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From Zero to One: A new perspective on the fuzzy front end of innovation and the Stage-Gate® model

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A B S T R A C T

The Stage-Gate® model has historically provided a systematic framework for New Product Development (NPD). However, the evolving landscape of innovation necessitates continuous enhancement. This paper redefines the model's foundational structure by advocating for the recognition of the Discovery Phase as Stage 1, emphasizing its essential role in aligning initial ideation with strategic goals, streamlining processes, and enhancing NPD efforts. Using a mixed-methods approach, including a systematic literature review, synthesis of illustrative examples and secondary data and case study analysis, the research demonstrates that formalizing the Discovery Phase improves early-stage decision-making, enhances alignment between front-end exploration and downstream execution and mitigates risks by supporting more informed project development. Synthesised sectoral examples show that incorporating the Discovery Phase improves feasibility, reduces risk, and boosts efficiency. For example, simulation planning early in innovation process increased manufacturing throughput by 52 %, while early IP checks lowered infringement risk. The proposed revision boosts the Stage-Gate® model's adaptability and integration with modern methodologies such as AI, Agile, Lean Startup, Design Thinking and TRIZ. The findings highlight how this change promotes a comprehensive approach to NPD. The implications extend to practical applications and future research, offering organizations a flexible framework that meets modern market and technological demands.

A R T I C L E I N F O

Keywords:
Stage-Gate® model;
Fuzzy front end of innovation (FFEI);
New product development (NPD);
Innovation management;
Discovery phase;
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1. Introduction

The Stage-Gate® model, developed by Robert G. Cooper in the 1980s, has been a foundational framework to guide New Product Development (NPD) across a wide range of industries [1]. Over time, this model has evolved to meet the changing needs of businesses, reflecting the dynamic nature of innovation, but its fundamental structure–stages separated by decision-making gates–has remained the same [2, 3]. Traditionally, the model begins with the Discovery Phase, also known as Idea Stage, “pre-stage” or “Stage 0”, often treated as an implicit, preliminary, or optional stage [1, 4]. The Stage-Gate® model has not always given the Discovery Phase the same weight as its subsequent phases, despite its critical role in idea generation and opportunity exploration [5]. Because the label 'Stage 0' can suggest a mere preparatory footnote, we refer to the Discovery Phase as Stage 1 to signal that it stands on equal footing with the later stages. This proposed renumbering is further substantiated in Section 6 and also echoes Thiel’s '0 to 1' metaphor, which portrays innovation as the leap from nothing to the first spark in the innovation process—precisely what happens during the Discovery Phase [6].

The Discovery Phase is described as the "fuzzy front end", characterised by ambiguity, creativity, and the exploration of new possibilities [7-9]. It involves activities such as opportunity exploration, market analysis, and alignment with organisational goals [1, 2] and, in some cases, can function as a process on its own [10]. Despite its significance, this initial stage has been underemphasised in both practice and literature, often considered "pre-work" or a preliminary and implicit activity rather than a formal part of the process [1, 4, 5, 9]

Our research explores the evolution of the Stage-Gate® model, with a focus on the rationale for recognising the Discovery Phase as an integral part of the innovation process by establishing it as a Stage 1 rather than Stage 0. Through an analysis of historical trends in innovation models and the increasing importance of early-stage decision-making [11-13], we argue that redefining Stage 1 offers significant theoretical and practical benefits. In particular, we examine how formalising this phase aligns it more closely with the rest of the NPD process, making it an inseparable part of the innovation framework.

Furthermore, we discuss the integration of modern innovation techniques, such as open innovation and data-driven decision-making, and how these approaches fit within the redefined structure. These techniques enable organisations to respond more effectively to emerging market trends and technological advancements [7, 14-17], solidifying the Discovery Phase as an essential part of the Stage-Gate® model.

This study begins by examining the origins and development of the Stage-Gate® model, highlighting key adaptations over time. The central argument focuses on the renumbering of the Discovery Phase to Stage 1, supported by theoretical foundations, practical insights, and case studies. We then discuss modern approaches to innovation, illustrating how they align with the revised structure of the Stage-Gate® model. Finally, we outline key implications for future research and practical applications, providing a forward-looking view on NPD practices.

2. Methodology and research approach

We used a mixed-methods research design, combining a systematic literature review (SLR), synthesis of illustrative examples and secondary data and case study analysis to deepen understanding of the Stage-Gate® model and support redefining the Discovery Phase as Stage 1. This approach structured our exploration of existing literature and real-world examples, strengthening the conceptual framework developed throughout the study.

The SLR systematically gathered, synthesised, and evaluated existing literature on the Stage-Gate® model and its adaptations in the context of modern innovation methodologies. The review followed a defined search strategy, using databases such as Scopus, Web of Science, and Google Scholar, with search terms including "Stage-Gate model", "New Product Development", "Discovery Phase", "Case Study", and "Fuzzy Front End". We restricted the inclusion criteria to peer-reviewed academic papers, industry reports, and case studies published between 2000 and 2024, with most the sources falling within this period, ensuring a focus on recent advancements in innovation management. Key gaps in the literature were identified, particularly the need to redefine the Discovery Phase in light of its actual usage. These findings laid the foundation for the conceptual proposition developed in this study.

To complement the SLR, a detailed analysis of case studies and illustrative examples was incorporated to demonstrate the application of innovation methodologies within organisations. These examples, drawn from published industry cases and validated secondary sources, were synthesised to contextualise how Discovery Phase practices vary across sectors. This analysis highlights how elements of the Discovery Phase are often implicitly integrated into broader NPD frameworks, supporting the argument for formalising this phase as an integral part of the Stage-Gate® model.

The research proposes a significant adaptation, redefining the Discovery Phase as a theoretical contribution that structures early-stage ideation in NPD. While the conceptual arguments are supported by the SLR and case study analysis, further empirical research is needed to validate these propositions across various industries and company sizes. Future studies should focus on testing the effectiveness of the proposed renumbering in different industrial contexts and investigating how companies that do not explicitly define a Discovery Phase manage early-stage ideation through other stages of the Stage-Gate® model.

