

THEORETICAL FRAMEWORKS SHAPING INNOVATIVE PRODUCT DEVELOPMENT FOR THE REGIONAL IMPROVEMENT: A MULTIDISCIPLINARY PERSPECTIVE

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Abstract

In the realm of innovative product development, a multidisciplinary and scientifically grounded approach plays a pivotal role in shaping the creation of novel solutions. As society faces complex problems and rapidly evolving needs, understanding the scientific methodologies and theories underpinning innovative product development is crucial. Research aim is to comprehensively analyze and synthesize the diverse theoretical foundations from various scientific disciplines that influence the process of innovative product development. Research methods include literature review, content analysis, and expert interviews were employed to identify and categorize relevant theoretical frameworks from various disciplines. The study's key findings emphasize the importance of a multidisciplinary approach in innovative product development. The study highlights the roles of creativity, economics, and psychology in product development, stressing the need to weave diverse scientific theories into a systematic approach for user-centric solutions. The study highlights the integrative nature of innovation by elucidating the diverse theoretical foundations underpinning product development, enhancing understanding of how various scientific theories converge to drive innovation systematically. The findings underscore the importance of a multidisciplinary approach in guiding real-world product development, offering practical insights for innovators, educators, and professionals seeking to optimize the innovation process and create user-centric solutions.

Key words: Innovative Product Development: Multidisciplinary Approaches.

Introduction

In today's dynamic environment, characterized by rapid technological and business advancements, the ability to innovate remains a cornerstone for organizational sustainability and success. Companies are compelled to navigate a hyper-competitive landscape, dramatically shaped by digital marketplaces and expansive social media channels. The challenge lies in discerning the most effective product development methods from a plethora of available strategies, which hinges on a deep understanding of the theoretical interplay that supports innovation. This paper sets out to provide a critical evaluation of the principal theories and methodologies that underpin the sphere of innovative product development, offering insights that are essential for fostering competitive and groundbreaking products.

There is a limited amount of research on multidisciplinary approaches to innovative product development. Kozłowski & Yamin have analyzed organizational culture and motivation in a multidisciplinary context as key drivers of innovation in organizations (Kozłowski & Yamin, 2010). Comparatively more research has focused on the impact of new technologies on innovative product development in a multidisciplinary context and the interaction of innovation ecosystems in a multidisciplinary approach (Casper & van Waarden, 2021). The multidisciplinary approach to innovative product development is relevant in innovation education, and there is a relatively large body of research on the development process in a multidisciplinary approach, which mainly includes several approaches from innovation and creativity theories (Prestes Joly *et al.*, 2019). The authors of the paper determine the need to identify and conceptualize key underlying theories that contribute to innovative

product development in a multidisciplinary context in order to improve organizations' understanding of innovation development in a multidisciplinary context. The aim of this review is to identify key multidisciplinary theoretical frameworks relevant to the overall ecosystem of innovative product development, maximizing the interdisciplinarity knowledge field on innovation development.

Materials and Methods

This study combines a literature review with interviews to examine the theoretical frameworks behind innovative product development. The literature review analyzes scientific articles, books, and conference papers, while the interviews involve six experts with extensive experience in successful product development. The interviews allow for a detailed exploration of each expert's perspective on the theoretical frameworks. The qualitative nature of the interviews aims to gather nuanced information not found in existing literature. By integrating the results of the literature review and interviews, the study aims to provide a comprehensive understanding of the theoretical foundations of innovative product development. The use of multiple data sources improves the validity and reliability of the study's findings.

Results and Discussion

The scientific literature is rich in theoretical approaches and methods for innovative product development, incorporating knowledge from different fields - engineering, economics, business management, design, psychology, material science, engineering, etc., while at the same time the scientific literature is highly fragmented across the different theories.

