

Article

Serial Multiple Mediation of the Impact of Customer Knowledge Management on Sustainable Product Innovation by Innovative Work Behavior

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Abstract: Customer knowledge management (CKM) is a relatively new research domain, aiming at exploring the potential of customer knowledge for the open innovation process of companies. The present paper aims at performing a complex analysis of the serial mediation phenomenon of the impact of CKM on sustainable product innovation (SPI) by innovative work behavior (IWB). The dimensions considered for IWB in the present research are the following: idea exploration, idea generation, idea championing, and idea implementation. In the first phase of our research, we performed a semantic analysis of the main concepts, ideas, and theories, based on a critical literature review. Thus, we reached a deeper understanding of the complexity of the concept of knowledge by learning the theory of knowledge fields and knowledge dynamics. As a result of this conceptual phase, we designed the research model and a questionnaire to be addressed to managers from the business environment. In the quantitative phase of the present research, we used the statistical software packages, SPSS version 26.0, and the PROCESS macro for SPSS, version 3.5. We used well-known criteria for reliability, validation, and interpretation of the numerical results. The final results demonstrate a significant serial mediation phenomenon regarding the impact of CKM on SPI by the IWB. These results are important in developing the co-creation process of new products by using customer knowledge. The present research reveals some original ideas concerning the impact of CKM on SPI by using a serial mediation process performed by basic innovative work dimensions. The implications of the present research are significant for both academics and practitioners in designing open innovation in knowledge ecosystems.

Keywords: customer knowledge management; open innovation; sustainable product innovation; innovative work behavior

1. Introduction

Knowledge is considered a strategic resource of knowledge-intensive companies [1–3], contributing significantly to developing a company's dynamic capabilities [4] and achieving competitive advantage [5–8]. Knowledge integrates rational, emotional, and spiritual fields [9] and constitutes a resource that becomes a driving force in creating successful business and knowledge strategies for sustainable development [10,11]. The rational knowledge field contains explicit knowledge that is the result of rational thinking and that

can be expressed by using a natural or symbolic language. The emotional knowledge field comprises the wordless knowledge that represents the emotional state of our body and mind. It is personal knowledge that reflects the reaction of our body to any interaction with the environment, and it is the result of processing the information that is provided by the sensory system to the emotional brain [12,13]. The field of spiritual knowledge contains beliefs, values, insights, ideals, and religious concepts that can be integrated at the organizational level, leading to organizational spirituality [14,15].

Sustainability is the dynamic capacity of a company to build up its future within the triple bottom line framework [16,17], and it needs both knowledge vision and knowledge leadership [18–20]. The triple bottom line (TBL) construct was coined by Elkington [21] and is extensively used in correlation with the construct of sustainability. It expresses the idea of expanding the environmental agenda, such that it will integrate both economic and social lines. From this perspective, sustainability depends on innovation and renewal capital. It also depends on knowledge management and its dynamics with customers and their needs. Learning directly from the customers about their needs, knowledge managers can focus the innovation process on creating new products to satisfy those needs. Sustainability results as a logical consequence of the convergence between customer needs and the company's capability to satisfy them with new products and services, within the TBL framework. The whole process becomes more relevant in the context of an emerging economy, where the concepts of customer knowledge management and sustainable product innovation are not so well-developed.

Customer knowledge management (CKM) is about focusing on the knowledge dynamics between the company and its customers, integrating knowledge from customers, for customers, and about customers [22,23]. Expanding the knowledge management system toward customers creates the necessary conditions for developing open innovation and those dynamic capabilities needed for achieving a competitive advantage within the framework of business sustainability [24,25]. CKM is a collaborative process in which customers are invited and stimulated to come up with ideas for new products and services and to co-create them together with employees and managers from the company. "According to the service-dominant logic approach, collaborative competence allows including customers and other external stakeholders such as business partners in the innovation process, and using them to foster change" [25] (p. 14).

The flow of knowledge directed toward customers aims at making them aware of the new products and services offered by the company and helping them in their purchasing decision-making [26]. That knowledge can also be very useful in the buying cycle, during the phase of efficiently using the purchased products. Managing the knowledge flow about customers shifts the focus to customers' preferences and their past transactions, their present and future needs [27]. That knowledge incorporates the perceptions of customers about the purchased products and services; it reflects their level of satisfaction as expressed through knowledge dynamics between rational, emotional, and spiritual knowledge in the well-known field of sentiment analysis [28,29].

The newest component of CKM is the knowledge that comes from customers. That knowledge is important in stimulating open innovation, a process designed to improve the quality of products and services and to create new goods for the market. Managing the flow of knowledge from customers can be achieved by transforming customers into co-creators in the innovation process, using their creativity for the benefit of both the company and society. This is a collaborative approach, based on high psychological tension and on directing the knowledge dynamics toward product and service innovation [26,30,31].

CKM impacts sustainable product innovation [23,24], especially through this new component of knowledge from customers, including factors that contribute to TBL implementation. "The emergence of sustainability as a major driver of innovation highlights a number of important issues that merit investigation, such as potential avenues for sustainable innovation and sustainable product innovation and factors underlying differences between firms in their commitment to a sustainable innovation orientation" [32] (p. 14).

Thus, sustainable product innovation (SPI) is recognized as an important factor in a firm's dynamic capability for achieving competitive advantage and promoting the firm's sustainability. Many firms today transform their closed innovation into open innovation to take advantage of their customers' experience and behavior, which are powered by knowledge dynamics [33]. CKM transforms the knowledge management system into a knowledge management eco-system by integrating customers' knowledge. When a firm is practicing closed innovation, customers' knowledge is untapped and is explored only through marketing research, in a limited way. Developing CKM implies incorporating customers and their knowledge into the extended knowledge ecosystem, stimulating knowledge-sharing as a basic phenomenon of creating knowledge inflows [34]. Because CKM deals with inflows created by individual customers, the whole phenomenon can be better understood in terms of micro-foundations [35], i.e., integrating knowledge micro-contributions into knowledge macro-constructs at the firm's level. That is an interesting demonstration of the capacity of a given firm to act as a learning organization [36–39]. Organizational learning developed within the limits of the company is now growing, enlarging and crossing over the interface to work with customers.

The impact of customer knowledge management on sustainable product innovation as a complex process, including the flow of knowledge from customers and the mediation performed by the innovative work behavior, has not yet been explored in the literature. There is a gap of knowledge between what we know about the influence of customers on sustainable product innovation and the complex reality of customer knowledge dynamics concerning their needs. To reduce this knowledge gap, we designed exploratory research trying to better understand the dynamics between these three main constructs: customer knowledge management as an independent variable, sustainable product innovation as a dependent variable, and innovative work behavior as a mediator. The current research is particularly relevant for the emerging economies, where the role of innovative work behavior in that area of dynamics is lacking. The relationship between customer knowledge management and sustainable product innovation is nonlinear and it is mediated by the innovative work behavior (IWB) that integrates the following components or dimensions: idea exploration, idea generation, idea championing, and idea implementation. All these components can boost workers' capabilities to innovate [40–42]. Creativity is a potential state of any worker, but it exists at different levels, and it generates new concepts and ideas as a result of an individual motivational field and not of the managerial constraints or any job description formats. Thus, IWB reveals a certain commitment from individual workers to the innovation process, a commitment that operates like a triggering mechanism. This form of innovative work behavior implies a high level of creativity and the willingness to use the creative mind for the benefit of the organization, improving the quality of the existing products and services and designing new ones to satisfy the consumers' needs [41,43]. IWB can be prepared from university studies if the governance of the university focuses on the importance of innovation in business, and if the curriculum for business education contains the necessary components to achieve that purpose [44,45].

The purpose of the present research is to analyze, in the context of an emergent economy, the serial multiple mediations of the association between customer knowledge management (CKM) and sustainable product innovation (SPI) by innovative work behavior (IWB), through its four dimensions: idea exploration, idea generation, idea championing, and idea implementation. That leads to the following research question:

RQ: How important is the serial multiple mediations of the association between CKM and SPI by IWB dimensions?

