

Green Crowdfunding: An Empirical Study of Success Factors

Filippo Corsini , Francesco P. Appio , and Marco Frey 

Abstract—Despite the growing body of research on crowdfunding, there is still a critical need to clarify the essential elements of its connection to sustainability. This study explores how various constructs, such as green product codesign, green market insight, environmental legitimacy, and the stage of product development, bear on the success of crowdfunding endeavors intended to finance eco-friendly products. We employed a questionnaire to gather insights from 113 campaign initiators, deviating from the predominant focus on web-based data collection found in much of the existing literature. The collected data were then examined through the application of structural equation modeling techniques. The findings indicate that, with the exception of environmental legitimacy, all the examined constructs exhibited a positive effect on the campaign's success. Furthermore, it was observed that the stage of development subtly diminishes the positive relationship between green product codesign practices and the success of a crowdfunding campaign. Our study offers valuable theoretical insights in light of these findings. In addition, the article proffers pragmatic suggestions for more effective crowdfunding of sustainable products.

Index Terms—Green crowdfunding, legitimacy theory, new product development (NPD), success factors, sustainability.

I. INTRODUCTION

OVER the past 30 years, the paradigm of environmental sustainability has progressively come to the forefront [1]. Companies, which are critical to achieving environmental sustainability, began to recognize the need to act as they realized that many resources once thought to be abundant and thus used carelessly for decades are now becoming scarcer [2]. Since the product can significantly impact environmental performance, several companies have begun implementing sustainable product design initiatives. These approaches seek to diminish the environmental footprint of a product throughout its life cycle without compromising other vital characteristics, including quality, functionality, or technical specifications [3]. Incorporating ecodesign considerations into a product is not an inexpensive endeavor [4], [5], and insufficient funding can pose a substantial obstacle to the development of environmentally sustainable products [6].

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In this context, crowdfunding could be highly beneficial. Crowdfunding is soliciting funds from the general public through specific internet-based platforms [7]. Crowdfunding now encompasses a wide range of activities, from supporting cultural organizations to funding scientific research, from assisting in humanitarian situations to promoting innovation and overcoming barriers to traditional financial investment [8].

In particular, reward-based models can be viewed as an appropriate tool for encouraging product ecodesign [9]. In reward-based crowdfunding, a benefactor of the campaign acquires a nonmonetary benefit, such as a product, in exchange for a financial endowment, usually predetermined by the advocate of the campaign [10]. The reward-based paradigm is used by most well-known crowdfunding platforms, including Kickstarter and Indiegogo [11].

Although the field of crowdfunding research is growing, there is a notable scarcity of studies that explore the use of reward-based crowdfunding in the development of green products within the academic literature [12], [13]. While a majority of studies center on determining the variables that drive the success of reward-based crowdfunding campaigns [14], [15], [16], [17], [18], [19], they often overlook the aspect of sustainability, a theme presently touched upon in only a handful of investigations [20], [21], [22]. This underscores the necessity to illuminate the pivotal components of the crowdfunding-sustainability nexus, thereby charting a path for future research. Our work aids in assessing the intricacies of green crowdfunding initiatives [12], [13], [23], through the lens of factors that could significantly influence the success of such endeavors. We specifically examined the impact of the following constructs on the success of a crowdfunding campaign: green product codesign, green market insights, environmental legitimacy, and stage of product development. Furthermore, we investigated the moderating effect of the stage of development on the three previously mentioned constructs and the crowdfunding campaign's success. The innovation of our research emanates not only from the constructs tested but also from the methodology employed. Our data were gathered through a questionnaire designed to explore campaign initiators' perceptions, a deviation from the prevalent reliance on web-based data culled solely from crowdfunding campaigns in the current literature [7], [24], [25]. Though not superior to web-based data, the exploration of campaign initiators' perceptions might enrich the literature by examining several additional constructs, thereby more effectively outlining success factors of crowdfunding initiatives. For instance, the attitudes and convictions of campaign initiators cannot be merely

inferred from web-based data. Furthermore, the insights derived from campaign initiators can enhance the existing literature by curbing the subjectivity of researchers. For instance, relying on web-based data Pati and Garud [26] analyzed the impact of the product development stage on the success of crowdfunding campaigns; the authors rated the development stage of the campaigns grounding on descriptions, photos, and videos of the products. In this respect, campaign initiators may possess a distinctive and more precise understanding of their product's stage of development. Current crowdfunding studies could thus garner substantial benefits from questionnaire data exploring campaign initiators' perceptions, ranging from the identification of novel constructs to the confirmation of variables previously gauged through alternative methods.

Our results indicate that although green product codesign and green market insights positively influence the success of a campaign, environmental legitimacy does not have a significant effect. In addition, although the development stage has a positive effect on campaign success, we found that it moderates and weakens the positive correlation between green product codesign practices and the success of the crowdfunding campaign. The findings from our research enrich the collection of knowledge about the importance of green product codesign in determining the success of an initiative, as well as the impact of green market insights in promoting a campaign's success. In addition, our study sheds light on various managerial considerations, providing strategic guidance for those planning crowdfunding campaigns.

II. THEORETICAL BACKGROUND AND HYPOTHESES DEVELOPMENT

Recently, a handful of studies have begun to delve into the realm of green crowdfunding campaigns, particularly the key factors that drive their success [9], [27], [28], [29], [30]. Yet, the exploration of green crowdfunding remains in its formative stages, as indicated by early literature reviews positing that the intersection of crowdfunding and sustainability is an understudied area [31], [32]. A thorough examination of how particular aspects pertaining to green crowdfunding influence the success of these initiatives is notably absent in existing literature.

Existing research predominantly focuses on the role of comments from backers and potential backers in green crowdfunding [30], [33], [34]. However, the utilization and operationalization of these comments in managing a green crowdfunding campaign, and their contribution to its success, remain underexplored.

In this context, our research progresses from this premise to more comprehensively explore whether funders' perspectives on sustainability can facilitate the enhanced development of a product. This includes shaping its design and implementation, while maintaining a focus on its environmental sustainability. Such an approach may significantly contribute to the campaign's success.

Comments within a crowdfunding campaign can also be a valuable source of information, particularly about consumer

preferences related to specific environmental attributes of a product, such as the type of materials used, reparability, and product lifespan. This codesign approach can guide entrepreneurs in refining their initial concept, potentially leading to greater campaign success. Therefore, our research is focused on gaining a deeper understanding of how these comments are utilized in managing a green crowdfunding campaign and their potential impact on the campaign's success.

Other studies have primarily concentrated on communication-related aspects in green crowdfunding, such as social media presence [35] and third-party endorsements [36]. However, there is a noticeable gap in understanding how these communication and engagement dynamics might enhance the environmental reputation of a crowdfunding campaign, thereby contributing to its success. Our research aims to fill this gap by providing a more comprehensive understanding of communication and engagement dynamics in green crowdfunding.

