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Article

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A Framework Proposal for Building Ideation Models on the Front End of Innovation

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Abstract: Idea generation, as a key component of the Front End of Innovation (FEI), is a critical phase in entrepreneurial endeavors, serving as the foundation for new venture creation and product development. Innovation management and entrepreneurship literature underscores the importance of idea generation, emphasizing its role as an essential precursor to successful ventures and products. While academic research has extensively explored the FEI and idea generation methods, a significant gap remains in developing FEI models for broad use or specific contexts. Especially, there is a lack of action-oriented, performative models that offer detailed, applicable techniques and tools. Existing models often adopt only a corporate perspective, are overly broad, use complex structures or miss the use of new emerging digital tools, which makes these models not accessible or relevant to entrepreneurs or applicable across different industries or product types. To address these issues, employing the Integrative Literature Review Methodology, this study proposes a comprehensive FEI framework designed to facilitate the development of new idea-generation models that cater to different types of users and contexts and incorporate contemporary techniques and tools. The framework focuses on six (6) key dimensions of FEI models: (1) Model Orientation, Scope and Context; (2) Innovation Type and Innovation Drivers; (3) Model Structure and Visualization; (4) Flow of Activities, Flexibility and Adaptability; (5) Core FEI Activities and Granularity; and (6) Toolkit (Tools and Techniques), offering a range of recommendations for each. It aims to provide scholars and practitioners (entrepreneurs, teams, or companies) with a systematic approach to creating usable FEI models that make the Front End of Innovation more structured and predictable.

Keywords: idea generation; front-end of innovation; FEI models; framework; entrepreneurship.

Introduction

The idea generation is considered a part of the front-end of innovation (FEI), otherwise known as the Fuzzy Front End (FFE), and it precedes the formal new product development (NPD) process. Over the years, researchers and practitioners have developed numerous concepts, models, and frameworks over the years to understand and navigate this phase better. For instance, regarding the FEI, Deschamps in1995 (as cited in Brem & Voigt, 2009) developed "The idea tunnel" as a flow-oriented approach, Koen et al. (2001) presented a circular shaped model known as "New concept development", while Boedderich (2004), Sandmeier et al. (2004) and Trotter (2011) proposed more comprehensive process-oriented frameworks. Additionally, The Stage-Gate process (Cooper, 1983) and the 8-stage New Product Development Process (Kotler & Armstrong, 2017) are notable concepts that integrate FEI into the complete NPD process. Other notable methodologies, such as the Lean Startup Methodology, Agile Methodology, and Design Thinking, do not focus only on the front end and provide a more holistic view, covering the journey from idea generation to product launch. Additionally, several approaches, such as User-driven (von Hippel, 2005), Design-driven (Verganti, 2009), Customer Knowledge Management (Bratianu et al., 2021), and Open Innovation (Bratianu et al., 2021; Chesbrough, 2003), are also considered important in the Front End of Innovation.

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In our prior research, we investigated both traditional and contemporary methodologies and tools for generating business ideas, including suggestions for future research to dive deeper into the ideation process. Given the plethora of methods available for idea generation (Bezovski et al., 2021; Park et al., 2021; Sandmeier et al., 2004; Uribe Ocampo & Kaminski, 2023), our research focus has transitioned towards exploring existing and conceiving new concepts that specifically aid in idea generation in the FEI scope.

A recurring observation from the FEI models we have studied is their tendency to either be overly broad (conceptual), adopt only a corporate perspective rather than addressing the needs of different types of users such as solopreneurs, small teams or new startups, employ complex elaborations and structures; or fail to incorporate emerging digital resources and tools readily available for exploitation. In line with that, Brandtner (2017), based on an extensive literature review of FEI models, concludes that improvement in the FEI has a high potential for improving the organisation's innovation capability. Additionally, Uribe Ocampo and Kaminski (2023), among the identified gaps for further research, consider fostering creativity in FEI, introducing methods and tools, and developing practical and usable models. These gaps in the academic studies pinpoint specific problems for the entrepreneurs on the Front End of Innovation regarding the existing FEI models. These problems must be addressed by designing new, contemporary and appropriate FEI models.

In light of the need for new Front End of Innovation (FEI) models, the existing literature on such models, while extensive, lacks a clear and cohesive framework to guide the development of new FEI models. Notable works such as Brandtner (2017), Brem and Voigt (2009), Uribe Ocampo and Kaminski (2023), and especially Park et al. (2021) offer valuable insights, but these studies are either focused on specific elements or remain largely descriptive. Consequently, scholars, entrepreneurs, or organisations seeking to develop new FEI models must undertake a time-intensive investigation of existing models, starting from Cooper (1983) and Koen et al. (2001) up to the many contemporary models. Through our efforts to develop a new FEI model, we realised that no consolidated framework currently exists that systematically incorporates previous models' critical features and dimensions. This paper addresses that gap by proposing a structured framework that synthesises the attributes of existing models and provides practical and theoretically based recommendations for future development, thereby streamlining the entire process for researchers and practitioners.

To address this gap, the research question guiding this paper is: "What comprehensive framework can facilitate the structured development of Front End of Innovation (FEI) models, addressing the fragmented nature of existing approaches and enabling more efficient model creation for diverse innovation contexts?"

In addition to the above, the primary objective of this study is to develop a comprehensive, streamlined, and flexible framework that supports the creation of new FEI models with varying contexts and features. This framework is specifically tailored for the Front End of Innovation (FEI) and is designed to address all important FEI dimensions/features, including integrating rapidly evolving online tools and digitally enhanced techniques. The ultimate goal is to provide scholars and practitioners—such as innovative companies, research and development sectors, entrepreneurs, small teams, and innovators—with a structured and strategic instrument for developing theoretically grounded, action-oriented and technique-rich idea-generation models across different contexts.

Integrative literature review

In scholarly works, the idea-generation process is recognised as a component of the Front End of Innovation (FEI) (Boedderich, 2004; Khurana & Rosenthal, 1998; Koen et al., 2001). The FEI signifies the initial stage of the entrepreneurial journey before the formal New

Product Development (NPD) process (Brandtner, 2017; De Brentani & Reid, 2012; Koen et al., 2014). This crucial stage sets the foundation for subsequent innovation and development activities.