The present work is based on a systematic literature review and quantitative research. The first phase of our work focused on critical analysis of the literature and interpretative assessment of the main ideas and theories. The quantitative approach has been utilized by selecting and designing a questionnaire and addressing it to 300 of the managers and employees of 12 medium and large multinational companies from different business segments in Romania.

The originality of the present research comes from the design of the research model that reflects the correlations between customer knowledge management and sustainable product innovation under the serial mediation of innovative work behavior dimensions. Even if, intuitively, one may consider the impact of customer knowledge management on sustainable product innovation, it is not a direct and linear correlation. It is a non-linear relationship mediated by innovative work behavior dimensions. Considering all four dimensions of the mediator, and all possible alternatives of their intervention in the mediation process, contributes to the added value of the present research. In addition, the context of the current research is that of an emergent economy where customer knowledge management is not so well developed.

The added value of the current research results from a better understanding of the complex dynamics between the constructs of the proposed research model, in the context of an emergent economy. The extant literature concerning customer knowledge management and its impact on sustainable product innovation in emergent economies is very scarce and there is a need for such an exploration.

The remainder of the paper is structured as follows. After this short introduction, we present in the next section a critical review of the literature, related to the three basic constructs used in this research: customer knowledge management, sustainable product innovation, and innovative work behavior dimensions. Then, we present our research design and methods, followed by results and discussions. Finally, we present a synthesis of conclusions, some research limitations, and potential directions for further research.

2. Literature Review

2.1. Customer Knowledge Management (CKM)

Customer knowledge management is an integral part of knowledge management and customer relationship management. It is focused on managing the knowledge dynamics between the organization and its customers involving three types of knowledge: (a) knowledge for customers; (b) knowledge from customers, and (c) knowledge about customers [46–49]. CKM is built on the idea of transforming customers from passive marketing research objects into active co-creators of value by their knowledge contribution to the innovation process. Customers are those who know best what their needs are and how these needs change over time. They know best how to express those needs integrating into their communication with organizations rational, emotional, and spiritual knowledge [27,50]. However, the customers do not know the capabilities of the organization regarding satisfying their needs; thus, the knowledge from the customer component should be guided by managers, through knowledge, to customers' knowledge flow. There are also some aspects of the innovation process that cannot be disclosed to customers.

Engaging the customers in conversation with organizations represents an opportunity for decision-makers to understand more profoundly the dynamics of the external business environment and its trends. When the time dimension is integrated into these knowledge flows that cross the organizations' interface, we may consider strategic conversations. As Spender and Strong [51] remark, "Today, as perhaps never before, it's critical to pay attention to the outside world because the speed of change has accelerated, bringing new threats and opportunities at an often-bewildering pace. To be able to avoid danger and seize the advantage in this sped-up environment, good ideas for bolstering and evolving the business model can and should come from everywhere, including players outside the firm" (p. 164). Thus, businesses need to extend their strategic conversations to customers and to learn from them [52,53].

Chua and Banerjee [27] perform an interesting analysis of the role played by social media in customer knowledge management, focusing their attention on Starbucks. They investigate the relevance of social media in the dynamics of knowledge flows between organizations and customers by considering the following mechanisms: microblogging services, social networking services, location-aware mobile services, and corporate discussion forum services. They selected Starbucks because of the unexpected results obtained by the

company in developing efficient customer knowledge management by using social media systems. For instance, the corporate discussion forum services initiated on the platform *My Starbucks Idea* succeeded, only two months from its inauguration, in collecting over 41,000 ideas from customers and the Facebook page accumulated, almost exponentially, over 31 million likes. These results allow the Starbucks managers “to comprehend customers’ behaviors, preferences, expectations, levels of satisfaction, and ways they react to new products and changes” [27] (p. 243).

Cui and Wu [24] analyze the role of CKM in innovation and demonstrate the benefit of developing interaction between firms and their customers in creating new products and services. Exploring and extracting data, information, and knowledge from customers increases the absorptive capacity of firms [54] and stimulates their organizational learning processes. Furthermore, knowledge-sharing increases the organizational knowledge entropy [55], a supportive phenomenon of innovation and business performance [56–58]. Taherparvar, Esmaelipour, and Dostar [59] perform a systematic analysis of the correlations between customer knowledge management, innovation capability, and business performance, with reference to the banking industry. Their findings show that customer knowledge management impacts the innovation process of the firm and contributes in this way to a fast response to new changes in the market. “CKM pays attention to both customer knowledge and firm knowledge and invests in both external and internal competencies, so it enables firms to create new products and services to respond to variable market situations” [59] (p. 594).

2.2. Sustainable Product Innovation (SPI)

The initial concept of *sustainable development* was coined by the United Nations Commission on Environment and Development’s (Brundtland Commission) report, in a document entitled *Our Common Future* [60]. From that moment the concept has been continuously refined and enriched in meanings and dimensions, up to the understanding of “triple bottom line” [16,17]. Today, the United Nations’ seventeen sustainable development goals (SDGs) aim to achieve decent lives for all on a healthy planet by the year 2030 [60–62].

Sustainable product innovation is integrated into this comprehensive agenda, focusing on the strategic objectives formulated in the SDGs program. Varadarajan [32] defines *sustainable product innovation* as being the “firm’s introduction of a new product or modification of an existing product whose environmental impact during the lifecycle of the product, spanning resource extraction, production, distribution, use, and post-use disposal, is significantly lower than existing products for which it is a substitute” (p. 17).

Sustainable product innovation can be extended to incorporate service innovation and process innovation, such that researchers consider the larger sphere of *sustainable innovation* [63–65]. Stryja and Satzger [66] remark that customers can play an important role in testing new products. Touching them and judging their ease of use when in operation are good opportunities for people to discover the novel features and advantages of the new products. Then, by sharing the acquired knowledge with the firm’s managers, they can provide insightful feedback for the decision-makers. Knowledge-sharing, especially in the form of tacit knowledge, contributes significantly to the innovation process in wise companies, as shown by Nonaka and Takeuchi [1,2].

Knowledge management should be extended from organizations to ecosystems such that it can successfully incorporate the data, information, and knowledge acquired from customers and the external business environment and create new premises for sustainable product innovation and organizational performance [67,68]. Advancements in organizational structures and information technology have enabled the development of online working platforms for knowledge-sharing and business processes, called coworking spaces (CWS) [69,70]. People share their experience, expertise, and new ideas, which are integrated by the knowledge leaders and used to design new products and services in this open innovation process [71–73]. However, the new CWS implies a certain level of trust between knowledge managers and customers that is a very sensible variable in the context

of increased market competition [74,75]. Based on these above arguments extracted from the literature, we can formulate the following hypothesis:

Hypothesis 1 (H1). *Customer knowledge management (CKM) positively influences directly sustainable product innovation (SPI).*

2.3. Innovative Work Behavior (IWB)

According to Pian, Jin, and Li [76], innovation is a critical process for firms in achieving competitive advantage and reaching sustainable development goals. Innovation is an organizational process, but creativity and the generation of new ideas are individual phenomena. Thus, to make the distinction between the two levels of knowledge-sharing and knowledge integration, some authors introduced the concept of *innovative work behavior* [76–79]. The semantic of this construct is “finding innovative opportunities, generating innovative ideas, taking actions and ultimately yielding innovative achievements. Employees’ innovative behavior mainly comprises two parts: the generation and implementation of innovative ideas” [76]. This innovative work behavior is closely related to that of epistemic motivation, which reflects the psychological needs of an individual in searching for new knowledge and learning new concepts, ideas, and theories [76]. In addition, the cultural mindset of the social context can stimulate or inhibit innovative work behavior [80,81]. The two basic components or dimensions introduced by Pian, Jin, and Li [76] can be further refined as follows: idea exploration, idea generation, idea championing, and idea implementation.