The proposed framework provides a foundational, conceptual model that requires further testing and refinement through empirical studies. The adaptation offers flexibility for modern innovation management, but it must be validated to retain the core efficiency of the Stage-Gate® model.

3. Systematic innovation process

In increasingly competitive markets, innovation, a critical component of modern business strategy, drives growth and success [18, 19]. The innovation process is a complex undertaking that consists of numerous internal and external processes [20, 21]. Through the NPD, the systematic innovation process aligns creativity with strategic goals and market demands [22-24].

The Stage-Gate® model is a prime example of a systematic innovation process [3]. The structured approach offers a clear framework for managing product development from concept to launch, ensuring that innovation efforts are organised, repeatable, and strategically focused [25]. By dividing the innovation process into distinct stages with decision gates, the Stage-Gate® model allows for thorough evaluation and planning at each stage, which helps to mitigate risk and improve efficiency. This systematic approach ensures that organisations maintain alignment between creative exploration and practical constraints, resulting in focused, efficient, and effective innovation [26].

For example, the pharmaceutical industry often employs a systematic innovation process for drug development, ensuring close alignment between research, development, and regulatory bodies [27]. Such alignment not only accelerates the time to market but also ensures compliance with stringent regulations [16]. The high failure rate in NPD is a significant challenge, with top performers succeeding while others face significant failure [28, 29].

To address the challenges in NPD, many firms have implemented the Stage-Gate® process to enhance innovation [15, 30]. Among the most critical key success factors in NPD are speed to market, strategy, and tactics [28, 31-33]. Strategy defines the overall direction of innovation efforts, while tactics provide steps to ensure alignment between execution and resource allocation. These two factors are essential for ensuring the innovation process remains focused on speed and efficiency [1, 25, 34]. However, numerous firms continue to grapple with failures that are often attributed to poor organisation and rigorous execution [29, 35, 36].

Cooper developed the Stage-Gate® model in the late 1980s to improve efficiency and effectiveness in product development [3, 37]. The model, which consists of multiple stages separated by gates, initially focused on rigorous planning and evaluation [11].

Despite its success, critics have expressed concern about potential inflexibility in fast-paced environments [9, 38]. One of the primary challenges in systematic innovation is balancing creativity with resource constraints. However, this can be addressed by implementing processes that allow for rapid iteration, granting the organisation greater flexibility [13]. Methodologies such as Agile or Lean can seamlessly integrate into the systematic innovation process, allowing for rapid iterations and continuous hypothesis testing, which improves flexibility in the innovation cycle. By combining the structured approach of Stage-Gate® with the adaptive nature of Agile, firms can better manage uncertainty while maintaining a focus on strategic goals [39]. The Stage-Gate® model's ongoing evolution, including modifications and adaptations, reflects the dynamic nature of the field and the need for continuous refinement to remain competitive [40, 41].

4. The original Stage-Gate® model

Developed on the basis of the 1980's NewProd system [37, 42], Cooper's original Stage-Gate® model has become a standard framework for managing product development processes. The model consists of distinct stages and gates, each of which serves a distinct purpose in ensuring the project's systematic progression [3].

The five stages of the traditional Stage-Gate® model include scoping, business case development, development, testing and validation, and launch [2]. Each stage consists of high-level tasks and is followed by a gate, which is a decision point at which the project's progress is assessed using predetermined criteria, allowing Go/Kill decisions on further investing [2].

This methodical approach enables innovators and organisations to reduce innovation project failures through planning and control. The model incorporates information gathering, data integration, and analysis at each stage, followed by gates that determine the project's resource investment [2]. Cooper compares this process to purchasing options on an investment, in which low-cost options are acquired initially and subsequent decisions about continuing the investments are made based on increasing levels of information [2].

Each Stage-Gate® stage gathers information to reduce risks and uncertainties [2, 3]. As the project progresses, stages build on one another, requiring different resource allocation at each stage. For example, later stages like testing and validation may require substantial investments in prototypes or market research [14, 15].

The model's reliance on gates ensures that decisions are based on increasingly accurate data, thereby continuously managing risk [43].

The Stage-Gate® model's impact on industry practices has been profound. For instance, large corporations like Procter & Gamble have successfully implemented the model, significantly enhancing their product development efficiency [14, 15]. Other sectors, such as telecommunications, have applied the model to improve portfolio governance [44]. Academic research recognised the model’s value in balancing creativity with control, though some critiques call for industry-specific adaptation [13, 41].

The original Stage-Gate® model begins with the Scoping stage and concludes with the post-Launch assessment [3]. The Discovery Phase, or Idea Stage, is important but not considered a standard stage of the Stage-Gate® model. While the initial stages do not require large financial investments, later stages such as Go to Development involve significant and specific resource allocation [2, 14, 15]. The details of the original Stage-Gate® model are summarised in Table 1.

Table 1 Details of the original Stage-Gate® model

Stage/Gate	Name	Description
Pre-stage, Stage 0	Discovery Phase, Idea Stage	The conception and accumulation of innovative new product ideas.
Gate 1	Idea screen	The selection and priority setting of product ideas for an NPD project regarding a dynamic process with a high degree of uncertainty.
Stage 1	Scoping	A preliminary analysis of the market and technology, including an evaluation of the most fundamental financial values.
Gate 2	2nd screen	A decision regarding the project's progression should be made based on the collection and analysis of information that has been subjected to rigorous conditions.
Stage 2	Building a business case	The conceptualisation of the business case, which includes an in-depth development plan and a launch strategy for the market.
Gate 3	Go to development	The decision must be made regarding the profitability of the project and the release of revered resources.
Stage 3	Development	The development of new technologies as well as the analysis of various marketing and production endeavours.
Gate 4	Go to testing	Evaluation of the project's ability to be technically realised and management of the R&D budget.
Stage 4	Testing and validation	The validation of the financial plan, the evaluation of the technological performances, and the acceptance of the customers all need to be performed.
Gate 5	Go to launch	Authorisation to enter the market.
Stage 5	Launch	Product commercialisation and market entry.
Post-launch review	Monitoring	The launch process is being evaluated.

Source: [3]

However, critics have pointed out potential weaknesses, such as rigidity, which may hinder flexibility in fast-paced industries like high-tech, where rapid iteration and adaptability are crucial [9].

