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Innovationology: A Comprehensive, Transdisciplinary Framework for Driving Transformative Innovation in the 21st Century

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Abstract: In an era of rapid technological advancements, complex global challenges, and intense market competition, the ability to generate and scale innovative solutions has become a critical imperative for organizations, policymakers, and societies worldwide. However, the existing academic landscape has lacked a cohesive, multidisciplinary framework for comprehensively understanding the multifaceted nature of innovation. Innovationology, a newly established scientific discipline, aims to address this gap by providing a unifying, transdisciplinary approach to the study and practice of transformative innovation. This comprehensive article introduces Innovationology as a cutting-edge science that integrates insights from diverse fields, including management, psychology, sociology, economics, and technology studies. Innovationology posits that innovation is a multilayered, context-dependent phenomenon, shaped by the intricate interplay of individual, team, organizational, and ecosystem-level factors. By synthesizing the latest theoretical advancements and empirical evidence, this article presents a holistic model of Innovationology that illuminates the key determinants of radical, game-changing innovations capable of disrupting existing industries and creating new market spaces. The article delves deep into the individual cognitive, behavioral, and motivational drivers of innovativeness, the team dynamics and organizational structures that foster collaborative innovation, and the ecosystem-level characteristics that catalyze the emergence and scaling of transformative innovations. Importantly, the article explores the crucial role of contextual factors, such as socio-cultural norms, institutional support, and resource availability, in shaping innovation outcomes. This article also establishes the epistemological foundations of Innovationology, grounding it in a transdisciplinary, holistic, and pragmatic approach to knowledge generation. Innovationology embraces a pluralistic epistemology that acknowledges the complexity and context-dependence of innovation, drawing on diverse methodological approaches to capture the multifaceted nature of this phenomenon. Furthermore, the article outlines the object of Innovationology, which is to provide a comprehensive, evidence-based understanding of the drivers, processes, and outcomes of transformative innovation. Innovationology seeks to elucidate the multilevel determinants of innovation, the dynamic interplay between various factors, and the contextual influences that shape innovation trajectories. By establishing a unifying, transdisciplinary framework, Innovationology aims to bridge the gap between innovation theory and practice, empowering a wide range of stakeholders to unlock the transformative potential of innovation. Importantly, this article outlines the practical applications of Innovationology, providing comprehensive strategies and evidence-based interventions for cultivating innovative mindsets, designing innovation-conducive organizational systems, and navigating the challenges of innovative ecosystems. The implications of Innovationology for entrepreneurs, corporate leaders, policymakers, and innovation scholars are discussed in detail. By establishing Innovationology as a distinct, authoritative scientific discipline, this article sets the foundation for a more holistic, context-sensitive understanding of innovation and its multifaceted drivers. The insights generated by this new science can empower global organizations, institutions, and policymakers to address the complex, interconnected challenges of the 21st century through the strategic deployment of transformative innovations.

Keywords: innovationology; innovation science; transdisciplinary research; transformative innovation; multilevel determinants; innovative ecosystems; epistemology; pragmatism; context-dependent process; organizations; holistic model; strategies; innovative mindsets; innovative ecosystems; entrepreneurs; corporate leaders; policymakers; science; paradigm shift; sociology; psychology; management; complexity; polycentric governance; inclusive innovation; sustainable development; Schumpeter; Drucker; Dewey

