management" OR "project management") AND Second confounding operation: ("sustainability") W/255 AND a Third discerning operation: ("conceptual framework"). **Data Retrieval and Extraction**: Employment of the formulated search strategy to retrieve literature and export data in formats conducive to analysis. Ensuring the extraction captures essential bibliographic details, selecting export formats such as CSV, Excel and RIS for their versatility. Literature was exported to their respected formats and then imported into VOSViewer with descriptive statistics being directly produced by Scopus Metrics Analysis tool. As of February 1, 2024, 563 documents were identified, adhering to specific search parameters including English language, with publications from 2018 to 2023, and content limited to research articles and conference papers. **Data Cleaning and Preprocessing**: The study conducted data cleansing to remove duplicates and errors and standardise data formats for analysis. Where necessary, manually inspected data for accuracy and categorise it according to the analytical needs of the study, only providing columns to suite the software applications requirements. Data was categorised based on analytical criteria set out for citation analysis, content analysis, co-citation analysis, co-authorship analysis, and co-theory analysis, ensuring a streamlined and focused dataset for subsequent analysis. This structured approach underscores the meticulous process of bibliometric analysis in exploring transdisciplinary sustainability within the context of construction project

management, setting a foundation for in-depth investigation and interpretation of the research landscape in this field.

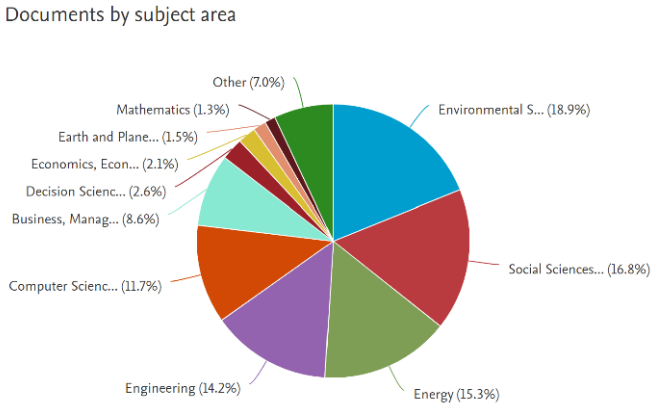
RESULTS

Bibliometric Analysis

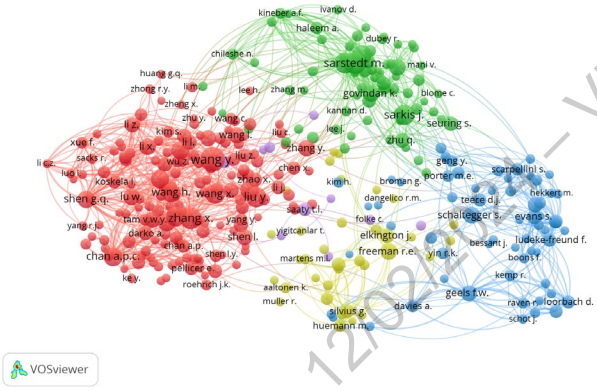
Descriptive Statistics: Scratching at the Surface

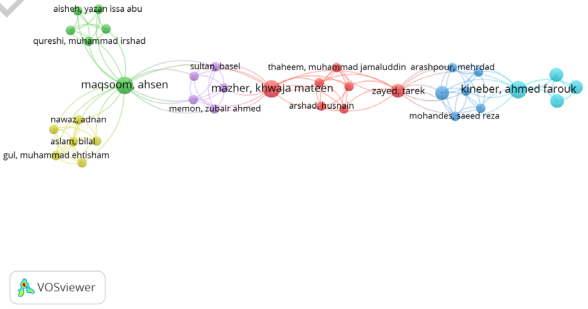
The bibliometric analysis reveals a notable increase in research on sustainable construction project management, with publications rising from 50 in 2018 to approximately 175 in 2023. This trend highlights the growing academic interest and interdisciplinary engagement in sustainability within the construction sector. Prominent journals such as 'Sustainability Switzerland' and 'Journal of Cleaner Production' lead this surge, signifying a broadening knowledge base. Contributions from 'Energies' and 'Procedia Computer Science' further underscore the cross-disciplinary nature of the research. Influential figures like A. Maqsoom and A. Kumar stand out as key thought leaders for their predominant use of theory through conceptual frameworks in their publications, with institutions like Delft University of Technology and the University of Johannesburg showcasing a wide-ranging, global commitment to sustainability that surpasses regional confines, this is an interesting perspective as it is solely based on output rather than the use of a conceptual framework in the formation of transdisciplinary theory. The engagement spans across diverse fields, from 'Environmental Sciences' to 'Computer Science', painting a complex picture of the research ecosystem. Yet,