2.4. Problem Description and Summary of Research Gaps

This section is based on an empirical literature review and research gaps associated with how companies integrate customer knowledge processes and employ innovative work behavior methods in their relationship with product innovation. The findings indicate that there is insufficient information from previous studies, particularly related to customer knowledge management practices, the importance of an innovative work behavior process as part of innovation culture, and performance in product innovation.

One of the essential building components regarding the innovation process is determined to be information and the particular constructs related to knowledge management. However, aside from a few studies on customer knowledge and sustainable product development in relation to those organizational processes that lead to employees displaying innovative work behavior, there is still much more research to be conducted in the literature. In the same context, a few studies on knowledge management and organizational processes have reinforced the role of knowledge-sharing (previously referred to as *knowledge transfer* and *knowledge-sharing intentions*) in organizational effectiveness, particularly in terms of innovation capability, knowledge creation, and innovativeness [82–84]. There is, however, research to back up the link between knowledge-sharing and innovation. Alhady et al. [85] have stated that an organization that encourages its employees to contribute knowledge (inside groups and organizations) is expected to generate better and fresh ideas, encouraging new business prospects, thereby enabling organizational innovation activities.

Kuo et al., [86] examined data from employees to investigate the interconnections between workplace collaboration, job satisfaction, knowledge sharing, and product innovation. Nevertheless, the majority of research approaches the knowledge-sharing concept as “sharing best practices” and, in the same regard, innovative work behavior is strongly related to “idea generation” (Mura et al. [77]). Furthermore, Cyril Eze et al. [87] argue that merging knowledge from small groups of employees can decrease overlap, increasing the reliability and efficiency of job performance as well as a creative climate.

Raykov [88] demonstrates in his research that employees with higher education and greater knowledge have a beneficial influence on the organizational capacity for adopting innovation.

Kamasak and Bulutlar [89] studied the impacts of knowledge-sharing on innovation by assessing knowledge transfer (as a form of knowledge about something) and knowledge-

sharing. Employing multiple regression analysis, they concluded that collecting specific knowledge has a positive and substantial influence on all forms of innovation, although knowledge transfer per se had no effect on exploratory innovation. Akhavan et al. [90] examined a complete model of sociopsychological factors, technical, and cultural enablers on knowledge-sharing behaviors, as well as analyzing their impact on innovative work behavior. Knowledge-sharing, on the other hand, was defined as “intention to share knowledge” rather than “knowledge transfer” and “knowledge collection.” While knowledge sharing is claimed to be a process through which knowledge may be exchanged between persons, individuals get new capabilities to facilitate new actions as a result of such knowledge transfer. Consequently, knowledge-sharing adds value to existing knowledge inside a company and positively influences innovativeness [90].

Customer knowledge management is perceived as a driver of innovation (Gassmann et al. [91]) or as a means to handle innovation, whereby it is considered as the sense of knowledge for, from, or about the customer (Desouza et al. [31,46,85]), while at the same time counting the customer as a co-creator. Nicolai et al. [92] use the concept of prosumerism to signify those brands that look for more interaction with the customer as a source of knowledge, especially related to knowledge gained directly from the customer. Even more significantly, the negative side effects of customer integration, such as the signaling of brands, the likelihood of choosing the wrong customers for co-creation activities, or other aspects related to the customer’s personality, experience, points of view and the financial risks in this relationship with the brand are important considerations to incorporate into the model [93,94].

According to Githii’s [93] research, there is compelling evidence that knowledge management practices play a pivotal role in innovation, and that employee innovation should be encouraged by organizational processes and structures that support their attempts to learn and acquire new knowledge. In addition, Masih et al. [95] state in their research that knowledge-sharing stimulates employees to innovate, and that management should provide incentives for employees to develop both their knowledge-sharing and innovative potential. The authors’ findings revealed that knowledge-sharing behavior had a positive impact on innovative work behavior and advised leaders to focus on developing innovative behaviors in employees throughout their everyday job by promoting knowledge-sharing. Several pieces of further research indicate that knowledge-sharing has a positive effect on the innovation process [96–99].

According to Wang and Noe [100], insufficient emphasis has been placed on the impact of creative culture on knowledge-sharing. Furthermore, the relationship between employee knowledge-sharing and innovative behavior in emerging economies is relatively under-theorized and empirically unproven [101]. When compared to Western countries, studies of customer knowledge management in Eastern countries are still insignificantly experimental and underexplored [94].

Furthermore, Dayan, Heisig, and Matos [84] and Harlow [102] attempted to demonstrate the relationship between knowledge management and business outcomes using key drivers such as customer knowledge, corporate culture, employee teamwork, innovation capabilities, and specific business processes. They have not, however, explained how each variable influences CKM and innovation performance within the context of the business segment. Thus, the current study is intended to address contextual gaps by exploring the serial effect of innovative work behavior as a mediator in the relationship between CKM and sustainable product innovation on several business segments within an Eastern economy.

Based on this conceptual research model, and the critical analysis of the literature review, we formulate the following research hypotheses:

Hypothesis 2 (H2). *Customer knowledge management (CKM) positively influences sustainable product innovation (SPI) through the mediation of idea exploration (IE).*

Hypothesis 3 (H3). *Customer knowledge management (CKM) positively influences sustainable product innovation (SPI) through the mediation of idea generation (IG).*

Hypothesis 4 (H4). *Customer knowledge management (CKM) positively influences sustainable product innovation (SPI) through the mediation of idea championing (IC).*

Hypothesis 5 (H5). *Customer knowledge management (CKM) positively influences sustainable product innovation (SPI) through the mediation of idea implementation (II).*

Hypothesis 6 (H6). *Customer knowledge management (CKM) positively influences sustainable product innovation (SPI) through the serial mediation of idea exploration (IE) and idea generation (IG).*

Hypothesis 7 (H7). *Customer knowledge management (CKM) positively influences sustainable product innovation (SPI) through the serial mediation of idea exploration (IE) and idea championing (IC).*

Hypothesis 8 (H8). *Customer knowledge management (CKM) positively influences sustainable product innovation (SPI) through the serial mediation of idea exploration (IE) and idea implementation (II).*

Hypothesis 9 (H9). *Customer knowledge management (CKM) positively influences sustainable product innovation (SPI) through the serial mediation of idea generation (IG) and idea championing (IC).*

Hypothesis 10 (H10). *Customer knowledge management (CKM) positively influences sustainable product innovation (SPI) through the serial mediation of idea generation (IG) and idea championing (IC).*

Hypothesis 11 (H11). *Customer knowledge management (CKM) positively influences sustainable product innovation (SPI) through the serial mediation of idea championing (IC) and idea implementation (II).*

Hypothesis 12 (H12). *Customer knowledge management (CKM) positively influences sustainable product innovation (SPI) through the serial mediation of idea exploration (IE), idea generation (IG), and idea championing (IC).*

Hypothesis 13 (H13). *Customer knowledge management (CKM) positively influences sustainable product innovation (SPI) through the serial mediation of idea exploration (IE), idea generation (IG), and idea implementation (II).*

Hypothesis 14 (H14). *Customer knowledge management (CKM) positively influences sustainable product innovation (SPI) through the serial mediation of idea exploration (IE), idea championing (IC), and idea implementation (II).*

Hypothesis 15 (H15). *Customer knowledge management (CKM) positively influences sustainable product innovation (SPI) through the serial mediation of idea generation (IG), idea championing (IC), and idea implementation (II).*

Hypothesis 16 (H16). *Customer knowledge management (CKM) positively influences sustainable product innovation (SPI) through the serial mediation of idea exploration (IE), idea generation (IG), idea championing (IC), and idea implementation (II).*

These hypotheses will be better understood after the presentation of the research model in the next section, where these hypotheses are associated with the connections between the variables.

3. Materials and Methods

The proposed conceptual framework is a serial multiple-pathway representation investigating the mediating effect of innovative work behavior (IWB) dimensions as intervening variables on the relationship between customer knowledge management (CKM) as an independent variable and sustainable product innovation (SPI) as a dependent variable. The research instruments related to the presented constructs were adopted from research studies that have used the same instruments.