Drawing from the adopted research methodology and keeping the primary objective of our study in mind, this integrative literature review focuses on existing FEI frameworks and models. Our goals are to analyse the most relevant and influential FEI models, extract their key dimensions, and identify gaps and opportunities that warrant further research in this field. This approach will ensure a comprehensive understanding of the field and establish a theoretical foundation for our new FEI framework for developing idea-generation models.

The first prominent model regarding the innovation process that specifically recognizes Idea generation as a separate phase was developed by Thom (Thom, 1980, as cited by Brandtner, 2017). The other two separate phases in Thom's model are Idea acceptance and Idea realization. Another early NPD model was the popular Stage-Gate model designed by Cooper (1983). The first version of the model consisted of 7 stages (and gates), and the first three (in FEI) were idea generation (and screening), preliminary assessment (and evaluation), and concept development (and testing). Then, the model continues with the product development stages. Both of these models do not separate the FEI from the full and formal NPD. Deschamps et al., in 1995 (as cited in Brem & Voigt, 2009) introduced the "idea tunnel" as the first notable model that specifically deals with the FEI and separates it from the NPD. This model, presented in the form of a funnel, elaborates on collecting, creating, pre-selecting, checking, refining, and evaluating ideas. It is based on a "development funnel" previously proposed by Hayes (1988). Khurana and Rosenthal (1998) introduce the product strategy, opportunity identification, and market technology and analyses in their model, among other elements. The model emphasizes the importance of aligning product strategy with the company's existing portfolio and incorporates strategic aspects. The four key roles they identify (core team, project leader, executive review committee, and senior management) highlight the importance of cross-functional involvement in the front-end process and offer a company perspective.

Koen et al. (2001) introduce the New Concept Development (NCD), which, in addition to the circular, non-linear approach, recognizes the influence of the environment and also the internal "engine," providing a more holistic view of the innovation process. The circular structure of the model recognizes the highly iterative nature of developing new product ideas. This model becomes one of the most prominent in the FEI. While it is applicable to both corporate and entrepreneurial contexts, it does not prescribe specific tools for each activity.

Boeddrich (2004), besides the main phases, emphasizes the role of the company for each step of the innovation process, aiming to achieve continuous innovation. The "Integrated Front-End Process Model" by Sandmeier et al. (2004) is notable for emphasizing customer involvement methods. By suggesting specific tools like fair visits, discussions, workshops, brainstorming, and rating sheets, it provides practical guidance for implementing customer-centric processes. Riel et al. (2013) propose a stage-gate process model supported by an extensive literature review and expert interviews from 11 companies. They identify six key success factors emphasizing the importance of the top management, the corporate culture and the creative and collaborative environment. This model also integrates internal and external sources of ideas towards open innovation. Regarding the aforementioned customer involvement and the introduction of open innovation in FEI models, a recent study suggests that Customer Knowledge Management (CKM), as a structured approach, has a direct impact on Innovative Work Behavior (IWB), particularly in the areas of idea exploration and idea generation, both of which are essential components of the Front End of Innovation and has a positive effect on sustainable product innovation (Bratianu et al., 2021).

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Frishammar et al. (2016), unlike older models, explicitly acknowledge the inherent uncertainty and complexity during the front-end phase in their problem-solving approach. They recognize that radical innovations often emerge from ambiguous situations where traditional rules and frameworks may not apply. Brandtner (2017), in his PhD thesis, investigates principles related to Front-End Innovation (FEI). He distinguishes between process and non-process principles and integrates process-related ones into a comprehensive, theoretically grounded, and practically applicable model.

Uribe Ocampo and Kaminski (2023) propose a Late FFE model—DTRIZ methodology, which combines Design Thinking (DT) and TRIZ (Theory of Inventive Problem Solving), aiming to leverage the strengths of both approaches. The authors propose 40 techniques/tools that are categorized to support different activities across the phases of their model. The selection of tools includes well-known techniques (like brainstorming or mind mapping) and more specialized TRIZ-based tools (such as the 40 Inventive Principles or Contradiction Matrix). The model is validated through case studies in the personal health equipment sector, demonstrating its practical applicability in real-world innovation contexts.

Park et al. (2021), in their extensive systematic literature review study, identify different aspects of the FEI models: model type (pull, push, combined, network), level of innovation (radical, incremental), structure (procedure, performative, combined) tasks (opportunity identification, idea generation, mission statement, requirements list, conceptual design, prototyping) and toolkit availability. An important output of this study is the suggested strategies for the development of New FEI models regarding the above-mentioned aspects.

Besides the core activities and their granularity identified in the Front End of Innovation (FEI) models, other dimensions that are important for our study and for demystifying the FEI include the methodological Approach (Orientation), Context Scope, Innovation Type, Innovation Drivers, Flow, Model Flexibility, Model Framework (Structure), and Toolkit (FEI Tools and Techniques).

The papers that we have investigated and those included in our literature review collectively show the evolution of thinking about the Front End of Innovation (FEI) from initial recognition of its importance to more detailed, practical models for implementation. This evolution reflects a shift from viewing the FEI as a mysterious, unmanageable phase to recognizing it as a complex but potentially structured process that can significantly impact innovation success. The field is increasingly adopting more comprehensive, practical, and context-specific approaches to managing the Front End of Innovation. Consequently, some authors, including ourselves, prefer the term Front End of Innovation over the previously more common Fuzzy Front End (FFE).

Table 1. Overview of relevant research papers on FEI Models

Author/s	Model Name / Label	(Core) Activities and Granularity	Additional notes
First NPD models			
Thom (1980)	NDP model	- Idea generation - Idea acceptance - Idea realisation	The first innovation model recognising idea generation as a separate phase.
Cooper (1983)	Stage-Gate NPD model	I. Idea Generation (and screening), II. Preliminary Assessment (and evaluation) III. Concept development (and testing). + IV, V, IV, IIV NPD stages	Discusses the FEI (phases) as part of the whole NPD. It introduces the concept development and testing as an important stage.
First (Early) FEI models			
Deschamps et al. (1995)	The idea tunnel	Collecting, creating, pre-selection, checking, refining and evaluating ideas	The first model that specifically focuses on FEI. It represents the process as a funnel.

