GREEN NEW PRODUCT DEVELOPMENT:

THE PIVOTAL ROLE OF PRODUCT GREENNESS

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Abstract

This study aims to develop an integrative framework for green new product development (NPD) based on the existing literature and to empirically study the applicability of that integrative framework. This study answers three calls: for research that is rooted in a traditional NPD perspective, for research that integrates marketing aspects in a model of green NPD and for research that acknowledges variations in greenness. The results from eight case studies in two industries (i.e., the chemical and food industries) substantiate the integrative framework and suggest that it provides a good basis for understanding green NPD. The study demonstrates that green NPD is not fundamentally different from traditional NPD but does contain features and underlying mechanisms that reflect the increased complexity of green NPD. The framework incorporates the targeting and positioning of green product innovations, thus establishing itself as a holistic framework. Most importantly, the study shows how greenness plays a pivotal role in tying the various elements of the framework together. The realized greenness of a new product is a central concept that helps managers understand complex relationships among industry type, green targeting and green positioning.

Managerial Relevance Statement

Managers face several challenges in green new product development (NPD), many of which are related to the marketing aspects of green product innovations. This study presents an integrated framework for green NPD that may help managers better understand green NPD. The framework explicitly includes the marketing aspects of green product innovations that have been largely neglected in previous frameworks, thus providing a more holistic and managerially relevant framework. More specifically, our study suggests that managers may stimulate the development of green products by implementing a green company policy and/or stimulating an extended market orientation within the organization. Additionally, managers must have an understanding of the role that greenness plays when marketing green new products. Our study shows that this is a complex matter that requires managers to consider both the greenness of the product and the industry-specific factors when making a decision with regard to targeting (i.e., aiming at a green niche/segment or a mass market) and positioning (i.e., emphasizing functional attributes or green attributes). The findings also indicate that managers should not only consider customer and financial performance to evaluate green NPD, but also consider green external and internal reputation as possible benefits of green NPD.

I. INTRODUCTION

Over the last few decades, firms have included ecological ('green') considerations in their product development strategies, which has led to an increasing number of green product innovations. For example, in a 2009 Forrester study, 84% of the companies surveyed indicated they have green or socially responsible products in development or on the market [15]. The increased attention on the development and launch of green product innovations may be the result of a growing awareness that green products represent a "significant market potential" [51, p. 195]. However, organizations that want to develop green products face multiple challenges [10]; understanding the development of green products should therefore be of great interest for these organizations. More insight into green new product development (NPD) may be the starting point for improving this process and lowering the failure rate of green product innovations [10].

Fortunately, the growing attention on environmental issues in NPD practice has been met by a growing academic attention on green NPD, especially in the environmental management literature [1, 3, 22]. A recent and extensive literature review uncovered over 8,500 publications on green innovation [49]. While this literature review shows that a majority of the publications focus on economic topics at the meso- and macro-levels (i.e., industry and national policy levels), rather than on managerial topics, the latter is also attracting academic attention. A growing stream of studies has investigated more organizational aspects of green product innovation, including the antecedents of green product innovation activities [e.g., 2, 27, 30, 45], the effects of various strategies on green product innovation [1], the specific design strategies such as recycling and remanufacturing [35] and the antecedents of market and environmental performance of green product innovations [44, 46].

While these studies have provided important insights, Dangelico and Pujari noted as recently as 2010 that "there is little knowledge on why and how companies integrate

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environmental sustainability into new product development" [10, p. 472]. This lack of knowledge may be due to the rather fragmented nature of green NPD studies, thus providing little overview of the antecedents, processes and outcomes of green product development [see 4 for an exception]. Therefore, it is now appropriate to integrate the findings on green NPD. To increase our understanding of green NPD, this paper sets out to (1) review the literature, resulting in an integrative framework and (2) determine whether the framework is applicable for understanding green NPD based on empirical findings from eight NPD projects.

More specifically, our study builds on and contributes to the previous literature in three distinct ways. First, following suggestions from several researchers [3, 4, 44], we combine insights from traditional and green NPD literature. In doing so, we move away from the current inclination to "view the environment as a distinct functional domain, isolated from core business issues" [13, p. 641], such as NPD. This approach ensures a more coherent and theoretically grounded perspective on green NPD and it increases the legitimacy of the green NPD field [4]. Second, we explicitly include marketing variables in our study, as suggested several times [44, 46], as these variables are generally not integrated into the green NPD literature. Dangelico and Pujari [10] identified several challenges in green NPD, many of which are related to marketing aspects of green product innovations. This suggests that an integrative framework for green NPD should include these marketing aspects. Third, our study acknowledges variations in greenness of product innovations. Consistent with recent findings by Dangelico and Pujari [10] and Dangelico and Pontrandolfo [9], we suggest that the dichotomous treatment of green versus non-green product innovations that is usually observed in the literature does not lead to a good understanding of green NPD. Rather, our study suggests that there are various 'shades of green' and that how NPD should be perceived depends on the greenness of the product to be developed. In other words, it shows that the

various issues of green NPD should not be considered in isolation. Rather, the greenness of the product innovation plays a pivotal and integrating role in green NPD.