In comparison, Lean or Agile emphasise flexibility and rapid iteration, allowing companies to pivot based on real-time feedback. While the Stage-Gate® model provides structured control, it may not match the speed required in dynamic environments. Nevertheless, it excels in industries where compliance, regulatory considerations, or large-scale investments demand more structured processes, such as deep-tech [16], pharmaceuticals, or consumer goods [2].

In essence, the original Stage-Gate® model is a well-defined and time-tested embedding of clear goals and a competent execution path [2]. In its original form, it has helped improve the efficiency and effectiveness of NPD processes by offering a systematic technique that blends creativity with control [23, 28, 35]. As industries evolve, the need for flexibility has led to modern adaptations [13, 26, 39].

5. Evolution of the original Stage-Gate® model

Introduced by Cooper in 1990, the Stage-Gate® model [3] emerged as a distinct five-stage, five-gate framework, building on the insights and methodologies of the earlier NewProd system [37, 42]. The original version adopted a 'one size fits all' approach for a structured and systematic innovation management [3].

While the NewProd system laid the groundwork, the introduction of the Stage-Gate® model marked a significant advancement in the field, providing a clear and standardised process that would become widely adopted across various industries [1, 2, 40, 45]. However, users of the original Stage-Gate® model found its rigid five-stage structure limiting for smaller projects, leading to early adaptations and community customisations that recognised the need for flexibility and responsiveness in varying project contexts [1].

Table 2 The Stage-Gate® model evolution showcasing the key developments and adaptations

Year	Name	Short description
1985	NewProd	NewProd, an industrial new product development process model with seven stages (Idea, Preliminary Assessment, Concept, Development, Launch, Trial, and Launch), includes activities and evaluation points for product development and marketing, emphasising market orientation and timely evaluation [37, 42].
1990	Stage-Gate process	Stage-Gate® enhances efficiency in product development from idea to launch, treating innovation as a manageable process with stages and gates as quality checkpoints. This improves decision-making, focus, and speed [3].
2008	Stage-Gate LITE and XPRESS (Spiral Development)	Spiral development allows quick iteration and design adjustments. LITE and XPRESS versions scale the process for different project types; LITE handles simple requests, and XPRESS addresses moderate-risk projects like improvements, modifications, and extensions [2, 45].
2016	Agile-Stage-Gate	The Agile-Stage-Gate model combines Stage-Gate® structure with Agile methodologies to enhance response times, communication, and productivity, helping industries launch products faster [40, 46].
2022	5th generation Stage-Gate (Triple A System, Value Stream Management)	The 5th Generation Stage-Gate® Idea-to-Launch Process is comprehensive and a flexible NPD system that enhances efficiency, effectiveness, and success with additions like Value Stream Mapping, Concurrent Processing, Iterations, Tougher Gates, and Agile integration are added to improve NPD [1].

5.1 Hybridisation of the Stage-Gate® model

Much like species in nature, the Stage-Gate® model has evolved to adapt in complex innovation processes. From its origins as a standard, one-size-fits-all framework [3], it initially underwent small incremental adjustments designed to address the specific needs of different projects [2].

As industries became more complex and innovation processes more dynamic, the model experienced more significant adaptations. New branches of the original Stage-Gate® system emerged–frameworks that shared the same fundamental principles but introduced new, hybrid approaches to development [40, 46]. These new hybrids represent major evolutionary leaps, transforming how companies approach product development. By incorporating iterative feedback, rapid prototyping, and a customer-centric focus, these hybrids have significantly expanded the model's adaptability to a broader range of industries, particularly those requiring continuous market responsiveness and flexibility [1, 13].

As Table 2 illustrates, the Stage-Gate® model has transformed over the years to meet evolving industry demands and challenges with modifications addressing various challenges [1, 2, 5, 45]. Some organisations have adapted the Stage-Gate® model to suit specific needs, either by reducing the number of stages to speed up simpler projects [2, 16] or by increasing them for more complex ones, ensuring stringent quality controls [1, 47]. Adaptations have also focused on accelerating product development through parallel processing [46], spiral development [2], and integrating continuous customer feedback [1]. Sector-specific customisations have been introduced to keep up with rapid technological advances and meet ever faster market demands [1, 12, 40, 47].

Most adaptations redefine stages or gates, while some expanded the model by introducing entirely new stages that combine traditional Stage-Gate® principles with other innovation methodologies [5, 8, 13, 16]. Agile principles marked a major turning point [2, 40], leading to hybrid models that integrate also other innovation methodologies such as Design Thinking and Lean Startup [12, 13].

This multifaceted approach has enriched the Stage-Gate® model, providing managers with insights into the combinatory possibilities of different methodologies [1, 28, 45]. It enables informed decisions, accelerating NPD [28] and represents a significant milestone in the evolution of the Stage-Gate® model, reflecting a growing recognition of the need for flexibility, customisation, and responsiveness in innovation management [1, 28, 45].

In today's dynamic innovation landscape, flexibility and adaptation remain essential [48, 49]. While the Stage-Gate® model has proven robust and widely adopted, it is not immune to the unique challenges presented by various industries and projects [16]. As a result, the model's stages and gates have undergone conscious adaptations – referred to as customisation or hybridization – to meet diverse industry needs [2, 13, 40].

Customisation extends beyond the integration of methodologies like Agile, Design Thinking, and Lean Startup; reflecting broader shifts in NPD and innovation demands [12]. In industries such as manufacturing and healthcare, process customisation is essential for coping with rapid technological advances and meeting regulatory standards [1, 50, 51]. For instance, the healthcare industry has integrated additional gates for regulatory approvals, ensuring compliance with strict medical standards before advancing to development stages [16, 50].

However, customisation brings both benefits and challenges. While customisations enhances the responsiveness and adaptability of the Stage-Gate® model, it can also introduce complexities that must be carefully managed [14, 15, 39]. One of the primary risks of over-customisation is added complexity, which can slow down decision-making and reduce the model's original efficiency customisation [7, 13]. In the technology sector, this has meant combining stages to speed up development [52], while in healthcare, additional gates may ensure regulatory compliance [47, 50]. Balancing flexibility, customisation, and the core principles of the Stage-Gate® model can be challenging [39, 53].