the mismatch between author affiliations and their publication's geographical attributions suggests a need for a nuanced approach to evaluating research impact, advocating for an analysis that extends beyond mere publication counts to encompass qualitative assessment and theoretical contributions, the need for a co-theory analysis from an infocratic lens is evident.



Bibliometrics: A Co-Citation and Co-Author Analysis of Theory in Sustainable Construction Project Management Research

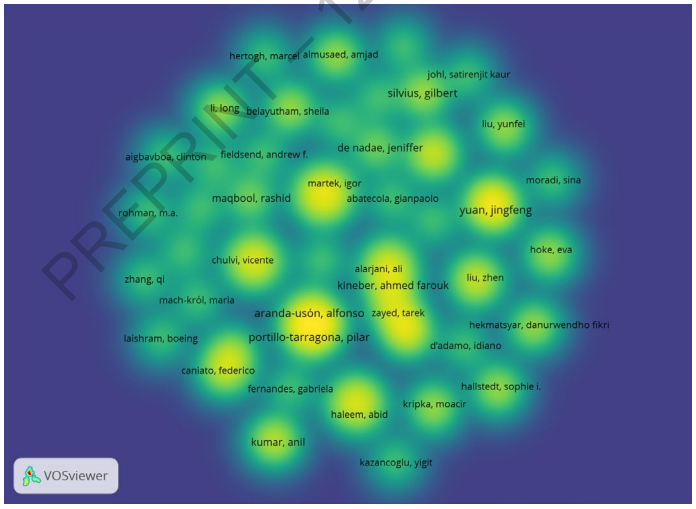


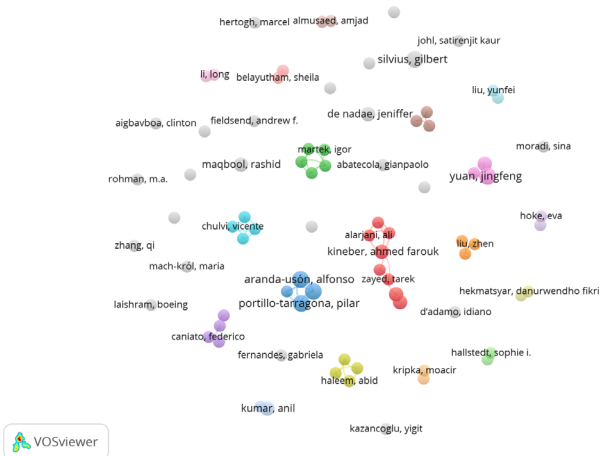


The co-citation and co-authorship network analysis, as visualised and interpreted from a theocratic lend within the sustainable construction project management field of research, it directly addresses, and resolves the study's hypotheses through empirical evidence addressing the limitations of quantitative insights generated purely from a quantity-based perspective. **H1: Interdisciplinary Integration in Construction Project Management**: The central positioning of authors like Ahmed Maqsoom and Tarek Zayed, and the presence of distinct clusters, where transdisciplinary sustainability is most likely going to breakthrough, empirically demonstrate the significant interdisciplinary integration within the field. This is contravention to the previous identified statistic, which places the University of Johannesburg as the thought leader on sustainability theory. This supports the hypothesis that bibliometric analysis reveals a trend towards holistic approaches in addressing transdisciplinary sustainability issues. The network's diverse clusters and the central roles of key contributors underscore a broad interdisciplinary collaboration, aligning with the