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1. Introduction

Innovation has long been recognized as a fundamental driver of economic growth, societal progress, and organizational competitiveness (Moleka, 2024a ; Schumpeter, 1942; Drucker, 1985; Kanter, 1983). In an increasingly dynamic and rapidly evolving global landscape, characterized by disruptive technological advancements, complex socio-economic challenges, and intense market competition, the ability to generate, implement, and scale innovative solutions has become a critical strategic imperative for both private and public sector organizations (Christensen, 1997; Christensen & Raynor, 2003; Mazzucato, 2013). However, the existing academic landscape has lacked a cohesive, multidisciplinary framework for comprehensively understanding the complex, multilayered phenomenon of innovation (Anderson, Potočnik & Zhou, 2014; Weber & Rohracher, 2012). Management scholars have primarily focused on the organizational antecedents and processes of innovation, while economists have emphasized the role of market forces, technological change, and macro-level policies in shaping innovation dynamics (Fagerberg, 2005; Tidd & Bessant, 2018). Psychologists have explored the cognitive and behavioral factors that drive individual innovativeness, while sociologists have examined the social and cultural dimensions of innovation diffusion (Amabile, 1988; Rogers, 2003; Hargadon & Bechky, 2006). Innovationology, a newly established scientific discipline, aims to address this disciplinary divide by providing a unifying, transdisciplinary approach to the study and practice of transformative innovation. Innovationology integrates insights from management, psychology, sociology, economics, and technology studies to offer a comprehensive, context-sensitive framework for understanding the complex, dynamic phenomenon of innovation (Moleka, 2024b). This article introduces Innovationology as a cutting-edge science that posits innovation as a multilayered, context-dependent process, shaped by the interplay of individual, team, organizational, and ecosystem-level factors (Khurana & Dutta, 2021 ; Carst, 2023). Drawing on a thorough review of seminal and cutting-edge research, the article presents a holistic model of Innovationology that illuminates the key determinants of radical, game-changing innovations capable of disrupting existing industries and creating new market spaces. Importantly, the article establishes the epistemological foundations of Innovationology, grounding it in a transdisciplinary, holistic, and pragmatic approach to knowledge generation. Innovationology embraces a pluralistic epistemology that acknowledges the complexity and context-dependence of innovation, drawing on diverse methodological approaches to capture the multifaceted nature of this phenomenon (Frenken, 2017).

Furthermore, the article outlines the object of Innovationology, which is to provide a comprehensive, evidence-based understanding of the drivers, processes, and outcomes of transformative innovation (Laranja, Perianez-Forte & Reimeris, 2022). Innovationology seeks to elucidate the multilevel determinants of innovation, the dynamic interplay between various factors, and the contextual influences that shape innovation trajectories. Importantly, this article outlines the practical applications of Innovationology, providing comprehensive strategies and evidence-based interventions for cultivating innovative mindsets, designing innovation-conducive organizational systems, and navigating the challenges of innovative ecosystems. The implications of Innovationology for a wide range of stakeholders, including entrepreneurs, corporate leaders, policymakers, and innovation scholars, are discussed in depth. By establishing Innovationology as a distinct, authoritative scientific discipline, this article sets the foundation for a more holistic, context-sensitive understanding of innovation and its multifaceted drivers. The insights generated by this new science can empower global organizations, institutions, and policymakers to unlock the transformative potential of innovation and address the complex, interconnected challenges of the 21st century.

2. Foundations of Innovationology

Innovationology is a newly established scientific discipline that aims to provide a comprehensive, transdisciplinary framework for understanding the complex, multifaceted nature of innovation (Moleka, 2024b). Grounded in a synthesis of insights from diverse academic fields, Innovationology offers a unifying approach to the study and practice of transformative innovation.

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2.1. Defining Innovationology: A Transdisciplinary Perspective on Innovation

At the core of Innovationology is the recognition that innovation is not a linear, isolated phenomenon, but rather a dynamic, multilayered process that arises from the intricate interplay of individual, organizational, and systemic factors, all of which are embedded within broader socio-cultural, political, and environmental contexts (Moleka, 2024c; Schumpeter, 1942; Fagerberg, 2005; Tidd & Bessant, 2018). This view challenges the traditional, often siloed approaches to innovation research and practice, which have tended to overlook the interconnected, context-dependent nature of this critical driver of progress (Tabilo, 2023). Innovationology, as a distinct scientific discipline, is characterized by the following key tenets:

1. Transdisciplinary Approach: Innovationology embraces a transdisciplinary perspective, integrating knowledge, methods, and frameworks from various academic fields, including management, psychology, sociology, economics, and technology studies. This synthesis of diverse disciplinary insights enables a more comprehensive understanding of the multifaceted nature of innovation (Moleka, 2024d).
2. Multilevel Analysis: Innovationology proposes a multilevel model that elucidates the individual, team, organizational, and ecosystem-level determinants of transformative innovation. This approach recognizes the complex, interdependent nature of innovation processes and outcomes (Ambos, Brandl, Perri, Scalera & Van Assche, 2021 ; Moleka, 2024d).
3. Contextual Embeddedness: Innovationology acknowledges the critical role of broader socio-cultural, political, and environmental contexts in shaping the expression and impact of innovation. It emphasizes the importance of understanding the contextual factors that influence innovation dynamics (Zhang, Zeng, Liang, Xue & Cao, 2023).
4. Practical Relevance: Innovationology aims to bridge the gap between theory and practice by generating insights that can inform the design of innovative talent management practices, organizational structures and processes, and ecosystem-level policies and initiatives (Moleka, 2024d).
5. Interdisciplinary Collaboration: Innovationology encourages and facilitates collaboration among scholars and practitioners from diverse backgrounds, fostering the cross-pollination of ideas and the co-creation of innovative solutions. By establishing Innovationology as a distinct scientific discipline, this article sets the foundation for a more holistic, evidence-based understanding of the complex, multifaceted nature of innovation (Moleka, 2024d). The insights derived from this new science can empower a wide range of global stakeholders to navigate the challenges and unlock the transformative potential of innovation in the 21st century.

2.2. Epistemological Foundations of Innovationology

Innovationology is grounded in A transdisciplinary, holistic, and pragmatic approach to knowledge generation. This epistemological stance acknowledges the inherent complexity and context-dependence of innovation, and embraces a pluralistic methodology to capture the multifaceted nature of this phenomenon.

2.2.1. Transdisciplinary Epistemology

Innovationology rejects the traditional disciplinary silos that have often characterized innovation research. Instead, it embraces a transdisciplinary epistemology, which seeks to integrate and transcend disciplinary boundaries to generate a more comprehensive understanding of innovation (Frodeman et al., 2017). This approach recognizes that the complex, dynamic nature of innovation cannot be fully captured by any single academic discipline, and requires the synthesis of diverse perspectives and knowledge domains.

2.2.2. Holistic Epistemology

Innovationology adopts a holistic epistemology that views innovation as a multidimensional, interconnected phenomenon. This perspective acknowledges that innovation is not merely the sum of its individual components, but an emergent property that arises from the dynamic interplay of individual, team, organizational, and ecosystem-level factors (Moleka, 2024c). By embracing a holistic

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lens, Innovationology aims to uncover the systemic patterns and causal mechanisms that underlie transformative innovation.

2.2.3. Pragmatic Epistemology

Innovationology is underpinned by a pragmatic epistemology that emphasizes the practical relevance and actionable nature of research insights. This approach recognizes that the ultimate goal of Innovationology is to generate knowledge that can be effectively translated into real-world applications and interventions to drive innovative outcomes (Dewey, 1920; Rorty, 1982). Innovationology seeks to bridge the gap between innovation theory and practice, empowering a wide range of stakeholders to navigate the challenges and unlock the transformative potential of innovation. By embracing a transdisciplinary, holistic, and pragmatic epistemology, Innovationology positions itself as a distinct scientific discipline that can provide a comprehensive, context-sensitive, and actionable understanding of the complex phenomenon of innovation. This epistemological foundation enables Innovationology to generate insights that are both theoretically robust and practically relevant, thereby empowering global stakeholders to address the multifaceted challenges of the 21st century.

2.3. Objet of Innovationology

The primary object of Innovationology is to provide a comprehensive, evidence-based understanding of the drivers, processes, and outcomes of transformative innovation. Specifically, Innovationology seeks to elucidate:

1. Multilevel Determinants of Innovation: Innovationology aims to identify and explain the individual, team, organizational, and ecosystem-level factors that shape the emergence, development, and scaling of radical, game-changing innovations. This includes exploring the cognitive, behavioral, and motivational attributes of innovative individuals, the dynamics and structures that foster collaborative innovation within teams and organizations, and the ecosystem-level characteristics that catalyze the growth and diffusion of transformative innovations.
2. Dynamic Interplay of Factors: Innovationology is concerned with understanding the complex, interdependent relationships between the various determinants of innovation. It seeks to elucidate how these factors interact and influence one another, leading to the generation and scaling of transformative innovations.
3. Contextual Influences on Innovation: Innovationology emphasizes the critical role of broader socio-cultural, political, and environmental contexts in shaping innovation dynamics and outcomes. It aims to uncover the ways in which contextual factors, such as societal norms, institutional support, and resource availability, enable or constrain the innovation process.
4. Practical Applications and Interventions: Innovationology is committed to bridging the gap between innovation theory and practice. It seeks to generate actionable insights and evidence-based strategies that can inform the design of innovative talent management practices, organizational systems, and ecosystem-level policies and initiatives. By establishing a comprehensive, transdisciplinary framework for understanding the multifaceted nature of innovation, Innovationology aspires to empower global organizations, institutions, and policymakers to unlock the transformative potential of innovation and address the complex, interconnected challenges of the 21st century.