Author/s	Model Name / Label	(Core) Activities and Granularity	Additional notes
Khurana and Rosenthal (1998)	Stylised Model of the Front End of NPD. (Holistic approach prior to NPD)	- Product strategy - Opportunity identification, - Idea generation, - Market and technology analyses - Product concept, - Project planning,	Offers company perspective, including strategy and four key roles (core team, project leader, executive review committee, senior management.) It suggests process orientation and/or a culture-driven approach.
Koen et al. (2001)	New concept development (NCD)	- Influencing factors - Opportunity Identification - Opportunity analyses - Idea Genesis - Idea Selection - Concept & Development - Engine	Recognise the influence of the environment and the internal engine in driving the process. Besides, it applies to entrepreneurs in the company context but does not suggest specific tools.
Other notable FEI models			
Boeddrich (2004)	A New Approach Towards Organizing the FFE of the Innovation	- Strategic guidelines for innovation - Idea generation and adoption - Idea screening, execution and conceptual development - Preliminary projects - Portfolio of innovation projects	Defines the company's responsibilities for each step in the process to achieve continuous innovation.
Sandmeier et al (2004)	Integrated Front-End Process Model	- Market and Technology Opportunities (search areas and opportunity selection) - Product and Business Ideas (generating, screening, selection) - Draft Concept / Business Plan	Comprehensive process model. Suggests methods/techniques to employ accompanied by a level of customer involvement.
Riel et al. (2013)	Ideation reference process mode	- Impulse - Prerequisites (analyses, strategic aspects, resources) - Idea Generation (participants, tools, guidelines) - Idea Selection	Emphasises the importance of top management and corporate culture. Integrates internal and external sources of ideas towards open innovation. Focuses on the ideation process (via six success factors).
Firshammar et al. (2016)	The Front End of Radical Innovation	- Problem mapping (internal and external analysis) - Problem creation (calcification, formulation) - Problem-solving (idea development, concept)	Problem-solving approach. Involves users in problem-defining. Deals with radical (high degree) innovation.
Notable and recent (systematic) literature review studies on FEI models			
Brandtner (2017)	Process Model for the Front End of Innovation	(Innovation) Strategy Input (Environment) - Signal scanning Analysis - Detecting Sparks (relevant signals) Output - Strategy planning - Idea generation - (to) NPD process	Comprehensive and complex. Describes key activities. Does not propose tools or techniques. Offers extensive literature review on FEI models and defines gaps
Park et al. (2021)	266 Fuzzy front-end studies	- opportunity identification - idea generation - mission statement - requirements list - conceptual design - prototyping	266 FEI (or FFE) studies were examined. Suggests FEI model development strategies (drivers) regarding type, structure, performance, toolkit, etc.

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Author/s	Model Name / Label	(Core) Activities and Granularity	Additional notes
Uribe Ocampo & Kaminski (2023)	Late FFE model—DTRIZ methodology	Early FFE 1. Understand (environment, users, technology) Late FFE 2. Ideate (generate ideas, concepts, prototypes) 3. Evaluate (test, analyse)	Designed for the personal health equipment sector but applicable in different industries. Integrates the TRIZ (technology aspects) and DT - design thinking (user aspects). Suggests 40 techniques/tools that support the activities.

Source: own processing

Having in mind the *gaps in FEI literature*, despite the critical importance of the Front End of Innovation (FEI) in the innovation lifecycle, a recurring observation from our study of FEI models is their tendency to be overly broad (only conceptual), adopt a corporate perspective rather than focusing on individual entrepreneurs, employ complex elaborations and structures, and/or fail to incorporate emerging digital resources and tools readily available, which could significantly enhance the idea generation process.

Dooley et al. (2002) found that despite extensive literature in the area, many firms fail to adopt adequate front-end processes. This suggests a gap between theoretical models and practical implementation, particularly for smaller entities like solopreneurs. Brandtner (2017), based on an extensive literature review of FEI models, concludes that improvement in the FEI has a high potential for enhancing an organization's innovation capability. However, existing literature has mainly focused on the idea generation stage, while other stages (such as the strategic aspect) at the Front End have received little attention. The number of holistic and practical approaches to managing the FEI is low, and few empirical studies have clarified Front End practices (Brandtner, 2017). In this context, structuring the FEI by specifically addressing key activities at this early stage is emphasized.

Uribe Ocampo and Kaminski (2023) identify several gaps for further research, including fostering creativity in FEI, introducing methods and tools, and developing practical and usable models. Further research trends proposed by Joachim and Spieth (2020) include understanding the differences and similarities in FEI caused by different types of innovation (incremental, radical, service, or eco-innovation), improving knowledge about creativity in FEI (conceptualization, creative environment, methods, and tools), and furthering the understanding of the FEI process, activities, and decision-making.

Costa and Toledo (2016) and Seclen-Luna and López-Valladares (2020) argue that FEI needs to be consolidated regarding real model evaluations, proposals of specific and usable models, and the insertion of techniques to execute activities. Florén et al. (2017) indicate that although studies on FEI have evolved in recent years, they are incomplete and do not effectively help in their practical application in companies because it is not yet clear which activities should be executed at this stage, how to execute and control them, and what key results are expected. Park et al. (2021) noted that most existing models are procedural, considering "what" tasks and activities should be carried out, while few are performative, considering "how" tasks and activities can be executed. They indicated that a model effectively balancing performative and procedural styles has not yet been identified. While scholars like Brandtner (2017), Uribe Ocampo and Kaminski (2023), and Park et al. (2021) have made valuable contributions to understanding and structuring the FEI, their work primarily focuses on larger organizational contexts. The unique challenges and opportunities solopreneurs and small teams face in navigating the fuzzy front end of innovation remain underexplored, especially in light of rapidly evolving digital technologies (Nambisan et al., 2017).

Methodology

The background for this study extends to our ongoing research efforts to investigate FEI and New Product Development and develop practical guidelines for entrepreneurs and companies to navigate these crucial stages of venture creation in the digital age. At this point, our research team has explored traditional and new online models for generating business ideas and methods for validating business and product ideas. We have also focused on developing models for digital entrepreneurs for both ideation and idea validation. Considering the extensive academic research on FEI on the one hand and the academic gap for contemporary, contextual, and action-oriented models on the other, this study employs an Integrated Literature Review Methodology as a streamlined process. This approach allows us to efficiently direct our research efforts directly towards the study's objective, namely, developing a framework that supports the creation of new FEI models.