II.   THEORETICAL BACKGROUND

A. Defining Green Products

Whether a product is green constitutes a complex issue and is often the subject of debate [10, 49]. Products that are claimed to have 'environmental benefits' possess – more often than not – no such qualities, but they are simply less harmful to the natural environment than others [42]. Therefore, green products are herein defined as new products whose greenness is significantly better than conventional or competitive products. Greenness is continuous rather than dichotomous [49]: 'green' products represent a significant improvement in greenness, which can be either small or large, whereas 'non-green' refers to no or an insignificant improvement in greenness.

Greenness consists of many underlying qualities [9, 35]. The environmental impact of products occurs across three dimensions: materials, energy and pollution [9]. In each of the three dimensions, the environmental impact may be reduced, or a positive contribution may be realized [9]. In this paper, we consider a product innovation to be 'green' if it performs better on any or a combination of the three dimensions compared to conventional or competitive products.

B. Integrative Framework

The framework (Figure 1) for this study takes a market orientation–innovation– performance perspective as a starting point and integrates this perspective with findings from the literature on environmental management and green NPD. As the market orientation– innovation–performance perspective is rooted in the resource-based view of the firm, it offers a valuable foundation for analyzing how the incorporation of green issues affects a firm's competitive advantage [23, 56]. From the resource-based view of the firm, innovation

performance is explained by factors in the realm of information processing, product characteristics and introduction strategy [5]. We briefly discuss the elements of the framework next.

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The framework proposes an extended market orientation and a green company policy as the main antecedents of green product innovation. Extended market orientation is an extension of the market orientation construct that conceptualizes information processing with respect to both market stakeholders and non-market stakeholders as major market factors [36]. Much of the innovation management literature has proposed market orientation, which refers to processing of information about customers and competitors, as an important driver of successful product innovation strategies [6, 28]. In addition, the literature on green NPD has shown that processing information about non-market stakeholders, such as regulators and special interest groups, is a critical antecedent of green product innovation [7, 11, 16, 33, 43]. Green company policy, the second main antecedent of green product innovation, refers to the level of commitment that a firm demonstrates through its values, norms and management practices to initiatives that limit the environmental impact of the firm. Green company policy has a major influence on green product innovation [4, 10, 45].

Extended market orientation and green company policy affect the product characteristics of green innovation [4, 46]. In the green NPD literature, much attention has been devoted to describing and explaining one product characteristic in particular: greenness (see above for a more detailed discussion). It is the defining characteristic of the innovation that sets green NPD apart from 'regular' NPD. However, other product characteristics may also be relevant for a good understanding of green NPD. In particular, several authors have argued that managers must balance greenness with other product characteristics, as high levels of greenness frequently come at the expense of other characteristics [4, 10, 42]. Apart from

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greenness, we therefore include relative advantage and product cost as relevant product characteristics in our framework. Relative advantage, the degree to which an innovation is superior to the product it supersedes or with which it competes, is affected by market orientation and affects innovation performance [25, 31, 40]. Product costs are the costs for researching, developing and manufacturing the innovation. Another important product characteristic in the context of green NPD is the newness of the innovation [51], which has been found to be associated with both market orientation and performance [34].

In addition to product characteristics, the framework in this study proposes introduction characteristics as a main element of innovation in the context of green NPD. Few studies have considered introduction characteristics in relationship to the other elements of our framework. In the context of green products, introduction strategies can be characterized by the degree to which green aspects are incorporated in targeting and positioning [18, 47]. Green targeting is the degree to which a consumer segment that values green attributes is targeted, and it ranges from a small deep-green niche targeting to mass targeting [32, 47]. Green positioning is the degree to which green attributes are used to communicate to the market how the product differs from existing products. Some firms place green attributes at the core of their positioning, whereas others are reluctant or see little opportunity to do so [18, 55].

Innovation outcomes are conceptualized in four dimensions: financial performance, customer performance, technological performance and reputation [21, 24]. Financial performance refers to the profitability of the innovation compared to industry norms. Customer performance is conceptualized as the sales or market share relative to competitors. Technological performance refers to the degree to which a product established a technological 'platform' from which other innovations can be developed. Reputation has not been studied extensively as one of the consequences of green NPD. However, expected

reputational gains have been shown to be a driver of green NPD [10] and proposed as a consequence of green marketing [39].