Customer knowledge management (CKM) has recently emerged as a key business activity, especially as a dynamic approach toward the creation of customer value [103]. CKM is a combination of several knowledge processes, defined by factors such as knowledge acquisition or *knowledge from* customers regarding products, services, and their experiences in relation to specific companies' brands, employees, partners, and related market; knowledge application or *knowledge about* customer behavior, habits, and demands intertwine with knowledge transfer, analysis, and interactions between customers and the company across units or employees; knowledge-sharing as an important action of *knowledge for or to* the customer, based on the personalization of experiences and different products and services, which should be the creative or innovative responses of knowledge acquisition and knowledge application processes [45,104]. This study adopts the work of Garcia-Murillo and Annabi [26], Gibbert et al. [46], and Gebert et al. [105] for the CKM measurement. Examples of items used in measuring the *knowledge from* scale are: "Is customer knowledge an active strategy used by the company?"; "Do employees share their work experiences and essential customer information with coworkers?"; the *knowledge about* scale has items such as "The company facilitates obtaining and using knowledge about customers' needs and desires; does the company encourage employees to use and curate ideas and knowledge about customers?" [106].

IWB is defined and measured by four characteristics that are generally linked to distinct stages of the innovation process: *idea exploration* is a process characterized by the combination and reorganization of information and existing knowledge for solving or improving performance; *idea generation* relates to generating ideas about new products and services or the combination and reorganization of information and existing knowledge for solving or improving performance; *idea championing* becomes relevant once an idea has been generated and should be prompted to ensure its performance and benefits in exceeding the costs of development and implementation; *idea implementation* is the proof of concept, the viable test of the idea, a result-oriented attitude that should make innovation part of regular work processes and refine the business case for the idea [107–109]. The ten-item scale measuring IWB was adopted from the studies by De Jong and Den Hartog [78] and measures a self-reported level for four different tasks, namely: *idea generation*, *opportunity exploration*, *championing*, and *idea application* on a five-point scale ranging from 1 ("never") to 5 ("always").

SPI is defined and measured by constructs like *product innovativeness*—the capacity to make significant changes in product specifications and functional characteristics, e.g., eco-efficiency; *process innovativeness*—the capability of a company to engage in and facilitate innovative concepts through new and/or existing knowledge into marketable solutions of new sustainable products; *product performance*—as the ability to create value through eco efficiencies, long-term competitive advantage, overall financial performance by reducing the impact, increasing recyclability and product functionality, e.g., environmentally friendly materials or recyclable products. [106,110]. Figure 1 illustrates the research model.

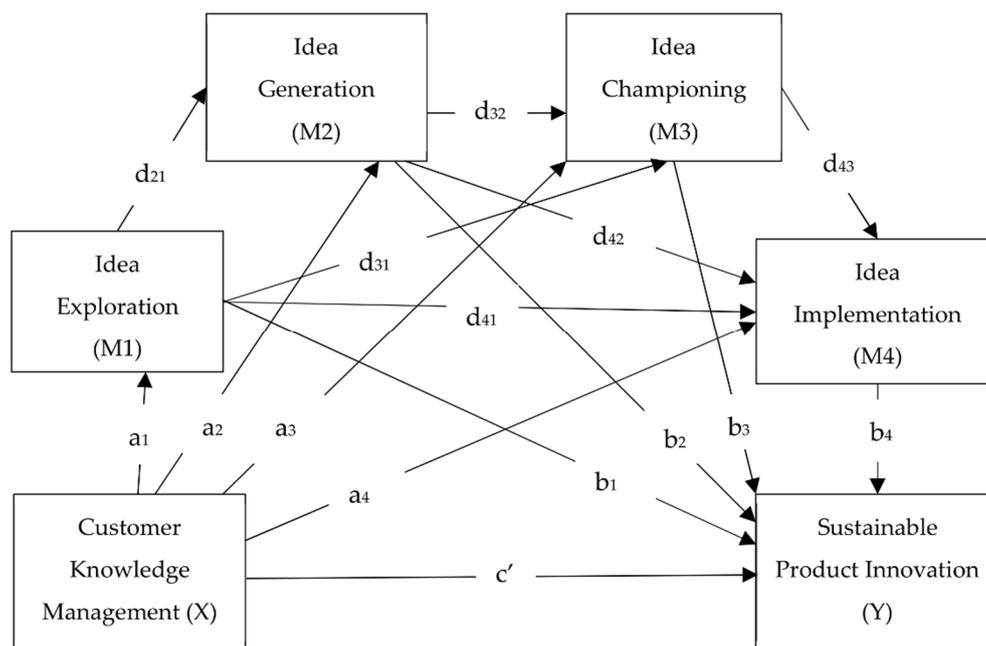


Figure 1. Serial-multiple mediation of idea exploration (M1), idea generation (M2), idea championing (M3), and idea implementation (M4) in the relationship between customer knowledge management (X) and sustainable product innovation (Y).

The measurement scale for sustainable product innovation (SPI) was adopted from studies of the Chen construct using a five-point Likert-type continuum, with responses ranging from 1 (strongly disagree) to 5 (strongly agree). Examples of SPI construct items: *product innovativeness* contains items such as “frequency of integrating new methods for solving problems related to reduce their impact on the environment and be healthy for the consumer”, *process innovativeness* includes items such as “the company stimulates originality in innovative and creative thinking behavior”, and *sustainable product performance* (for example: “What is the degree of sustainable product performance and efficiency condition for success not just economically but environmentally too?”) [111,112]. A sustainable product innovation scale is currently needed; there is no single sustainability standard that applies to all goods and product development. The majority of today’s sustainability initiatives are targeted at particular business sectors, such as construction or the food and beverage industry [105]. Given the many different interpretations of sustainable product development, the authors have integrated into the product innovation process construct the three main pillars of sustainability: the environmental approach, the impact on society, and sustainable economic reliability [113,114].

A synthesis of the research hypotheses and their associated pathways, as shown in Figure 1, is presented in Table 1.

Considering the above, the present paper incorporates exploratory and confirmatory analysis to determine the underlying patterns for each construct, supported by bivariate correlation and regression analysis of the mediation, to determine the relationship between antecedents (i.e., predictor variables) and outcomes.

To test the specified model, a questionnaire was administered (self-administered) to employees and managers from 12 medium and large multinational companies from different business segments in Romania. A purposive sampling method has been utilized to collect detailed knowledge about the essential role of customer knowledge systems in sustainable innovation activities. Choosing the 12 companies as a sample for this study has two advantages. First, the companies have stated their sustainability initiatives, are perceived as highly competitive, customers play an essential role in their day-to-day business activities, and they already have integrated CKM systems to connect with their customers and apply external ideas that can be used to launch innovative products or services more quickly than their competitor. Second, we took into account the diversity of

business segments—3 telecom companies, 4 retailers, 3 banks, and 2 service companies. For a better selection of the companies, considering the above reasons, the annual CSR index report—Romania CSR Index 2020—has been taken into consideration. A stratified sampling method has been used to divide the respondents into subgroups, based on relevant characteristics like job role, business department, and management hierarchy. The discrepancy of gender representation is caused by the presence of males and females in the specified jobs or departments and by their willingness to respond to the questionnaire. The parity of gender representation, in this case, has a lower relevance because the relevant selection criteria are based on characteristics that imply activities related to CKM systems, managing and support for innovative behavior, decision-making, and involvement related to the innovative processes.

Table 1. Research hypotheses.