Lastly, the stage of product development in the context of green crowdfunding has been explored [22], [30]. Yet, research in this area is still nascent, and the detailed understanding of how the product development stage might affect other constructs in green crowdfunding is significantly lacking in current literature. Our research, therefore, also aims to enhance understanding of this aspect within the realm of green crowdfunding.

The upcoming sections will present the hypotheses that our research intends to substantiate, thereby contributing to the enrichment of scholarly discourse in this field.

A. Green Product Co-Design

In addition to making financial commitments, funders might also take an active role in crowdfunding projects by contributing to idea development, giving the entrepreneur suggestions on the project itself [37]. Through their engagement, the product or service can be refined and modernized prior to its market debut, enhancing the caliber of the crowdfunded offering [17]. Given that funders in reward-based crowdfunding also represent potential customers, dialogues between entrepreneurs and funders could result in valuable insights [37], [38]. The mechanism through which funders convey to entrepreneurs their viewpoints, or hints concerning specific attributes of the product, or about its further development, is depicted in this study as green product codesign. Throughout this process, funders may propose enhancements to the attributes of the product or service before it enters the market, thereby reinforcing or affirming some decisions made by the entrepreneur [17], [39]. Codesign has a significant impact on participants because the goods they help to create are perceived as distinct, adding value above and beyond their utilitarian value [40].

Anecdotal evidence suggests that backers (or potential backers) may voice their opinions on sustainability-related topics, such as codesign the product and its environmental characteristics [12], [13]. Within such a framework, funders can contribute their expertise, concepts, and suggestions, codesigning the product while ensuring that facets pertaining to the product's sustainability are upheld [9]. Therefore, suggestions may

foster a deeper understanding of donors, and their counsel and evaluations could enhance not only the product's technical dimensions [38], but also further refine its environmental attributes or identify environmental facets to be addressed during product development [36], [41].

While surveying broad crowdfunding initiatives, most contemporary research indicates a favorable correlation between the interactive dynamics of project creators and backers (or potential backers) and the success of the crowdfunding venture. However, the majority of these studies merely evaluate those suggestions by counting the number of comments posted on crowdfunding platforms as a metric to measure such dynamics [38], [42]. Furthermore, the influence of product codesign on success could radically shift when considering environmentally related aspects, as it is vital for funders to comprehend the environmental issues to be addressed and the impacts of product lifecycle [43]. Hence, given that research into crowdfunding sustainable products is still nascent, a more comprehensive understanding of the repercussions of green product co-design practices on campaign success is needed. As a result, the first hypothesis we propose to test is as follows.

HP1: Green product codesign positively impact the campaign's success.

B. Green Market Insights

Crowdfunding serves as a tool for market insight gathering, as suggested by Petruzzelli et al. [12]. However, gathering insights and information in this context can be challenging, partly because crowdfunding lacks the sophisticated social integration mechanisms of traditional organizations, as noted by Moussavou [44]. In the realm of crowdfunding, information primarily flows through comments and updates which are interactions between supporters and project creators, [45], [46]. This information dissemination is a key aspect of the crowdfunding process. In such context, various studies propose that crowdfunding could be considered a research mechanism for garnering insights into the market viability of a concept [47], [48]. In other words, before making an investment choice, businesses can learn about consumer preferences by preselling a product through these channels [49]. Several studies [50], [51], [52] indeed demonstrate that this generates a significant real option value of learning: entrepreneurs may update their ideas about the preferences of all of its customers by studying the choices of the backers. Market insights can also impact aspects such as pricing strategies and the decision to offer discounts to potential backers [53].

In green crowdfunding campaigns, market insights can regard consumer preferences in relation to specific environmental product characteristics (e.g., type of materials used, easiness of repair, lifetime expectancy, etc.) and thus support the entrepreneur in updating the original idea driving the campaign to greater success. Crowdfunding campaigns offer a variety of goods or services as rewards, and the way backers react to specific rewards may help determine how well their overarching strategy for firm environmental orientation meets consumer expectations [37].

Because research on green crowdfunding has not yet considered this interaction, we propose the following hypothesis.

HP2: Green market insights through crowdfunding campaign positively impacts the campaign's success.

C. Environmental Legitimacy

According to Chen [54], one important factor contributing to crowdfunding campaigns' success is legitimacy. Legitimacy is "a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially construction system of norms, values, beliefs, and definitions" [56, p. 574]. Entrepreneurs are tasked with convincing potential backers of the validity and suitability of their projects on crowdfunding platforms, venues where the public possesses scant or no preliminary information about the enterprises [54]. Several types of legitimacy have been identified in the literature on legitimacy: moral legitimacy [55], [56], associational legitimacy [57], and technological legitimacy [58]. In examining crowdfunding initiatives for social enterprises, Lehner [59], for example, suggests that crowdfunders often look more at the project's ideals and underlying values and, thus, at its moral legitimacy. For these reasons, crowdfunding may be an especially well-suited solution to the financing needs of businesses that promote societal solutions. Environmental legitimacy is defined as "the generalized perception or assumption that a firm's environmental performance is desirable, proper, or appropriate" [59, p. 94]. According to the authors, a company gains legitimacy when its environmental performance meets stakeholder expectations. A crowdfunding campaign can confer enhanced legitimacy on the individuals proposing the campaign via initial societal engagement, enabling people to discern and endorse environmental necessities it considers meritorious [60], thus emitting a potent signal of investment to other prospective financiers. In other words, through early societal engagement, crowdfunding can improve a company's environmental reputation [61]. This environmental legitimacy may be a motivating indicator for more investors, influencing the initiative's success. Hence, here is the hypothesis that needs to be tested.

HP3: Environmental legitimacy built through the campaign has a positive impact on the campaign's success.

D. Product Development Stages

The stage of product development has also been recently explored as a factor determining the success of crowdfunding initiatives [26]. The academic literature has thoroughly examined the new product development (NPD) process; presently, a multitude of NPD models adeptly encapsulate the steps entailed in the creation of new products. These instruments may be regarded as guides that delineate and steer the necessary procedures to transition a new product from a concept or opportunity to a triumphant introduction to the market [62].

Booz and Hamilton's [63] model is one of the most well-known and is still associated with excellent results [64], [65]. This model has been recast and molded over several decades, most notably with the Stage-Gate approach proposed by Cooper

and Kleinschmidt [66] and more recently revised by Cooper [67] and Cooper and Sommer [68]. This NPD framework categorizes product development into five stages [67]. Each stage includes concurrent, cross-functional, and prescribed activities that must be completed. The stages suggested by this NPD framework are as follows.