The *Integrative Literature Review Approach*, as Torraco (2005) outlined, maps the Front End of Innovation (FEI) and proposes a framework for building effective FEI models. This methodology was chosen for its ability to review, critique, and synthesise representative literature on a topic in an integrated way, facilitating the generation of new perspectives and frameworks.

The literature review process (stage one) began with an examination of the reference lists and citations in Brem and Voigt's (2009) and Brandtner's (2017) extensive works on FEI models. By examining these references, our starting base of papers was enlarged with notable works such as those by Cooper (1983), Koen et al. (2001), and Boeddrich (2004). Examination of these papers helped us refine the terminology, specifically the use of relevant keywords for the FEI domain, for further literature sourcing. In the second stage, literature was sourced primarily from Scopus and Google Scholar, chosen for their extensive coverage of academic publications across multiple disciplines. This initially gave us a list of over 250 works that was then reduced to around 50 (stage three), while only 22 were included in the literature review and the 12 most relevant (for our framework) in the literature overview (Table 2).

The selection of representative literature (stage three) was guided by four key criteria: quality, credibility, relevance, and diversity. The quality and credibility of the literature were assessed based on the reputation of the authors, the rigor of the methodologies used, and the consistency of the findings. Studies directly addressing FEI models or related concepts were prioritized, and efforts were made to include a broad spectrum of perspectives to capture the evolution of thought in the field. Additionally, the number of citations was used as an indicator of the influence and relevance of each study, with recent papers included to ensure the review reflects the current state of research.

A manual systematic data analysis process was implemented to record key details from each selected study, focusing on important dimensions of FEI models. The extracted data was then synthesized thematically, identifying recurring patterns, emerging trends, and gaps in the literature. The Integrative Literature Review Approach allowed for a comprehensive analysis of existing FEI models and approaches. Each identified model or approach was critically analyzed, examining its strengths, weaknesses, underlying assumptions, and contexts in which it was developed or applied. This critical analysis formed the basis for the subsequent synthesis. The synthesis phase involved looking for patterns, commonalities, and differences across various FEI approaches. This process aimed to create a more holistic understanding of FEI, going beyond mere summarization to generate new insights and perspectives.

Based on this synthesis, we developed new recommendations for building FEI models. These recommended approaches are organized around six key dimensions identified through our analysis. The integrative approach allowed us to identify the key dimensions

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and the associated gaps in existing literature, specifically the developed FEI models, and propose ways to address these gaps. For instance, our emphasis on data-driven approaches and integrating toolkits into the model structure addresses identified limitations in current FEI models.

This methodological approach is particularly suitable for a complex, multifaceted topic like FEI, where multiple perspectives and approaches exist and where more comprehensive, integrated frameworks are needed to guide both research and practice. The resulting framework and recommendations aim to bridge theory and practice, providing insights that are both academically rigorous and practically applicable in organizational settings.

A proposed framework for FEI model development (an overview)

The Front End of Innovation (FEI), also known as the Fuzzy Front End (FFE), is a critical phase in the innovation process that precedes formal product development (Kim & Wilemon, 2002). This phase is characterized by high levels of uncertainty and ambiguity, yet it significantly influences the success of new products and ventures. For entrepreneurs, particularly those operating in the digital space, navigating this phase effectively can mean the difference between a successful launch and a failed venture.

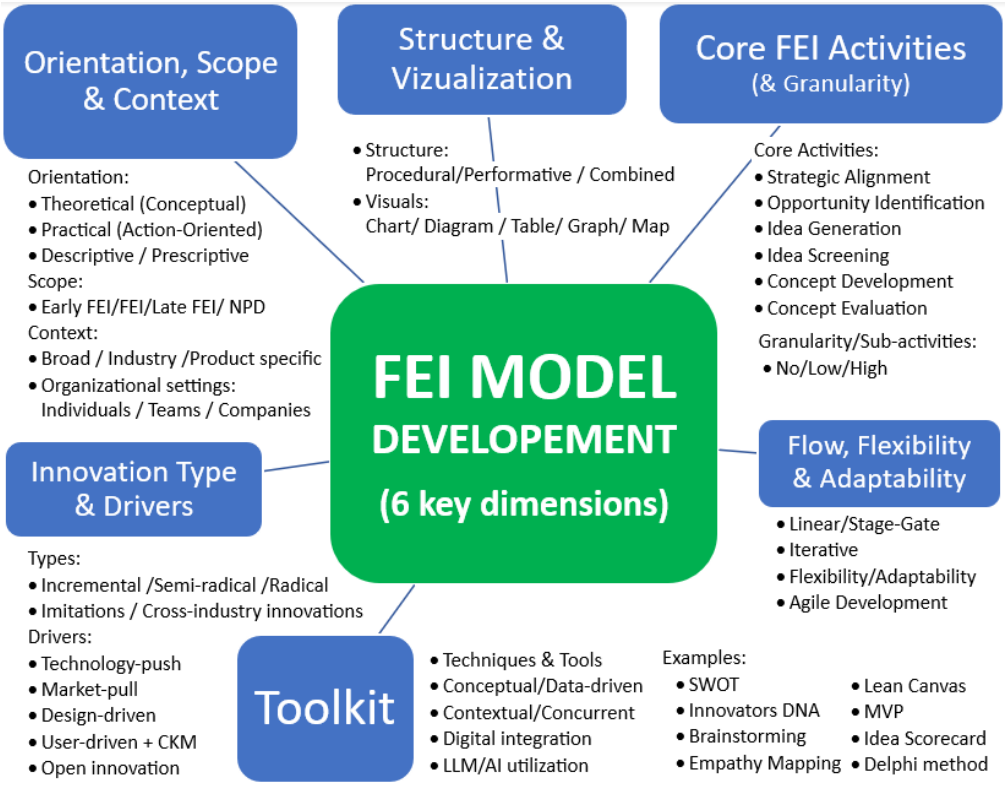

Figure 1. Framework for the development of FEI models
Source: own processing

Despite the extensive body of literature on FEI, the field lacks action-oriented (performative) models adaptable to different users, contexts, and industries. It also lacks a cohesive and adaptable framework that can effectively guide the development of FEI models across diverse organizational contexts and academic settings. In response to this critical gap, we propose a comprehensive framework (Table 2) that synthesizes key insights from existing research and delineates the essential dimensions of FEI models and