No.	Hypotheses	Pathways
H1	CKM positively influences directly SPI	c'
H2	CKM positively influences SPI through the mediation of IE	a1b1
H3	CKM positively influences SPI through the mediation of IG	a2b2
H4	CKM positively influences SPI through the mediation of IC	a3b3
H5	CKM positively influences SPI through the mediation of II	a4b4
H6	CKM positively influences SPI through the serial mediation of IE + IG	a1d21b2
H7	CKM positively influences SPI through the serial mediation of IE + IC	a1d31b3
H8	CKM positively influences SPI through the serial mediation of IE + II	a1d41b4
H9	CKM positively influences SPI through the serial mediation of IG + IC	a2d32b3
H10	CKM positively influences SPI through the serial mediation of IG + IC	a2d42b4
H11	CKM positively influences SPI through the serial mediation of IC + II	a3d43b4
H12	CKM positively influences SPI through the serial mediation of IE +IG + IC	a1d21d32b3
H13	CKM positively influences SPI through the serial mediation of IE + IG + II	a1d21d42b4
H14	CKM positively influences SPI through the serial mediation of IE + IC + II	a1d31d43b4
H15	CKM positively influences SPI through the serial mediation of IG + IC + II	a2d32d43b4
H16	CKM positively influences SPI through the serial mediation of IE + IG + IC + II	a1d21d32d43b4

The questionnaire comprises four sections: demographic, construct alignment, specific construct scales (innovative work behavior; customer knowledge management; sustainable product innovation), and respondents' viewpoints on the importance and role of the construct practices, as well as their relation to sustainable innovation processes. The respondents are from multiple departments and hierarchical levels of management (employees, line, middle, and top managers).

4. Results

This section of the study explains the data collecting, processing, and analysis techniques used. It encompasses the research architecture, demographics, sample and sampling techniques, data collection methodologies, data interpretation, and variable measurement.

The presented framework should not be considered as a rigid sequence but should rather be seen as an iterative and nonlinear process where customer knowledge management (CKM) has a direct effect on the innovative work behavior (IWB) mediator, which is then reconfigured, allowing for the framing and improvement of new knowledge across various components and entities of the internal organizational process. This relationship connects knowledge quality to its internal and external business contexts, resulting in better product innovation processes. It is critical to think of this framework as a dynamic mechanism in which CKM has a direct effect on IWB; the changes that affect IWB will have a causal effect on the outcome in SPI.

After reviewing for outlier responses, a total of 152 questionnaires were confirmed. Participants ranged in age from 20 to 60 years old ($M = 28.71$, $SD = 7.67$), with management and execution responsibilities within the organization accounting for 43 and 109 respectively (38 males and 114 females) (Table 2). A purposive convenience sample strategy was employed to acquire data. The objective of the study was briefly described to the participants before completion, and informed consent was obtained.

Table 2. Job and gender distribution.

Job Category	Male	Female	Frequency	Percentage
Upper Management				
Executive director	3	2	5	3.3
Senior Brand Manager	4	3	7	4.6
Total	7	5	12	7.9
Middle Management				
Regional Manager	2	4	6	3.9
Sales Manager	3	2	5	3.3
Marketing Manager	2	5	7	4.6
Branch Manager	1	7	8	5.3
CRM Manager	3	2	5	3.3
Total	11	20	31	20.4
Lower Management				
Team Leader	3	5	8	5.3
Technical Supervisor	3	2	5	3.3
Customer Relationship Officers	1	11	12	7.9
Social Media Specialist	1	8	9	5.9
HR Assistant	1	5	6	3.9
Total	9	31	40	26.3
Employee				
Administrative Officer	2	5	7	4.6
Back Office	1	11	12	7.9
Branch Sales Officers	2	7	9	5.9
Front Desk Officers	1	10	11	7.2
Credit Officers	2	7	9	5.9
Bank Tellers	1	7	8	5.3
Retail Support	1	7	8	5.3
Total	10	54	64	42.1
Not Identifiable				
IT Support or IT developer	1	4	5	3.3
Total	38	114	152	100.0

The construct scales were pre-tested to ensure the collection of consistent and reliable data that accurately represented the relationships between the three constructs in the proposed model (i.e., CKM, IWB, and SPI). The initial versions of the scales were tested by a total of 115 people. After a thorough examination of each item's contribution to scale reliability, the final version of the questionnaire was developed.

Reliability testing was performed using Cronbach's alpha for all the research model variables. The results were higher than the recommended value of 0.6, which indicates that the reliability of the variables was acceptable: CKM (0.871), IWB (0.872), and SPI (0.608).

Although the alpha observed for the SPI scale was relatively low, according to Perry and colleagues [114] (p. 364), an alpha value of between 0.50 and 0.70 shows moderate reliability and is often encountered in scales with a small number of items. Moreover, George and Mallery [115] stated that accepting a low Cronbach's alpha value should be based on an informed understanding of the data characteristics rather than applying perfunctory benchmarking, such as the mere adoption of $\alpha > 0.06$ or 0.07. For all three scales, the ratings were provided using a 5-point Likert-type scale (1 = strongly disagree, 5 = strongly agree). Statistical results for correlations between variables are presented in Figure 2.

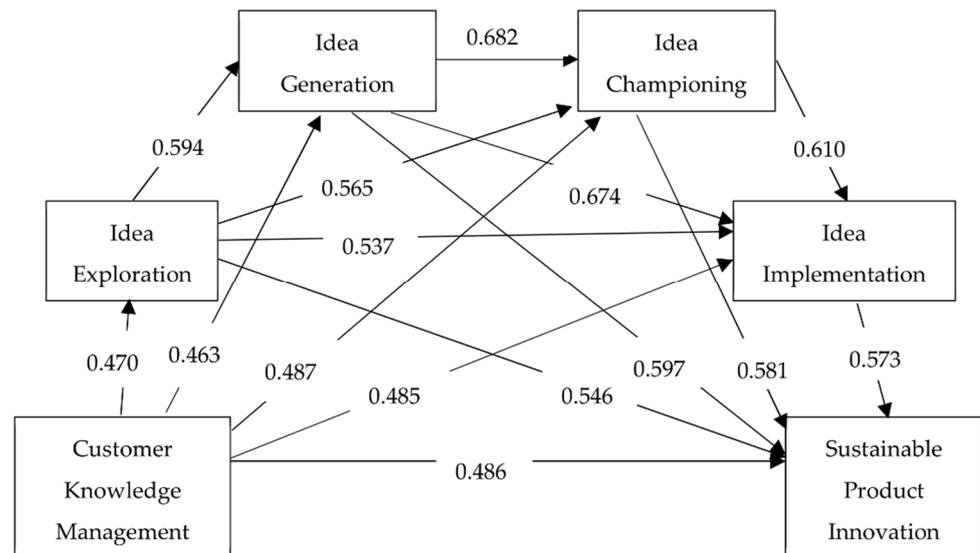


Figure 2. Statistical results for correlations between variables.

SPSS 26.0 version software and the PROCESS macro analysis for SPSS version 3.5 have been used to evaluate the collected data. Finally, the Sobel test (quantpsy.org/sobel/sobel.html (accessed on 1 October 2021)) was used to establish whether the decrease in the effect of the independent variable following the inclusion of the mediator variable is significant. The skewness and kurtosis values for data distribution are considered to be within acceptable limits [116].

The findings presented in Table 3 show that the majority of the respondents, with a mean aggregate score of 3.84 and a standard deviation of 0.692, agreed with the numerous assertions that organizations are aware of and engaged in customer knowledge acquisition as an important factor in ideation processes. Nevertheless, the moderate correlation coefficients between CKM and IWB, in this case, originate from the respondents' pessimistic evaluation that pointed out the inefficient system for managing customer knowledge or applicable solutions to improve the novelty of new ideas.

Table 3. Descriptive statistics constructs (N = 152).

	Mean Statistic	Std. Deviation Statistic	Skewness Statistic	Kurtosis Statistic
Customer Knowledge Management	3.84	0.692	−0.998	1.809
Innovative Work Behavior	3.53	0.611	−0.134	−0.340
Sustainable Product Innovation	3.79	0.407	−0.553	0.679

Data were evaluated for mean scores and standard deviation to determine the statistical significance of the proposed measures. The results highlight the fact that respondents consider CKM customer knowledge management and innovative IWB work behavior (i.e., exploring ideas, generating, promoting, and implementing) to be essential in-company

activities, stressing the value of knowledge-sharing as a prerequisite for product innovation, organizational learning, skill growth, and customer knowledge best practices.