- 1) *Stage 1. Preliminary assessment or scoping:* This stage, which corresponds to the ideation stage, involves prework designed to discover opportunities and generate ideas.
- 2) *Stage 2. Screening:* This stage entails a preliminary assessment of the level of demand for the ideas developed as well as the manufacturing capacity of the company.
- 3) *Stage 3. Development:* Refers to the actual design and creation of the new product. At this stage, lab tests, in-house tests, or alpha tests are carried out to ensure that the product meets the specifications under controlled conditions.
- 4) *Stage 4. Testing and validation:* The verification of the proposed new product and its marketing and production. Customer tests, beta tests, and field trials are carried out at this stage.
- 5) *Stage 5. Commercialization or launch:* The product is ready for full commercialization at this stage.

The literature on crowdfunding has largely ignored how the stages of development may influence the overall success of crowdfunding initiatives. To the best of our understanding, solely Pati and Garud [26] have examined the moderating influences of the product development stage and product innovativeness on the interaction between social interaction and crowdfunding success within the realm of mobile application technology. According to the authors, social interaction benefits products in the early stages of development more than products in the commercialization stage. The authors, however, only used a simplified version of the NPD with two stages of development (an ideation and conceptual development stage and a production and commercialization stage) and did not test the influence of the product development stage on the success of the crowdfunding initiative directly. In such a context, because the stage of development can influence the success of green crowdfunding, the hypothesis to be tested is as follows.

HP4: The later the NPD stage, the higher the success of the crowdfunding campaign for the development of the environmentally friendly product.

Ultimately, given that the project's developmental phase might affect the interplay among the other constructs examined and the success of the crowdfunding endeavor, our research intends to evaluate three supplementary hypotheses. As stated above, entrepreneurs and financiers connect and exchange suggestions, which might help the project's codesign and allows for an appraisal of its future feasibility [69]. Within conventional product development, Ernst et al. [70] indicate that entrepreneurs exhibit greater adaptability and receptiveness to recommendations during the initial stages of product creation. Entrepreneurs at the earlier stages of product development are more likely to gain from this type of social interaction because they emphasize honing their ideas utilizing suggestions from future users and clients [71]. Contrarily, because entrepreneurs in the later stages

of development have a more established product, they might find it more expensive and complex to add new ideas to alter the current product, potentially harming the product's success when commercialized [70]. In such a context, because the stage of development can impact the relationship between the green product co-design practices and the success of the campaign, we identified the following hypothesis to be tested.

HP5: The stage of development moderates the relationship between green product codesign and campaign success.

Some studies suggest that crowdfunding could be viewed as a tool for market insights helping gather information about an idea's market potential and that such might directly impact the crowdfunding initiative's success [51], [52]. The broader literature on market information and product development presents incongruities regarding the effect of various NPD stages on a product's market success [72], [73]. For instance, Guan and Chen [72] suggest that market insights are most important during the ideation stage as in such stage, modification of the products is still possible; companies able to acquire that insights in earlier stages of product development have the greatest success when the product reaches the market. Other studies suggest that market insights are more crucial at later phases of product development when making decisions on testing, and a company needs to assess how well-generated prototypes operate in actual use [73], [74]. Given the fact that such a relationship has been marginally investigated in crowdfunding campaigns and especially in green crowdfunding campaigns, we aim to test the following hypothesis.

HP6: The stage of development moderates the relationship between green market insights and campaign success.

A crowdfunding campaign may also confer greater environmental legitimacy, thus emitting a robust signal of investment to additional prospective financiers [60]. The influence of legitimacy on the crowdfunding project's success could be contingent upon numerous factors, including the product's stage of development. Pati and Garud [26] contend that legitimacy would confer a more substantial advantage to projects in the nascent phases of development compared to later stages, which derive legitimacy from prototypes and proof of concept. Other studies, on the other hand, suggest that having a product almost ready for commercialization might be better able to build legitimacy and, in turn, have greater campaign success. Jones and Moncur [75] indeed noticed that campaigns that have "got something they were ready to deliver" (p.10) are better able to leverage legitimacy than those that, for example, have "still got research and development to do" (p.10) considering the mixed results, we thus propose the following hypothesis.

HP7: The stage of development moderates the relationship between environmental legitimacy and campaign success.

III. METHODS

A. Data Collection

A multistep procedure has been implemented to collect questionnaire responses from crowdfunding campaign creators. To

begin, we decided to focus on projects made available on Kickstarter and Indiegogo as those platforms are the most globally known regarding reward-based crowdfunding [76] and also because they served in many types of research as a common data source for this type of crowdfunding [34], [77]. For the identification of green crowdfunding initiatives, we utilized data assembled by a web scraping enterprise [78] that possesses collections of Kickstarter and Indiegogo projects. Datasets made available by Webrobots.io represent a widely used source of information in academic studies on crowdfunding [79], [80]. Those datasets contain information such as the project's name, a brief description of the project, the project launch date, the campaign deadline, the primary category of the project, and the project weblink. Overall, the datasets for the years 2009 through 2020 comprise more than 200 000 projects hosted on Kickstarter or Indiegogo platforms. Subsequent to the retrieval of these datasets, an initial selection of projects was conducted by employing the categorization systems utilized by both Kickstarter and Indiegogo to segment projects. This was to isolate initiatives concentrated exclusively on product creation. Then, using a list of keywords, projects relevant to the investigation were chosen (i.e., projects aiming at developing environmentally sustainable products). After reviewing the relevant literature on sustainable product development, the keywords were chosen [81], [82], [83], [84]. Environmentally sustainable products, according to the literature reviewed, are as follows:

- 1) products made from low-impact materials (e.g., renewable, biological, or recycled materials);
- 2) products with a longer lifespan (e.g., products that are easily repairable, durable, modular, upgradable, easy to disassemble, or remanufacturable);
- 3) products made to be recyclable;
- 4) products made to be compostable or biodegradable;
- 5) products efficient in the use phase and products fueled by renewable energy.

In detail, the following keywords were used to identify campaigns that were focused on the development of environmentally sustainable products by analyzing the product descriptions available in the datasets: “sustainable” OR “ecologic*” OR “biol*” OR “recycled” OR “renewabl*” OR “durab*” OR “repair*” OR “remanufactur*” OR “upgradab*” OR “modular*” OR “reusab*” OR “disassembl*” OR “recyclab*” OR “compostab*” OR “biodegradab*” OR “energy efficien*” OR “renewable energy.”

Through this filtering process, we pinpointed more than 3000 crowdfunding campaigns targeted at the development of environmentally sustainable products. We used a python routine to scrape the campaign's web pages, first and second, websites of project proposers, to look for contact information (email addresses). We gathered contact information for 1411 project campaigns. It appears that numerous campaigns discontinued their websites and contact emails following the campaign's conclusion, hence the total includes the elimination of non-functional emails.

