The Hybrid Model Matrix. Enhancing Stage-Gate with Design Thinking, Lean Startup, and Agile

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10 July 2024

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Managers can use the Hybrid Model Matrix to decide when to use design thinking, Lean Startup, or Agile with Stage-Gate to boost new product development.

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Overview: The Hybrid Model Matrix supports managers' decision-making regarding which new product development (NPD) processes to activate for a specific project. Stage-Gate is the backbone process of the matrix, and design thinking, Lean Startup, and Agile are plugged in to create three different hybrid models. The matrix also provides guidance regarding when R&D managers might use each model. The Hybrid Model Matrix outlines four approaches—linear Stage-Gate and the three hybrid models—that R&D managers may activate selectively based on company knowledge of users and categories. R&D managers can use the Hybrid Model Matrix to guide NPD projects better since they can determine the most suitable model given each opportunity's specific context.

Keywords: New product development, Hybrid model, Stage-Gate, Agile, Design thinking, Lean Startup

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Given the complexity of new product development (NPD) within manufacturing firms, linear NPD processes such as the traditional Stage-Gate cannot handle the iterative cycles and external collaboration that characterize today's product development efforts (Sommer et al. 2015). To be innovative, organizations need to embrace flexibility and agility to respond effectively to the external environment (Magistretti et al. 2019). Research shows that some manufacturing organizations have successfully implemented the Agile–Stage-Gate hybrid model (Sommer et al. 2015): they have embedded Agile methodologies within the Stage-Gate process, supported customers' involvement in the process, and improved responsiveness to changing customer needs (Cooper 2016). A new set of hybrid models has emerged that involves design thinking and Stage-Gate (Franchini, Dosi, and Vignoli 2017), and Lean Startup and Stage-Gate (DelVecchio, White, and Phelan 2013).

Our research considers the Stage-Gate process as the leading NPD model with its hybridization with Agile development, design thinking, and Lean Startup. Companies struggle to use such hybrid models due to inherent tensions between the iterative methodologies and the traditional gating system (Cooper and Sommer 2018), and because the underlying philosophy of these methodologies often conflict with the existing organizational culture (Mahmoud-Jouini, Fixson, and Boulet 2019). We conducted a case study with a global manufacturer that currently uses hybrid models, and we share our Hybrid Model Matrix to help R&D managers in implementing hybrid models.

Theory and Research Question

Introduced in the 1980s, Stage-Gate remains the most widely adopted NPD process. Major corporations still use it (Cooper 2016). Companies have tried to adapt Stage-Gate based on a project's complexity and risk (Cooper 2014) and its type and size (Vedsmand, Kielgast, and Cooper 2016).

In 2000, Agile entered the manufacturing world from the software industry. It made the Stage-Gate process more flexible, increased the success rate of innovation projects (Misra, Kumar, and Kumar 2009), and improved cost control, product functionality, and on-time delivery (Karlstrom and Runeson 2005). The Agile–Stage-Gate hybrid model incorporates Agile scrum cycles during the development and testing stages within the Stage-Gate process (Cooper and Sommer 2016; Magistretti et al. 2019).

Other hybrid models emerging in companies' NPD processes include design thinking (Brown 2008) and Lean Startup (Ries 2011) practices. For instance, Procter & Gamble uses design thinking to support development teams in idea development, team achievement, and learning (Carlgren, Rauth, and Elmquist 2016), while General Electric has developed FastWorks, a framework based on Lean Startup principles such as rapid deliverables and continuous learning, to accelerate the NPD process (Power 2014).

Senior managers are often reluctant to abandon traditional Stage-Gate processes. They have concerns about introducing hybrid models due to inherent tensions between the Stage-Gate process and Agile (Cooper 2016), design thinking (Hölzle and Rhinow 2019), and Lean Startup (DelVecchio, White, and Phelan 2013) methodologies. It can also be difficult to challenge consolidated organizational practices and transform a company's organizational culture from a Stage-Gate structured paradigm to a more creative and dynamic innovation engine (Meyer and Marion 2010). The literature recommends using the established Agile–Stage-Gate hybrid model "in more ambiguous and uncertain initiatives . . . to help reserve Agile for projects that truly need it" (Cooper and Sommer 2018, p. 25) as that hybrid model requires dedicated resources. Researchers do not agree about which stages and for which projects Agile will work (Cooper and Sommer 2018). In addition, scant literature exists regarding hybrid models that rely on design thinking and Lean Startup methodologies.

Design thinking, Lean Startup, and Agile development are assimilated methodologies at the organizational level that support NPD processes as stand-alone methodologies or in hybrid models. Given their widespread diffusion, we aimed to understand the main variables that signal when to use hybrid models and to investigate in which phases of Stage-Gate companies should embed a specific methodology (design thinking, Lean Startup, and/or Agile).