anticipation that the study would uncover substantial interdisciplinary integration. **H2: Forecasting Interconnected Disciplinary Thoughts for Transdisciplinary Collaboration**: The network's structure, with its varied clusters and interconnections, illustrates the effective forecasting of interconnected disciplinary thoughts. The visualisation of co-authorship patterns provides concrete evidence of existing and potential areas for transdisciplinary collaboration, affirming the hypothesis that bibliometric analysis can identify key areas for such collaboration through an analysis of theory. This observation of inter-cluster connections and thematic diversity within the network suggests that the study successfully maps the landscape of collaborative efforts essential for advancing transdisciplinary sustainable practices. **H3: Enhancing Methodological Rigour through Co-Theory Methodology**: The comprehensive mapping of co-authorship relationships, highlighting strong and frequent collaborations, reflects the application of a co-theory methodology, however, transdisciplinarity remains unobtainable due to the silo of single disciplinary thought amongst predominant authors in this field of study that enhances methodological rigour. The analysis supports the hypothesis that employing bibliometric and co-theory approaches contributes to the development of a more comprehensive theoretical framework for transdisciplinary sustainability. By identifying influential authors and groups within the network, the study demonstrates how bibliometric analysis, underpinned by co-theory, fosters innovation and theoretical advancement in sustainable construction project management research. It must also be stated, upon inferential analysis, the study uncovers an unexplained phenomenon, whereby, traditional citation metrics fail to identify the true problem solvers amongst academics and scholars in this field, upon further analysis the co-theory authorship network analysis not only validates the study's hypotheses but also showcases the effectiveness of co-theory bibliometric analysis in enhancing understanding of interdisciplinary integration, forecasting collaborative opportunities, and strengthening methodological rigour to mitigate this shortcoming. This empirical evidence, derived from analysing patterns of collaboration and influence within the research community, affirms the study's contribution to advancing the theory and practice of transdisciplinary sustainability in construction project management.

Bibliometric Model of Transdisciplinarity (BMT): A Co-Theory Analysis in Sustainable Construction Project Management Research





The visualisation from the bibliometric model of transdisciplinarity (BMT) underscores the intricate web of collaborations pivotal for fostering transdisciplinary approaches in sustainable construction project management. Each node, an author, not only signifies an individual contributor but also serves as a marker for the depth and scope of their influence within the network, with those at the core making substantial theoretical advancements. Authors with varying colours indicate thought leaders in the use of theory in their respective disciplinary silos. With authors in grey in possession of high publication counts and metrics but unable to bridge the transdisciplinary thought due to the lack of theory in their works. These authors, although prolific in publication, fail to address the complexity of sustainability using theory. Proximity between nodes reveals the strength of collaborative ties, suggesting shared research interests and potential co-theory development. The network's density, particularly where nodes cluster tightly, represented by 'hot spots' of deeper colour variation, indicates thriving research communities likely to spearhead transdisciplinary breakthroughs. These clusters, discernible through concentrations of nodes and distinct colour variations, embody the various sub-disciplines and theoretical frameworks that enrich the field. This **BMT** visualisation is instrumental in pinpointing key contributors and collaborative constellations that are at the forefront of integrating transdisciplinary theories into sustainable construction project management. It elucidates the operationalisation of co-theory within the field, as manifested through collaborative networks and collective research endeavours, providing a roadmap for engaging with the field's most innovative research and for contributing to the evolution of theoretical frameworks within this dynamic domain.

The **BMT** visualisation offers empirical support to the study's hypotheses, mapping the collaborative networks within sustainable construction project management and demonstrating the operationalisation of co-theory in the field. **H1: Interdisciplinary Integration in Construction Management**: The visualisation's densely clustered nodes, especially those central to the network, confirm **H1** by illustrating significant interdisciplinary integration. Authors at the heart of the visualisation, due to their numerous contributions, are likely driving the advancement of theory within the field. Authors at the outmost ring appear 'cooler' due to their lack of use of theory to explain their phenomenon. This supports the hypothesis that the application of bibliometric analysis would uncover substantial interdisciplinary integration, as these central figures typically represent the convergence of multiple disciplinary insights through the use of theory. **H2: Forecasting Interconnected Disciplinary Thoughts for Transdisciplinary Collaboration**: The proximity of nodes within clusters, indicative of strong collaborative ties, speaks to **H2**. The visualisation implies that the bibliometric model can effectively forecast interconnected disciplinary thoughts, with the observed clusters likely representing areas of current and potential transdisciplinary collaboration. This aligns with the hypothesis that the bibliometric analysis would facilitate the identification of key areas for transdisciplinary collaboration, a fundamental step for advancing sustainable practices within the field. **H3: Enhancing Methodological Rigour through Co-Theory Methodology**: The presence of distinct research communities within the visualisation and the identification of key researchers leading these clusters address **H3**. The visualisation confirms that employing a co-theory methodology, guided by bibliometric analysis, does contribute to methodological rigour. It does so by revealing how co-theory is operationalised within the field through collaborative networks and shared research endeavours, thus leading to a comprehensive and effective theoretical framework for sustainability within construction project management. The BMT visualisation directly ties back to the study's hypotheses by empirically demonstrating the integration of