5.2 Stage-Gate® model hybrids

Building on the evolution of the Stage-Gate® model, several hybrid approaches have emerged that integrate other innovation methodologies to enhance flexibility, responsiveness, and customer-centricity. These hybrids represent significant adaptations of the original model, combining its structured framework with the iterative and collaborative principles of methodologies like Agile, Design Thinking, Lean Startup, and TRIZ.

One of the most well-known hybrids is the integration of Agile principles into the Stage-Gate® model [1]. Agile methodology divides the development cycle into sprints, which are characterised by iterative development, continuous feedback, and adaptability [36]. This hybrid approach combines the flexibility and rapid iteration of Agile with the structure and discipline of the Stage-Gate® model. Cooper & Sommer [40, 46] report positive results from this integration.

In software and technology industries, the Agile-Stage-Gate® model improves time-to-market by enabling faster product iterations without sacrificing strategic oversight [9]. Teams can rapidly prototype and test concepts, allowing for quick development cycles and constant product refinement. The Agile-Stage-Gate® model enhances collaboration by encouraging cross-functional teamwork and breaking down departmental silos that often hinder innovation. It also improves responsiveness to market changes, enabling swift adaptations to shifts in customer demands. Communication becomes more streamlined, with clear feedback loops enhancing understanding among team members and stakeholders.

However, integrating Agile with Stage-Gate® comes with challenges. Aligning Agile's iterative cycles with Stage-Gate®'s sequential decision-making process can cause tension between teams or team members focused on flexibility and those adhering to predefined milestones. Overcoming this requires careful planning and open communication to ensure both approaches complement each other. Success stories from industries such as consumer electronics highlight significant reductions in development time when these challenges are effectively managed [12, 16].

Design Thinking, a human-centred innovation methodology, emphasises empathy, creativity, and iterative problem-solving [54]. When integrated with the Stage-Gate® model, it fosters a user-centric approach to product development, blending innovation with structured development processes [53]. Teams focus on understanding and addressing user needs, which encourages creative ideation and exploration of a wider range of solutions.

Design Thinking unfolds through five stages: Empathize, Define, Ideate, Prototype, and Test. This integration enables rapid experimentation, prototyping, and iterative testing for efficient idea validation. It also promotes interdisciplinary collaboration, bringing together diverse perspectives to enrich the development process. Balancing creativity with systematic development ensures that products align with real user demands, guided by continuous feedback [55].

Maintaining the creative freedom that Design Thinking encourages while adhering to the structured, sequential gates of the Stage-Gate® model, poses certain challenges [12]. Organisations need to foster an environment where innovation thrives within a disciplined framework. This approach has been particularly successful in industries like consumer goods, where deep understanding of user preferences is essential [16, 56].

Integrating Lean Startup principles introduces a business-focused, iterative, customer-centric, and experimental approach [12, 57]. This hybrid emphasises market alignment, efficiency, and reduced resource waste [58] by focusing on building minimum viable products (MVPs), conducting rapid testing, and learning from customer feedback to pivot accordingly [16, 58-60]. By minimising waste and optimising resource utilisation, organisations achieve efficiency and prioritise real customer needs throughout the development process. Rapid iterations enable continuous learning and swift incorporation of real-world insights, ensuring the product remains aligned with market needs [58, 59, 61].

While highly effective in industries like software development, challenges arise when applying Lean Startup principles in heavily regulated sectors like pharmaceuticals, where compliance demands a more structured approach [53, 57, 59, 62].

The Theory of Inventive Problem Solving (TRIZ), developed by Genrich Altshuller, is a methodology that offers a systematic approach to solving engineering and design challenges, offering tools for creative problem solving, overcoming contradictions, and inventing new solutions [63]. Integrating TRIZ with the Stage-Gate® model combines systematic problem-solving with structured development. This encourages teams to challenge assumptions, think creatively, and develop breakthrough innovations within a methodical and disciplined framework [64].

While the hybrid promotes inventive problem-solving and robust decision-making, balancing TRIZ's analytical rigour with early-stage flexibility can be challenging. Teams must navigate the depth of analysis required by TRIZ without hindering the speed and adaptability necessary in fast-moving sectors [10, 63, 65-67]. A summary of the key benefits of each Stage-Gate® model hybrid is provided in Table 3.

Table 3 Summary of the key benefits of each Stage-Gate® model hybrids

Hybrid Variant	Key Benefits
Agile-Stage-Gate® model [1, 9, 12, 16, 36, 38-40, 46]	– Rapid prototyping and development – Continuous improvement of the product – Enhanced cross-functional collaboration – Quick responsiveness to market changes – Streamlined communication and feedback loops – Improved risk management – Alignment with customer needs
Design Thinking and the Stage-Gate® model [12, 16, 53, 56]	– User-centric innovation through empathy – Enhanced creativity and ideation – Rapid experimentation with prototypes – Interdisciplinary collaboration – Balanced structure between creativity and systematics – Increased market alignment – Feedback-oriented development
Lean Startup Approach and the Stage-Gate® model [12, 57-59, 61]	– Cost efficiency by minimising waste – Strong customer alignment – Accelerated learning through rapid iterations – Market responsiveness to trends – Risk mitigation via continuous validation – Enhanced scalability – Data-driven decision-making based on real-world insights
TRIZ and the Stage-Gate® model [24, 63-65, 67-70]	– Encourages inventive problem-solving – Provides a systematic approach to complex challenges – Facilitates the generation of novel ideas – Help resolve conflicting requirements – Integrates knowledge across industries – Aligns innovations with business goals – Supports robust, analytical decision-making

5.3 Implications of Stage-Gate® model hybridisation

Customisation has proven critical in maintaining the relevance and effectiveness of the Stage-Gate® model in an ever-changing landscape [1]. These hybrid approaches – Agile, Lean, Design Thinking, and TRIZ – offer distinct advantages but also introduce complexities that require careful management, especially when resources are limited [13, 16, 39, 62].

As industries evolve, balancing flexibility with structured decision-making is essential. Customisation frameworks help organisations identify key decision points, assess risk levels, and tailor the model to align innovations with strategic goals, avoiding over-complication [1, 13, 53, 59].