3. A Multilevel Model of Innovationology

Innovationology proposes a comprehensive, multilevel model that illuminates the individual, team, organizational, and ecosystem-level determinants of transformative innovation. This framework synthesizes insights from diverse disciplinary perspectives to provide a holistic understanding of the complex, dynamic nature of innovation.

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3.1. Individual-Level Determinants of Innovation

At the individual level, Innovationology highlights the crucial role of cognitive diversity, creative thinking, and entrepreneurial mindset in driving transformative innovation (Amabile, 1988; Burt, 2004; Simonton, 1999).

Key individual-level factors include:

3.1.1. Cognitive Complexity and Divergent Thinking

Innovationology emphasizes the importance of cognitive complexity and divergent thinking as critical individual-level attributes that enable the generation of novel, unconventional ideas and the making of diverse cognitive associations (Guilford, 1967; Runco, 2014). Individuals with high levels of cognitive complexity are better equipped to identify and frame problems in innovative ways, see connections between disparate concepts, and generate creative solutions.

3.1.2. Domain-Relevant Expertise and Skills

Innovationology recognizes the pivotal role of specialized knowledge and technical competencies in underpinning innovative behavior. Domain-relevant expertise allows individuals to deeply understand the challenges and opportunities within a particular field, enabling them to develop innovative solutions that build upon and extend existing knowledge (Amabile, 1988; Ericsson et al., 2006).

3.1.3. Entrepreneurial Orientation

Innovationology highlights the importance of entrepreneurial orientation, characterized by traits such as risk-taking, proactiveness, and innovativeness, in driving transformative innovation. Individuals with a strong entrepreneurial mindset are more inclined to explore new possibilities, experiment with novel ideas, and persist in the face of uncertainty (Lumpkin & Dess, 1996; Kollmann et al., 2017).

3.1.4. Intrinsic Motivation and Passion

Innovationology emphasizes the vital role of intrinsic motivation and passion in fueling innovative behavior. Individuals who are intrinsically driven to explore, experiment, and create, often guided by a sense of purpose and meaning, are more likely to engage in the effortful, persistent, and risk-taking activities required for successful innovation (Amabile, 1988; Grant, 2008).

3.2. Team-level Determinants of Innovation

At the team level, Innovationology highlights the role of psychological safety, task interdependence, and knowledge sharing in fostering collaborative innovation (Edmondson, 1999; Paulus & Nijstad, 2003; Hülsheger et al., 2009).

Key team-level factors include:

3.2.1. Psychological Safety

Innovationology emphasizes the critical importance of psychological safety, which refers to an environment of interpersonal trust and mutual respect that encourages team members to take risks, experiment, and voice dissenting views without fear of negative consequences. In psychologically safe teams, individuals feel empowered to contribute their unique perspectives and engage in creative problem-solving (Edmondson, 1999; Newman et al., 2017).

3.2.2. Functional Diversity

Innovationology recognizes the value of functional diversity within teams, which refers to the presence of diverse expertise, backgrounds, and perspectives. This diversity can enhance the team's collective creativity and problem-solving capabilities by exposing members to a wider range of information, knowledge, and alternative viewpoints (Paulus & Nijstad, 2003; van Knippenberg et al., 2004).

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3.2.3. Knowledge Sharing and Integration

Innovationology emphasizes the importance of effective knowledge sharing and integration within teams, which enables the exchange, combination, and recombination of diverse insights and expertise to generate novel solutions. This process of collaborative knowledge creation is a key driver of team-level innovation (Hargadon & Bechky, 2006; Argote & Ingram, 2000).