The statistical significance of the proposed measures was analyzed for mean scores and standard deviation. The highest descriptive statistical values indicated by the majority of the respondents were related to CKM, with a mean aggregate score of $M = 3.84$ and a standard deviation of $SD = 0.692$, which agree with the various assertions that companies utilize customer knowledge data and invest in knowledge acquisition and sharing processes. Innovative work behavior (IWB), with a mean aggregate score of $M = 3.53$ and $SD = 0.611$, shows that companies paid less attention to innovative behavior practices, especially outside the employee's daily work, and the way fresh ideas were generated when it came to addressing problems related to sustainable solutions. It also showed how the management embraced innovation risk and creativity and, finally, to what degree problems and opportunities were anticipated [108].

The sustainable product innovation (SPI) descriptive statistical values indicate that respondents supported the importance of sustainable innovation processes ($M = 3.79$, $SD = 0.407$). This was measured by comparing how the companies performed relative to market benchmarks, how their products were differentiated, and the efficiency of innovative processes, product performance, and the company's ability to adjust to market changes. According to the respondents, companies are now focusing more on the economic outcome, such as product and service quality, reduced costs, and market deliverables, and less on minimizing or eliminating negative impact, the balance between environmental, social, and economic needs, or internal opportunities for innovation.

The analysis of the data presented in Table 4 highlights a second essential condition of the proposed framework, meaning the satisfactory positive linear relationship between innovative work behavior (IWB) constructs and sustainable product innovation (SPI) ($r = 0.546$ to 0.597), showing a direct effect of the variable IWB on SPI, which is a necessary condition for the role of innovative work behavior (IWB) in mediation effect. This result validates Hypothesis 1 (H1/c').

Table 4. Correlation matrix (N = 152).

		X	M1	M2	M3	M4	Y
(X) Customer knowledge management	Pearson Correlation	1	0.470 **	0.463 **	0.487 **	0.485 **	0.486 **
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000
(M1) Idea exploration	Pearson Correlation	0.470 **	1	0.594 **	0.565 **	0.537 **	0.546 **
	Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.000
(M2) Idea generation	Pearson Correlation	0.463 **	0.594 **	1	0.682 **	0.674 **	0.597 **
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.000
(M3) Idea championing	Pearson Correlation	0.487 **	0.565 **	0.682 **	1	0.610 **	0.581 **
	Sig. (2-tailed)	0.000	0.000	0.000		0.000	0.000
(M4) Idea implementation	Pearson Correlation	0.485 **	0.537 **	0.674 **	0.610 **	1	0.573 **
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000
(Y) Sustainable product innovation	Pearson Correlation	0.486 **	0.546 **	0.597 **	0.581 **	0.573 **	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	

** Correlation is significant at the 0.01 level (2-tailed).

The findings show that respondents strongly agree on many aspects related to innovative processes, including the way companies nurture employees' opinions and whether they acquired knowledge about products and services from customers or new additions in the industry, regardless of the company's actions in developing specific interaction processes.

Another significant point on which respondents agreed was the significance of tools, processes, and company interest in customer knowledge acquisition and collaboration workflows. This suggested that the companies' customer knowledge-based methods accommodated employees' attitudes and behaviors regarding the introduction of innovative new products and services. These findings support Satyendra, Dutta, and Nayak's [117] hypothesis that a company's knowledge infrastructure and process capacities impact its performance in customer knowledge management and its co-creation value for customers.

The relationship between the constructs was interpreted using correlation analysis based on the proposed model and from the results of Pearson's correlation analysis; the constructs of customer knowledge management (CKM) has a satisfactory (moderate) relationship with innovative work behavior (IWB) constructs ($r = 0.470$) and a positive linear relationship with sustainable product innovation (CKM) constructs, with a similar correlation coefficient of $r = 0.486$.

The relationship of innovative work behavior (IWB) variables (as a serial condition) and sustainable product innovation (SPI) indicates a strong positive correlation coefficient, highlighting the causative connection between variables. Customer knowledge management (CKM) is viewed as an agglutination process that improves the innovative process and increases the level of participation of practice-based teams, implying that innovative work behavior (IWB) and customer knowledge management (CKM) are effective determinants of long-term innovative results for companies. This demonstrates that the companies' customer knowledge acquisition strategies accommodated employees' perspectives and attitudes about the industry's adoption of innovative and sustainable product innovation.

Based on the path coefficients for the mediation analysis, featuring a —the effects of the independent variables on the mediators CKM→IWB, and b —the individual direct effect of the mediators on the dependent variables IWB→SPI, the findings presented in Table 5 explain the significant level of the total effect c (standardized $Effect = 0.0954$, $p < 0.001$) of CKM on sustainable product innovation (SPI). When customer knowledge management (CKM) and all other mediating variables (IE, IG, IC, II)/IWB were simultaneously entered into the equation, the relationship between CKM and SPI with respect to the direct effect was at a significant level ($c' = 0.0290$, $p < 0.0436$). It can be stated that a unit increase in customer knowledge management (CKM) variables has an individual direct effect on each mediator variable that, independently, would lead to an increase in scores on the sustainable product innovation process. This means that managing customer knowledge is a critical prerequisite for developing an effective organizational innovation culture and improving sustainable product innovation.

Table 5. Path coefficients and 95% confidence interval predicting SPI scores (N = 152).

Path	Effect	LLCI	ULCI	SE	t	p -Value
Total effect (c)	0.0954	0.0677	0.1230	0.0140	6.8179	0.0000
Direct effect (c')	0.0290	0.0008	0.0571	0.0142	2.0353	0.0436
a_1	0.1610	0.1123	0.2089	0.0247	6.5264	0.0000
a_2	0.0788	0.0311	0.1265	0.0242	3.2615	0.0014
a_3	0.0658	0.0148	0.1168	0.0258	2.5481	0.0119
a_4	0.0494	0.0045	0.0943	0.0227	2.1765	0.0311
b_1	0.0980	0.0079	0.1881	0.0456	2.1499	0.0332
b_2	0.1096	0.0006	0.2186	0.0552	1.9876	0.0487
b_3	0.0895	0.0015	0.1775	0.0445	2.0108	0.0462
b_4	0.1031	0.0025	0.2038	0.0509	2.0249	0.0447

The path coefficient a_1 indicates the direct effect of customer knowledge management (CKM) on idea exploration (IE) ($a_1 = 0.1610$, $p < 0.0$); in addition, path a_2 is the direct effect of customer knowledge management (CKM) on idea generation (IG) ($a_2 = 0.0788$, $p < 0.0014$); path a_3 the direct effect of customer knowledge management (CKM) on idea championing (IC) ($a_3 = 0.0658$, $p < 0.0119$); and path a_4 the direct effect of customer knowledge management (CKM) on idea implementation (II) ($a_4 = 0.0424$, $p < 0.0311$).

The coefficients path b_1, b_2, b_3, b_4 indicate the individual effect of the mediators' variables without a serial mediation effect on sustainable product innovation (SPI).

The proposed serial multiples mediator model with four mediators in the causal chain sequence, M1 = IE, M2 = IG, M3 = IC, and M4 = II, was established to study the effects of innovative work behavior (IWB) constructs on the relationship between the independent variable, customer knowledge management (CKM), and the dependent variable, sustainable product innovation (SIP).

5. Discussion

5.1. Hypotheses Validation

This validation identified sixteen distinct pathway effects of CKM on SIP. These sixteen effects include one direct effect (CKM→SPI); four passing through a single mediator (CKM→IE→SPI; CKM→IG→SPI; CKM→IC→SPI; CKM→II→SPI); six passing through two mediators in chain sequence (CKM→IE→IG→SPI; CKM→IE→IC→SPI; CKM→IE→II→SPI; CKM→IG→IC→SPI; CKM→IG→II→SPI; CKM→IC→II→SPI); four passing through three mediators in chain sequence (CKM→IE→IG→IC→SPI; CKM→IE→IG→II→SPI; CKM→IE→IC→II→SPI; CKM→IG→IC→II→SPI); and one through all four mediators in the chain sequence (CKM→IE→IG→IC→II→SPI). The four equations (one for each of the four consequent variables) representing the mediation model of the four serial multiple mediators are depicted in Table 6.