Innovation theory is a frequently discussed method for fostering innovation in scientific literature (Chaminade & Edquist, 2006). Innovation theory is the cornerstone of any study on the development of innovative products, aiming to understand and explain the processes, mechanisms and factors that contribute to innovation in organizations, industries and society at large. It includes a range of theoretical frameworks and models that help researchers, policy makers and practitioners to analyze, predict and promote innovation (Lundvall, 2007). Innovation theories usually start with a definition of innovation, as innovation can cover a wide range of activities, from the development of new products and services to the introduction of new processes, business models and organizational structures. These theories explore the different factors that stimulate and influence innovation. Common drivers include technological development, market demand, competition, government policy and cultural or social factors (Sundbo, 1998). Many innovation theories describe stages or phases of the innovation process, which may include idea generation, research and development, testing, commercialization and diffusion or adoption (Christensen, Anthony, & Roth, 2004). Some theories focus on how innovations diffuse through society, and how they are adopted by organizations. For example, Everett Rogers' Diffusion of Innovations theory (Rogers, 2003) divides adopters into different groups and examines the factors that influence their acceptance of new ideas or technologies, although it also faces significant criticism (Lundblad, 2003). Modern innovation theory often focuses on the complex networks and ecosystems that support and foster innovation (Afonso, Monteiro, & Thompson, 2010). They involve cooperation between businesses, universities, research institutions, government agencies and other stakeholders (Rampersad, Quester, & Troshani, 2010). An important aspect is the concept of open innovation, promoted by Henry Chesbrough. It suggests that organizations can benefit from both sourcing ideas and innovations from external partners and licensing their innovations to others (Chesbrough, 2003). Innovation theories also focus on how to measure and evaluate innovation in organizations. Metrics may include patent applications, R&D expenditure, revenues from new products, but they differ from the economic evaluation of innovation (Brattström *et al.*, 2018). Another important aspect of innovation theory research is to understand the barriers to the introduction or adoption of innovation. These barriers can include risk aversion, resource constraints, regulatory barriers and resistance to change indicators (Sipahutar *et al.*, 2020). Lewis R.'s theory of the '9X Effect' (Lewis, 2023) of balancing innovative product and behavioural change explores why consumers resist adopting innovative products, even when they offer advantages over existing options. Innovation theory itself is multidisciplinary and draws on fields such as

economics, management, sociology, psychology and engineering (Sipahutar *et al.*, 2020). Although it is continuously improved, it does not cover important stages of innovative product development such as cost-benefit approaches, regulatory, consumer behavior aspects, etc., which are discussed later in the paper.

Theories of creativity and problem solving provide a framework for organizations to generate creative ideas, identify problems and find effective solutions (Kozbelt, Beghetto, & Runco, 2010). In the context of innovation, these theories help guide the processes of ideation and problem-solving that lead to new products, services and processes. The most important aspects of creativity and problem-solving theories relevant to innovation are divergent thinking, which is a core concept of creativity theories (Baer, 2014). It refers to the ability to generate different solutions in response to problem. Theories of creativity emphasize the importance of encouraging divergent thinking as a prerequisite for finding innovative solutions (Acar & Runco, 2019). Two widely used and described theories of creativity are Design Thinking and User-Centered Design, which are two complementary theoretical approaches to innovation. They focus on creating products and services that meet users' needs and expectations. These methodologies prioritize empathy, iteration, and collaboration to ensure that innovation is user-centered and effective (Oxman, 2017). User-centered design is a specific approach that puts the user at the center of the design and development process. It focuses on creating products and systems that are intuitive, efficient, and enjoyable for users (Pratt & Nunes, 2012). The traditional problem-solving model (CPS) is a structured approach to fostering creativity. It includes steps such as problem-finding, fact-finding, idea-finding, solution-finding and acceptance-finding. CPS encourages the exploration of multiple perspectives and the use of techniques such as brainstorming and mind mapping (Treffinger, 1995). Flow theory suggests that people are most creative and productive when they are in a state of 'flow', characterized by deep concentration, high motivation and a sense of timelessness (Botticchio & Vialle, 2009). Within theories of creativity, a separate distinction should be made between theories of problem solving, which emphasize the importance of accurately identifying and defining the problem (Weisberg, 2019). This stage involves understanding the root causes of the problem, collecting relevant data and formulating an effective problem statement. Another approach is analytical problem solving, which involves breaking down complex problems into smaller, more manageable parts. Techniques such as root cause analysis, decision trees and SWOT analysis help to identify possible solutions and their impacts (Greiff, Holt, & Funke, 2013). TRIZ (Cerit, Küçükayzıcı, & Şener, 2014) (Theory of Inventive Problem Solving) is a problem-solving theory that provides a structured approach to finding inventive

solutions to technical problems. It involves the analysis and application of exemplary inventive solutions in different fields. InnoMatrix is also a problem-solving theory that provides a structured approach to innovation development based on consumers' past behavior in purchasing new products (Batraga *et al.*, 2019).

In the context of innovation development, these theories often intersect, as creativity plays an important role in generating new ideas, while problem-solving strategies guide the process of transforming these ideas into practical and effective solutions (Proctor, 2010). To effectively innovate, both creativity and structured problem solving are needed to address the creation and implementation aspects (Sousa, Monteiro, & Pellissier, 2009). **Game theory** should be distinguished, which provides a framework for strategizing interactions between different stakeholders or organizations involved in the innovation process (Baniak & Dubina, 2012). It helps analyze competition and cooperation dynamics, make informed decisions, and maximize results in situations where one party's actions impact others.