We used Dillman's [85] formula to determine an appropriate sample size that is representative of the population; using this formula, 89 respondents are the ideal number to generalize a

population with a 95% confidence level and a 10% margin of error. A questionnaire was distributed to the 1411 campaigns to assess the aforementioned hypotheses. The questionnaire had several sections; the first section aimed at gathering information about the crowdfunding campaign. Specifically, in this segment, we solicited information from respondents regarding the platform where the project was listed, the funding goal of the campaign, the actual funds raised, the campaign's year, the count of backers, and the category of environmentally sustainable products proposed in the campaign. Another section was designed to gather information about creators' agreement on several statements to measure green product co-design, green market insights, and environmental legitimacy. The instruments employed to measure these constructs are elaborately detailed in Section III-B. The last section gathered data concerning the stage of product development using a single inquiry.

The questionnaire underwent a preliminary test facilitated by a company that had conducted a crowdfunding campaign for the development of a green product. This allowed us to get feedback on how thorough the questionnaire was and, if necessary, modify the questions to eliminate inconsistencies. The questionnaire completed by the testing company was not included in the final sample of respondents.

The distribution of the questionnaire took place through email during the final quarter of 2021 and the initial quarter of 2022, with responses accrued via an online platform. To mitigate social desirability bias or the propensity for respondents to provide overly favorable responses, as indicated by Nederhof [86], the anonymity of survey participants was preserved. Because we received 113 responses, there are no concerns about generalizability because the sample size is larger than what the Dillman formula suggests. Among the 113 respondents, 76 campaigns were hosted on Kickstarter (76.26%), 26 campaigns were hosted on Indiegogo (23.01%), and the remaining 11 campaigns were hosted on both platforms (9.73%). Regarding the distinction between successful and unsuccessful projects, 77 projects received successful funding, accounting for 68.14%, whereas 36 did not, comprising 31.86%. To mitigate bias concerns associated with the self-selection process, we ensure that the comparison of successful to unsuccessful projects within the reachable population and the final sample is proportionate; that is, the 113 responses represent a comparable proportion of successful and unsuccessful projects found in the contactable group. However, we must acknowledge that the financial success rate of the respondents was slightly higher than the overall population of green campaigns, which was 52.54%. Table I furnishes supplementary descriptive statistics pertaining to the varieties of environmentally sustainable products.

B. Measurements

1) *Formulating Scales for Quantifying Green Product Co-Design, Green Market Insights, and Environmental Legitimacy:* By considering that green product codesign, green market insights, and environmental legitimacy have, to the best of our knowledge, never been measured before, we relied on Hinkin's

TABLE I
DESCRIPTIVE STATISTICS ABOUT PRODUCT TYPOLOGY DEVELOPED BY RESPONDENTS IN CROWDFUNDING CAMPAIGNS

Typology of sustainable product	Projects		Successful projects	
	Number	Percentage	Number	Percentage
Products made from low-impact materials	45	39.82%	36	31.86%
Products with a longer lifespan	32	28.32%	26	23.01%
Recyclable products	8	7.08%	4	3.54%
Compostable or biodegradable products	13	11.50%	7	6.19%
Use efficient products and products fueled by renewable energy	15	13.27%	4	3.54%
Total	113	100%	77	68.14%

[87], [88] scale development approach to devise an appropriate measure.

Items for measuring constructs were generated deductively through a review of relevant literature. In detail, we conducted a comprehensive review of pertinent literature [10], [12], [36], [39], [41], [47], [54], [59], [60], [61], [89], [90], [91], [92], which aided in identifying crucial constructs and variables relevant to our investigation. Drawing from these insights, we crafted initial survey items, aligning them with the theoretical foundations of our study. Each survey item was meticulously designed to accurately capture the distinct nuances of the constructs we intended to measure, reflecting the most current insights in the field being investigated.

Following the identification of initial survey items, we embarked on a testing phase for our questionnaire to guarantee its clarity and relevance. This phase involved creating the initial questionnaire and engaging in iterative test and discussion with a company that had previously conducted a crowdfunding campaign for a green product. This step was instrumental in refining our questions, enabling us to finetune the language and phrasing for enhanced understanding. In more detail, this iterative process ensured that each question was finetuned to accurately reflect the constructs we were measuring, thus enhancing the validity of our instrument and ensuring it was well-suited to capture the nuanced perspectives of respondents.

Following the collection of responses, we conducted a psychometric analysis to evaluate the validity of the constructs. To assess construct validity, exploratory factor analysis was performed, confirming that the items effectively represented the intended constructs (see Appendix I). For reliability, Cronbach’s alpha was calculated for each scale to ensure consistency in responses (see Appendix II). This testing process was essential in ensuring that our questionnaire reliably and accurately measured the key dimensions of our study, laying foundation for our analysis and conclusions.

Concerning green product codesign, we relied on three items as detailed in Table II. These items were evaluated using a five-point Likert scale. Although there are studies that enhance the overall comprehension of codesign in various crowdfunding contexts [93], [94], we opted to utilize a specific measure for green product codesign. This approach aims to capture the unique dimensions in which the codesign process may influence the development of green products.

We relied also on three items to assess green market insights. Also, in this case, the items were developed with the relevant literature in the field, as presented in Table III. Also, in this case, the three items were assessed on a five-point Likert scale.

TABLE II
ITEMS USED TO MEASURE GREEN PRODUCT CODESIGN

Items developed for measuring green product codesign	Supporting motivation for the items
Feedback received from backers was useful to better develop the product and the environmental characteristics.	Feedback bolsters the inventive process inherent in new product development and enhances the congruence between product attributes and customer requirements [12], [39], [41].
Feedback from backers proved instrumental in aligning the functional requirements of the product with the objectives of environmental sustainability.	Forbes et al. [89] support that feedback might help creators develop functional product characteristics. Corsini & Frey [9] argue that crowdfunding platforms help collect product feedback, thus also allowing them to match functional product requirements and sustainability aspects.
Backer feedback was valuable in pinpointing the environmental considerations to be incorporated into product development.	Calic & Mosakowski [36] support that customer feedback may lead an entrepreneur to adopt a sustainability orientation during product development.

TABLE III
ITEMS USED TO MEASURE GREEN MARKET INSIGHTS

Items developed for measuring green market insights	Supporting motivation for the items
The crowdfunding platform allowed to extensively acquire environmentally related information from the market (e.g., about other sustainability related projects).	Moisseyev [90] and Brown et al. [91] suggested that crowdfunding can be considered an information-gathering tool to track and compare product ideas with those of competitors.
The crowdfunding initiative provided an avenue to gauge the market viability of the concept for the sustainable product.	Beier et al. [47] argue that the reactions of the target groups during a crowdfunding campaign provide valuable insights into general market demand for the new product and customer preferences concerning specific product features. This might also apply to socially related campaigns [93].
The crowdfunding campaign served as a research tool for better understanding the environmentally sustainable product features appreciated by customers.	Belleflamme & Lambert [10] posit that crowdfunding serves as a market test, reflecting to entrepreneurs the potential users' interest in the product or service offered. This assists in an objective assessment of the business idea and facilitates enhancements to the offering based on the feedback obtained. Lam and Law [96] are confident that this might also apply to sustainable products.