Methodology

We opted to conduct a single case study (Eisenhardt 1989) of a representative company (Siggelkow 2007) that used Stage-Gate as its standard NPD process, and design thinking, Lean Startup, and Agile methodologies to support NPD. The selected company, which remains anonymous because some of the NPD projects we present are ongoing, is a global leader in the food and beverage industry. To guarantee proximity to the field and to understand practices as they happen, one coauthor was involved in a one-year study of the company's R&D. We performed 28 interviews with managers from R&D, Marketing, HR, and Finance (average time length 56 min), three meetings with the Design Thinking Head (average time length 91 min), and a three-hour workshop with 12 participants from the R&D, Marketing, and Strategy departments (Figure 1). We recorded, transcribed, and analyzed data, and we triangulated interviewees' answers with official company documents (Jick 1979). We conducted our research in four phases.
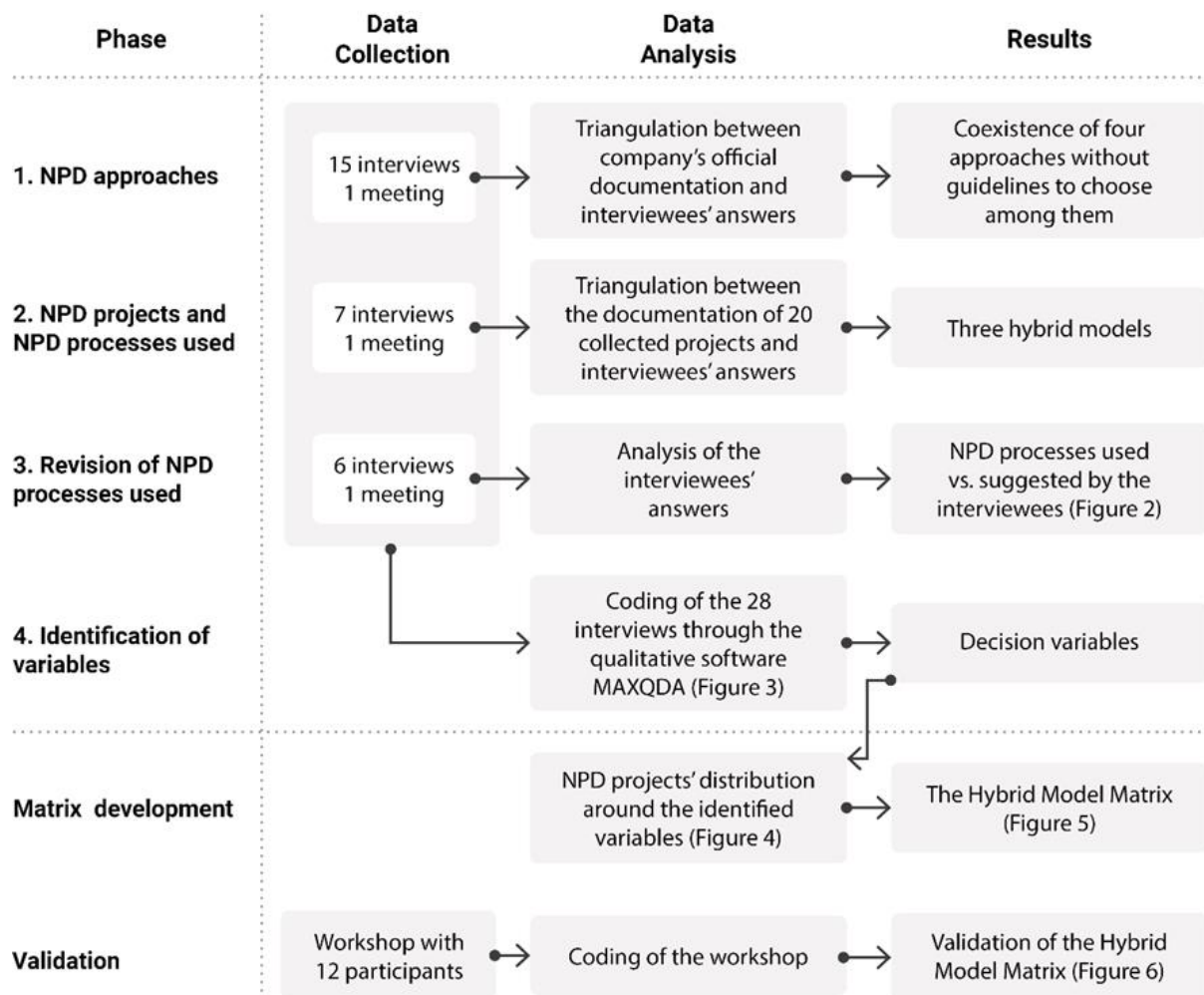
Figure 1: Methodology

Phase 1—NPD Approaches

In Phase 1, we aimed to understand how the company implemented the different NPD approaches. Stage-Gate is the company's main NPD process, but for the last five years it has used design thinking, Lean Startup, and Agile methodologies to support NPD. The company has developed internal organizational structures and processes to apply the three methodologies, but managers have no formal guidelines regarding when to activate them.

Phase 2—NPD Projects and NPD Processes Used

The Phase 2 interviews went deeper at the project level. We asked interviewees to recall the most interesting NPD project in which they were involved, describe the project and process used, and explain what worked and what did not. We identified 20 projects, and for each we traced the NPD process and whether the company hybridized the Stage-Gate process. We identified three different hybrid models.

Phase 3—Revision of NPD Processes Used

The fact that managers selected a specific NPD process for those 20 projects does not mean

that it was the best choice. The company has no formal guidelines to determine which NPD process to use nor does it have any shared knowledge about when to use the three identified hybrid models. During the Phase 3 interviews, we selected six senior R&D and marketing managers, and we asked them to reflect on whether they would have selected the same NPD process for each of the 20 projects. In the cases where the interviewees indicated they would have selected a different NPD process, we asked them what process they would have chosen among the four identified NPD processes and why (Figure 2).

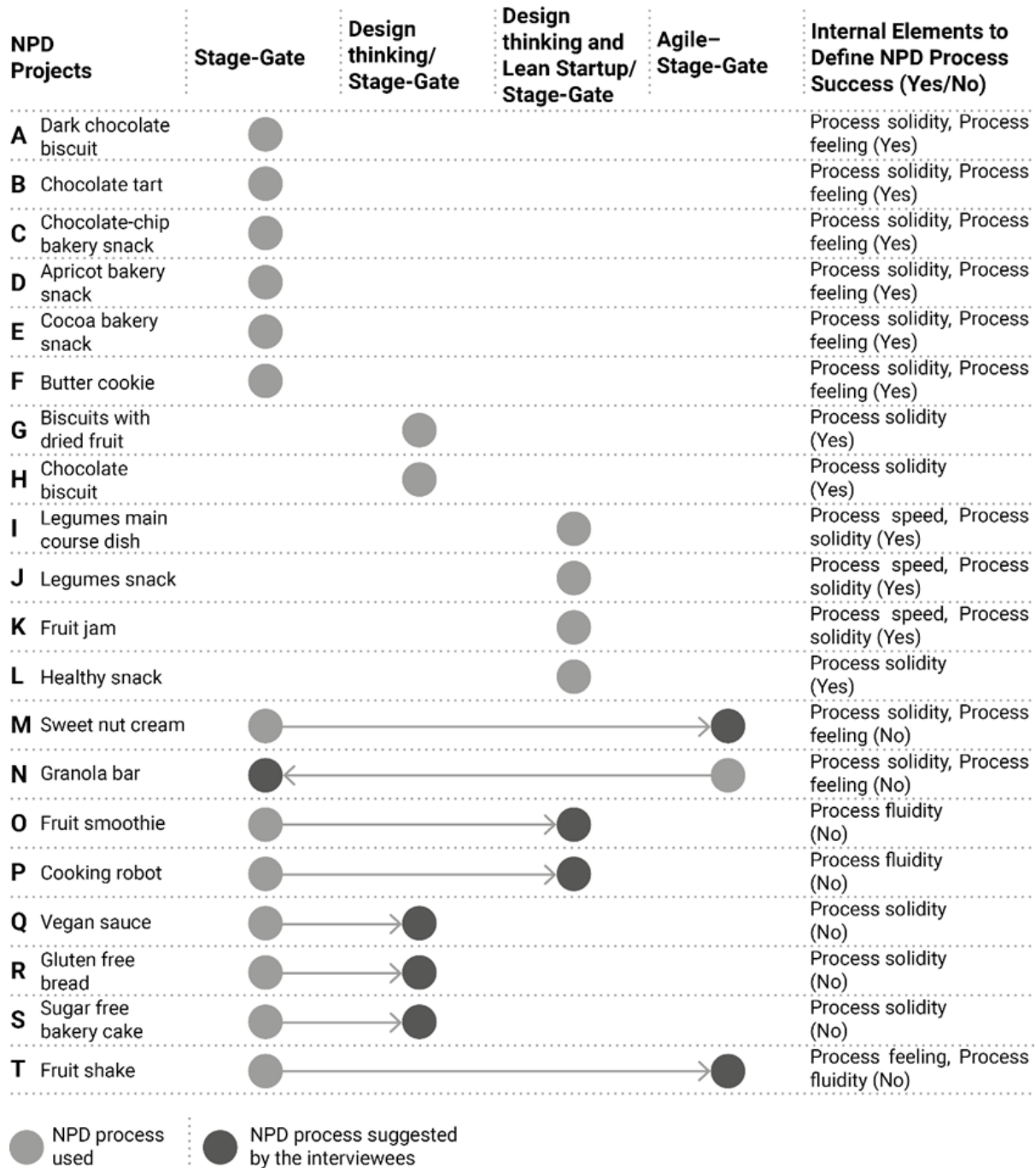| NPD Projects		Stage-Gate	Design thinking/ Stage-Gate	Design thinking and Lean Startup/ Stage-Gate	Agile–Stage-Gate	Internal Elements to Define NPD Process Success (Yes/No)
A	Dark chocolate biscuit	used				Process solidity, Process feeling (Yes)
B	Chocolate tart	used				Process solidity, Process feeling (Yes)
C	Chocolate-chip bakery snack	used				Process solidity, Process feeling (Yes)
D	Apricot bakery snack	used				Process solidity, Process feeling (Yes)
E	Cocoa bakery snack	used				Process solidity, Process feeling (Yes)
F	Butter cookie	used				Process solidity, Process feeling (Yes)
G	Biscuits with dried fruit		used			Process solidity (Yes)
H	Chocolate biscuit		used			Process solidity (Yes)
I	Legumes main course dish			used		Process speed, Process solidity (Yes)
J	Legumes snack			used		Process speed, Process solidity (Yes)
K	Fruit jam			used		Process speed, Process solidity (Yes)
L	Healthy snack			used		Process solidity (Yes)
M	Sweet nut cream	used			→ suggested	Process solidity, Process feeling (No)
N	Granola bar	suggested ←			used	Process solidity, Process feeling (No)
O	Fruit smoothie	used		→ suggested		Process fluidity (No)
P	Cooking robot	used		→ suggested		Process fluidity (No)
Q	Vegan sauce	used	→ suggested			Process solidity (No)
R	Gluten free bread	used	→ suggested			Process solidity (No)
S	Sugar free bakery cake	used	→ suggested			Process solidity (No)
T	Fruit shake	used			→ suggested	Process feeling, Process fluidity (No)