Table 6. Causal chain indirect effects, and 95% confidence interval, predicting SPI scores according to models ($X \rightarrow M1 \rightarrow M2 \rightarrow M3 \rightarrow M4 \rightarrow Y$) (N = 152).

Indirect Effects	Path	Effect	SE	LLCI	ULCI
Total indirect effect		0.0664	0.0123	0.0433	0.0919
CKM→IE→SPI	a_1b_1	0.0158	0.0073	0.0020	0.0305
CKM→IG→SPI	a_2b_2	0.0086	0.0057	-0.0003	0.0219
CKM→IC→SPI	a_3b_3	0.0059	0.0039	-0.0006	0.0147
CKM→II→SPI	a_4b_4	0.0051	0.0033	-0.0003	0.0127
CKM→IE→IG→SPI	$a_1d_{21}b_2$	0.0084	0.0051	-0.0002	0.0197
CKM→IE→IC→SPI	$a_1d_{31}b_3$	0.0032	0.0022	-0.0002	0.0084
CKM→IE→II→SPI	$a_1d_{41}b_4$	0.0019	0.0015	-0.0006	0.0051
CKM→IG→C→SPI	$a_2d_{32}b_3$	0.0040	0.0028	-0.0003	0.0104
CKM→IG→II→SPI	$a_2d_{42}b_4$	0.0032	0.0022	0.0002	0.0088
CKM→IC→II→SPI	$a_3d_{43}b_4$	0.0011	0.0009	0.0000	0.0035
CKM→IE→IG→IC→SPI	$a_1d_{21}d_{32}b_3$	0.0039	0.0022	-0.0003	0.0088
CKM→IE→IG→II→SPI	$a_1d_{21}d_{42}b_4$	0.0031	0.0020	0.0002	0.0078
CKM→IE→IC→II→SPI	$a_1d_{31}d_{43}b_4$	0.0006	0.0005	0.0000	0.0019
CKM→IG→IC→II→SPI	$a_2d_{32}d_{43}b_4$	0.0008	0.0006	0.0000	0.0022
CKM→IE→IG→IC→II→SPI	$a_1d_{21}d_{32}d_{43}b_4$	0.0008	0.0005	0.0000	0.0020

The serial mediation roles were tested using the bootstrapping method developed by Preacher and Hayes [116] and implemented by PROCESS, model 6 from Hayes's study [118]. This serial multiple mediation model of the four mediators presumes that all the variables that are modeled first affect the variables that are modeled later in the causal sequence.

Hypothesis 2. CKM positively influences sustainable product innovation (SPI) through the mediation of idea exploration (IE). The indirect effect of customer knowledge management on sustainable product innovation through the mediation of idea exploration is statistically significant and indicate the first shortcut mediation, which means that the increase in customer knowledge has an impact on idea exploration (single mediator) outcome, which in turn increases the output in sustainable product development CKM→IE→SPI ($a_1b_1 = 0.0158$). The lower limit confidence interval (LLCI) is 0.0020 and the upper limit confidence interval (ULCI) is 0.0305, the output based on the p -value ($p < 0.001$), and both LLCI and ULCI values $\neq 0$ indicates indirect effect between CKM and SPI through the

mediation of IE, but with a fairly small effect [115]. The result reveals that idea exploration (IE) is usually regarded as a strategic tactic for driving the innovation process, and it concerns the employee's interaction with customers, which usually requires effort and resources such as knowledge infrastructure research or studies related to proof of concept, among other things. It should be noted that the customer knowledge management process influences idea exploration, which in turn lowers the risk of failure and enhances product innovation [47,119].

Hypothesis 3 to Hypothesis 5. The second to fourth indirect effect passing through a single mediator was the specific effect of involving idea generation (IG), idea championing (IC), idea implementation (II) as single mediators in the relationship between CKM and SPI is not significant for any of the hypothesis because the coefficient interval crosses the zero value, meaning there is no mediation effect (shortcut mediation). $CKM \rightarrow IG \rightarrow SPI$, $a_2b_2 = 0.0086$, 95% CI: (-0.0003, 0.0219); $CKM \rightarrow IC \rightarrow SPI$, $a_3b_3 = 0.0059$, 95% CI: (-0.0006, 0.0147); $CKM \rightarrow II \rightarrow SPI$, $a_4b_4 = 0.0051$, 95% CI: (-0.0033, 0.0127). The results show the underlying complexity of innovative work behavior and its dimensions corresponding to innovation process phases because employees might be anticipated to engage in any combination of these behaviors at different times and levels. As a consequence, employees frequently require related or additional abilities for the various dimensions of IWB and specific knowledge [120].

Hypothesis 6 to Hypothesis 9. The fifth to eight indirect effects passing through a causal chain sequence of two mediators in serial indirect effect yielded no mediation effect. Idea exploration (IE) idea generation (IG), idea championing (IC), idea implementation (II) as pairs of mediators in the hierarchical causal relationship between CKM and SPI is not significant for any of the hypotheses because the coefficient interval crosses the zero value, meaning there is no serial mediation effect. $CKM \rightarrow IE \rightarrow IG \rightarrow SPI$, $a_1d_21b_2 = 0.0084$, 95% CI: (-0.0002, 0.00197); $CKM \rightarrow IE \rightarrow IC \rightarrow SPI$, $a_1d_31b_3 = 0.0032$, 95% CI: (-0.0002, 0.0084); $CKM \rightarrow IE \rightarrow II \rightarrow SPI$, $a_1d_41b_4 = 0.0019$, 95% CI: (-0.0006, 0.0051); $CKM \rightarrow IG \rightarrow IC \rightarrow SPI$, $a_2d_32b_3 = 0.0040$, 95% CI: (-0.0003, 0.0104). The results highlight the fact that the respondents believe that additional labor activities that are not part of the job description are undervalued, resulting in limited participation in the knowledge process and related innovative activities; therefore, external relations and networks supplement the employees' knowledge domain [121].

Hypothesis 10. The nine causal indirect effects, passing through a chain sequence of two mediators involving idea generation (IG), and idea implementation (II) as mediators in the relationship between CKM and SPI, hold significant meaning; there is an indirect chain sequence mediation effect but with a fairly small impact. $CKM \rightarrow IG \rightarrow II \rightarrow SPI$, $a_2d_42b_4 = 0.0032$, 95% CI: (0.0002, 0.0088). Thus, a higher CKM (increase impact) leads to better idea generation, which in turn translates to better idea implementation and, overall, a direct effect on sustainable product innovation SPI.

Hypothesis 11. The tenth causal indirect effect passing through a chain sequence of two mediators involving idea championing (IC), and idea implementation (II) as mediators in the relationship between CKM and SPI is significant meaning there is an indirect chain sequence mediation effect but with a fairly small impact. $CKM \rightarrow IC \rightarrow II \rightarrow SPI$, $a_3d_43b_4 = 0.0011$, 95% CI: (0.0000, 0.0035). Thus, higher CKM (increase impact) leads to better idea championing which in turn translates to better idea implementation and, overall, a direct effect on sustainable product innovation SPI.

Hypothesis 12. The eleventh causal indirect effect, passing through a chain sequence of three mediators involving Idea exploration (IE) idea generation (IG), idea championing (IC) as an indirect chain sequence mediation effect in the relationship between CKM and SPI, is not significant for any of the hypothesis because the coefficient interval crosses the zero value, meaning there is no mediation effect. $CKM \rightarrow IE \rightarrow IG \rightarrow IC \rightarrow SPI$, $a_1d_21d_32b_3 = 0.0039$, 95% CI: (-0.0003, 0.0088).