TABLE IV
ITEMS USED TO MEASURE ENVIRONMENTAL LEGITIMACY

Items developed for measuring environmental legitimacy	Supporting motivation for the items
Our crowdfunding project allows us to support environmental needs that are deemed worthy by people.	Drury and Stott [92], alongside Frydrych et al. [60], support that crowdfunding may bestow legitimacy on a venture, with the crowd selectively endorsing the social needs it considers meritorious.
The majority of our crowdfunding backers are primarily interested in the sustainability and core values of the project.	Lehner [59] and Lehner & Nicholls [61] maintain that crowdfunding investors commonly prioritize the ideas and core values underlying an opportunity over detailed business plans, thereby focusing on its legitimacy.
The crowdfunding campaign enabled us to develop our project based on the values and opinions that everyday people hold regarding the environment.	Lehner & Nicholls [61] and Chen [54] support that social initiatives seeking funds in crowdfunding platforms allow a company to build upon everyday people's values.

Environmental legitimacy was never measured with a questionnaire. We, thus developed three items ourselves, relying on different academic sources as presented in Table IV. In this case, three items were created, and we asked respondents on a five-point Likert scale whether they agreed with those items.

2) *Metrics for Crowdfunding Campaign Success, Product Development Stage, and Control Variables:* The crowdfunding campaign's success was determined by analyzing the amount received in excess of the amount requested by the project creators. The "all-or-nothing" rule for reward-based crowdfunding platforms stipulates that project creators set a specific deadline and a minimum financial target at the campaign's inception. Funding is only received if the amount pledged by backers meets or surpasses this target by the campaign's end date, ensuring that creators have the necessary funds to proceed with their project as planned [7].

The product development stage was measured using one question following the five stages of NPD. Thus, asking respondents which the following states the product was when launched through the campaign: preliminary assessment or scoping stage, screening stage, development stage, testing and validation stage, commercialization or launch stage. To avoid any potential misunderstanding in the questionnaire, we described each stage as presented in Section II-D.

At last, in a supplementary model, we tested several control variables: the count of crowdfunding campaign supporters, the sum solicited during the campaign, and the campaign's year of occurrence. Furthermore, in the last two supplementary models examined, we incorporated the platform utilized for funding acquisition and the product classification as additional control variables.

IV. RESULTS

To test our hypotheses, the information gathered from the surveys was analyzed using a structural equation model. Testing

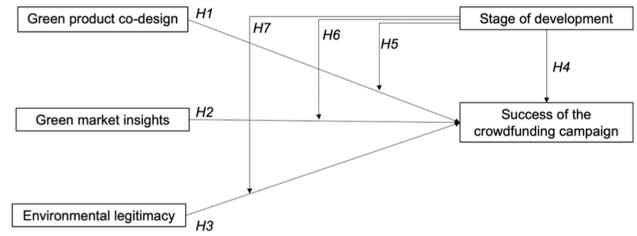


Fig. 1. Model tested.

a structural model with latent variables encompasses two principal steps: initially, confirming the validity of the measurement model, and subsequently, implementing the structural model. SPSS 23 and AMOS 23 were used to perform the calculations.

A. Measurement Model's Validation

The initial step we undertook was a confirmatory factor analysis, an approach deemed beneficial for validating the measurement model. The fit indices, displayed in Table V, attest to the goodness of the measurement model. As in our case, a good model fit is indicated by a nonsignificant χ^2 [97]. In addition, a model is considered to have a good fit if the χ^2/df ratio is less than 3 [98], which is also observed in our case. Lastly, a good fit is further evidenced by a comparative fit index (CFI) greater than 0.90 and a Tucker–Lewis index (TLI) exceeding 0.95 [98].

We also acknowledged the potential for common method variance (CMV) to introduce bias into the data. To evaluate this risk, we utilized the single common method-factor approach as recommended by Podsakoff et al. [99]. This procedure necessitates the incorporation of a latent variable into the measurement model for testing purposes. Each item was loaded onto its respective theoretical construct as well as the newly developed latent variable. The structural parameters were then evaluated for both the model with and without the latent variable. In our case, we can be confident that the bias has no effect on the results as the measurement model with a latent variable performs worse than the measurement model.

In Table VI, other psychometric are presented in detail the composite reliability (CR), max reliability (MaxR(H)) were assessed. Table VII elucidates the average variance extracted (AVE) and the maximum shared variance (MSV), which facilitate the evaluation of the measurement model's convergent and discriminant validity. A construct exhibits substantial convergent validity when its AVE value surpasses 0.5 [98]. Discriminant validity is established when the MSV is consistently lower than the AVE across all constructs [100].

B. Fitting the Structural Model

The results are displayed in Table VII, where, to verify the robustness of our findings, we illustrated various models tested; in these models, we incorporated several control variables. Model 1, which was introduced in Section II and illustrated in Fig. 1, demonstrates acceptable goodness-of-fit indices.

In model 1 HP1 is supported ($\beta = 0.229$; $p < 0.05$) as presented in Table VII. This means that green product codesign positively

TABLE V
ASSESSMENT OF THE MEASUREMENT MODEL

Model	χ^2	df	χ^2/df	CFI	TLI	RMSEA
Measurement model	25.404	24	1.059	0.99	0.99	0.073

TABLE VI
RELIABILITY AND VALIDITY RESULTS

	CR	AVE	MSV	MaxR(H)	Green product co-design	Green market insights	Environmental legitimacy
Green product co-design	0.911	0.774	0.211	0.912	0.880		
Green market insights	0.856	0.665	0.397	0.861	0.459	0.815	
Environmental legitimacy	0.791	0.559	0.397	0.799	0.446	0.630	0.748

TABLE VII
RESULTS OF THE STRUCTURAL MODELS TESTED

Constructs and variables tested	Model 1	Model 2	Model 3	Model 4
Green product co-design	0.229**	0.213**	0.267**	0.211**
Green market insights	0.324***	0.330***	0.372***	0.370***
Environmental legitimacy	0.178 (ns)	0.131 (ns)	0.022 (ns)	0.041 (ns)
Product development stages	0.251***	0.207***	0.183**	0.196**
Amount requested	-	-0.217*	-0.139**	-0.055*
Number of backers	-	0.113*	0.089*	0.078*
Year of the campaign	-	0.097 (ns)	0.035 (ns)	0.040 (ns)
Kickstarter (dichotomous)	-	-	0.295 (ns)	0.324 (ns)
Indiegogo (dichotomous)	-	-	-0.006 (ns)	0.042 (ns)
Products made from low-impact materials (dichotomous)	-	-	-	0.243*
Products with a longer lifespan (dichotomous)	-	-	-	0.226*
Recyclable products (dichotomous)	-	-	-	0.175 (ns)
Compostable or biodegradable products (dichotomous)	-	-	-	-0.079 (ns)
Use efficient products and products fueled by renewable energy (dichotomous)	-	-	-	0.121 (ns)
Model fit	$\chi^2/df=1.100$, CFI=0.99, TLI= 0.99, RMSEA=0.03	$\chi^2/df=1.056$, CFI=0.99, TLI= 0.99, RMSEA=0.02	$\chi^2/df=2.240$, CFI=0.83, TLI= 0.80, RMSEA=0.105	$\chi^2/df=2.587$, CFI=0.73, TLI= 0.68, RMSEA=0.119