Finally, the framework proposes industry type as a contextual construct. Industry type refers to the importance of green issues in the industry as a whole, which is reflected by the stringency of green regulation and the level of green demand. In the green strategic management literature, industry type has been shown to moderate the relationships between the antecedents of green strategy and green strategy itself [2]. Furthermore, industry effects on the implementation of green NPD have been found to be significant and strong [1]. Specifically, green demand and green regulation do not affect green NPD in the same manner in all firms [30], which suggests that there are complex interactions between the industry environment and firm-specific factors.

III. RESEARCH METHODS

A. Case Selection

We employed a case study approach because case studies are especially suitable when the aim is to gain an in-depth understanding of a complex process such as green NPD [57]. More specifically, we adopted a multiple-case design and relied on replication logic, in which the individual cases are considered individual experiments and each experiment can thus strengthen the support for a certain generalization [57]. In this study, we use an embedded design [57] where the case studies comprise eight NPD projects, which are embedded in four firms. All eight selected cases are located in the Netherlands and consist of completed NPD projects in which physical products were developed and introduced. Case selection is based on theoretical grounds, imposing diversity on industry, firm size and product innovations. The reasons for having diversity among the case studies is *not* to have a representative sample, as would be the case in survey-based samples, but to ensure that important differences or patterns are not left unobserved [52, 57].

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Industries were selected on the degree of regulatory pressure because this is likely to have an impact on various aspects of green NPD [41]. Two industries were selected: the chemical and food industries. These industries represented two quite different positions in green regulation in the Netherlands. The chemical industry was an example of a stringent regulatory environment [26]. The food industry, conversely, had not witnessed heavy green regulatory pressure, except through voluntary agreements between the industry and the regulators to reduce the environmental impact of packaging and packaging waste.

Within the selected industries, firms were selected based on their size because size may have an impact on the nature of innovations in general [50] and green NPD in particular [41]. The smallest organizations in the design have approximately 20 employees; the two largest organizations are multinational firms with 50,000 or more employees.

Within the selected firms, and in cooperation with key informants from these firms, product innovations were selected based on two criteria: whether green issues were incorporated into the project and whether the product was successful. To ensure diversity within the first criterion, product innovations were selected with varying levels of greenness according to the a priori assessments of a key informant in each case. These assessments were based on the degree to which green issues were considered during the NPD process, from the perception of the key informants. To ensure diversity regarding the second criterion, both successes and failures were selected. This selection was based on a priori assessments and those of a key informant in each case. Studying successes and failures can be especially rewarding for green NPD because both the trade press and informal discussions with managers seem to suggest that many green products have failed [42]. Some of the a priori assessments were not entirely accurate, but the procedure was successful in achieving diversity in both greenness and success.

B. Data Collection

Data were collected through in-depth interviews with key informants as well as site visits and document research, thus resulting in data triangulation [57]. Key informants were identified by asking each informant to identify other potentially interesting informants (snowballing method). Field notes of the interviews were sent to a company evaluator and/or interviewee for corrections and remarks to achieve investigator triangulation [57].

Using a topic list reflecting the framework described above, semi-structured in-depth interviews were held with 25 informants, and the interviews typically lasted between one and two hours. Informants originated from three domains: general management, marketing and research and development (Table 1). The number of informants per firm depended on the number of cases studied within the firm and the size of the firm; the number thus varies greatly. While the environmental management business function was present as a separate entity in the large firms, it was never involved in the product development and introduction activities. Instead, one or more 'environmental champions' [22] from research and development were usually involved in the product development efforts. By investigating multiple domains, source triangulation was achieved [57].

<div align="center">= = TABLE 1 ABOUT HERE = =</div>

The operationalization of greenness warrants some elaboration. The most commonly advocated approach to determine the greenness of a product is life-cycle analysis [17, 19]. Life-cycle analysis is a method that quantifies the environmental impact of a product from "cradle to grave". Life-cycle analysis, however, is fraught with many unresolved problems [12], such as the problem of weighting the various impacts against each other [53] and the limited suitability for radically new products [8]. Therefore, the construct of greenness was operationalized from the results of the interviews. In the interviews, most informants focused on the major green aspects of the product category. For each case, improvements on these

green aspects were then compared with the available information on the green aspects of other products, both from the case study firm and from competing firms. If a product's improvements on the selected green aspects represented the 'best available technology' [54], the greenness was assessed as 'very high'. If a product represented no improvements on the selected green aspects, the greenness was assessed as 'very low'.

C. Analysis

The case data were analyzed in five steps. First, case reports were written, and the information was organized. Second, these case reports were discussed with two researchers who did not participate in the data collection. Such researcher triangulation [29] minimizes the chance of bias when data are collected by one respondent and serves as a preliminary case analysis [38]. Third, we coded the data using the framework as an initial starting point for the coding procedure. In addition, partially ordered information displays were developed for each case [38]. Fourth, five large, case-ordered matrices were developed for a cross-case analysis to summarize the findings per variable [38]. Finally, we used a pattern matching method to allow the identification of cross-construct relationships [38, 57].