their features (Table 2). Building on the comprehensive review by Park et al. (2021), contemporary models from Brandtner (2017) and Uribe Ocampo & Kaminski (2023), and foundational FEI models such as those introduced by Koen et al. (2001) and Cooper (2008), our proposed framework aims to streamline the development of new idea generation models within the FEI phase. This framework is particularly tailored to address the complexities of an increasingly digitalized and rapidly evolving business landscape. It is designed to offer a structured yet flexible approach, enabling scholars and organizations to tailor their innovation model development to their unique challenges and objectives. By systematically addressing the complexities of the FEI phase, this framework empowers organizations to enhance their innovation capabilities and improve their likelihood of achieving market success. It also equips researchers to lead this process by utilizing the framework.

The proposed framework targets *six (6) key dimensions*, each deeply rooted in the relevant literature. These dimensions include *(1) Model Orientation, Scope and Context; (2) Innovation Type and Innovation Drivers; (3) Model Structure and Visualization; (4) Flow of Activities, Flexibility and Adaptability; (5) Core FEI Activities and Granularity; and (6) Toolkit,* incorporation FEI Tools and Techniques. These dimensions represent the most critical aspects of Front-End Innovation (FEI) models, as discussed in relevant FEI literature, while most extensively detailed in the research by Park et al. (2021). However, our framework reorganizes these features into a more intuitive and comprehensible structure, facilitating clearer understanding and better visualization as presented in the mind map (Figure 1).

Additionally, we have refined the terminology to align with the most prevalent terms used in innovation management and entrepreneurial literature. This reorganization, linguistic refinement and visual enhancement are intended to make the framework more accessible and understandable for both scholars and practitioners, ensuring it resonates with a broader audience. For each of the six dimensions outlined in the framework, we further present (below in the text) a focused analysis based on the integrative literature review. This includes a concise elaboration of each dimension's theoretical foundations, practical applications, and specific nuances. Additionally, we provide actionable approaches tailored to address the diverse needs and challenges encountered during the iterative development process (Table 2).

Table 2. FEI Framework for Building Idea Generation Models

FEI dimensions	Features	Recommended Approaches
1. Model Orientation, Scope and Context	**Orientation:** • Theoretical (Conceptual) • Practical (Action-Oriented) • Descriptive / Prescriptive **Scope:** • Early FEI/FEI/Late FEI/ NPD **Context:** • Broad / Industry /Product specific • Organizational settings: Individuals / Teams / Companies	• Focus on practical models • FEI & Early FEI Scope • Contextual Adaptability • Empirical Grounding • Prescriptive Clarity • Iterative Development
2. Innovation Type and Innovation Drivers	**Types of Innovation:** • Incremental /Semi-radical/Radical • Imitations/Cross-industry Innovations **Innovation Drivers:** • Technology-push • Market-pull • Design-driven • User-driven • Open innovation	• Incremental, radical and imitation innovation paths • Contextualization and conceptualisation • Customer Knowledge Management (CKM), • Open innovation approach • Sustainability focus

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FEI dimensions	Features	Recommended Approaches
3. Model Structure and Visualization	**Structure:** Procedural/Performative/Combined **Visuals:** Chart/Diagram/Table/Graph/Map	• Combining procedural structure with performative sub-activities • Modular design - based on project needs • Appealing Visual representation
4. Flow of Activities, Flexibility and Adaptability	• Linear • Stage-Gate • Iterative (loopbacks) • Flexibility/Adaptability • Agile (Rapid) Development	• Agile development (Preferred) • Stage-Gate hybrid (Option) • Implementing planned flexibility • Provide a feedback mechanism
5. Core FEI Activities and Granularity	**Core Activities (6):** Strategic Alignment, Opportunity Identification, Idea Generation, Idea Screening and Selection, Concept Development, Concept Evaluation and Validating. **Granularity/Sub-activities:** • No/Low/High granularity	• Inclusion of 6 core tasks • Contextual Simplification (3 of 4 rule) • Strategic Alignment Throughout • Cross-functional integration • Hierarchical Structure for sub-activities • Flexible Depth of granularity
6. Toolkit, FEI Tools and Techniques	• Conceptual/Data-driven • Contextual/Concurrent • Digital integration • LLM/AI utilisation	• Contextual Performance Tools • Tools for Concurrent Collaboration • Qualitative Focus • Integration of tools with Model • Digital Enablement • Leverage of LLM and AI

Source: based on the authors' insights

Our approach is designed to support continuous refinement of the framework by offering insights that can help adapt and evolve the model to suit different contexts and applications. This means that as new Front-End Innovation (FEI) models are developed, our guidance will assist in customizing the framework to fit both broad, general use cases and more specific, context-driven applications.

Dimensions of Front-End Innovation (FEI) models and proposed strategies for model development

This section explores the key dimensions of Front-End Innovation (FEI) models, which are vital for developing effective models aligned with organisational goals and adaptable to various innovation environments. We examine the six core dimensions, from methodological foundations to structural components, highlighting how these elements shape the innovation process. Following this, we offer specific recommendations for each dimension, providing actionable guidance for organisations. These recommendations emphasise flexibility and adaptability, acknowledging the need for customised approaches in unique innovation landscapes.

Model orientation, scope and context

The Model Orientation, Scope, and Context are crucial aspects of Front-End Innovation models. They encompass how these models are conceptualised, what they cover, and where they are intended to be applied.

Model orientation reflects the model's approach, ranging from theoretical to practical. Theoretical models provide high-level frameworks for understanding FEI processes, aiding academic research and organisational conceptualisation. In contrast, practical models offer concrete guidance for implementing FEI processes in organisations, often including specific tools and techniques. Within this spectrum, models can be either descriptive or prescriptive (Koen et al., 2001). Descriptive models explain how innovation occurs based on empirical research, identifying patterns and challenges in real-world innovation. Prescriptive models, on the other hand, propose optimised processes and best practices (what should be done), guiding organisations toward effective innovation.