interdisciplinary research, the capacity to forecast collaborative networks, and the contribution of co-theory methodology to the field's methodological rigour. It validates the effectiveness of the bibliometric approach in providing a nuanced understanding of the collaborative and transdisciplinary nature of contemporary sustainable construction project management research.

DISCUSSION

Advocacy of Objective Truths: Insights and Limitations on Current Metrics

Advocating Bibliometrics: SDG-Focused Transdisciplinarity in Project Management as a Discipline and Construction Project Management as a Sub-discipline

In the academic discourse surrounding bibliometrics and transdisciplinary collaboration, the study at hand offers substantial evidence to advocate for the integration of these approaches within the realm of sustainable construction project management. The study confirms the efficacy of bibliometric analysis in mapping the interdisciplinary nature of scholarly work. It aligns with the assertions of Porter et al., (2006) that bibliometrics can reveal hidden patterns of collaboration and intellectual synergy, which are vital in navigating the complexity inherent in transdisciplinary research in addressing the SDGs. This advocacy is bolstered by the visualisation of dense clusters of collaboration within the BMT, which illustrates how co-theory approaches can operationalise transdisciplinarity, leading to methodological innovations and the advancement of comprehensive sustainability models (Lawrence and Després, 2004; Weaich et al., 2023a). Furthermore, the study's findings resonate with the principles of the Theory of Transdisciplinarity as proposed by Nicolescu, (2002). It demonstrates that complex societal challenges, like those encountered in sustainable construction, require the convergence of diverse disciplinary perspectives, corroborating the necessity for a 'logic of the included middle' where binary oppositions are transcended, fostering a space for complementary insights. The empirical evidence gleaned from the bibliometric analysis confirms the Theory of Transdisciplinarity, highlighting the interconnected nature of disciplinary knowledge and the emergence of new, collaborative approaches to sustainability challenges in construction project management. This confirmation underlines the study's hypotheses that bibliometric analysis can significantly enhance the understanding of interdisciplinary integration and inform effective policymaking, as stated by Zupic and Čater, (2015). The Theory of Transdisciplinarity's tenet of 'complexity and multiple levels of reality' is evidenced through the study's results, showing that no single discipline can unilaterally address the multifaceted nature of sustainability. This is further validated by the presence of various stakeholders within the network, supporting Nicolescu, (2002) assertion that transdisciplinarity must involve diverse experiences and knowledge beyond academic silos. The literature offers varied arguments on the utilisation of bibliometrics for transdisciplinary collaboration. While Hood and Wilson, (2001) and Leydesdorff and Rafols, (2009) argue for the objectivity and empirical strength of bibliometrics in measuring research impact and fostering collaboration, others like Bornmann and Mutz, (2015) caution against the potential biases and the risk of quantitative measures overshadowing qualitative richness, this is made evident by prolific authors who fail to effectively utilise theory in addressing complex studies like the multifaceted problems facing SDGs. This study contends that while bibliometrics is not without its limitations, when applied with methodological rigour, it provides an invaluable framework for assessing and fostering transdisciplinary collaborations. It supports the argument that bibliometric analysis, when integrated with a co-theory

approach, can both reveal and promote the synthesis of interdisciplinary knowledge necessary for tackling the SDGs within construction project management, advocating for its use as a tool to understand and enhance collaborative efforts across disciplines (Aristotle, 1994; Hadorn et al., 2008; Weaich et al., 2023a).

CONCLUSION

Concluding Remarks: Achieving Transdisciplinarity in Project Management

Empirical Evidence: Supporting Bibliometrics in Transdisciplinary SDG Research

In conclusion, the study contributes to the academic dialogue on bibliometrics and transdisciplinarity by affirming the potential of bibliometric analysis as a tool for fostering transdisciplinary collaboration in sustainable construction project management. It substantiates the Theory of Transdisciplinarity through empirical evidence and aligns with the literature that supports the advancement of collaborative, cross-disciplinary research approaches to address the SDGs. The study's results serve as a testament to the critical role of transdisciplinary collaboration in achieving comprehensive and sustainable solutions across complex research fields and topics.