impacts the campaign’s success. Also, HP2 is supported ($\beta = 0.324$; $p < 0.000$); thus, green market insights positively impacts the campaign’s success. On the other hand, HP3 is not supported in the tested model; this means that environmental legitimacy obtained through the campaign does not impact the success of the campaign. Finally, HP4 is also supported ($\beta = 0.251$; $p < 0.000$), meaning that the higher the development stage, the greater the crowdfunding campaign’s success.

To ascertain the robustness of our findings, an additional model (Model 2) also examined three control variables that could affect the success of crowdfunding endeavors. The first control variable, the number of backers, proved to be statistically significant ($\beta = 0.113$; $p < 0.1$), exerting a positive effect on the success of the crowdfunding campaign, corroborating findings from other studies in this domain [e.g., 102]. In addition, the second control variable, the funding goal set for the campaign, was found to be statistically significant ($\beta = -0.217$; $p < 0.1$), suggesting that higher financial targets are inversely related to the campaign’s success. This finding aligns with prior research [7] as well as more contemporary studies [27], [35]. Lastly, the campaign’s year, also considered as a control variable, did not have a statistically significant impact.

To further ascertain the robustness of our findings, we conducted tests on two additional models (Model 3 and Model 4), examining the influence of the crowdfunding platform and

the types of sustainable products involved. Specifically, in Model 3, we introduced two additional binary variables into the equation—one for campaigns launched on Kickstarter and the other for those on Indiegogo. Neither variable proved to be statistically significant, and the model exhibited a poorer fit compared to the first two models. In Model 4, we assessed different product categories, including those using low-impact materials, designed for longevity, recyclable, compostable or biodegradable, efficiency-focused, and powered by renewable sources. We generated a binary variable for each category and included them in our model. The analysis indicated that products using low-impact materials and those designed for longevity had a statistically significant higher likelihood of campaign success. However, the fit of Model 4 was unacceptable.

Finally, the moderating effects were determined using the guidelines proposed by Cohen [102]. Recalling the HP5, it was stated that the stage of development moderates the relationship between green product codesign and the crowdfunding campaign’s success. Fig. 2 suggests that the interaction term ($\beta = -0.112$; $p < 0.05$) is significant. HP5 is fully supported. Conversely, as depicted in Fig. 2, HP6 and HP7 are not supported. In accordance with the methods of Aiken et al. [103], the data from the path coefficients were utilized to illustrate the moderating influence of the product development stage on the nexus between green product co-design and the triumph of the crowdfunding

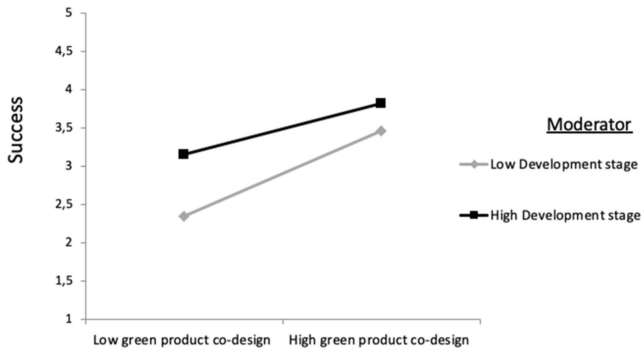


Fig. 2. Interaction effect of stage of development between green product co-design and the success of the crowdfunding campaign.

campaign, as in Fig. 2. The development stage dampens the positive relationship between green product co-design and the crowdfunding campaign's success. In other terms, although both low and high development stage projects benefit from high green product co-design, the benefit is less substantial for the projects that are at a high development stage compared to those at a low development stage.

V. DISCUSSION

A. Implications for Theory

Our study results add to the body of research on the success of crowdfunding initiatives, particularly those that examine green crowdfunding campaigns [104], [105], [106].

The first contribution to the crowdfunding literature concerns the importance of green product codesign in determining the initiative's success. Studies on electronic commerce platforms indicate that online customer assessments significantly sway consumer choices [107], as well as the triumph of crowdfunding endeavors [108]. Nonetheless, in crowdfunding, supporters have the ability to do more than merely offering reviews; indeed, they may also contribute to product design. According to the literature on innovation management, there is a solid correlation between crowd suggestions and product commercialization [109], [110]. Suggestions play a crucial role in the product development process, serving to identify issues and propose solutions [111], and offering guidance on production techniques [112]. This input is instrumental in enhancing the prospects of success for crowdfunding campaigns. According to our findings, suggestions could also aid in the codesign of the product's environmental characteristics, match functional product requirements with environmental sustainability goals, and suggest environmental aspects to address in product development, all of which contribute to the success of the crowdfunding initiative.

This outcome further enhances our understanding of green product codesign in crowdfunding. It supports the findings of Chan et al. [23], who suggest that emphasizing sustainability in project communication can strengthen backer engagement, thereby playing a significant role in the success of crowdfunding campaigns.

Our research results, by emphasizing that the crowd can provide helpful suggestions for how to improve the product by incorporating relevant environmental improvements, contribute not only to theoretical aspects but also to the debate about the “wisdom of the crowd” [113]. The concept of collective intelligence, or the “wisdom of the crowd” refers to the superior problem-solving and decision-making abilities that emerge from the aggregation of information from large groups of individuals, which often surpass the expertise of individual specialists [113]. This phenomenon leverages the diverse insights of the community, enabling the collective to identify more effective solutions to challenges and resolve a greater array of problems than could be achieved by individuals alone, due to the synergistic amplification of their collective knowledge [114]. Several scholars, including Lang et al. [115] and Yasar et al. [14], have underscored the crucial role of social interplay between entrepreneurs and the crowd in the course of crowdfunding endeavors. They have provided empirical evidence on the merit of community suggestions, implying that backers and prospective supporters demonstrate remarkable discernment in evaluating and giving suggestions on products. Corsini and Frey [106] proposed anecdotal evidence for the “environmental wisdom of the crowd” and the empirical results of our study seem to support such a capability. Consequently, the crowd transforms into a proactive catalyst of change, possessing the ability to steer the course of the crowdfunding campaign and wield persuasive authority over the project creators. This is a timely result because the crowd may assist project creators in aligning their campaigns with the overall sustainable development goals [116], [117], playing an essential societal role.