IV.   CASE FINDINGS

The findings are reported as case vignettes in Table 2 and in a condensed format in Table 3. Space limitations and confidentiality restrictions do not permit us to elaborate on the unique identifying context of each case. The case findings deepen our understanding of green NPD and especially of the pivotal role of greenness in NPD.

= = TABLE 2 AND TABLE 3 ABOUT HERE = =

A. Antecedents

Table 3 shows that companies vary in the degree to which they use information about customers, competitors and non-market stakeholders and in their green company policy. CoffeeCo, for example, did not use any information about customers, competitors, or any

other stakeholder that could have impacted green NPD. In some cases, information for green NPD was generated by scrutinizing customers or competitors. For example, FoodCo conducted extensive market research to determine whether customers preferred mayonnaise made with free-range eggs over regular mayonnaise. However, informants in several cases indicated that especially non-market stakeholders (i.e., stakeholders other than customers and competitors, such as regulators, special interest groups and suppliers) are a potential source of information about green issues. The role of such stakeholders was especially important in the case of Coating2, where information about green issues was obtained by focusing on regulators. Based on their understanding of regulators, managers believed that a certain toxic ingredient would be banned. Thus, beliefs about future regulations were the main reason for developing a new product based on radically new green technology, whereas information about customers and competitors played only a minor role in developing this product.

The cases show that the development of green products may also be influenced by green company policy. A commitment to green issues that is reflected in a company's values, norms and practices may sometimes 'spill over' into NPD. In the case of CoffeeCo, a company that is a front-runner in green production management, the company itself is highly committed to green issues. Under the influence of this high green commitment, the company developed a very green product, Coffee1, though it had no information about customers, competitors, or other stakeholders to suggest that this development would be a good idea. Remarkably, the same company also developed Coffee2, a product that was not intended to score high in greenness but nevertheless turned out to be moderately green. The high green commitment of the firm ensured that the Coffee2 project was conducted in a relatively green way by using the firm's low emission roasting facilities and using elements of greener products wherever possible.

B. Product Characteristics

   The cases show that companies consider greenness to be a product characteristic that,

throughout the whole NPD process, must be balanced against non-green characteristics, such

as relative advantage, newness and product cost. While in some cases there is an opportunity

to break the trade-off between green and non-green issues (as in the case of Additive), in

many cases these issues are difficult or even impossible to reconcile. For instance, Coating4

was intended as a technical update to an existing product that would solve several

functionality issues by using a green technology. Developers quickly realized they could

solve the functionality issues by applying the green technology in a non-green manner. Thus,

in the case of Coating4, greenness was sacrificed to ensure the better functional properties of

the product. Similarly, in the Coffee1 case, greenness was difficult to reconcile with other

product characteristics, such as product costs. In the development of Coffee1, the product

developers refused to sacrifice greenness and consistently attached a high priority to a

multitude of green issues throughout the life-cycle. Therefore, the realized greenness of

Coffee1 was very high, though it came at a very high product cost. All green and very green

products in the study have a high or very high product cost, suggesting that none of the firms

succeeded in developing a green product without incurring extra costs. Hence, the results

suggest that a distinction must be made between *intended greenness* (the initial priority that is

attached to green issues) and *realized greenness* (the degree to which a product outperforms

conventional or competitive products on one or more green attributes). Because developing

green products is a process of balancing green and non-green issues where one preference is

to be sacrificed for another, the intended and realized greenness levels frequently differ.

While the collection and use of information on (non-)market stakeholders and green company

policy explains intended and realized greenness to a large extent, these antecedents cannot

fully explain the levels of greenness for all cases. Industry effects (i.e., differences in the

green market demand for green products and in the stringency and design of regulations concerning green issues) should also be considered. This is especially clear when comparing two cases (Sauce and Coating3) that were relatively similar in terms of use of market information and green company policy but displayed very different greenness levels. There was no green demand in the market for mayonnaise (Sauce), although there was green demand in a related market (eggs). Therefore, despite a moderate green commitment of the organization and after collecting and using information about green issues, marketers concluded that a green product would not be successful, and consequently, the product in the Sauce case was developed with a low priority for green issues, thus resulting in very low realized greenness. In the market for Coating3, however, a niche demanding green technology was emerging. A competitor had moved in with a green product, and regulators were drafting green regulations. Collecting and using information in this industry led to a high priority of green issues in the development process that resulted in high realized greenness.