● NPD process used   ● NPD process suggested by the interviewees

Figure 2: NPD processes used vs. suggested by interviewees

When explaining why a process was appropriate or not, interviewees mentioned internal NPD process elements. Process speed is one of the most cited as are process fluidity, solidity of the

process, and process feeling. When interviewees referred to those elements, they used expressions such as "We were stuck" and "We had to start all over again" (process fluidity); "We had enough data" and "We needed more information to design" (process solidity); and "We felt safe" and "The project had lights and shadows" (process feeling). Interviewees did not refer to the success of a product on the market as an element to understand whether the process was good enough, as too many variables beyond the NPD process can affect its outcome.

Phase 4—Identification of Variables

We performed qualitative data analysis by coding key passages in which the interviewees recalled an NPD process decision. We used the qualitative software MAXQDA for our qualitative data analysis. Following the coding technique described by Gioia, Corley, and Hamilton (2013), we identified recurrent categories emerging from interviewees' words such as "new category," "existing category," "consumer driven," and "consumer need." We then aggregated them into second-order themes such as "knowledge about product category" and "knowledge about users" and obtained a set of more abstract categories that identify our decision variables (Figure 3).
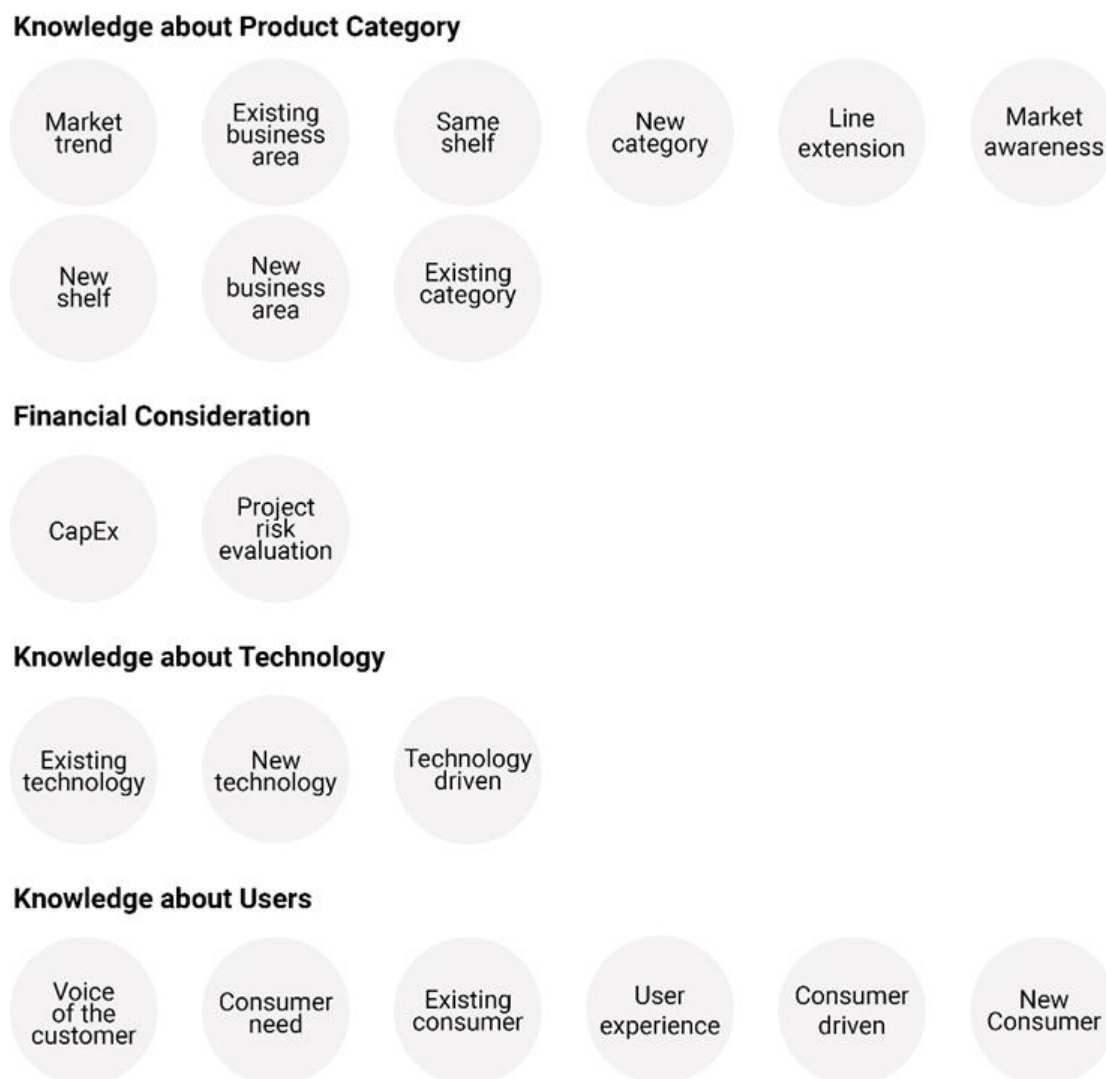

Figure 3: Data structure

Results

We present our results according to the four phases in our methodology.