RECOMMENDATIONS

Bibliometric Insights: Bridging Transdisciplinary Gaps in Sustainable Development

The utilisation of bibliometrics provides a unique lens through which academics, grant funders and policy makers can discern the current state and gaps in transdisciplinary research. This section discusses the insights garnered from a bibliometric perspective and identifies the lacunae that exists within transdisciplinary research domains. Bibliometric analyses, such as those conducted in this study, have unveiled a substantive engagement in transdisciplinary research within sustainable construction project management. However, they also illuminate gaps in the literature. These gaps manifest as underrepresented disciplines within the literature, insufficient collaboration across fields, and a lack of research addressing SDGs in the context of construction project management (Waltman, 2016; Zupic and Čater, 2015). The bibliometric mapping reveals not only the density and intensity of current research efforts but also the areas where cross-disciplinary engagement is lacking, suggesting potential avenues for future research (Bornmann and Mutz, 2015).

Most Prominent Fields	*Least Prominent Fields*
Environmental Science	Medicine and Health Sciences
Social Science	Earth and Planetary Science
Energy	Economics
Engineering	Decision Science
Computer Science	Business Management

Transdisciplinarity: Research Gaps

While the study affirms the value of transdisciplinary approaches, it also identifies several research gaps. These include the need for more empirical studies that test the applicability of transdisciplinary theories in practice and a deficit in the literature regarding how transdisciplinary methods can be systematically implemented within the construction industry to address sustainability challenges (Lawrence and Després, 2004; Weaich et al., 2023a). The gaps point to the need for a deeper integration of theoretical constructs from diverse disciplines such as sociology, economics, and environmental science, and their operationalisation in real-world construction project scenarios. The Theory of Transdisciplinarity, as proposed by Nicolescu, (2002), remains the predominant theoretical framework for understanding and executing transdisciplinary research. Its principles of complexity, the logic of the included middle, and the transcendence of disciplinary boundaries are well-suited for addressing the multifaceted nature of sustainability challenges in construction project management and a wide array of fields. The study advocates for the adaptation of this theory as it provides a comprehensive approach that incorporates various levels of reality and encourages the participation of diverse stakeholders, which is essential for holistic problem-solving and innovation (Nicolescu, 2002; Weaich et al., 2023c).

Transdisciplinarity: Potential Transdisciplinary Fields

The potential for transdisciplinary fields to emerge from the current research landscape is significant. This study's analysis of bibliometrics showcases areas where there is an intersection of multiple disciplines, signalling ripe opportunities for the development of new transdisciplinary domains. These include the integration of environmental sciences with digital technologies, the convergence of economic models with sustainability principles, and the amalgamation of social sciences with engineering practices. These emerging fields could significantly benefit from transdisciplinary research methods to develop innovative solutions for the complex challenges faced within the industry, particularly in addressing the SDGs (Hadorn et al., 2008; Lee et al., 2016). The bibliometric insights reveal the extent to which transdisciplinary research is currently being undertaken and highlight the critical gaps that remain. The Theory of Transdisciplinarity is recommended as a guiding framework due to its alignment with the complexities inherent in sustainable construction project management. The study underscores the potential for the creation of new transdisciplinary fields that leverage the strength of collaborative, cross-disciplinary scholarship to address the pressing needs of society, advocating that only research which encompasses theory will provide the tools to meet the globally envisioned goals for 2030 (Adabre et al., 2021; Aghimien et al., 2020; Hannon and Zaman, 2018; Office of the President, 2012).