The evolution of the Stage-Gate® model through hybrids reflects the recognition that no one-size-fits-all solution exists [23, 28, 35]. Leveraging each methodology's strengths, organisations can create a more adaptive, customer- or industry-centric, and responsive innovation process, enabling them to stay competitive in today's rapidly changing markets [8, 12, 26].

This need for adaptability is particularly evident in the early stages of innovation, when ideas take shape and market alignment begins. Focusing on adaptability during these initial phases allows organisations to generate numerous ideas, explore a wider range of concepts, respond swiftly to emerging trends, and integrate customer feedback more effectively. Emphasis the front end of innovation (FEI) helps set a solid foundation for the product development process, increasing success in later stages [2, 13, 25].

6. The neglected stage

The role and importance of the front end of innovation (FEI), have gained increasing attention in the last decade [4, 5, 13, 71]. This NPD stage involves the generation of ideas and their preliminary analysis, forming the foundation of subsequent product development phases [72].

Research consistently emphasises that a well-managed FEI can significantly impact the success of new products. Florén and Frishammar [4] highlighted the FEI's role in capturing customer insights and turning them into innovative product concepts, leading to sustainable competitive advantage. Markham [71] noted that neglecting the FEI often leads to cost overruns and delays, as initial uncertainties and risks remain unaddressed. Cooper [1] emphasised that robust FEI processes lead to higher NPD success rates through better market alignment and resource allocation.

Building on this foundation, recent research continues to validate and expand upon these findings. Kock *et al*. [73] demonstrated that effective ideation portfolio management in the FEI enhances innovation performance through better idea selection and prioritization. Eling *et al*. [74] found that combining rational and intuitive approaches in early idea evaluation improves decision quality and NPD outcomes. Koen *et al*. [75] confirmed that organisations with effective FEI processes achieve faster time-to-market and greater product success. Moreira and Vidor's [13] bibliometric analysis showed that emphasising FEI shortens development cycles and improves product performance.

Despite this consensus, the Stage-Gate® model underemphasises the critical role of the FEI. While, Moreira & Vidor highlight that while the FEI is essential, the original model treats it as a preliminary stage, referring to it as "Idea Stage ", "Stage 0" or the "pre-work" phase [76]. This framing diminishes the importance of Discovery Phase in practice, even though it directly influences the success of product innovation by shaping initial concepts and aligning them with organisational goals [13, 75].

This paper proposes a redefinition of the Stage-Gate® model, renumbering Stage 0, known as Discovery Phase, to Stage 1 and shifting all subsequent stages accordingly. This change emphasises the importance of the initial idea generation phase and aligns with the views expressed in existing research. By renumbering this phase as "Stage 1", we acknowledge that it is not a mere prelude but a critical phase that sets the tone for the entire innovation process [1, 4, 5, 71].

Renumbering the Discovery Phase addresses the inconsistent treatment of the FEI across industries, despite evidence of its pivotal role in determining the outcome of NPD projects [13]. Renaming the Discovery Phase or Idea Stage as Stage 1 would align the Stage-Gate® model with this evidence, placing greater emphasis on idea exploration and early-stage evaluation. While Cooper [2, 76] describes the fuzzy front end (including ideation, scoping, and building the business case) in his work, he did not explicitly reclassify it as Stage 1. This research proposal offers an original contribution by advocating for its formal recognition as a critical component rather than a preliminary phase.

This shift also addresses emerging challenges in NPD, such as sustainability and data-driven decision-making, which are becoming increasingly important [13, 26]. The FEI should incorporate a more formalised evaluation of environmental and social impacts, as well as comprehensive data analysis [14, 15]. Though not fully addressed in the current Stage-Gate® model, integrating these considerations into Stage 1 ensures that innovations are aligned with modern expectations and societal goals at inceptions [7, 13, 16].

By treating the FEI as Stage 1, the Stage-Gate® model becomes even more adaptable, allowing for the seamless integration of contemporary innovation methodologies. The redefined model fosters flexibility and ensures that organisations can tailor the model to suit their specific project needs and industry trends. The following innovation methodologies can be integrated at different stages of the revised Stage-Gate® model:

- *Design Thinking:* Integrating Design Thinking into Stage 1 encourages creativity and empathy-driven problem-solving from the very beginning of the innovation process. This methodology focuses on understanding user needs, generating ideas, and prototyping solutions—activities that are essential during the Discovery or Idea phase. By embedding Design Thinking at this early stage, organisations can ensure that user-centric insights drive the development of ideas, setting a strong foundation for all subsequent stages [12, 16, 55, 56].
- *TRIZ:* Traditionally applied in later stages, TRIZ can also benefit Stage 1 by fostering systematic innovation from the outset. TRIZ provides a structured approach to solving complex design and engineering challenges, making it an effective tool for overcoming contradictions and identifying inventive solutions early in the ideation process. Applying TRIZ in

Stage 1 helps gather valuable insights and shape ideas that are not only creative but also technically viable, streamlining the path to later-stage development [64, 65, 67].

- *Agile:* Commonly utilised in Stages 4 and 5 for iterative development, Agile practices enhance Stage 1 by introducing iterative cycles of ideation and feedback right from the start. In the Discovery or Idea Stage, Agile's flexibility and focus on continuous feedback ensure that ideas evolve rapidly in response to market needs or stakeholder input. This early incorporation of Agile principles helps reduce risk by refining concepts before they move into more resource-intensive stages [38, 39, 46].
- *Lean Startup:* Though usually applied in Stages 3 and 6, Lean Startup can also be integrated into Stage 1 to emphasise rapid experimentation and customer validation from the earliest phases of innovation. By testing hypotheses and gathering feedback early on, organisations can ensure that the ideas they pursue are aligned with market demands, thus reducing the likelihood of costly pivots in later stages. Lean's focus on minimising waste and continuous validation makes it particularly effective in ensuring that the ideas generated during Stage 1 are viable and scalable [12, 57-59, 61].