Phase 1— Coexistence of Four Approaches Without Guidelines to Choose Among Them

We found that managers can activate design thinking, Lean Startup, and Agile development when needed, depending on available organizational resources—such as support from business units, budget to back NPD projects, and specialists' availability—even if no activation guidelines are present in the official documentation. No company structure supports management decision-making in understanding when, for a given project, it makes sense to activate one methodology over another. Managers have developed a practical understanding of the advantages and values of each NPD process.

Stage-Gate—The company has been using the typical 5-Stage 5-Gate process (ideation, concept, business case, development, testing, launch, and post-launch review phases) since the 1990s to support its product launches. Shorter Stage-Gate versions (3-Stage 3-Gate and 2-Stage 2-Gate processes) can be activated in cases of incremental improvements or small investments. To classify NPD projects and decide which Stage-Gate versions to adopt, the company uses a framework based on two variables: knowledge about the product category and the project's estimated capital expenditures (CapEx). The company assigns a formal leader and team to each Stage-Gate project, and it provides senior management gatekeepers who assess the project's progress.

Design thinking—The company created a Design Thinking Area within its R&D department early in 2015 to support projects using design thinking. The company has two fulltime design thinking experts. Through internal structured processes, any project leader from any department can ask for methodological support. In the design thinking projects, the appointed team aims to learn about user needs and habits, discover the solution design principles, and develop functional elements of the product. The most common tools used are contextual interviews, observations, online surveys, personas, customer journey maps, "how might we" questions, mind maps, brainstorming, storyboards, and rough prototypes.

Lean Startup— The Open Innovation department is the company reference point for the Lean Startup approach, and any project leader can ask for methodological support. When the company uses Lean Startup to develop a project, it selects a team that can be either internal or external. The goal is fast delivery of a product to market, to test design and business assumptions—for example, recipes, price, supply chain relationships, and shelf positioning. The team first identifies a set of hypotheses and then deploys the Build-Measure-Learn cycle.

Agile development— The company uses Agile to speed up the NPD process, build in the voice of the customer, and empower the team in making decisions. When the company develops a project phase using Agile, it creates a cross-functional team of 11 people dedicated full-time to the project to develop and iteratively test product, price, packaging, and other attributes with customers. Typical Agile elements used during the projects include the product and sprint backlog, to the scrum board and the daily stand-up meeting.

Phase 2—Three Hybrid Models

Out of the 20 projects, we found that the company used Stage-Gate for 13 and 3 specific hybrid models for the remaining 7.

Design thinking/Stage-Gate— During the ideation phase, the company uses the design thinking methodology to support the Stage-Gate process. The NPD process starts with a product vision. For example, Project G started with the vision "We need a biscuit with dried fruit" (see "Project G: Biscuits with Dried Fruit"). The design thinking methodology develops the product vision by generating different coherent ideas, making them tangible through rough prototypes, and gathering user feedback. Users' interactions with prototypes provide priceless reactions that the company analyzes to design around them. The Project G design thinking team tested rough prototypes of different shapes and different ingredients and understood which ones best fit users' needs. Once the team validated the ideas, it managed the other phases of the NPD process (concept, business case, development, testing, and launch) through Stage-Gate. Depending on each project's specifics, the Design Thinking Area decides whether to support the internal team with external resources. When using internal resources, the Design Thinking Area creates a team of expert employees from different departments and involves the Design Thinking coach to facilitate the process. For external resources, the Design Thinking Area partners with design studios, universities, or other research organizations that report the research progress weekly to the appointed company team. In all cases, the process lasts from 4 to 14 weeks.

Project G: Biscuits with Dried Fruit

Project G entailed exploring the dried fruit market trend to exploit it within the company's own biscuit category. Biscuits are one of the company's most profitable categories, but dried fruit users were completely new. The challenge was wide, and the team decided to ask the Design Thinking Area for methodological support to explore how users could react to the many ways in which the dried fruit could be mixed with a biscuit. The Design Thinking Area involved an external research organization for the ideation phase. The design thinking methodology support lasted eight weeks. The external research organization updated the company's internal team weekly, and the internal team participated in the design of the rough prototypes that the external team tested. The results confirmed the dried fruit trend. The company approved a final product idea of a crisp biscuit with two different dried fruits with specific elements regarding the shape, the ingredients, and the packaging's sustainability. The product idea, along with insights from users regarding the moment of consumption (snack), refined the initial product vision, which was a generic biscuit with dried fruit. The company then used Stage-Gate to manage the project.

Design Thinking and Lean Startup/Stage-Gate— This hybrid model supports the ideation and concept phases with design thinking and the business case phase with Lean Startup. The company uses this model when no product vision is evident at the outset. For example, Project I started with a broader challenge: "How might we embed the legumes trend within our products to respond to the increasing healthiness request?" (see "Project I: Legumes Main Course Dish"). The design thinking methodology reframes the problem in the ideation phase mainly by conducting user interviews and gathering observations. For example, Project I's team realized that users wanted to feel a raw sensation, have a poly-sensorial experience, and express their creativity while cooking a dish with legumes. Accordingly, the team designed a product idea of "legumes seeds." In the concept phase, the design thinking methodology

defines the product concept's general attributes (packaging, brand choice, or general recipe) by iteratively developing and testing rough prototypes and by defining the design principles— namely, the attributes that the product needs. Project I design principles included the shape of the pieces (diamond-like shape), the number of legumes (a mix of three different legumes), and the recipe (100 percent legumes flour). At the end of the concept phase, the design thinking methodology offers a physical product concept, which the company turns into a minimum viable product (MVP) to kick off the business case phase with the Lean Startup methodology. In this phase, the team launches the MVP on the market to experiment with unclear business decisions (such as shelf positioning, brand positioning, or packaging). Once the company validates the business case, the project follows development, testing, and launch phases with the Stage-Gate process. The design thinking phases last between three and nine months, depending on the depth of the challenge. Once an MVP is developed, the company can either involve a retailer or form a startup to run the Lean Startup experiments on the market.