C. Green Targeting

The findings demonstrate the applicability of the green targeting construct. The cases display the full range of green targeting, varying from green niche targeting to targeting a non-green segment or even mass targeting (Table 3). In some cases, managers struggled to find the right target group. For Coating2 and Coffee1, informants indicated that it was difficult to decide whether to use green targeting. In both cases, internal debates led to a change in targeting (Table 3 reports the targeting strategy that was finally selected). Coffee1, for instance, was initially targeted at high quality restaurants and hotels. Having established relationships with these customers, the company hoped the sale of its new green product would be relatively easy. However, existing customers appeared to be primarily interested in quality. The organization finally realized that the product would be more appropriate for a

niche of coffee users who demonstrate high green and social commitments, such as local governments and frontrunners in corporate social responsibility.

The findings show that both greenness and industry type affect green targeting. Green products tend to be targeted at a green niche if such a green niche is present or emerging. In three of the four cases with a (very) green product, only a green niche market was believed to be more receptive to the green product developed. This is a direct consequence of the inability of most companies to reconcile greenness with other product characteristics such as costs. Companies that had developed green products felt, to some degree, forced to target market niches that valued greenness much more than other product characteristics. Coffee2 was an interesting case in this regard. Although the product was moderately green and a green niche was present, the product was not targeted at a green niche because managers thought that its green benefits would appeal to a larger audience. However, in this case, there was ongoing debate about the appropriateness of the targeting.

D. Green Positioning

The findings illustrate the use of green positioning in the cases (Table 3). The findings show that two basic positioning strategies can be distinguished but that a combination of strategies is also possible. Some of the case products were positioned as green products in the market, whereas others were positioned using only functional (non-green) aspects. Only in the positioning of Sauce was a combination of functional and green positioning used. The marketing communication surrounding Sauce emphasized that free-range eggs were used as raw material (a green attribute), but this was mainly emphasized to signal high quality (a functional attribute).

The greenness of the innovation plays an important role in understanding why companies decide to position their products as green. In three of the four cases where a product was developed with high or very high realized greenness, managers opted for green positioning

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(i.e., Coffee1, Coating2 and Additive). These three products are not the same products that have green targeting. In one of the four cases where a product was developed with high or very high realized greenness, a functional positioning was chosen (Coating3). Although Coating3 is a green product and was targeted at a green niche, it is not positioned as a green product. Industry type could explain this strategy, as several competitors had moved into a small niche for products based on a similar green technology and PaintCo communicated that it had the product with the best functional characteristics within that green niche.

E. Outcomes

The results show that greenness, to a large extent, explains financial and customer performance, as none of the products with high or very high realized greenness had high financial or customer performance. In fact, based on financial and customer performance, the three non-green products were the most successful. A possible explanation for this observation is that, though green niches were emerging in some markets, market demand for green products in these industries was still low. Thus, *industry type* also matters with respect to explaining performance outcomes.

While green products generally display low financial and customer performance, the results also suggest that they are positively related to reputation outcomes of NPD. This reputation may refer to the perceptions of external stakeholders (*external reputation*) or the perceptions of internal stakeholders (*internal reputation*). Additive, for instance, gained the organization a reputation with external stakeholders, especially after cooperating in a showcase project that demonstrated the greenness of the product. For Coating3, external reputation outcomes were identified as an objective of the NPD project, as the firm's reputation was under pressure. The company developed the product to demonstrate green technological competence. Coffee1 experienced both internal and external reputation outcomes: the product combined many green improvements, which helped the company gain

a reputation among its employees and external stakeholders as being an environmentally responsible organization.

Developing very green products frequently requires high innovativeness on the part of the firm. In these cases, the company develops and launches a product that is both very green and very innovative. Both Additive and Coating3 pioneered new breakthrough technologies to realize a high degree of greenness. Our informants for these cases note that many of their stakeholders recognized this fact and that, as a consequence, the company earned a reputation of being both innovative and green.

V.   DISCUSSION

This study set out to develop an integrated framework for green NPD based on the existing literature and to empirically study the applicability of the framework. Based on the literature study, we suggest that green NPD may be understood by focusing on extended market orientation and green company policy as antecedents of product characteristics that must be balanced (i.e., greenness, relative advantage, costs and newness) and introduction characteristics that must be established (i.e., green targeting and green positioning). These product and introduction characteristics, in turn, determine the financial, customer, technological and reputation NPD outcomes. The results from the eight case studies allowed us to substantiate the integrative framework and suggest that the framework provides a good basis for understanding green NPD.

The contribution of our study is threefold. First, following suggestions from the green NPD literature [3, 4, 44], this framework integrates insights from the traditional NPD literature and from the environmental management literature. The integrative framework confirms that green NPD is not fundamentally different from traditional NPD but that it also highlights unique aspects of green NPD, such as green company policy. By proposing an integrative framework, this study departs from a research tradition that has considered green

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NPD to be fundamentally different from traditional NPD. Furthermore, this study adds to a growing literature stream that synthesizes insights from traditional NPD and environmental management by presenting a framework that integrates research on strategic orientations in NPD and green NPD.