Regarding the moderation effect of the product development stage on the relationships between green product codesign and campaign success, our results confirm findings suggested by general literature on product development; thus, contributing to the literature about the role that customers might assume in new product codesign [118], [119], [120]. Also, within the sphere of crowdfunding, entrepreneurs in the initial phases of product development stand to benefit significantly from suggestions, potentially enhancing the success of their endeavors.

Our research underscores the critical role that acquiring green market insights plays in the successful outcome of a campaign. Our study adds to the body of knowledge on crowdsourcing by focusing on a relatively new research line that investigates the informational side of crowdfunding campaigns on the demand side (i.e., project creators). Previous research indicates that in some cases, project owners regarded the informational component of crowdsourcing as equally, if not more, important than the collection of funds [69]. The principal informational benefit of reward-based crowdfunding lies in its function as a test market, disclosing insights into the market potential of novel products [104], [105], [121]. Indeed, project initiators reap benefits irrespective of whether the contributions aid in learning authentically about consumer predilections [122], or pertain to the product's environmental attributes. By carrying out our empirical examination of the value of sustainability information in crowdfunding for entrepreneurs, we augment the scholarly corpus that posits project proprietors comprehend

how to harness sustainability information obtained for steering their crowdfunding ventures towards success. In the domain of information economics and marketing, literature indicates that pricing strategies function as indicators of quality in the presence of incomplete information [50]. We contributed to such literature underlining that green market insights could also drive better pricing strategies in environmentally sustainable product development, allowing entrepreneurs to better understand the market for their products and, for instance, offer discounts, thus increasing the success probability of the campaign.

This study's results additionally enrich the scholarly understanding of crowdfunding and its role in establishing legitimacy. We show that increased environmental legitimacy in crowdfunding environmentally friendly products does not affect campaign success. These discoveries, while counterintuitive, challenge earlier scholarship in this domain [60], further contributing to a nuanced understanding of legitimacy within the framework of crowdfunding. In a similar context, Chen [54] unearthed a fascinating relationship: the triumph of a crowdfunding campaign inversely corresponds to moral legitimacy, signifying that socially and environmentally driven initiatives often face lesser success compared to their commercially focused counterparts.

Our findings regarding environmental legitimacy align with the perspectives offered by Petruzzelli et al. [12], who underscore the distinct dynamics of sustainability-oriented campaigns. They point out the unique motivations of backers in these campaigns, which are influenced by a combination of altruistic and normative reasons. This indicates that attaining environmental legitimacy in crowdfunding campaigns might necessitate aligning the campaign's objectives with the deeper, value-driven motivations of backers. This approach involves addressing not only the tangible benefits but also the intangible, value-based aspects of sustainable projects.

According to Lehner [59], the project's underlying values influence the crowdfunding campaign's success. In our case, the lack of statistical significance of environmental legitimacy seems to imply that it takes time before public perceptions of environmental legitimacy begin [123] and produce some kind of beneficial effect on a company/crowdfunding project proposer. Yang et al. [124] and Li et al. [125] corroborate across diverse contexts that following the enactment of precise environmental regulations, or when enterprises steer their operations toward the creation of environmental or green innovations, the establishment of legitimacy and reputation demands patience. This is primarily because surmounting stigma constitutes the initial stride. As a result, it is reasonable to believe that complex constructs (such as environmental legitimacy) entail a longitudinal dimension before spreading and influencing the course of action. In a crowdfunding context, the duration of a campaign may be quite short in order for environmental legitimacy to develop and contribute to the campaign's success.

Butticè et al. [29] highlight the varying impact of environmental sustainability orientation across different countries, which adds an important dimension to our discussion

on environmental legitimacy. Their findings imply that the perception of environmental legitimacy in crowdfunding campaigns might be significantly influenced by the broader environmental context and cultural norms of different regions, suggesting a nuanced approach to building and communicating environmental legitimacy in line with regional expectations and values.

B. Managerial Implications

Our findings suggest that environmental suggestions are critical to the campaign's success. In such a case, a strategy for further involving backers in the development of the product's environmental characteristics could be to offer the ability to participate in product codesign of environmental aspects as a prize in crowdfunding campaigns. This method has been deemed as a best practice for financing other innovative products [126]. Furthermore, another managerial suggestion for campaign managers could be to provide the most active supporter of the campaign with an advisory board environmentally related role in the company that promoted the campaign, thus recognizing their knowledge contribution and further benefit in the development of new products.

A significant result of our research from a managerial standpoint is the interaction effect between the development stage and green product codesign in influencing the success of the crowdfunding campaign. In other words, while suggestions received at a lower stage of development significantly impacts campaign success, suggestions received at a later stage of development has less of an impact. Thus, a suggestion for project managers would be to be open to green product codesign practices in the early stages of NPD but to avoid engaging in those suggestions once the product is almost ready, as it may not contribute much to the success of the initiative.

Our findings also suggest that crowdfunding platforms enable the acquisition of green market insights, which is critical for determining the success of the initiative. Platforms that leverage crowd knowledge are becoming increasingly important in the new internet economy. In such a framework, well-established companies can rely more on such instruments as a strategy to seek sustainability information in a creative and proactive manner. Firms that meticulously heed the needs of green consumers often exhibit heightened creativity in their offerings and marketing tactics, potentially fostering eco-design innovations across the enterprise.

In conclusion, certain managerial implications concerning environmental legitimacy can be discerned. The attainment of environmental legitimacy via crowdfunding campaigns that employ a myriad of techniques and tools—such as videos, comprehensive descriptions, links to external content—to relay the project's environmental facets, does not exert an influence on the success of crowdfunding, as echoed by other studies [122]. In such a case, project creators could broaden the context of communication, for example, by creating a narrative for the sustainable materials used, the innovative sustainable production process, or even by coupling the environmental message with

other pro-social messages (e.g., preserving craftsmanship or heritage). Environmental legitimacy can also be obtained through environmentally related certifications, which may serve as tools to inform and educate stakeholders about a company's activities [127].

While this may be valid, requesting that crowdfunding platforms like Kickstarter and Indiegogo validate the environmental claims of the projects they host and offer certification could conflict with their commercial objectives. Given these considerations, a wise managerial suggestion might be to look for funding on platforms that are more pro-socially/environmentally oriented (e.g., Ecocrowd, Oneplanetcrowd), as these platforms may be better suited for leveraging on environmental legitimacy. For example, the crowdfunding platform Ecocrowd emphasizes that campaigns are currently being screened using a strict checklist to determine the true sustainability of the product and avoid any greenwashing activities [128]. Indeed, the lack of impact of environmental legitimacy on crowdfunding success could also be due to consumer skepticism regarding green product claims, which often arises from concerns about greenwashing. In this context, Corsini and Frey [9] demonstrated that backers and potential backers appear to be adept at identifying greenwashed messages in crowdfunding campaigns. This skepticism can lead backers to question or dismiss the environmental legitimacy of campaigns. This suggests that in addition to traditional legitimacy-building strategies, campaign creators should also address and mitigate potential skepticism to enhance the appeal of their projects.