Future Research: Developing a Theory to Adress Sustainability

Future research in the development of theory to address the SDGs must chart a course through the confluence of multiple disciplines, reflecting a commitment to transdisciplinary synthesis. Theoretical advancements should aim to encapsulate the integrative essence of the SDGs, weaving together threads from environmental science, urban planning, socioeconomics, technology, and governance, among others. Such research should prioritise the construction of robust theoretical frameworks and conceptual frameworks that are versatile enough to address the SDGs' diverse targets. These frameworks must be rooted in empirical evidence and adaptable to the evolving challenges posed by sustainability issues. Future studies should also focus on the

operationalisation of these theories within practical settings, evaluating their effectiveness in real-world scenarios and refining them based on iterative feedback. There is a need to foster collaborative environments where stakeholders from academia, industry, and policy can co-create knowledge (Abbas et al., 2022; Abdullahi and Kehinde, 2023; Adabre et al., 2022; Adewunmi et al., 2023; Afsar et al., 2020; Aigbavboa et al., 2017; Chan et al., 2018; Chen et al., 2017; Dobarrio Machado Ciccarino and Serrano Fernandes Rodrigues, 2023; Godin et al., 2021; Golić et al., 2023; Hagbert et al., 2013; Hosseini et al., 2018; Jelinek et al., 2024; Kaur Bedi, 2018; Khan et al., 2022; Latos, 2018; O'higgins, 2001; Olanrewaju et al., 2022; Parafiniuk, 2014; Portillo-Tarragona et al., 2018; Scarpellini et al., 2020; Shi et al., 2013; Silvius and Schipper, 2014; Venkata Mohan et al., 2016; Yin and Li, 2018; Zabalza Bribián et al., 2011; Zheng et al., 2017; Zhou et al., 2021). This would not only enhance the relevance and applicability of theoretical models but also ensure that they are informed by a rich tapestry of experiences and perspectives. To support this endeavour, future research should leverage and expand upon bibliometric methodologies to map the trajectory of interdisciplinary research, identify emergent trends, and spotlight underexplored areas that could contribute to the SDGs. By doing so, academia can offer a compass to navigate the complexities of sustainable development, guiding efforts toward a more equitable and resilient future.

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ABSTRACT REVIEW FORM

Dear Reviewer,

Please use the form below to evaluate the abstract and make a recommendation. Rate each component of the abstract on a scale of 1 to 5, where 1 is Poor, 2 is Below average, 3 is Average, 4 is Good, and 5 is Excellent. If necessary, kindly provide constructive comments and suggestions for improvements. Your comments will help the author(s) to improve the quality of the paper.

PAPER ID: WS0418

TITLE OF ABSTRACT: ACHIEVING SUSTAINABLE TRANSDISCIPLINARY RESEARCH IN CONSTRUCTION PROJECT MANAGEMENT: A BIBLIOMETRIC APPROACH.

PLEASE PROVIDE YOUR EVALUATION OF THE ABSTRACT IN THE FORM BELOW

COMPONENTS OF THE ABSTRACT TO BE EVALUATED	**REVIEWER'S EVALUATION** (Scale 1-5)
The research topic/area is relevant to the conference	**Yes**
The title of the abstract is clear and consistent with the content	**Yes**
Problem statement: The research problem is clearly described and contextualised	4
Research aim: The research aim and/or specific objectives are clearly defined	4
Research design and methodology: The research design and methodology for executing the work is clearly explained and appropriate for the work	4
Findings/Results: The findings/expected findings from the study are clearly articulated	4
Conclusion/value of the study: The key consequence/value of the work is clearly explained	4
OVERALL COMMENTS/SUGGESTIONS FOR IMPROVEMENT. The abstract is well done.	

RECOMMENDATION (Please mark "X" in the relevant box

Accept	**X**	Reject	

JOINT INTERNATIONAL CONFERENCE

SuDBE SOUTH AFRICA 2024

29th July - 2nd August 2024
Wits University
Johannesburg, South Africa

23 January 2024

Mr. Malcolm Weaich
School of Construction Economics and Management
University of the Witwatersrand
South Africa

Dear Mr. Malcolm Weaich,

ACCEPTANCE OF ABSTRACT FOR WABER & SUDBE 2024 CONFERENCE

Thank you for submitting your abstract for the WABER & SuDBE 2024 Conference. I confirm that your abstract with the following details has been accepted.

Paper ID#: WS0418
Title of Paper: Achieving sustainable transdisciplinary research in construction project management: a bibliometric approach
Author(s): Malcolm Weaich, Prisca Simbanegavi, Pride Ndlovu and David Root.

Congratulations on the acceptance of your abstract. We look forward to receiving your full paper by **31 March 2024.** The full paper template and other information are available on the Conference website www.wabersudbe.com

Yours Sincerely,

Samuel Boakye Yiadom
WABER SuDBE 2024 Conference Team