Incorporating these innovation methodologies within the appropriate stages strengthens the Stage-Gate® model, making it more comprehensive and adaptable. This approach aligns the innovation process with modern industry demands, ensuring that each stage – starting with the newly emphasised Stage 1 – captures the strategic and operational needs of organisations more effectively. As the model adapts to different project types and sectors, it becomes a more powerful tool for managing complexity and fostering continuous innovation. The renumbered Stage-Gate® model, with its increased focus on the FEI, better equips organisations to navigate competitive and fast-evolving markets. This is evolutionary step towards sustaining innovation success and maintaining a competitive edge [1, 13, 16].

6.1 Representation of the renumbered Stage-Gate® model

To clarify the proposed renumbering and restructuring, the Table 4 summarises the changes. Renumbering as Stage 1, and shifting all subsequent stages accordingly, provides clearer guidance and emphasises FEI's integral role.

Table 4 Details of the amended Stage-Gate® model

Stage/Gate	Name	Description
Stage 1	Idea Stage	Conception and accumulation of innovative new product ideas.
Gate 1	Idea screen	Selection and prioritisation of product ideas for an NPD project within a dynamic, uncertain process.
Stage 2	Scoping	Preliminary analysis of the market and technology, including basic financial evaluation.
Gate 2	2nd screen	Decision on project progression based on rigorously analysed information.
Stage 3	Build a business case	Conceptualisation of the business case, including an in-depth development plan and a launch strategy for the market.
Gate 3	Go to development	Decision on project profitability and resource allocation.
Stage 4	Development	Development of new technologies as well as the analysis of various marketing and production endeavours.
Gate 4	Go to testing	Evaluation of technically feasibility and R&D budget management.
Stage 5	Testing and validation	Validation of the financial plan, evaluation of the technological performance, and customer acceptance.
Gate 5	Go to launch	Market entry authorisation.
Stage 6	Launch	Product commercialisation and market entry.
Post-launch review	Monitoring	Evaluation of the launch process.

The Discovery Phase or Idea Stage serves a critical role in the innovation process. To further substantiate the argument for renumbering this stage as Stage 1, we look to real-world examples where this stage has already been implicitly or explicitly recognised as crucial in various industries. The following case studies provide evidence of how leading organisations have adapted the Stage-Gate® model, supporting the proposed renumbering and its relevance in fostering successful innovation processes.

7. Case studies

Recognising the Discovery Phase as Stage 1 in the Stage-Gate® model is not just theoretical. Real-world applications across industries have implicitly or explicitly demonstrated this stage's crucial role in innovation. This section presents case studies that show how different organisations have adapted the model, supporting the necessity and practical impact of renumbering.

7.1 Case study 1: The Fiat Mio crowdsourcing project in Brazil

The Fiat Mio crowdsourcing project presents a compelling case for redefining the Discovery Phase and Idea Stage as Stage 1. The project began when a Fiat executive recognised the need to better respond to consumer demands. This led to the development of a co-creation platform that engaged the public in conceptualising a new car [17].

Fiat started with "Original Idea" stage, setting the foundation for the project's innovation process. Redefining the Discovery phase as "Stage 1" in the Stage-Gate® model aligns with Fiat's approach, emphasising the importance of this early ideation stage in fostering innovation [17]. As the project progressed, the remaining five stages focused on development, testing, and commercialisation, following a modified version of the Stage-Gate® model.

Fiat's approach shows how integrating consumer input early in the process provided insights that shaped the product from the start. Treating idea generation as a formal phase, Fiat used structured crowdsourcing to refine ideas in real time, demonstrating early-stage collaboration's value. Additionally, it reflects the growing importance of consumer-centric innovation practices in modern industries.

The Fiat Mio project validates redefining the Discovery Phase, illustrating how early-stage ideation, supported by crowdsourcing, is critical to NPD [17].

7.2 Case study 2: Agile-Stage-Gate® hybrid in the toys and power segments

Sommer *et al.* [38] presents a comparative case study of two companies in the toys and power segments that adopted hybrid Agile-Stage-Gate® models, using "Idea" stage as Stage 1, explicitly recognising it as the initial stage. Recognising "Idea" stage as Stage 1 highlighted its importance for aligning development with market needs.

Combining Agile with the Stage-Gate® model enhanced flexibility and responsiveness as despite challenges these companies resulted in greater adaptability and faster decision-making in the early stages of innovation [38]. This approach shows that treating the early idea phase as a formal stage can reduce the time and cost of later stages by catching potential problems early on. By implementing Agile cycles of feedback, companies were able to ensure that Stage 1 was not merely a brainstorming session but a rigorously managed phase critical to the success of the entire product development process.

Both companies used iterative feedback mechanisms within Stage 1 to adapt to changing market conditions [38]. This operationalisation of the Discovery Stage reflects the need to redefine it as Stage 1, showing that modern NPD depend on the flexibility and responsiveness that Agile methodologies can bring to the early stages of innovation.

7.3 Case study 3: Procter & Gamble's SIMPL model

Procter & Gamble (P&G), a leader in product innovation, exemplifies the prioritisation of early-stage innovation through its adaptation of the Stage-Gate® model, called SIMPL [52]. The SIMPL consists of five stages and four gates, with Stage 1 being explicitly named Discovery:

- Stage 1: Discovery – This stage focuses on ideation, exploration, and the identification of new opportunities, setting the foundation for subsequent stages.

- Stage 2: Design – Conceptualising and designing products to align with customer needs and market demand.
- Stage 3: Qualify – Rigorous testing and validation to ensure product quality.
- Stage 4: Ready – Preparing the product for launch, including supply chain and marketing coordination.
- Stage 5: Launch – Product release, including sales and distribution efforts.

P&G's formal implementation of the Discovery Stage as Stage 1 underscores the importance of early-stage innovation. P&G's framework rigorously evaluates new opportunities to ensure alignment with market needs and strategic goals before progressing, enhancing the likelihood of product success. This operational approach further validates the necessity of redefining the Discovery Phase in the broader Stage-Gate® model [52].

Moreover, P&G's SIMPL model provides a clear example of how Stage 1 can be tailored to meet specific organisational needs, depending on the type of product or market being targeted. This structured yet flexible approach demonstrates that redefining the Discovery Phase is more than symbolic; it is essential for effective innovation management. This case study supports the argument that emphasising Stage 1 helps align ideation with business objectives.