Project I: Legumes Main Course Dish

Project I aimed to answer the question: "How might we embed the legumes trend within our products to respond to the increasing healthiness request?" Given the company's limited knowledge of the users—that is, the legumes lovers or carb-fear users—and the lack of clarity about the product category, the Design Thinking Area involved a partner university in the project. The project excluded a pasta solution as healthy users were not considering carbs a viable option. During the ideation phase, the design thinking team realized that users wanted to feel a raw sensation, by recognizing the authenticity of the ingredients they use to cook; to have a poly-sensorial experience, by feeling different texture to perceive the meal as extremely tasty; and to express their creativity while cooking a dish with legumes. The ideation phase concluded with a product idea of "legumes seeds" having different types of pressed legumes flour. During the concept phase, the design thinking team gathered useful information from the users' interaction about the shape of pieces (diamond-like shape), the number of legumes (mix of three different legumes), the number of ingredients per piece (each grain made of a single legume), and the composition (100 percent legumes flour). The team tested several prototypes until it chose the final concept that represented a range of main course or side dishes that were made of 100 percent legumes flour processed into diamond-shaped grains. The project entered the business case stage with several open questions such as which shelf (rice, legumes and cereals, other shelves), what format (single portion, three people portions, family pack, other formats), and which brand. The company tested the first version of the product at a big retailer. After a year of iterations and tests conducted using Lean Startup principles, the company structured the market launch of the product and the project went through the final phases of the Stage-Gate process (development, testing, and launch). The product is now part of the company's offerings in European markets, and the company is evaluating a US-market launch. Project I is a successful example of a hybrid model.

Agile–Stage-Gate— Agile development scaffolds the Stage- Gate process in the development and testing phases to acquire knowledge about some category dynamics. The company uses Stage-Gate to manage previous and successful phases. For example, Project N had to improve the product visibility within the market shelf and test different prices (see "Project N: Granola Bar"). To do this, the Agile team iteratively delivered different versions of the product in six different stores for a period of six months. The team gathered insights directly from the field through qualitative (interviews) and quantitative (shelf-rotation measures) methods and iteratively refined the product variables under investigation. The Agile team comprises 11 full-

time internal experts who have the authority to make decisions based on the field analysis. The Agile team presented all results gathered in the development and testing gates.

Project N: Granola Bar

Project N's purpose was to develop a variant of an existing granola bar. During the development and testing NPD phases, Agile development supported the Stage-Gate process. In the project's development phase, the company conducted a feasibility and viability check. The company needed to understand how to improve the product visibility within the market shelf, given that the packaging of the basic version of the product did not reflect its "premium" qualities. It also needed to evaluate whether or not the product supported a higher price than its basic version. The Agile team designed several experiments around packaging and price options and tested them within different stores. The company discussed the gathered results during the gates. Project N went through the launch phase of the Stage-Gate process. The product is now successfully placed within the Italian market.

Phase 3—NPD Processes Used versus Suggested by Interviewees

For 12 projects out of 20, we found agreement among interviewees regarding the NPD processes used and the NPD processes the respondents suggested. For example, when talking about Project I, interviewee 13 reported, "The case of the Legumes Main Course Dish proves that the integration between emergent methodologies, like design thinking and Lean Startup, and our classical innovation process makes sense. . . . The use of design thinking and Lean Startup in the first phases of the project allowed us to speed up the development process."

For the remaining eight projects, interviewees suggested a different process. For instance, when talking about Project P, interviewee 1 stated, "After the launch, we realized that the product concept did not work . . . and we found ourselves trying to redesign the solution. . . . It happened because we have not explored enough. In those cases, the involvement of the Design Thinking Area since the beginning would have helped because it would have clarified what the drivers are, what the design principles are, and what the right user experience is."

Phase 4—Decision Variables

The company's official documentation does not specify any procedure that identifies the most appropriate hybrid model to use at the beginning of a new project. Stage-Gate is the only standard process, and managers can modify it by introducing one of the other three methodologies. However, the choices managers make are not necessarily based on shared best practices, and they depend on the specific manager or situation. When asked, our interviewees could not explain what variables drive management to decide which methodology to embed in the Stage-Gate process. Interviewees often provided detailed explanations about why they chose (or would have chosen) a specific methodology for a project.

Knowledge about product category and about users emerged as crucial discriminant variables to identify the proper NPD methodologies that hybridize the Stage-Gate process. For example, regarding knowledge about users, interviewee 4 reported, "We worked together with the Design Thinking Area on the legumes snack project [Project J]. . . . I believe that such deep analyses are needed when the project involves a new consumer—namely, people interested in

a world that the company does not know yet, because in these cases the Stage-Gate analyses only are not enough."

According to the interviewees and the company's official documentation, financial consideration is an element that defines project risk assessment and portfolio decisions, and it is not viewed as a variable that should drive the selection of the NPD methodology. Interviewee 13 said, "If a project exceeds a certain amount of CapEx, it is now managed as a key project, no matter the fact that it is just the improvement of an existing product . . . but the driver to identify innovation paths should not be the CapEx of the project."

Our interviewees also indicated that technological knowledge should not be a relevant variable in the NPD methodology selection because every project has to face this issue during the technical feasibility assessment, and it impacts the depth and length of the NPD process. Interviewee 13 said, "Every time we develop a project, we need to face some questions. Does the technology exist? Does the company own the technology? These questions address the feasibility assessment, which in turn allows understanding of how many NPD phases the project needs to go through."

The Hybrid Model Matrix

From our study we determined two relevant variables that should inform the selection of the most suitable NPD methodology: knowledge about users and knowledge about product category. We defined a 2x2 matrix and classified the 20 collected projects within the four quadrants (Figure 4).
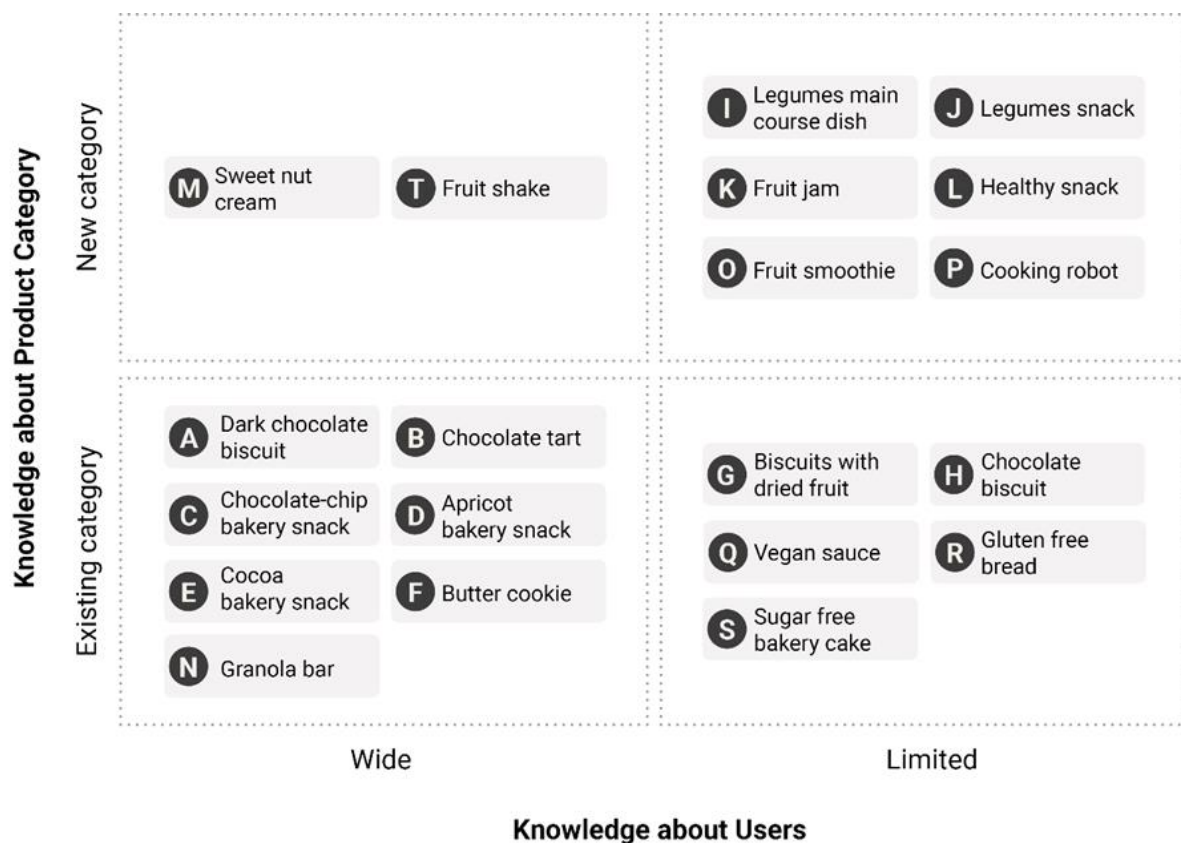