The second contribution of the study is that it integrates marketing aspects of green product innovations into a framework for green NPD. Prior research on green NPD or environmental management included aspects other than marketing, such as environmental concerns, design specifications, project team coordination, management support and product outcomes [4]. While these aspects are important, they offer only a partial understanding of the factors that impact green NPD outcomes, thereby prompting authors such as Pujari [44] and Pujari et al. [46] to call for the inclusion of marketing variables. By incorporating market orientation, green targeting, green positioning and customer outcomes, our study provides a more holistic perspective on green NPD, which is important because green marketing aspects are highly related to other NPD aspects.

The third contribution is that, by tying the framework elements together, our study suggests that greenness is pivotal. Indeed, it is crucial to make a distinction among the different shades of green, which range from traditional products (non-green) to light green products and, ultimately, to dark green products. Light green products show small but significant improvements in green aspects, whereas dark green products show large improvements. However, because greenness cannot be viewed in isolation of the other aspects of green NPD [9], we now elaborate on the pivotal role of greenness.

Our study shows that greenness is associated with the interplay between extended market orientation and green company policy in NPD. This association suggests that external orientations towards market stakeholders (customers and competitors), non-market stakeholders (all other stakeholders) and internal orientation (green company policy) *together*

drive greenness. Although each of these driving forces has been extensively studied in the green NPD literature, few studies have combined all three in this context. The finding that orientations towards market and non-market stakeholders influence greenness confirms the extant literature on stakeholder orientation [14, 20] and prior research in the context of environmental management and innovation, which suggests that addressing multiple stakeholders' issues is important [48]. In addition to extended market orientation, green company policy impacts how green issues permeate innovation, a finding that is consistent with previous studies on green NPD and strategic green management [2, 45]. Our study shows that while extended market orientation is sometimes the main driver of greenness, green company policy is the main driver of greenness at other times; at still other times, a combination of forces drive greenness. To fully understand the level of greenness of a product innovation, both forces must be studied.

Greenness is essential in understanding the introduction strategies of green products, as it affects both green targeting and green positioning. Whereas the literature has acknowledged that consumer segments with various levels of preference for greenness exist [e.g., 18, 32], this study links the level of greenness of the product to the decision whether to target a deep green segment. Whereas very green products are likely to target a green niche rather than the mass market, our study shows that this is not always the case. Similarly, whereas companies are likely to emphasize the green improvements in the product (green positioning) rather than the functional aspects when launching a dark green product, our findings show that green products are not always positioned as green. This result is consistent with recommendations in the environmental management field [e.g., 42, 47]. In addition, this study shows that green targeting does not automatically lead to green positioning and that industry-specific factors may explain the complex relationships between greenness, green targeting and green positioning.

Greenness also plays a role in understanding the interplay of reputation with other outcomes of NPD. Dark green NPD has, to some extent, objectives beyond the financial, customer, or technological performance outcomes. Whereas the traditional NPD literature has contended that different performance outcomes should be used for radical products than for incremental products [21], a similar point could be made for green products versus non-green products. External reputation enhancement, either in the domain of technology leadership or green leadership, for example, becomes an important non-economic indicator if products are greener. This finding corresponds with theoretical work that includes corporate reputation, along with business performance, as an outcome of green strategies [37]. More specifically, the findings suggest that a reputation of green leadership may compensate for low financial and customer performances. Similarly, the development of green products may also result in internal reputational benefits by creating a stronger feeling of identification with the organization among employees. Furthermore, a reputation of green leadership goes hand-in-hand with a reputation of technology leadership, as very green product innovations generally require advanced levels of technological development [51].

Finally, as the demand for green products and the stringency and design of regulation concerning green issues vary across industries, industry type helps explain differences in greenness and its effects, and it further substantiates the integrative character of the framework.

Given the pivotal role of greenness, it is important to understand this concept in greater detail. The case findings show that intended greenness must be distinguished from realized greenness. High intended greenness does not always accompany high realized greenness. Although previous literature has shown that intended greenness not always results in realized greenness [22], our study shows that greenness may also be realized without being intended.

This finding suggests that the distinction between intended and realized greenness is even more important than previously argued.

VI. LIMITATIONS AND FUTURE RESEARCH

The following limitations of our study offer suggestions for future research. First, our study suggests that understanding the green NPD process is about intended greenness, thus attaching priorities to green issues and realizing that intended greenness. Future researchers may want to study the various trade-offs that are involved in attaching priorities within the green NPD process. Such research would be consistent with the growing attention in the stakeholder management literature on how to address conflicting stakeholder issues. Second, while case studies may provide a certain contextual richness and a good overview of the complex processes, the generalizability of such studies (and thus our findings) is limited. Future researchers may want to test the integrative framework using quantitative methods, as such a study could also determine the relative importance of the green NPD features and the mechanisms at play in NPD projects for dark and light green product innovations. Third, the empirical context of our study was limited to green products in the chemical and food industries. Because the findings suggest an important role for industry type, specifically green regulation and green demand, future researchers may also want to include a greater variety of industries and investigate other drivers of change in industries, such as the availability and change rate of green technology. As countries may differ in legislation and regulations with respect to environmental issues, future research may even take an institutional perspective, including cross-country and cross-industry comparisons.