3.2.4. Collaborative Problem-Solving

Innovationology highlights the ability of team members to work together in an interdependent manner to tackle complex, ill-defined problems as a critical determinant of collaborative innovation. This collaborative problem-solving approach allows teams to leverage their collective knowledge, skills, and cognitive resources to address challenging innovation challenges (Paulus & Nijstad, 2003; Hülsheger et al., 2009). Innovationology underscores the importance of designing team structures, processes, and leadership approaches that cultivate collaborative innovation-enabling factors. Some key strategies include fostering collaborative team structures, adopting collaborative leadership approaches, and implementing structured brainstorming sessions, design thinking workshops, and "Innovation Jams" that encourage the active participation and engagement of all team members.

3.3. Organizational-level Determinants of Innovation

At the organizational level, Innovationology highlights the critical importance of innovation-conducive structures, processes, and cultures in enabling transformative innovation (Kanter, 1983; Christensen, 1997; O'Reilly & Tushman, 2004).

Key organizational-level factors include:

3.3.1. Organizational Structure and Flexibility

Innovationology emphasizes the degree of centralization, formalization, and modularity within an organization's structure as key determinants of its innovation capacity. Flexible, decentralized organizational designs that support rapid adaptation and experimentation have been shown to foster more transformative innovation, as they enable the agile reconfiguration of resources and the empowerment of employees to pursue novel ideas (Mintzberg, 1979; Burns & Stalker, 1961).

3.3.2. Resource Allocation and Innovation Management

Innovationology highlights the critical role of organizational processes and systems for identifying, funding, and scaling innovative initiatives. Effective innovation management practices, such as dedicated innovation funds, stage-gate review processes, and cross-functional collaboration, can enable organizations to identify, develop, and scale transformative innovations (Kanter, 1983; O'Reilly & Tushman, 2004).

3.3.3. Ambidextrous Organizational Design

Innovationology emphasizes the importance of organizations cultivating an "ambidextrous" design, which refers to the ability to simultaneously explore new opportunities and exploit existing capabilities. This dynamic balancing of exploration and exploitation has been found to be a key driver of sustained innovation and organizational adaptability in rapidly changing environments (March, 1991; Tushman & O'Reilly, 1996).

3.3.4. Innovation-supportive Culture

Innovationology highlights the critical role of organizational values, norms, and behaviors in creating a culture that supports and nurtures innovation.

Key cultural elements that have been shown to foster transformative innovation include a tolerance for failure, psychological safety, open communication, and a learning orientation (Schein, 2010; Tellis et al., 2009). Innovationology underscores the importance of aligning organizational design, management practices, and cultural elements to create an environment that is conducive to the emergence and scaling of transformative innovations.

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3.4. Ecosystem-level Determinants of Innovation

At the ecosystem level Innovationology highlights the role of network embeddedness, institutional support, and resource munificence in shaping the innovation landscape (Adner & Kapoor, 2010; Porter, 1998; Autio et al., 2014).

Key ecosystem-level factors include:

3.4.1. Innovative Ecosystem Configuration

Innovationology emphasizes the importance of the structure, composition, and interconnectedness of the network of organizations, institutions, and resources that enable innovation. The configuration of the innovative ecosystem, including the diversity of actors, the strength of linkages, and the centrality of key players, can significantly influence the emergence and scaling of transformative innovations (Adner, 2017; Ritala & Almpanopoulou, 2017).

3.4.2. Institutional Support and Regulation

Innovationology highlights the critical role of institutional support and regulation in catalyzing innovative activities. The presence of supportive policies, funding mechanisms, and infrastructural resources, as well as the establishment of appropriate regulatory frameworks, can create an enabling environment for the development and commercialization of transformative innovations (Mazzucato, 2013; Edquist, 2011).

3.4.3. Resource Munificence and Access

Innovationology emphasizes the importance of resource munificence, or the availability of financial, human, and technological resources, in supporting the innovation process. The ease of access to these resources, whether through venture capital, talent pools, or technological infrastructure, can significantly impact an organization's ability to develop and scale innovative solutions (Dyer & Singh, 1998; Autio et al., 2014).