An important group of **theories** are **cost-benefit** approaches, which are used to assess the costs and benefits associated with innovative product development, helping organizations and decision-makers to analyze the financial and non-financial aspects of innovation, enabling informed decisions on resource allocation, risk management and strategy development. One of the most frequently used approaches and one of the most widely used in the scientific literature is Cost and benefit analyses (CBA), which is a systematic approach to assessing the economic viability of an innovation project by comparing costs with benefits. CBA helps organizations to assess whether the potential financial benefits of an innovation project outweigh the investment required. It takes into account tangible (revenue growth, cost savings) and indirect (improved brand reputation, employee morale) benefits and compares them with direct and indirect costs. Return on Investment (ROI) is a financial indicator that measures the profitability of an innovation initiative by dividing the net benefits (benefits minus costs) by the initial investment. Total Cost of Ownership (TCO) calculates the total cost of implementing and maintaining an innovation throughout its life cycle, including acquisition, operation and disposal costs. TCO is valuable for assessing the long-term financial impact of innovation decisions. Cost-Effectiveness Analysis (CEA) compares the costs of different innovations with their respective outcomes or benefits, often measured in non-monetary units. CEA is particularly useful in healthcare and public policy. It helps organizations to identify which innovation interventions deliver the greatest results relative to their costs, thus allowing informed resource allocation (Avanceña & Prosser, 2022). Cost-Utility Analysis

(CUA) is an extension of CEA by including utility measures or quality-adjusted life years (QALYs) to assess the impact of innovations on quality of life. CUA is commonly used in healthcare to evaluate innovations such as treatments or interventions. It helps decision-makers to assess how innovations affect both the quantity and quality of life, allowing comparisons between different innovations in healthcare. Benefit-Cost Ratio (BCR) is a financial indicator that calculates the ratio of total benefits to total costs associated with an innovation project (Berawi *et al.*, 2017). BCR helps organizations determine whether an innovation initiative is economically viable. Real Options Theory (ROT) extends traditional financial analysis by considering the value of flexibility and the ability to adapt or abandon innovation projects based on changing circumstances. Real Options Theory helps organizations to assess the strategic value of waiting for, expanding or abandoning an innovation project based on market uncertainty and changing circumstances. Opportunity Cost (OC) analysis calculates the value gained or lost by choosing one innovation project over another, or by allocating resources to a particular project. Understanding opportunity costs is essential when prioritizing innovation projects and resource allocation. It ensures that organizations select projects that maximize value and meet strategic objectives (BarNir, 2014).

Theories from psychology and behavioral economics provide valuable insights into how users make decisions, which can aid in the design and adoption of innovative products. Consumer behavior theories, particularly those related to the consumer decision-making process, are crucial for the development of new ideas. There are numerous theories available, including VALS, Maslow's Pyramid, Theory of Planned Behavior, and Cialdini's Principles of Persuasion, that help understand consumer behavior.

There are two related **theories from material science and engineering**. The study of materials at the atomic and molecular level helps to select suitable materials for product design based on their properties (Himanen *et al.*, 2019). Engineering principles are concepts from different engineering disciplines, such as mechanical, electrical, and chemical engineering, that provide insights into the technical aspects of product development and, most importantly, the possibilities (Landry, Amara, & Lamari, 2002).

From an environmental science perspective, **theories related to sustainability**, such as the 'triple bottom line' (economic, social, environmental), are important in the context of innovation, helping to develop environmentally friendly and socially responsible products (Pan, Sinha, & Chen, 2021).

Regulatory theories are concerned with legal frameworks and compliance standards to ensure that innovative products meet legal requirements and

safety standards, e.g. ISO standards for innovation development (Manders, Vries, & Blind, 2016).

From an **information theory** perspective, Shannon's information theory can be used to design information-rich products and user interfaces to ensure effective information transfer (Guizzo, 2003).

Systems Thinking theory is an approach to innovation that takes into account the interconnections and interdependencies of complex systems. It promotes a holistic view of problems and opportunities, recognizing that changes in one part of a system can affect other parts (Checkland, 1999).

Among **project management theories**, some have revolutionized product development practice. For example, Agile, with its iterative and incremental approach, enables rapid response to changing market conditions (Nerur & Balijepally, 2007). Lean principles, derived from manufacturing, emphasize the pursuit of maximum efficiency. Together, these systems promote flexibility and customer orientation in product development. This theory, based on Eric Ries, emphasizes a scientific approach to the creation and management of successful start-ups and innovative products, iterating rapidly through feedback cycles of 'build-measure-improve' (Ries, 2011).

Theories such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology provide insights into users' perceptions of the acceptance of innovative products. These

models take into account factors such as perceived ease of use, perceived usefulness and social impact (Lala, 2014). The concept of a technology readiness scale, which measures the level of readiness of a given innovation in a uniform way, is widely used (Parasuraman, 2000).