Scope defines the model's coverage within the innovation process, ranging from models encompassing the entire New Product Development (NPD) process to those focused specifically on FEI. For example, the New Concept Development (NCD) model by Koen et al. (2001) focuses on FEI, while Cooper's Stage-Gate model (2008) covers the entire NPD process. Within FEI, there is a distinction between Early FEI (conceptualisation phase) and Late FEI (contextualisation phase), addressing strategic fit, idea generation, and preparation for formal product development.

Context in FEI models refers to the specific environmental and organisational factors the model addresses, including industry characteristics, product/service types, and organisational settings. Some models target specific sectors, while others are broader, addressing various organisational types, from large corporations to small start-ups and solopreneurs.

To effectively incorporate these elements into FEI models, consider the following recommended approaches:

- *Balancing practicality and theory:* While practical models are increasingly valued in the fast-changing business environment, it's essential to balance them with solid theoretical foundations. This ensures models are both academically robust and practically useful.
- *FEI scope with a degree of flexibility:* Recognizing the need for more focused attention on the FEI and specific stages of FEI, particularly the Early FEI, models should be designed with adaptable boundaries, maintaining the ability to integrate with broader New Product Development processes if needed. This allows specific innovation challenges to be addressed without losing sight of the overall innovation journey.
- *Contextual adaptability:* It is advisable to create models tailored to specific industries, products, or business models. Flexibility and adaptability should be built in, allowing customisation for various contexts while retaining core principles.
- *Empirical grounding:* Descriptive (and prescriptive) elements should be based on empirical research, leveraging big data, web-mining techniques, and management system information to accurately reflect real-world innovation complexities.
- *Prescriptive clarity:* When including prescriptive elements, models should provide clear rationales and, where possible, evidence for recommended practices. This can be achieved through the inclusion of case studies and illustrated scenarios, helping organisations understand not just what to do but why and how to implement these practices effectively.
- *Iterative development:* FEI models should evolve, incorporating feedback loops and empirical evidence from real-world applications to remain relevant and effective in changing business environments.

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Innovation type and innovation drivers

Innovation type and drivers are key dimensions that shape the structure and focus of FEI models, offering a framework for understanding the nature and origins of innovations. *Innovation type* refers to the degree of novelty, distinguishing between incremental, semi-radical, and radical innovations. Incremental innovation involves minor improvements to existing offerings, while radical innovation introduces entirely new products or models. Semi-radical innovation falls between these extremes, involving significant changes within an established framework. Imitation innovations (replications, copycats, shanzhai, cross-industry innovations) are also important and should not be overlooked for their potential in new venture creation (Frankenberger & Stam, 2020).

Innovation drivers refer to the sources of innovation, including Technology-push, Market-pull, Design-driven (Verganti, 2009), Open innovation (Chesbrough, 2003), and User-driven approaches (von Hippel, 2005), including structured CKM (Bratianu et al., 2021). These drivers influence the FEI process, with each approach offering distinct benefits. Contemporary FEI models often advocate for an integrated approach, combining these drivers for greater impact. For instance, Verganti's design-driven approach blends technology push with a focus on user experience, illustrating the synergy between different sources.

The interplay between Innovation Type and Drivers is dynamic. Radical innovations often emerge from technology-push or design-driven approaches, while incremental innovations align with market-pull or user-driven approaches. Imitation and cross-industry innovations are also vital, offering the potential for new venture creation.

To incorporate these dimensions into FEI models, consider the following recommended approaches: *multi-track innovation***:** support incremental, semi-radical, radical, and imitation innovation paths, enabling organisations to balance continuous improvement with disruptive opportunities; *contextualization and conceptualization:* tailor approaches during the early and later stages of FEI to align with the specific type of innovation pursued; c*ustomer knowledge management (CKM): integrate customer insights and feedback to enhance idea generation and co-create value, ensuring the innovation process aligns closely with market needs; open innovation integration:* leverage external ideas and technologies to accelerate innovation and reduce risks; s*ustainability focus:* address environmental and social concerns, uncovering new opportunities for innovation.

Model structure and visualization

The structure of Front-End Innovation (FEI) models is crucial for how organisations conceptualise and execute innovation. This dimension can be categorised into two main approaches: *procedural* and *performative. Procedural models* describe the sequence of innovation activities or stages, providing a step-by-step guide from initial ideas to developed concepts, like Cooper's Stage-Gate model (1990). *Performative models*, on the other hand, focus on the outcomes and effectiveness of the innovation process. They evaluate the success of the procedures and actions taken by assessing whether the desired results have been achieved. These models emphasise the practical effectiveness of innovation activities, measuring how well the innovation process meets its objectives and delivers value. Many contemporary FEI models blend these approaches. For example, the New Concept Development (NCD) model by Koen et al. (2001) combines a procedural framework with performative aspects, integrating key activities like opportunity identification with leadership and cultural elements.

The *visual representation* of the model is also an important aspect, enhancing understanding, communication, and implementation of FEI models. Common

visualisation techniques include diagrams, charts, conceptual maps, iterative cycles, tables, mind maps etc.

To effectively incorporate these structural elements into FEI models, these recommendations could be followed: *Hybrid structure:* this combination of a procedural framework with performative substructures offers a clear process while allowing flexibility in activities and emphasising organisational dynamics; *modular design:* create a customisable framework that adapts to different project needs, blending procedural and performative elements as needed; *effective visualization:* use clear, appealing and concise visual elements to aid understanding and implementation, making models more accessible and easier to apply.

Flow of activities, flexibility and adaptability

This dimension focuses on sequencing, organising, and adapting innovation activities within the dynamic environment of early-stage innovation. Traditionally, many product development models, including those covering the front end of innovation, followed a *linear or sequential structure*, exemplified by Cooper's Stage-Gate model (1990). While this approach provides clear guidance and control, it has become evident that innovation, especially in its early stages, is inherently iterative.

Iterative processes involve repeated cycles, each building on the previous one, reflecting the need for continuous learning and adaptation. *Flexibility* in FEI models goes beyond sequencing; it includes the model's adaptability to different contexts, project types, and changing circumstances. Such adaptability is vital in the diverse innovation landscape, where projects differ in scope, complexity, and uncertainty. *Agility*, originally from software development (as articulated in the Agile Manifesto by Beck et al., 2001), has increasingly influenced FEI models. Agile approaches emphasise flexibility, rapid prototyping, and continuous feedback, aligning well with the needs of front-end innovation. A notable example is the "Lean Startup" methodology by Ries (2011), which applies agile principles to innovation.