3.4.4. Ecosystem-Level Knowledge Sharing and Collaboration

Innovationology highlights the extent to which information, expertise, and best practices are shared within and across the innovation ecosystem as a key determinant of transformative innovation. Effective knowledge sharing and collaborative problem-solving among ecosystem participants can foster the cross-pollination of ideas and the co-creation of innovative solutions (Kogut, 2000; Powell et al., 1996). Innovationology emphasizes the importance of cultivating vibrant, well-functioning innovation ecosystems that can foster the emergence and scaling of transformative innovations. By understanding and shaping the complex, interdependent characteristics of innovative ecosystems, organizations and policymakers can create an environment that is conducive to the development and commercialization of game-changing innovations.

5. The Contextual Embeddedness of Innovation

Innovationology acknowledges the critical role of broader socio-cultural, political, and environmental contexts in shaping the expression and impact of innovation. The framework recognizes that innovation does not occur in a vacuum, but is deeply embedded within complex, dynamic systems that can either facilitate or hinder the innovative process.

5.1. Socio-Cultural Influences on Innovation

Innovationology emphasizes the ways in which societal norms, values, and cultural practices can profoundly influence individual, organizational, and ecosystem-level innovation dynamics. For example, societal attitudes towards risk-taking, failure, and uncertainty can shape an individual's propensity to engage in innovative behaviors (Hofstede, 2001; Shane, 1993). Similarly, organizational cultures that prioritize hierarchy, control, and conformity may stifle the creativity and entrepreneurial spirit necessary for transformative innovation (Schein, 2010; Tellis et al., 2009).

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5.2. The Role of Political and Regulatory Environments

Innovationology recognizes the critical importance of political and regulatory environments in shaping innovation outcomes. Governmental policies, funding initiatives, intellectual property regimes, and market regulations can either incentivize or constrain innovative activities at the organizational and ecosystem levels (Mazzucato, 2013; Edquist, 2011). The presence of supportive institutions, such as research universities, technology transfer offices, and innovation hubs, can also play a pivotal role in catalyzing the development and commercialization of transformative innovations.

5.3. Environmental and Technological Influences

Innovationology acknowledges the significant impact of environmental and technological factors on the innovation process. Changing resource scarcities, environmental regulations, and technological advancements can create both opportunities and challenges for organizations seeking to develop innovative solutions (Barbieri et al., 2016; Oltra & Saint Jean, 2009). For example, the emergence of disruptive technologies, such as artificial intelligence, renewable energy, or biotechnology, can dramatically reshape entire industries and spur the need for transformative innovation (Lee, Yun, Pyka, Won, Kodama, Schiuma... & Zhao, 2018). By emphasizing the contextual embeddedness of innovation, Innovationology encourages a more holistic, nuanced understanding of the complex, interconnected forces that shape innovation dynamics. This perspective enables the development of more effective, context-sensitive innovation strategies, policies, and interventions that can navigate the diverse, often rapidly changing environmental, technological, and socio-political landscapes.

6. Practical Applications of Innovationology

The insights derived from the Innovationology framework hold significant practical implications for a wide range of global stakeholders, including entrepreneurs, corporate leaders, policymakers, and innovation scholars.

6.1. Cultivating Innovative Mindsets and Behaviors

Innovationology can inform the design of talent management, learning, and development programs that nurture the cognitive, behavioral, and motivational attributes associated with individual innovativeness. By fostering creativity, entrepreneurial orientation, and a growth mindset, organizations can empower their employees to contribute to transformative innovation. This may involve implementing creativity training workshops, mentorship programs, and job rotations that expose individuals to diverse experiences and challenges (Amabile & Pratt, 2016; Dul & Ceylan, 2014).

6.2. Designing Innovation-conducive Organizational Structures and Processes

Innovationology can guide the development of organizational structures, management practices, and cultural elements that enable collaborative innovation. This includes the implementation of flexible, decentralized organizational designs, the establishment of dedicated innovation management systems (e.g., innovation labs, accelerators, venture capital funds), and the cultivation of innovation-supportive values and norms (e.g., psychological safety, risk-taking, learning from failure) (O'Reilly & Tushman, 2004; Kanter, 1983; Tellis et al., 2009).

6.3. Navigating Innovative Ecosystems

Innovationology can help organizations and policymakers navigate the complexities of innovative ecosystems by identifying the key determinants of ecosystem-level innovation. This includes the strategic positioning of organizations within the ecosystem, the cultivation of institutional support and resource access, and the facilitation of knowledge sharing and collaboration among ecosystem participants. Strategies may involve engaging in ecosystem mapping, building strategic partnerships, and participating in collaborative innovation initiatives (Adner, 2017; Ritala & Almpanopoulou, 2017).