Figure 4: NPD projects' distribution around the identified variables

By placing the 20 projects within the matrix and observing what NPD process the interviewees suggested for each project, we realized that each quadrant presented a specific NPD model (Figure 5).
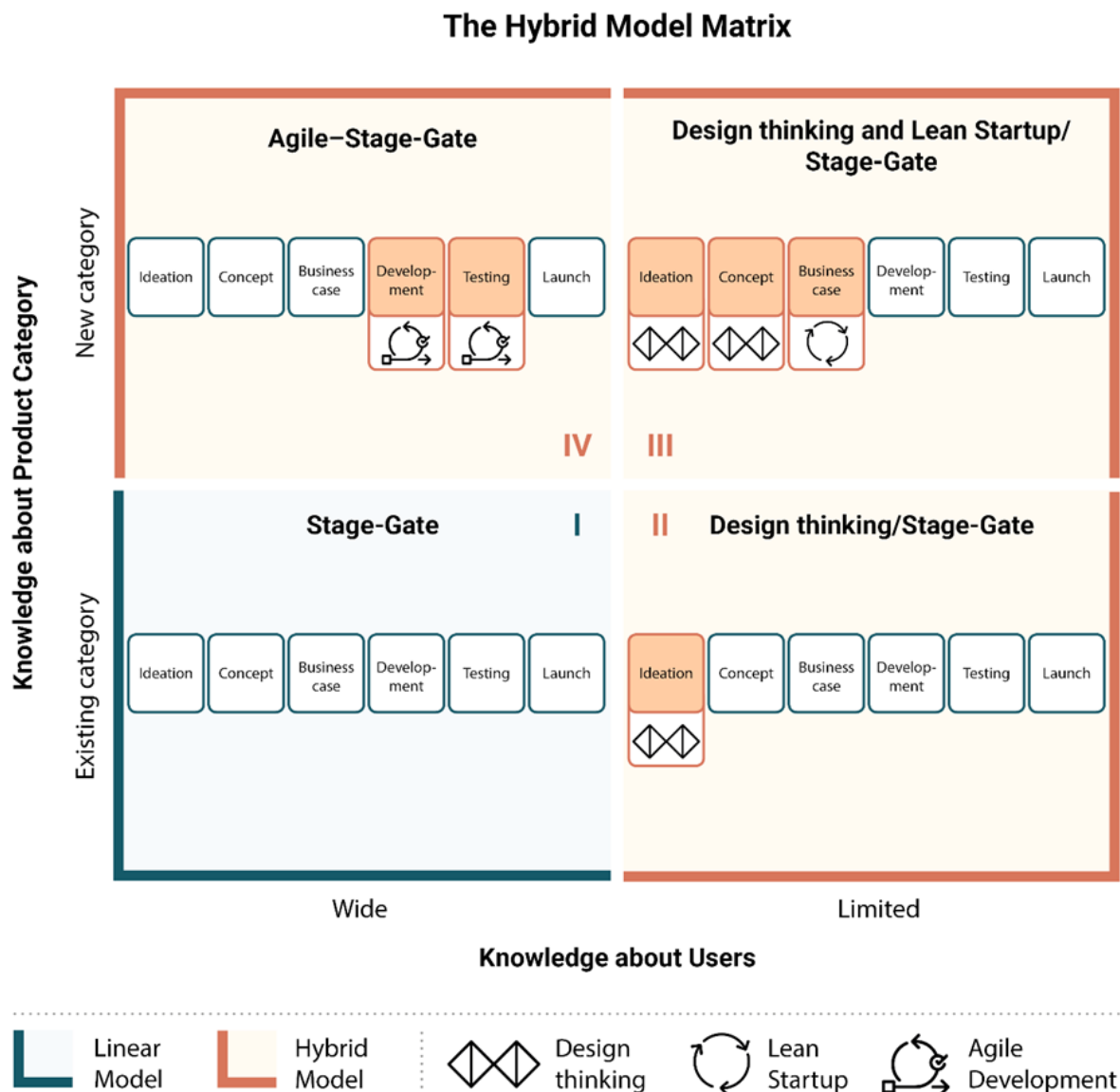

Figure 5: The Hybrid Model Matrix

When the knowledge about users and the category is wide, Stage-Gate perfectly fits as an NPD process since all the information and competence are inside the company already, and the company focuses on minimizing risks. Interviewee 10 expressed this while commenting on the dark chocolate project (Project A): "The biscuit [in its classical form] is one of the main products of the morning goods category . . . it is important to have its version for dark chocolate lovers. . . . That product must be the best ever, so every detail needs to be taken care of. This is just an improvement project; I do not think it costs anything. However, in my opinion, the obsession has to be maximum . . . and you use the Stage-Gate for such a project. You do not need to explore; you do not need to experiment."

During Phase 4, we discovered that when the company faces a knowledge gap in terms of category or users, other methodologies need to support the Stage-Gate process.

Low Knowledge about Users/High Category Knowledge— In this case, the design thinking/Stage-Gate hybrid model enables the company to learn about users. For instance, Interviewee 6 linked this suggestion to the necessity of confirming the habits of users to define or validate a product idea before performing other activities in the Stage-Gate. He said, "There are cases in which you already have a product, but you want to adapt it to a wider number of users [Project Q, R, and S]. In those cases, you need a deeper analysis of users than the one that Stage-Gate can offer. You need to understand if the market trend you are designing for is a will-o'-the-wisp or will stand for longer, and if it is worth a new product. . . . A good initial assessment on users with design thinking fits such an exploration, rather than the Stage-Gate."