VII. IMPLICATIONS FOR MANAGERS

Managers that engage in green NPD face several challenges, many of which are related to the marketing aspects of green product innovations. This study presents an integrated framework for green NPD that may contribute to a better understanding of green NPD. It

explicitly includes the marketing aspects of green product innovations that have been largely neglected in previous frameworks, thus providing a more holistic and more managerial relevant framework. More specifically, it indicates that managers should be aware of the role of greenness in green NPD compared with traditional NPD. The case results suggest that at the core, green NPD shares the features and underlying mechanisms of traditional non-green NPD. However, the traditional NPD framework may not be enough to understand green NPD. To understand green NPD, additional features and underlying mechanisms are important, and their importance depends on how green the products are. The darker green the product, the more the traditional NPD should be complemented. Whereas many firms have made progress in improving the collection of market information for product development, for developing dark green products they should expand the scope of their efforts by collecting information from nonmarket stakeholders as well. In fact, PaintCo was building an 'early warning system' for regulatory developments at the time of data collection. Such systems for generating nonmarket input for NPD can ensure that a broader range of developments is recognized in time. Eventually, such information generating systems could be combined into a comprehensive stakeholder monitoring system.

In addition, our study suggests that managers may stimulate the development of green products by green company policy and an extended market orientation. Building an extended market orientation, in turn, requires managers to install specific rules and procedures for green NPD, as such procedures may help balance green and non-green issues (that are brought in by the various stakeholders) during the green NPD process. Furthermore, such rules and procedures may indicate when and how tradeoffs must be made between, for instance, a greener ingredient and higher costs.

Another implication of our study is that managers must understand the role that greenness plays in the marketing of green new products. Our study shows that this is a complex matter

that requires managers to consider both the greenness of the product and the industry factors when making a decision with regard to targeting (i.e., aiming at a green niche/segment or a mass market) and positioning (i.e., emphasizing functional attributes or green attributes). These decisions are not always self-evident, as green targeting and green positioning may not be the optimal choice even for dark green products.

Finally, the results indicate that managers should be aware of performance outcomes other than the traditional performance measures. Reputation may not have immediate economic payoffs, but it could prove instrumental in preserving legitimacy in society and could contribute to continuity instead of financial performance. A good reputation is beneficial, for instance, in making a firm less vulnerable to scandals or crises. Similarly, internal reputation can have positive long-term effects. Therefore, managers should consider both external reputation and internal reputation as possible outcomes of NPD.

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Table 1: Cases and Informants for the Case Studies

	Chemical Industry		Food Industry	
	PaintCo	**PlasticCo**	**CoffeeCo**	**FoodCo**
Cases	Coating1	Additive	Coffee1	Sauce
	Coating2		Coffee2	
	Coating3			
	Coating4			
Informants	17	2	4	2
• General Management	3	2	2	0
• Marketing	9	0	1	1
• R&D	5	0	1	1

Table 2: Case Vignettes

Case	Project Description	Relevant Dimension of Environmental Improvement
Coating1	Development of a highly innovative car repair paint using new technology. The major improvement was thought to be durable gloss. It proved to be a big market success, not because of the durable gloss, but because it improved the speed of car repairs without visible differences with the original car paint. Green issues, such as volatile organic compounds (VOCs) and toxicity, played no role in its development.	Pollution
Coating2	Development of a product where the only goal was to address a single green issue attached to Coating1: the toxicity of isocyanates. It was the first car repair paint without isocyanates, which were needed in Coating1 and similar products. It was developed because the organization (wrongly) believed that isocyanates were soon to become an important issue for customers and regulators. Although it was a technological breakthrough, it was not a success otherwise.	Pollution
Coating3	After a competitor introduced the world's first car repair paint using waterborne technology, the organization developed a similar product. This involved learning about a green technology that was completely new for the organization. The resulting product was a waterborne car repair paint that resulted in low VOC emissions, which means that a major green issue had been addressed.	Pollution
Coating4	The main goal of this NPD project was to provide a technical update to Coating1 to solve several functionality issues that consumers experienced with Coating1. Although the new product was developed based on low-VOC (i.e., green) technology, the product was developed to be used with high-VOC complementary products. The fact that this would make the product non-compliant with green regulations in the future was deemed less important.	Pollution
Additive	Additive was developed as an alloying and mixing agent to improve the properties of polymers. Although not developed for this goal, a major application of Additive was as a recycling agent. Recycled plastics and rubbers have inferior properties compared to virgin materials. Additive could alleviate these problems. The application of Additive as a recycling agent emerged later in the process.	Materials
Coffee1	A sustainably grown coffee was developed to obtain two third-party certifications: one for social responsibility (acknowledging fair trade issues such as sustainable production, trade, and consumption) and the other for organic production (banning the use of chemical or synthetic pesticides). The project took an integral approach to greening, which exceeded the certification requirements, such as developing a new packaging to reduce environmental impact and using the firm's low-emission roasting facilities.	Materials Energy Pollution
Coffee2	Development of 'coffee pods' (a single serving of coffee) for a range of coffee varieties. The product was developed based on a gut feeling that bars and restaurants would like to offer a wide choice of coffee varieties to their clientele. Green issues were not addressed in the project, but the coffee from the Coffee1 case was offered as one of the varieties, and all varieties were produced in low-emission roasting facilities.	Energy Pollution
Sauce	Inspired by the popularity of free-range eggs in the Netherlands, a marketing executive suggested developing a mayonnaise based on egg-yolks from free-range eggs. Replacing the existing mayonnaise product with a free-range variety was thought to improve mostly the well-being of the egg-producing poultry. This product replaced the existing mayonnaise, without changes to most of the other product characteristics of the existing product. The packaging was redesigned to communicate the improvement.	Materials