VI. CONCLUSION

Our research endeavors to enhance comprehension of green crowdfunding initiatives, by probing into factors potentially instrumental in their success. This pursuit concurrently furthers the evolution of an overarching theory on crowdfunding, a construct yet to exist in its entirety as of now [31]. Our results indicate that green product codesign, green market insights, and the stage of development each positively influence the success of a crowdfunding campaign. Conversely, environmental legitimacy does not influence the success of the campaign. Finally, we measured and assessed the development stage's moderation over the three others constructs tested in our study. We discovered that the development stage, in particular, dampens the positive relationship between green product co-design practices and crowdfunding campaign success.

Although the significance of these outcomes is evident, certain limitations warrant acknowledgment. Primarily, the analysis hinges on a predefined set of keywords to pinpoint projects on crowdfunding platforms that pertain to sustainability. These terms were selected based on the pertinent literature on sustainable product design; however, there could be an inherent bias in this method.

It is important to acknowledge that our study did not incorporate quantitative data from crowdfunding platforms to independently validate our findings, as we prioritized respondent anonymity to mitigate social desirability bias. Utilizing metrics from these platforms, such as comments received from backers,

could have offered a more objective assessment of campaign success. Future research would be enriched by employing a dual approach that combines survey data with direct metrics from crowdfunding platforms. This would offer a more comprehensive and objective assessment of both campaign success and environmental impact. Implementing this integrated methodology could significantly enhance the understanding of green crowdfunding dynamics.

Closely related to the previously mentioned limitation, we must also recognize that our study was primarily centered on environmentally oriented backer interactions, and did not include a broader spectrum of backer engagement variables. This exclusion, such as overall engagement in the campaign and social media interactions, may have limited our insights into the factors driving crowdfunding success. Future research could expand upon this by incorporating a more comprehensive array of backer engagement variables. This should include not only environmental feedback but also general social media interactions and other non-environmental engagement factors. Such an approach would provide a fuller understanding of the diverse elements contributing to the success of crowdfunding campaigns, particularly in the context of green crowdfunding initiatives.

In addition, despite several measures taken to mitigate bias, such as ensuring confidentiality and randomizing question order, future quantitative studies could be enhanced by incorporating objective data to solidify the robustness of the analyses and findings. Although the questionnaire was tested, potential biases may still arise from the way measurements were assessed and questions were framed for the participants. This may also extend to issues relating to individual perceptions and memory. We must also recognize that the comparison of successful to unsuccessful projects within the reachable population and the final sample is proportionate. However, the financial success rate of the respondents was marginally higher than that of the overall population of green campaigns.

Some limitations arise from our decision to utilize structural equation modeling. Primarily, structural equation modeling assumes linear relationships between variables, which may not effectively represent the complex, nonlinear dynamics often observed in real-world scenarios. Future research could benefit from employing alternative approaches, such as nonlinear structural equation mixture models, to capture these dynamics more accurately.

Furthermore, structural equation modeling's effectiveness is closely tied to sample sizes, necessitating a cautious interpretation of findings. This limitation highlights the need to view SEM results as one of several potential interpretations of the data. In this regard, future studies could consider integrating both qualitative and quantitative methods to gain a more comprehensive understanding of the connections between specific factors and the success of green crowdfunding initiatives.

In addition, we believe that the platforms used by those projects (Kickstarter and Indiegogo) may have an impact on our results. Evaluating the impact of environmental legitimacy on

the success of crowdfunding projects on platforms with a pro-social/environmental orientation could attract more purpose-driven initiatives, potentially leading to different results [129]. Specialized crowdfunding platforms dedicated to green initiatives may offer enhanced support to campaigners in leveraging crowdfunding’s potential for green entrepreneurship. This could encompass assistance with co-design mechanisms as well as effective communication of environmental information to prospective backers. As a result, we request additional research into how green products are funded on other crowdfunding platforms.

Finally, further research could adopt an additional theoretical lens to investigate the topic. For instance, several studies have used the signaling theory as the backbone (e.g., [130]). Future research, grounding on the signaling theory, could, for instance, assess if, depending on the development stage, the potential backer perceives the environmental signals differently and if environmental legitimation implies that the project transmits quality signals to potential funders.

APPENDIX I

ROTATED FACTOR MATRIX

	Component 1	Component 2	Component 3
The crowdfunding platform allowed to extensively acquire environmentally related information from the market (e.g., about other sustainability related projects).	0.901		
The crowdfunding initiative provided an avenue to gauge the market viability of the concept for the sustainable product.	0.894		
The crowdfunding campaign served as a research tool for better understanding the environmentally sustainable product features appreciated by customers.	0.878		
Feedback received from backers was useful to better develop the product and the environmental characteristics.		0.870	
Feedback from backers proved instrumental in aligning the functional requirements of the product with the objectives of environmental sustainability.		0.845	
Backer feedback was valuable in pinpointing the environmental considerations to be incorporated into product development		0.781	
Our crowdfunding project allows us to support environmental needs that are deemed worthy by people			0.831
The majority of our crowdfunding backers are primarily interested in the sustainability and core values of the project			0.781
The crowdfunding campaign enabled us to develop our project based on the values and opinions that everyday people hold regarding the environment			0.778

APPENDIX II

DESCRIPTIVE STATISTICS OF THE ITEMS USED IN THE STUDY

Green product co-design	Mean	Standard Deviation	Cronbach's alpha
The crowdfunding platform allowed to extensively acquire environmentally related information from the market (e.g., about other sustainability related projects).	3.053	0.962	0.802
The crowdfunding initiative provided an avenue to gauge the market viability of the concept for the sustainable product.	2.884	1.116	
The crowdfunding campaign served as a research tool for better understanding the environmentally sustainable product features appreciated by customers.	3.008	1.064	
Green market insights	Mean	Standard Deviation	Cronbach's alpha
Feedback received from backers was useful to better develop the product and the environmental characteristics.	3.867	1.089	0.881
Feedback from backers proved instrumental in aligning the functional requirements of the product with the objectives of environmental sustainability.	3.778	1.258	
Backer feedback was valuable in pinpointing the environmental considerations to be incorporated into product development	3.823	1.204	
Environmental legitimacy	Mean	Standard Deviation	Cronbach's alpha
Our crowdfunding project allows us to support environmental needs that are deemed worthy by people	3.230	0.982	0.785
The majority of our crowdfunding backers are primarily interested in the sustainability and core values of the project	3.115	0.903	
The crowdfunding campaign enabled us to develop our project based on the values and opinions that everyday people hold regarding the environment	3.238	1.062	

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