Low Knowledge about Users/Low Category Knowledge— In this instance, our results suggest using the design thinking and Lean Startup/Stage-Gate hybrid model. As interviewee 6 explained, "If we decide to enter a new product category where the user knowledge is minimal, it is impossible to start the project with the Stage-Gate approach. . . . Stage-Gate requires data since the beginning, but in these cases, you have to deal with the fact that you have to collect data while you are working on the project because data is not available." Design thinking addresses the knowledge of the users' gap first by defining the product idea during the ideation phase, and second by defining the "product principles" during the concept phase. Interviewee 4 expressed this idea recalling the legumes snack project (Project J): "The [design thinking] team was able to define not just an idea: the team synthesized all the gathered insights into a list of design principles and turned them into the product concept. The design thinking methodology allowed the company to understand a new consumer." Similarly, Lean Startup adds information regarding the dynamics of the category that are still unknown to the company, and in particular, the ones that inquire about the product-market fit. As interviewee 3 stated, "The product concept the design thinking team came up with [Project J] did not match with any existing company's brand, and then we decided to launch a startup. . . . We were able to assess . . . different product channels. An e-commerce was launched, and the product was also tested within the university vending machines."

High Knowledge about Users/Low Category Knowledge— In this case, the Agile–Stage-Gate hybrid model seems to fit the company's lessons learned. This model enters when the company determines the product-market fit settled, but the company still needs to learn about "category rules." For example, Agile iterations inquire about product and packaging specifics and how those elements could impact the production lines or specific business elements such as price or shelf rotation. Interviewee 1 said, "When the fruit shake project [Project T] entered the Stage-Gate process, we knew many things about users . . . and we had many data that fostered the Stage-Gate analysis . . . . Unfortunately, we entered a new category, and we knew nothing about that category dynamics. Nevertheless, we had the overconfidence to set the packs, the prices, and the shelves because we were aware of users' preferences." Interviewee 1 also shared, "Only after the launch, we realized that the users did not recognize our product because all the others were structured differently, with a different range of prices, on a determined shelf. I believe that the Agile development process would have helped to understand the category dynamics."

Validation of the Hybrid Model Matrix

To validate the Hybrid Model Matrix, we performed a workshop with 12 participants from different functions. The attendees were not aware of the Hybrid Model Matrix we created since we presented the research findings to the company after validation. The workshop goal was to

test whether participants used "knowledge about the category" and "knowledge about users" as variables that identify the proper methodology, and whether they would suggest NPD processes in line with the ones outlined in the Hybrid Model Matrix. We asked attendees to list some "embryonic" projects they knew management wanted to develop. We grouped participants into two groups, and we asked them to choose a proper NPD process. The groups had to discuss the choices they made and reach a consensus when they disagreed. The workshop confirmed our finding that knowledge about users and knowledge about category are significant decision variables that guide the selection of hybrid models. By placing the "embryonic" projects around the validated matrix and observing the selected NPD processes, we found a complete overlap with the Hybrid Model Matrix. We summarize the final decision taken by the two groups, reporting one project per quadrant, out of the eight discussed (Figure 6).
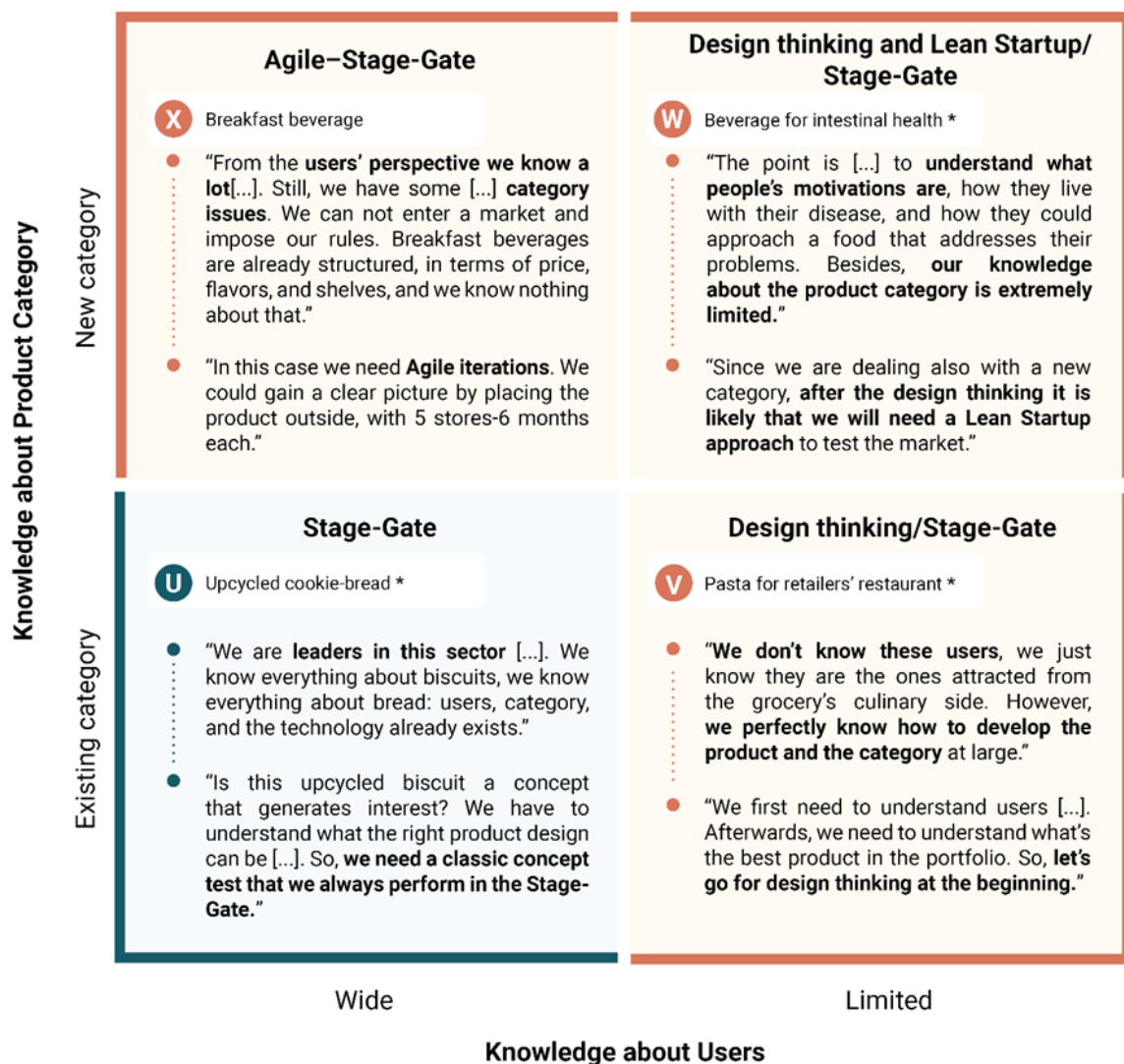
Each quadrant reports an "embryonic" project and two related quotations that express groups' decision about the project. The first quotation refers to the identification of the decision variables. The second quotation relates to the NPD process selection.