The shift towards more iterative, flexible, and agile FEI models highlights a better understanding of innovation's complex nature. However, even flexible models typically retain some level of structure or phases. To effectively incorporate this dimension into FEI models, consider the following approaches: *Agile development approach (preferred):* focus on improving the quality of information flow during iterations, ensuring each cycle builds meaningfully on the last; *Stage-Gate hybrid (option):* this model combines the decision points of the Stage-Gate model with flexible, iterative processes within each stage, blending structured decision-making with necessary adaptability; *planned flexibility:* balance structured processes with creative adaptation by defining clear phases or milestones while allowing flexibility in how teams achieve these points; *feedback mechanisms:* incorporate clear feedback loops throughout the process, involving internal stakeholders, potential users, and market insights to ensure the innovation process remains responsive and adaptive.

FEI core activities and granularity

Front-End Innovation (FEI) models typically outline core activities and sub-activities (granularity) that guide organizations from opportunity identification to developing well-defined concepts ready for further refinement. While specific terminologies may differ across models, a consistent set of core activities emerges in most FEI frameworks.

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The 6 core activities in FEI include:
1. *Strategic alignment:* Ensures innovation efforts align with organizational goals and market position. This involves analyzing resources, defining strategies, and establishing guidelines to drive continuous innovation.
2. *Opportunity identification:* Systematically scans the environment for potential innovation opportunities using trend analysis, market research, and technology forecasting techniques.
3. *Idea generation:* This process focuses on producing diverse solutions for identified opportunities through creativity techniques like brainstorming and design thinking, often involving cross-functional collaboration.
4. *Idea screening and selection:* Evaluates and filters ideas based on criteria like strategic fit and market potential, often using structured approaches like scoring models or innovation portfolios.
5. *Concept development:* Transforms selected ideas into detailed proposals involving product or service specifications, prototypes, and value propositions, often employing rapid prototyping and agile methodologies.
6. *Concept evaluation and validation:* Assesses developed concepts before formal development using feasibility studies, market analyses, and early customer feedback, often involving go/no-go decisions.

These activities, while not necessarily sequential, often overlap and interact. Additionally, different FEI models might emphasize certain activities over others or group them differently, but the core elements remain similar. For example, the New Concept Development (NCD) model by Koen et al. (2001) identifies five key elements that align with opportunity identification, idea generation, screening and conceptualization, but additionally adds the "engine" that resonates with the Strategic alignment.

Regarding the importance and the relevance of the proposed six core activities, Park et al. (2021) found that with over 64% prevalence, *idea generation, opportunity identification*, and *conceptual design* (as part of the wider *concept development*) were the most common activities found in FEI models. Furthermore, *strategic alignment* is frequently emphasized in front-end of innovation, where different studies (Boeddrich, 2004; Brandtner, 2017; Khurana & Rosenthal, 1998; Koen et al., 2001; Riel et al., 2013), while using varied terminology or focusing on specific aspects, consistently highlight the critical role of ensuring that innovation efforts align with an organization's strategic objectives. *Idea screening and selection*, regardless of that, is more often integrated with idea generation. Florén and Frishammar (2012) found it to be a distinct and important activity in many FEI models, which is in line with our observations in various studies (Boeddrich, 2004; Cooper, 1983; Koen et al., 2001; Sandmeier et al., 2004). Finally, the *concept evaluation and validation*, while typically associated with the NPD process that comes later, may also be critical in the FEI, as emphasized by Herstatt and Verworn (2004).

Granularity (the sub-activities) refers to the level of detail provided for each core activity. High Granularity models break down core activities into sub-activities or specific tasks, offering detailed guidance. For instance, opportunity identification might include sub-activities like environmental scanning, technology assessment and trend analysis. These models are useful for organizations or individuals new to structured innovation processes. Low Granularity models provide a high-level overview, offering more flexibility but less prescriptive guidance. The appropriate level of granularity depends on factors like organizational innovation maturity, project complexity, and team expertise. For example, experienced teams might favor lower-granularity models that offer flexibility, while less experienced teams might benefit from the detailed guidance of high-granularity models.

To effectively incorporate core activities and granularity into FEI models, these recommended approaches should be considered: *inclusion of core activities:* ensure all six core activities are included or consider combining related activities for efficiency. For example, strategic alignment could be integrated with opportunity recognition, idea

screening, and concept development; *contextual simplification (Minimum 3 of 4 rule):* to streamline the FEI process for specific contexts (e.g., solopreneurs or educational workshops), we suggest concentrating on the core activities that yield the highest value (Persimmon Principle). Although the most prominent core activities —opportunity identification, idea generation, concept development, and idea screening—are all important, we recommend focusing on at least three to enhance the efficiency and effectiveness of the FEI process in specific contexts; *strategic alignment throughout:* maintain a focus on alignment with overall business strategy to ensure that innovations contribute meaningfully to organizational goals; *Cross-functional integration*: promote collaboration across different functional areas to leverage diverse expertise and perspectives throughout the innovation process; *flexible depth:* different levels of granularity can be accommodated based on project complexity and team expertise, providing both high-level overviews and detailed breakdowns to suit varying needs.

Toolkit / FEI tools and techniques

The toolkit dimension in FEI models includes the specific tools, techniques, and methods used to support core activities and sub-activities in early-stage innovation. This dimension is essential as it connects conceptual frameworks with practical implementation, providing innovators with the means to execute various innovation processes. FEI toolkits vary in scope, specificity, and sophistication. Some models offer comprehensive tools for each activity, while others provide general guidance on tool selection. For example, models designed for experienced teams might focus on advanced techniques, whereas those aimed at beginners might prioritize more accessible, widely used tools.