Table 3: Summary Results of the Case Studies (continued on next page)

Case	Green Regulation/ Green Demand	Antecedents		
		Customer/ Competitor Information	**Non-market Stakeholder Information**	**Green Company Policy**
Coffee1 (1) [a]	Little green regulation Emerging green niche	Low customer Low competitor	Information not used	High green commitment
Coating2 (2)	Little green regulation No green demand	Low customer Low competitor	Information about regulators used	Moderate green commitment
Coating3 (3)	Green regulation upcoming Emerging green niche	Moderate customer High competitor	Information not used	Moderate green commitment
Additive (4)	Little green regulation Emerging green niche	Low customer Low competitor	Information about regulators used	(not assessed)
Coffee2 (5)	Little green regulation Green niche	Low customer Low competitor	Information not used	High green commitment
Sauce (6)	Little green regulation Green demand in related market	High customer High competitor	Information not used	Moderate green commitment
Coating4 (7)	Green regulation upcoming Emerging green niche	Moderate customer Moderate competitor	Information about regulators collected but not used	Moderate green commitment
Coating1 (8)	Little green regulation No green demand	Low customer Low competitor	(not assessed)	Moderate green commitment

[a] Cases are ranked in decreasing order of realized greenness of the product. (not assessed) = not enough data to assess this variable.

Table 3: Summary Results of the Case Studies (continued from previous page)

Case	Innovation			Outcomes
	Greenness	**Other Product Characteristics**	**Introduction Characteristics**	
(1)	Very high intended Very high realized	Moderately new Low relative advantage Very high product cost	Green niche targeting Green positioning	Low financial perf. Moderate customer perf. Moderate technol. perf. High internal reputation High external reputation
(2)	High intended High realized	Very new, but mod. to customer Low relative advantage High product cost	Mass targeting Green positioning	Low financial perf. Low customer perf. Very high technol. perf.
(3)	High intended High realized	New, but not to industry Moderate/low rel. advantage High product cost	Green niche targeting Functional positioning	Low financial perf. Very low customer perf. Very high technol. perf. High external reputation
(4)	Low intended High realized	New to industry & customer Moderate/high rel. advantage High product cost	Green niche targeting Green positioning	Low financial perf. Low customer perf. High technological perf. High external reputation
(5)	Low intended Moderate realized	New, but not to industry Moderate relative advantage High product cost	Mass targeting Functional positioning	Very low financial perf. Very low customer perf. High internal reputation
(6)	Low intended Very low realized	Not new Low relative advantage Moderate product cost	Non-green segment targeting Functional/green positioning	Moderate financial perf. High customer perf.
(7)	Low intended Very low realized	Not new Moderate relative advantage Moderate/high product cost	Non-green segment targeting Functional positioning	Moderate financial perf. Moderate customer perf. Low technological perf.
(8)	Very low intended Very low realized	Very new, but new to firm Very high relative advantage High product cost	Mass targeting Functional positioning	Very high financial perf. Very high customer perf. Very high technol. perf. High external reputation

[a] Cases are ranked in decreasing order of realized greenness of the product. (not assessed) = not enough data to assess this variable.

Figure 1: Integrative Framework for Green NPD

Antecedents	**Innovation**	**Outcomes**
Extended market orientation	Product characteristics	• Financial
• Customer information	• Greenness	• Customer
• Competitor information	• Relative advantage	• Technological
• Non-market stakeholder information	• Newness	• Reputation
	• Product cost	
Green company policy	Introduction characteristics	
	• Green targeting	
	• Green positioning	

Industry Type
Green regulation, Green demand