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6.4. Informing Innovation-oriented Policymaking

Innovationology can inform the development of innovation-focused policies, programs, and initiatives that catalyze the creation and growth of vibrant, well-functioning innovative ecosystems. This includes the design of targeted funding mechanisms (e.g., innovation grants, tax incentives, venture capital programs), the establishment of supportive regulatory frameworks (e.g., intellectual property protection, data governance), and the investment in innovation-enabling infrastructure and resources (e.g., research universities, technology transfer offices, innovation hubs) (Mazzucato, 2013; Edquist, 2011).

6.5. Advancing Innovation Scholarship

Innovationology provides a comprehensive, transdisciplinary framework for advancing innovation research. By integrating insights from diverse academic disciplines, Innovationology can guide the development of more robust, context-sensitive theories of innovation, as well as the design of innovative empirical studies that capture the multilayered nature of this complex phenomenon. This may involve interdisciplinary collaborations, the adoption of mixed-methods approaches, and the exploration of longitudinal and comparative research designs (Frodeman et al., 2017; Creswell & Plano Clark, 2017). By embracing the Innovationology framework, global organizations, institutions, and policymakers can develop more effective strategies and interventions for fostering innovative mindsets, designing innovation-conducive organizational structures and processes, and navigating the challenges of innovative ecosystems. The insights generated by this new science can empower a wide range of stakeholders to unlock the transformative potential of innovation and address the complex, interconnected challenges of the 21st century.

7. Future Research Directions

Innovationology presents a wealth of promising avenues for future research that can significantly advance our understanding of the complex, multifaceted nature of innovation. Building upon the comprehensive framework outlined in this article, several key areas emerge as critical priorities for future Innovationology research:

1. Innovationology and the Future of Innovation: Looking ahead, Innovationology should engage in foresight activities and scenario planning to anticipate the long-term trends, challenges, and opportunities that will shape the future of innovation. This can involve the exploration of megatrends, such as climate change, demographic shifts, and geopolitical realignments, and their potential impact on the innovation landscape. By proactively considering the evolving innovation landscape, Innovationology can empower global stakeholders to develop strategic, future-oriented approaches to navigating the complexities of the 21st century (Moleka, 2024d; Rohrbeck et al., 2015).
2. Longitudinal and Comparative Studies: To better elucidate the dynamic, context-dependent nature of innovation, Innovationology scholars should prioritize longitudinal and comparative research designs. Longitudinal studies can shed light on the evolving interplay of individual, team, organizational, and ecosystem-level factors over time, while comparative analyses across diverse contexts (e.g., industries, cultures, nations) can uncover the nuanced role of contextual influences on innovation trajectories (Pettigrew, 1990; Yin, 2018).
3. Transdisciplinary Research in Innovationology: Innovationology should expand its disciplinary boundaries to incorporate insights from diverse fields, including the arts, fiction, and spirituality. This cross-pollination of ideas can foster more holistic, creative, and inclusive approaches to understanding and fostering innovation. Collaborations with artists, writers, and spiritual thinkers can uncover novel perspectives on the drivers, processes, and outcomes of transformative innovation (Frodeman et al., 2017; Moleka, 2024d).
4. Innovation Metrics and Performance Evaluation: Innovationology should delve into the development of robust, multidimensional frameworks for measuring and evaluating the performance and impact of transformative innovations. This can include the exploration of both quantitative and qualitative metrics, as well as the assessment of financial, social, environmental, and ethical outcomes. Innovationology should also investigate innovative

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approaches to measuring intangible innovation-related assets, such as creativity, agility, and adaptability (Moleka, 2024e; Barney, 1991).

Quantitative Innovation Metrics:

- Traditional financial measures (e.g., revenue, profits, return on investment).
- Innovation output measures (e.g., number of patents, new product introductions).
- Productivity and efficiency metrics (e.g., time-to-market, cost of innovation).
- Market performance indicators (e.g., market share, customer satisfaction).