Figure 6: Validation of The Hybrid Model Matrix

How to Apply the Hybrid Model Matrix

The Hybrid Model Matrix provides four benefits: it supports decision-making; it helps with evaluating users and category knowledge; it supports learning; and it facilitates contingent applications of methodologies.

Decision-Making Support— Different types of innovation projects may require different innovation processes, and managers need to improve their ability to assess how they must modify or adapt their use of the Stage-Gate process (MacCormack et al. 2012). With no decisional supporting tool, managers might base their decision on their personal methodological preferences or fears; on available organizational opportunities such as free slots or available budget for project development from specific methodological areas (for example, coaches from the Design Thinking Area); or organizational culture and its eventual resistance towards certain practices. Every project can be potentially developed with any methodology. However, since hybrid models are expensive, the Hybrid Model Matrix can help managers decide when it is worthwhile to apply one or more of them.

User Knowledge and Category Knowledge— User knowledge and category knowledge are articulated in many elements. User knowledge includes knowledge of users' habits and preferences. Category knowledge includes knowledge about market dynamics, product price, and supply chain competencies. In theory, any company understands its knowledge of users and categories; therefore, R&D managers can identify precisely the most suitable process for starting NPD projects. However, when we tested the matrix, we found that managers could have divergent views regarding the classification of projects into high or low users and category knowledge, which sparked relevant discussions. When positioning a project in the matrix quadrants, managers should engage peers in their decision-making. Reaching a shared agreement on the NPD methodology before starting the project can prevent potential issues at later stages.

User knowledge and category knowledge refer to the company's own knowledge. Thus, the matrix has an internal point of reference. Two different companies developing the same project might require different NPD processes. The internal definition of the matrix variables offers an excellent advantage over other tools that require considering external variables such as technical risk and market risk (MacCormack et al. 2012). In particular, the use of internal information is more beneficial than using financial estimates or technological knowledge as decision variables. In fact, before starting the project, a company may struggle to have enough information to rely on CapEx or other financial elements for projects that do not yet have a solution. Suppose you want to start an NPD project with CapEx-reliable estimation. In that case, you might delay uncertain projects—for example, where user knowledge and category knowledge are unknown for the company and CapEx or other financial estimates are difficult to foresee—in favor of incremental projects or projects closer to the company domain (where user and category are known). This bias could lead to an unbalanced innovation portfolio and could be detrimental to any company not considering projects that might open new business opportunities.

Similarly, results do not suggest technological knowledge among variables that should be considered to define the NPD methodology selection. Our interviewees stated that technology definition is a problem every project faces in the technical feasibility assessment. Relevant technology should be defined during the project, as doing so beforehand could mislead the product definition. Further studies of the matrix use in other manufacturing contexts could reveal more about the technological knowledge variable.

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Learning in the Process— The Hybrid Model Matrix helps to position a project in terms of learning needs—that is, knowledge gaps about users or categories—and provides recommendations regarding which process might best fulfill those needs.

Based on the matrix, Stage-Gate is useful for projects that do not need to fulfill a significant learning in terms of users or category knowledge. Bagno, Salerno, and Oliveira da Silva (2017) also suggest Stage-Gate for incremental innovation and not for extreme or radical innovation. For innovations that require a significant learning effort, the matrix proposes ways to embed other methodologies within Stage-Gate.

Design thinking, Lean Startup, and Agile have common pillars, including using prototypes to learn in multidisciplinary teams (Dosi, Mattarelli, and Vignoli 2020), testing them with users, and iterating to define the solution progressively. Significant differences also exist among the three methodologies, and some studies show that if used incorrectly those methodologies can harm the learning process (Annosi, Foss, and Martini 2020).

Design thinking is useful when the goal is to learn about users' habits and needs (Brown 2009). The Hybrid Model Matrix suggests that use of hybrids with design thinking are best in situations of limited user knowledge. When the knowledge of the product category is high, the NPD team expects the NPD solution to be a variant of a known category, and the goal of design thinking is to understand how and, if possible, to embed new users' needs in the original product vision (Dell'Era et al. [2020] refer to design thinking as inside-out sprint execution). When the company also has limited knowledge of the product category, it has no prior definition of a possible solution; therefore the team needs to implement design thinking in more phases to identify solutions. In this broader application, design thinking reframes the challenge, defines the product's design principles, and devises with a solution concept ready to be developed (Dell'Era et al. [2020] refer to design thinking as outside-in creative problem solving).

Lean Startup is useful for learning about business models to gain product-market fit (Ries 2011). For those companies looking to design a product for a new category in which only limited knowledge about users exists, the Hybrid Model Matrix suggests using Lean Startup to define the business model elements. In the Hybrid Model Matrix, Lean Startup builds on the knowledge gained through the design thinking that occurs in lieu of the classical Lean Startup phase of product- solution fit. For the projects highlighted in this study, the company experimented with business model solutions by partnering with a retailer or by creating a startup.

Agile is useful when focusing on technical details of a product's feasibility (production choices) and viability (market positioning) to define those elements with structured experiments and users' iterations. Those iterations are different from those that define the business case with Lean Startup or product solution with design thinking. The company implements Agile when the final solution elements are clear, and it needs to fine-tune the given solutions. As interviewee 2 stated during the validation workshop, Agile gets suggested when it is "not a matter of asking the market if the product stands . . . [but rather when] you need to test the market share."

Contingent Applications of Methodologies— The matrix clarifies when to activate a specific methodology, but each methodology can be applied to the company's context. In terms of sector, a consumer packaged goods company could apply Agile development with short iterations and established retailer agreements, while an automotive company might apply the same method with long iterations and lead users' involvement. In terms of proficiency, a company with limited proficiency in design thinking could execute its sprint version (only for the ideation phase) with internal resources but leverage external consultancy for its extensive application (that needs problem reframing and concept definition).

Knowing in advance when to employ different methodological proficiencies is a big advantage from a human resources perspective. Large companies can create specific departments for each methodology within their R&D operations and then involve methodology specialists only in the most appropriate phase of NPD projects. Small- and medium-sized companies that cannot afford to retain staff proficient in multiple innovation methods (De Waal and Knott 2019) could activate ad hoc consultancy in specific phases of the process when they implement a precise methodology.

Conclusion

Companies that rely solely on Stage-Gate often struggle to enact new methodologies. Design thinking, Lean Startup, and Agile require significant investments—in terms of employee training, dedicated resources, and new organizational structures—and represent an approach that may run counter to the prevailing organizational culture. The Hybrid Model Matrix helps companies assess which projects will or will not benefit from those extra methodological competencies. Using the matrix, managers can implement the optimal process, concentrate on the NPD project and supporting the appointed teams, and accelerate innovation by focusing the company resources on the proper process. Companies can use the matrix to understand what knowledge gaps regarding users and category the project has to fill before it kicks off. By employing the Hybrid Model Matrix in their decision- making, companies can reduce conflicts, align stakeholders, and enhance learning.

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