7.4 Case study 4: Sustainability in the I2P^3® process at Evonik Industries

Wojciechowski *et al*. [77] describe how Evonik Industries AG implemented the I2P^3® Process, a sustainability-focused innovation framework based on the Stage-Gate® model. It includes six stages, starting with Stage 1: Idea Development, which assesses the societal and environmental impact of new ideas through the dimensions of People, Planet, and Profit.

Evonik's approach ensures sustainability is embedded from the start, evaluating ideas not just for ideation but for their impact on people, the environment, and profitability and solidifies the argument that the Discovery Phase or Idea stage should be redefined as Stage 1 to reflect its integral role in assessing sustainability, aligning with the Stage-Gate® model's goals of balancing innovation with societal and environmental responsibility [77].

Evonik's I2P^3® Process demonstrates how early-stage innovation can incorporate sustainability considerations from the very beginning. The company uses Stage 1 not only for ideation but also as a phase for conducting comprehensive sustainability assessments, evaluating each new idea based on its potential impact on people, the planet, and profitability [77]. This approach ensures that sustainability is not an afterthought but an integral part of the product development process.

By formalising this phase, Evonik rigorously scrutinises ideas before advancing them, aligning innovations with market and corporate social responsibility goals. This case supports treating the Discovery Stage as a formal NPD step to meet the growing demand for sustainable, responsible innovation.

7.5 Contextual evidence of discovery phase variation across sectors

The Discovery Phase is not a one-size-fits-all template. Companies vary its depth, tools, and resources according to five context drivers:

- *Resource & knowledge intensity:* industries vary in how much they invest in R&D, particularly during early-stage innovation. High-index sectors, such as electronics and pharmaceuticals, typically allocate more resources to basic, original and high-quality innovation efforts [78]. Cross-national evidence confirms that greater R&D investment, particularly in early phases, is positively associated with enhanced innovation performance across sectors and economies [34, 78].
- *Regulation & compliance:* sectors with high regulatory demands, such as pharmaceuticals, embed many more checkpoints early in the Discovery Phase to ensure GMP alignment and technical feasibility for later EMA/IND filings [79]. This increased diligence extends early-stage activities: preclinical development durations grew by 17 % between 2004 and 2012 [27]. This early diligence improves readiness for downstream development stages by strengthening de-

cision making and reducing the risk of late stage project termination, an increasingly critical need given that up to 90 % of drug candidates still fail in clinical trials [80].

- *Methods applied in early-stage innovation:* the Discovery Phase acts as a performance lever across sectors, particularly when supported by systematic methods and aligned with downstream development stages, reinforcing its role as a strategic driver of innovation success [50]. In software and IT, Agile practices such as iterative sprints and early customer feedback are integrated early, improving business case clarity and reducing risk. This approach is linked to gains in speed, cost, and quality [36], as well as a 25 % reduction in project effort and 20 % less rework in hybrid Agile Stage Gate models [46] In discrete manufacturing, simulation-based planning is increasingly embedded into the Discovery Phase to support early feasibility decisions. A print-shop pilot increased weekly output by 52 % and cut job time in half by using pre-execution modelling to optimise production scenarios [81].
- *Intellectual-property risk:* high-IP sectors such as deep-tech and specialty chemicals embed patent landscaping, Freedom-to-Operate and other IPR related checks into the Discovery Phase. These early evaluations begin with idea screening and intensify through early gates, adding time and coordination effort, but improve decision quality significantly and reduce infringement risk in later stages [21, 78, 82].
- *AI integration:* Data-rich industries are increasingly embedding generative AI into the Discovery Phase to support ideation, customer research, and feasibility assessment. Electronics and chemical companies use these tools to auto-rank ideas, simulate synthesis routes, and reduce uncertainty. Industry pilots report a 25-35 % drop-in screening time and more consistent Go/Kill decisions, aligning with broader digital economy trends accelerating innovation in manufacturing [83, 84].

These examples confirm that, although companies retain the same gate logic, they adjust the Discovery Phase to align with their resource intensity, regulatory requirements, preferred methods, intellectual property risk, and level of AI readiness. Taken together, this evidence reinforces our argument that the Discovery Phase, previously referred to as Stage 0 or the Idea Stage, is a crucial part of the innovation process and should be renumbered as Stage One to reflect its central role in driving successful innovation.

8. Discussion

This paper has proposed a significant refinement of the Stage-Gate® model by renumbering the Discovery Phase as Stage 1, recognising its essential role in the innovation process [1]. This change is not a superficial adjustment but rather a strategic realignment that simplifies the model and underscores the significance the importance of ideation and creativity [5, 13] within the Stage-Gate® model.

By renumbering the Discovery Phase, the model becomes more comprehensive and better aligned with modern innovation methodologies such as Agile, Design Thinking, TRIZ, and Lean Startup [1, 16, 26]. Case studies like the Fiat Mio crowdsourcing project and SIMPL by Procter & Gamble demonstrate that these adjustments improve clarity, flexibility, and strategic focus in the NPD process [17, 52].

The paper shows that ideation has always been a crucial component of NPD, and findings in FEI research confirm that we should never view it as optional or peripheral, but rather as the cornerstone of successful innovation. Modern methodologies further highlight the centrality of the Discovery Phase by integrating it into flexible and iterative innovation frameworks. For instance, Agile and Lean Startup approaches stress continuous feedback and adaptability, which aligns with the early-stage ideation process critical to innovation [1, 13, 16, 26].

While the benefits are clear, it is important to acknowledge the challenges that come with this change. Emphasising the Discovery Phase as Stage 1 could risk overloading this phase with too many tasks and expectations, which might slow down the early stages of the NPD process. The increased complexity of managing ideation, opportunity exploration, and market analysis as formalised steps could result in longer timelines, especially for companies that need to iterate quickly [13]. Additionally, there is the risk that, by formalising the Discovery Phase, some companies might become too rigid in their early-stage exploration, which could stifle creativity and hinder the flexibility that innovation requires [7].

The shift to renumber the Discovery Phase as Stage 1 provides a more intuitive, holistic, and consistent framework for innovation management, emphasising the critical role of early-stage ideation in driving the development of new products. However, this formalisation also introduces a potential challenge: balancing the need for structured, organised, orchestrated actions with the creative freedom required for ideation. Over-structuring the Discovery Phase may limit the open-ended exploration that often leads to breakthrough innovations [1].