A wide array of tools and techniques support different aspects of the innovation process, including: creativity tools (techniques like brainstorming, mind mapping, or SCAMPER for idea generation), analysis tools (methods like SWOT analysis, Porter's Five Forces, or PESTEL analysis), design tools (techniques from design thinking, such as empathy mapping, journey mapping, or rapid prototyping), decision-making tools (methods like decision matrices, Pugh concept selection, or the Analytic Hierarchy Process (AHP) for concept evaluation and selection), visualization tools (techniques like storyboarding, mood boards, or concept sketching to communicate and explore ideas) and collaboration tools (digital platforms or methodologies to facilitate team communication and idea sharing).

To integrate the toolkit dimension effectively into FEI models, take into consideration the following approaches: *contextual performance:* develop toolkits systematically interlinked for performance within specific contexts. For example, ensure tools for environmental scanning, market analysis, and technology assessment complement each other in opportunity identification; *concurrent collaboration:* design toolkit sets that facilitate collaboration across multiple functional domains, such as integrating ideation and strategic alignment tools to ensure creative ideas align with organizational strategy; *qualitative focus:* prioritize tools and techniques for processing qualitative data, which is often prevalent in the front end of innovation. This could include search engine data, advanced text analysis or sentiment analysis tools for customer feedback, and social media data; *digital enablement:* use digital tools to enhance collaboration and data analysis, such as online ideation platforms, idea management software, virtual reality prototyping tools, or AI-powered trend analysis software; *leveraging LLM and AI:* Incorporate Large Language Models (LLMs) and Artificial Intelligence (AI) to enhance FEI tools' capabilities or to facilitate techniques like SWOT analyses, brainstorming, or concept development.

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Discussion

This study proposes a comprehensive framework for developing Front-End Innovation models, addressing key gaps in existing literature and practice. The framework's six dimensions provide a structured approach to creating FEI models that are both theoretically grounded and practically applicable. In this section, we discuss the framework's academic and practical implications, limitations, and directions for future research.

Academically, the framework contributes to the discourse on FEI by synthesizing insights from various existing models and recent research, providing a more comprehensive understanding of FEI. Bridging the gap between theoretical concepts and practical applications lays a foundation for future research in this field and equips scholars with a tool to develop new FEI models. The framework's emphasis on flexibility and adaptability allows for the development of models tailored to different types of innovation, organizational contexts, and emerging methodologies, thus addressing the need for more versatile FEI models, as identified in previous research.

Practically, the framework offers several benefits for organizations and innovation practitioners. It enables the development of FEI models customized to the specific needs, industry contexts, and innovation goals, thereby addressing the gap between theoretical models and practical implementation noted in previous studies. Moreover, the framework's emphasis on integrating various tools and techniques can improve an organization’s overall innovation capability, leading to more effective and efficient innovation processes. These tools and techniques include but are not limited to Digital integration, Customer Knowledge Management, Open Innovation, Large Language Model utilization etc.

Despite these contributions, the proposed framework also has several limitations. While the Integrative Literature Review Approach (Torraco, 2005) provided a comprehensive background for synthesizing relevant literature, it carries inherent limitations. It brings certain challenges such as subjectivity in literature selection, omission of unpublished, new studies, overlooking practitioners' reports or other “grey literature” sources, etc. Additionally, while the synthesis and interpretation of literature are systematic, they are inevitably influenced by the researchers' perspectives, potentially impacting, for example, the identification, formulation and grouping of key dimensions in the proposed framework. Several additional limitations to the proposed framework are not directly linked with the methodology used. First, while it seeks to bridge the gap between theory and practice, its theoretical nature means that its effectiveness in real-world settings still requires empirical validation. Additionally, the framework's multidimensional structure may present challenges in implementation, especially for smaller organizations or those unfamiliar with structured innovation processes. Another concern is context specificity; although the framework aims to be adaptable, some aspects may be more applicable to certain industries or organizational types, necessitating further research to assess its effectiveness across diverse contexts.

This study additionally opens several avenues for future research. One key area is the empirical validation of the framework across different organizational contexts, industries, and innovation types. Future studies could also explore integrating emerging hybrid methodologies, such as combining Design Thinking and Lean Startup, within the framework to enhance its practical applicability. Another promising area of investigation is the role of AI and LLM in enhancing Front-End Innovation processes, particularly in idea generation, developing concepts and early-stage validation. Furthermore, research could focus on incorporating emotional and cognitive factors of creativity and innovation into the framework, potentially leading to more holistic FEI models. Lastly, studying the framework's applicability and necessary adaptations in different cultural contexts could enhance its global relevance.

While the proposed framework addresses several key gaps in FEI research and practice, it also opens up new questions and research directions. As innovation management continues to evolve, frameworks like this one will play a crucial role in bridging theoretical advancements with practical applications, ultimately contributing to more effective and efficient innovation processes in organizations.

Conclusions

This study introduces a comprehensive framework for developing Front-End Innovation (FEI) models, addressing a critical gap in both academic literature and practical application. The proposed framework synthesizes key insights from existing research and delineates six essential dimensions of FEI models: (1) Model Orientation, Scope and Context; (2) Innovation Type and Innovation Drivers; (3) Model Structure and Visualization; (4) Flow of Activities, Flexibility and Adaptability; (5) Core FEI Activities (and Granularity); and (6) Toolkit, including FEI Tools and Techniques.

The FEI framework's key features include a holistic approach covering all crucial aspects; adaptability to various contexts and innovation types; both theoretical foundations and practical aspects; addressing the visual structural clarity; incorporation of modern concepts such as digital integration, customer knowledge management, agility and open innovation and emphasizing the important toolkit dimension that bridges conceptual frameworks with practical implementation.

The benefits of this framework are multifaceted. For academics, it provides a structured approach to analyzing and developing FEI models, potentially leading to more cohesive research in the field. For practitioners, including entrepreneurs, innovators, and R&D teams, it offers a systematic guide to creating tailored FEI models that align with their specific needs and contexts. This can lead to more effective innovation processes, better resource allocation, and ultimately, higher success rates in new products and venture development.

By addressing the complexities of the FEI phase in a structured yet flexible manner, this framework empowers organizations to enhance their innovation capabilities and improve their likelihood of achieving market success. As the business landscape evolves rapidly, particularly in the digital sphere, this framework provides a robust foundation for developing FEI models that can adapt to changing circumstances while focusing on effective innovation practices.

Future research could focus on empirically validating the framework across various industries and organizational types and exploring how emerging technologies like AI and machine learning can be integrated into FEI models developed using this framework.

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