Qualitative Innovation Metrics:

- Organizational culture and climate (e.g., risk-taking, psychological safety, learning orientation).
- Employee engagement and motivation (e.g., job satisfaction, creativity, entrepreneurial mindset).
- Ecosystem collaboration and knowledge sharing (e.g., network centrality, diversity of partnerships).
- Societal impact and sustainability (e.g., environmental footprint, social equity, ethical considerations).

5. Multilevel Interactions and Feedback Loops: Innovationology research should delve deeper into the complex, nonlinear interactions and feedback loops between the various levels of analysis (individual, team, organizational, ecosystem). By adopting systems-oriented approaches, scholars can uncover the emergent, self-organizing properties that shape innovation dynamics and outcomes (Uhl-Bien et al., 2014; Moleka, 2024d).
6. Inclusive and Sustainable Innovation: Innovationology should expand its focus to explore the crucial role of inclusive and sustainable innovation in addressing the pressing global challenges of the 21st century. This line of inquiry can shed light on the socio-economic, environmental, and ethical implications of transformative innovations, as well as the design of innovation ecosystems that foster more equitable and sustainable development (Moleka, 2024b; Rosário et al., 2024).
7. Polycentric Governance of Innovation Ecosystems: Building on the ecosystem-level determinants of innovation, Innovationology research should investigate the potential of polycentric governance models to enhance the resilience, adaptability, and inclusiveness of innovative ecosystems. This can involve examining the interplay of multiple, nested decision-making centers and their impact on innovation outcomes (Moleka, 2024c; Ostrom, 2010).
8. Innovative Mindsets and Behaviors: Innovationology should delve deeper into the cognitive, motivational, and behavioral underpinnings of innovative individuals and teams. This can include the exploration of how specific training programs, job designs, and organizational interventions can cultivate creative problem-solving skills, entrepreneurial orientation, and a growth mindset (Amabile & Pratt, 2016; Dul & Ceylan, 2014).
9. Knowledge Integration and Collaboration: Innovationology should further examine the processes and mechanisms by which diverse knowledge, expertise, and perspectives are effectively integrated and leveraged to drive collaborative innovation. This can involve studying the role of boundary-spanning individuals, cross-functional teams, and knowledge-sharing platforms in fostering the co-creation of innovative solutions (Boh et al., 2016; Hargadon & Bechky, 2006).
10. Digital Transformation and Technological Disruption: As emerging technologies, such as artificial intelligence, blockchain, and the Internet of Things, continue to transform industries and societies, Innovationology should explore the impact of digital transformation on innovation dynamics. This can include investigating how novel technological capabilities can be leveraged to enhance innovation processes, as well as the challenges and opportunities posed by technological disruption (Nambisan, 2017; Acs et al., 2017).

By embracing these future research directions, Innovationology scholars can generate groundbreaking insights that expand the boundaries of innovation theory and practice. This robust, transdisciplinary research agenda can empower a wide range of global stakeholders to navigate the complexities of the 21st century and unlock the transformative potential of innovation for sustainable progress and societal well-being.

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8. Conclusions

Innovationology, a newly established scientific discipline, offers a comprehensive, transdisciplinary framework for understanding and cultivating transformative innovation. By integrating insights from management, psychology, sociology, economics, and technology studies, Innovationology provides a holistic, multilevel model that illuminates the individual, team, organizational, and ecosystem-level determinants of innovation. The practical applications of Innovationology span the domains of talent management, organizational design, ecosystem navigation, policymaking, and innovation scholarship. By embracing this transdisciplinary approach, global practitioners and scholars can develop more effective strategies and interventions for fostering innovative mindsets, designing innovation-conducive organizational structures and processes, and navigating the challenges of innovative ecosystems. As the world grapples with complex, multifaceted challenges, such as climate change, social inequities, and technological disruption, the need for transformative innovation has never been more pressing. Innovationology, as a new scientific discipline, offers a robust, evidence-based framework for understanding and cultivating the innovation that is vital for sustainable progress and prosperity in the 21st century. By establishing Innovationology as a distinct, authoritative scientific field, this comprehensive article sets the foundation for a more holistic, context-sensitive understanding of innovation and its multifaceted drivers. The insights generated by this new science can empower a wide range of global stakeholders to unlock the transformative potential of innovation and address the complex, interconnected challenges facing our world.

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