Emerging trends like artificial intelligence (AI), big data analytics, and sustainability practices will likely shape the future evolution of the Stage-Gate® model [1]. These trends offer significant opportunities to enhance the model's flexibility, efficiency, and innovation capabilities, but they also present challenges that organisations must address.

AI and big data, for example, can revolutionise early-stage decision-making by providing predictive insights into market trends and customer preferences, transforming the Discovery Phase [5, 13]. Similarly, sustainability practices may lead to the inclusion of new gate parameters that focus on evaluating the environmental and societal impacts [16, 26, 85]. Meanwhile, the continued rise of iterative innovation methodologies will drive the need for rapid market responses, particularly in industries with fast-moving dynamics [1, 40, 46].

However, integrating these emerging trends presents both challenges and opportunities. One challenge is ensuring that the adoption of these improvements does not over-complicate the model, which could reduce its overall efficiency or introduce decision-making delays [7, 13]. On the other hand, the ability to adapt more seamlessly to technological and regulatory changes will offer a significant competitive advantage [1].

Small and medium enterprises (SMEs) in particular may face different challenges when implementing a systematic innovation process compared to larger corporations [86]. Limited resources, budget constraints, a lack of innovation competencies, and less formalised processes can impact their ability to follow a structured NPD approach like Stage-Gate® [1]. However, these firms can benefit from a more flexible, iterative model that still emphasises early-stage validation and alignment with business goals [13].

The adoption of a revised Stage-Gate® model, starting with the Discovery Phase, enables organisations to rethink their innovation processes. This change, along with modern innovation methodologies, can boost the success rates of NPD in fast-moving industries where speed to market is crucial. Integrating data-driven insights from AI into Stage 1 will not only improve idea validation but also enhance information flow, risk management, and decision-making throughout all stages of the innovation process [13]. As industries and technologies continue to evolve, the revised Stage-Gate® model will remain adaptable, offering a flexible yet structured approach to innovation. Moving forward, the integration of emerging trends such as AI, big data, and sustainability will further enhance the model's relevance and applicability, ensuring that it remains a vital tool for managing innovation in an ever-changing business landscape.

9. Conclusion

The continuous evolution of the Stage-Gate® model reflects the growing need for customisation and flexibility in response to emerging trends and industry demands. This paper has proposed a fundamental shift in the model's structure by renumbering the Discovery Phase as Stage 1, recognising its essential role in the innovation process. This change aligns the model with modern innovation methodologies and emphasises the importance of early-stage ideation and creativity.

For practitioners, this renumbering enhances clarity and focus during the early stages of product development. It facilitates cross-functional collaboration, decision-making, and alignment with methodologies like Agile and Design Thinking, fostering a more flexible and customer-centred innovation process. Policymakers should support the adoption of such customisations, especially in industries where rapid innovation cycles and early-stage ideation are critical to market success.

While this paper makes a strong argument for renumbering the Discovery Phase, we must acknowledge several limitations. Firstly, empirical validation is required to assess the impact of this change across a broader spectrum of industries and company sizes. Further research is necessary to explore the unique challenges that different sectors may encounter when adapting the revised model. Additionally, it is important to recognise that for some organisations, this adaptation may not be entirely novel. Certain companies may already be informally integrating Discovery Phase activities into other stages of the model. These companies may compensate for not having a distinct Discovery Phase by using innovation techniques and methodologies within other stages, thus performing early ideation and exploration implicitly. Future research should test whether companies are indeed engaging in such implicit activities and assess whether formalising the Discovery Phase would offer them additional benefits.

Secondly, the increased complexity introduced by this customisation must be carefully managed to ensure that the Stage-Gate® model retains its core efficiency. Over-complicating the model could lead to decision-making delays, slowing down innovation rather than enhancing it. The balance between structured processes and maintaining flexibility for creative exploration will also be crucial in determining the model's success.

The proposed changes and adaptations of the Stage-Gate® model open new avenues for empirical research and practical exploration. Future research should focus on:

- *Implicit innovation activities:* research should examine how companies that do not formally recognise the Discovery Phase still engage in early ideation and exploration implicitly through other stages of the model. It is crucial to test whether such companies use innovation techniques and methodologies in these stages, which effectively substitute for a distinct Discovery Phase. Validating these practices will help determine whether formalising the Discovery Phase offers tangible benefits over implicit approaches [13].
- *Integration with other models:* exploring how the Stage-Gate® model can be effectively integrated with other innovation and project management models, such as TRIZ, Design Thinking, or Lean Startup, to create more holistic and flexible frameworks [1, 9, 13, 38, 40].
- *Role of AI in decision-making*: investigating the role of AI in enhancing decision-making, particularly in the early stages of innovation. AI could provide more data-driven insights into market trends, customer preferences, and project feasibility [1, 13, 16].
- *Impact Innovation:* examining how sustainability practices can be more deeply embedded within the Stage-Gate® model. Research could concentrate on creating new gate parameters, gates, and stages that evaluate environmental and societal impacts, prioritising sustainability throughout the innovation process [13, 26, 39].
- *Cross-industry applicability:* Investigating the impact of these proposed changes across different industries, considering how sector-specific challenges may affect the integration of hybrid models and customisation efforts [46, 49, 59].
- *Methodological approaches:* Future research on the Stage-Gate® model's evolution should employ a variety of research methods, including case studies, experimental design, surveys, interviews, risk and resource considerations [87]. Cross-industry analysis would provide valuable insights into how different sectors customise the model to meet their specific needs, offering a more comprehensive understanding of the model's adaptability and flexibility.

The flexibility and adaptability of the Stage-Gate® model have long been central to its widespread adoption across industries. By renumbering the Discovery Phase and incorporating emerging technologies, trends, and methodologies, this revised model holds the potential to significantly enhance the success of NPD processes. Given the increasing complexity of innovation processes, it is essential that further empirical research is conducted to validate these changes and assess their broader implications. The model's ability to continuously evolve in alignment alongside new innovation practices will ensure that it remains a powerful and relevant tool for organisations navigating the complexities of modern NPD.

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