The advent of the digital age has fostered the emergence of open source and crowdsourced innovation. These models use the collective intelligence of online communities to design and develop products. Notable examples are Wikipedia, Linux and open source software projects. This approach contradicts traditional notions of product development by emphasizing collaboration and shared ownership (Majchrzak & Malhotra, 2013).

These theories and concepts provide a framework for organizations to understand and overcome the complex process of creating innovative products by integrating scientific understanding with practical application in the organization. Depending on the product and the sector, different theories may play a greater or lesser role in guiding the innovation process. Authors have identified 12 basic groups of theories relevant to innovative product development - innovation, creativity, cost & benefit, user behavior, material science and engineering, regulatory, sustainability, information, project management, technology readiness and adaptation, connected systems, risk management theories.

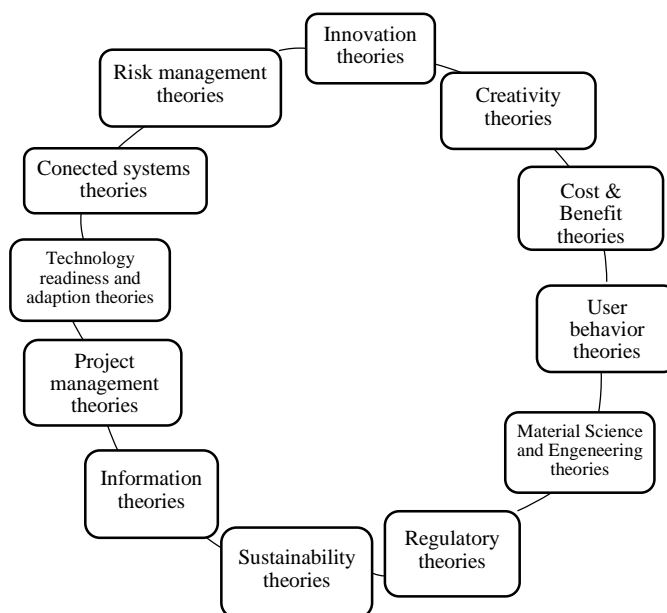


Figure 1. 12 groups of theories relevant to innovative product development.

The theoretical frameworks that shape innovative product development from a multidisciplinary perspective provide a comprehensive view of the multidisciplinary nature of innovative product development. The results highlight the complex interplay of different theories and methodologies in several fields. One of the findings is that successful innovative product development requires a holistic and interdisciplinary approach, taking into

account a spectrum of theories from different fields. However, this advantage is only available to organizations that navigate the complex landscape of innovation development.

The discussion centers on the organization's capacity to comprehend diverse innovation theories and explores avenues for conceptualizing methodological approaches to streamline innovation development. The

primary goal is to render the creation of high-value innovations more accessible and comprehensible for organizations. The discourse probes the organization's ability to fully grasp the spectrum of innovation theories. It raises questions about the practical feasibility of assimilating and applying these theories within organizational contexts. Consideration is given to how methodological approaches can be formulated to facilitate a clearer understanding of innovation processes within the organizational framework. The discussion contemplates strategies for enhancing the accessibility of innovation theories within organizations. This involves assessing how theories can be communicated and disseminated in a manner that is readily comprehensible to diverse stakeholders. The focus is on making the intricacies of innovation development more understandable. This includes exploring ways to demystify complex theoretical frameworks, ensuring that they resonate with the day-to-day operations of organizations. Future Research Avenues applies to Practical Application of Theories in terms of multidisciplinary perspective. A call is made for future studies to scrutinize the practical application of innovation theories. This involves analyzing which theories yield more productive outcomes for companies in real-world scenarios. The discussion proposes evaluating the effectiveness of different innovation approaches to identify those that consistently deliver expected results for organizations. The authors advocate for a dynamic outlook on existing theoretical frameworks. They propose that the classification of these frameworks should be subject to constant review and improvement.

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The ultimate objective is to strive for a more constructive innovation development system. This system should not only be effective but also user-friendly, ensuring ease of use and comprehension for organizations in their daily operations. In essence, the discussion encourages a forward-looking approach, urging organizations to actively engage with and adapt innovation theories. There is a potential for the development of a more practical, constructive, and user-friendly innovation framework that aligns seamlessly with the operational needs of organizations. This iterative process of review and improvement is envisioned as a pathway to foster a culture of innovation that is both impactful and accessible in organizational settings.

Conclusions

1. The field of innovative product development is constantly evolving, and new theories, methodologies and tools are constantly being introduced from both academia and industry.
2. As important as developing new theories and approaches is fostering a multidisciplinary understanding of the complex nature of innovation in organizations, and encouraging organizations to understand more appropriate choices in innovation development.
3. The literature review highlights the dynamic and multifaceted nature of innovative product development, emphasizing the importance of embracing a diverse set of theoretical frameworks for informed decision-making and successful outcomes.

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