Hypothesis 13 to Hypothesis 15. The twelfth to the fourteenth causal indirect effects, passing through a chain sequence of three mediators involving idea exploration (IE), idea

generation (IG), idea championing (IC), and idea implementation (II) as mediators in the relationship between CKM and SPI, is significant for any of the interval hypotheses because the coefficient is positive, meaning there is an indirect chain sequence mediation effect but with a fairly small impact for all three hypotheses. $CKM \rightarrow IE \rightarrow IG \rightarrow II \rightarrow SPI$, $a1d21d42b4 = 0.0031$, 95% CI: (0.0002, 0.0088); $CKM \rightarrow IE \rightarrow IC \rightarrow II \rightarrow SPI$, $a1d31d43b4 = 0.0006$, 95% CI: (0.0002, 0.0088); $CKM \rightarrow IG \rightarrow IC \rightarrow II \rightarrow SPI$, $a2d32d43b4 = 0.0008$, 95% CI: (0.0002, 0.0088). Thus, higher CKM (increase impact) leads to better idea generation, which, in turn, translates to better idea implementation and, overall, a direct effect on sustainable product innovation SPI.

Hypothesis 16. The fifteenth causal indirect effect, passing through all four mediators in a chain sequence involving IE), idea generation (IG), idea championing (IC), and idea implementation (II) as mediators in the relationship between CKM and SPI, is positive and significant as the bias-corrected bootstrap confidence interval is not an intersected zero value. The long-way mediation represents the casual chain of mediation and therefore represents the foundation of the serial mediation hypothesis. $CKM \rightarrow IE \rightarrow IG \rightarrow IC \rightarrow II \rightarrow SPI$, $a1d21d32d43b4 = 0.0008$, 95% CI: [0.0000, 0.020].

The total indirect effect size is 0.0664 and is positively significant, with a CI: (0.0433, 0.0919) < 0.001. As a result, it can be claimed with 95% confidence that the total indirect effect of the four mediators $IE \rightarrow IG \rightarrow IC \rightarrow II$ (IWB construct) when applied simultaneously is between 0.216 and 0.541. This supports the claim that, collectively, all four mediators fully mediate the effect of customer knowledge management (CKM) on sustainable product innovation (SPI).

All fifteen models of relationships between variables were compared in terms of the significant pathway created by each distinct order of mediators—as the results show, only seven sequences of significant indirect effects were validated.

The results of the mediation effect show that organizations presented in this study performed poorly in terms of idea generation. As a result, less than half of the respondents agreed with the assertions that idea generation for new and sustainable products or solutions occurred in their workplaces [113]. Employees mostly adhered to their daily work, as there was limited room for idea generation [119]. The frequency with which employees took the risk of being creative in solving problems was minimal. This can be attributed to rigid companies, internal procedures, and hierarchical steps, which accompany the development of ideas or the promotion of ideas in problem-solving, which is another reason why employees are less willing to take risks in innovative processes [92,120].

Employees are rarely able to put their ideas into action without authorization from their bosses. At the same time, there is little mobilizing support for or approval of innovative ideas, so employees appear to be less enthusiastic about tackling innovative behavior precisely because of the lack of promotion of innovative ideas by managers, who frequently face an inability to promote and encourage innovative work behavior among employees [47,121]. As a result, employees require more social skills throughout the support-seeking and implementation phases than they do during the idea-creation phase. Employees will be more involved with certain dimensions than others, depending on their competencies and position within the organization [90,122]. Furthermore, some employees will just focus on one aspect of IWB and delegate the remainder to other employees with other skills. Their IWB is just partially functional.

Another interesting aspect deduced from the results is related to the impact of innovative work behavior on customer knowledge processes, i.e., sharing knowledge. Even if there was recognition of customer knowledge processes as an important business asset in the company, there is still a lack of clear mechanisms for systematic adoption, evaluation of knowledge utility, or implementation of novel ideas—a process that is not for “everybody” but for decision-makers [108]. Another important aspect to be taken from the mediation results is that an increase in customer knowledge, especially in knowledge from the customer, has a positive impact on innovation quality, e.g., idea exploration, idea generation (IG), and idea implementation, which translate into innovation quality and

process innovativeness. Therefore, by using customer knowledge flows interlinked with IWB activities, companies will have a better understanding of the customer environment and be more aware of the new changes in customers' needs, which imply a positive impact in innovative performance related to sustainability solutions. An important takeaway of the mediation results (H13 to H16) shows that a company's knowledge infrastructure and process capacities, as well as its interest in nurturing the bundle of IWB practices, predispose it to efficiency in innovation outcome and customer knowledge.

The companies should reflect more on how to extract customer knowledge (type of resources), how sharing across employees and departments should be improved, and finally, how to exercise specific management support (combination of knowledge resources with a range of specialized teams) to ensure an innovative culture that is especially related to product sustainability.

5.2. Implications for Theory

The primary objective of this research is to advance the business literature by disentangling the interconnections between CKM, innovative work behavior, and sustainable product innovation. In this study, we found that CKM has a direct effect on IWB and has a positive effect on sustainable product innovation, through the mediation of IWB dimensions. Managers that focus exclusively on innovation capability may fall short of their planned performance goals if they do not leverage customer knowledge management and innovative work behavior processes as a source of competitive advantages in sustainable product innovation. As a result, organizations that attempt to improve their innovative performance should effectively manage the interconnection between customer knowledge and innovative behavior.

This study provides a framework by which CKM and IWB practices contribute to product innovation performance. There is no similar research that analyses the mediating effect of innovative work behavior in the relationship between CKM and SPI. In the same regard, the study offers the new insight that CKM makes IWB a valuable process in achieving superiority in sustainable product innovation. In particular, CKM is necessary but not sufficient for superiority in performance, while the potential value of CKM is realized through effective innovative work behavior. Using this study, firms can evaluate the positive impact of CKM on SPI and, therefore, business performance. The results of the study focus on IWB processes within the firm, as perceived by employees or their managers; nevertheless, it offers a new perspective showing that IWB contributes to customer relationships through increased customer centricity and related product innovation. Specifically, telecom and retail companies, by applying CKM in conjunction with IWB, can become more innovative and achieve better results on sustainability performance.

5.3. Research Limitations

Despite the usefulness of the findings, this study has some theoretical and practical limitations. First, as data were collected from a sample of multinational companies in Romania, the generalization of the findings was limited. Moreover, the overall effect of the business segment, industry type, or market share on CKM is unknown.

Firms having a higher market share, for example, might well be able to attract and manage customer knowledge more efficiently, and so exploit it more successfully in the process of sustainable innovation. Furthermore, the type of industry might influence CKM and the willingness of customers to share their knowledge and experience. We discovered a similar pattern in banks, where customers are more cautious of providing suggestions or of being active co-creators.

As previously indicated, we conducted our research in Romanian companies and multinational corporations within the Romanian business sector, which may be similar in development and mentality to nearby states; consequently, we do not consider the findings to be limited to our region. Given the nature of the relationships investigated and similar

solutions in other studies, we can conclude that our findings may have an eastern area validity, particularly in emerging economies such as Romania.

We also believe it is important to double-check the results using structural equation modeling (SEM) to explore the causal relationships between variables, while accounting for construct measurement error, or PLS-SEM, to better explain and identify the proposed framework's key target or driver constructs.

5.4. Practical Implications

Customer knowledge management has been regarded as a revolutionary organizational strategy. Unfortunately, the results of implementing CKM in a commercial setting are rarely discussed in the literature on knowledge management. This study examines the interaction between CKM, IWB, and SIP, in an attempt to fill this gap. Therefore, to improve innovation capabilities and sustainability performance, we recommend that managers should consider and manage both internal and external knowledge, as well as employees' willingness and involvement in innovative behavior.

We also believe that managers must be constantly aware of their customers' needs, challenges, ideas, and knowledge from consumers in particular—knowledge that is not present in internal tools or CRM systems—and use it as a vital source to help them compete in the marketplace. In general, managers should value external CKM as much as internal CKM and should pay attention not only to their employees' experience, ideas, information, and knowledge but also in a similar way to employee characteristics and job roles when forming innovative work teams, to bundle employees' knowledge and motivation, allowing powerful ideas to emerge; finally, the innovation performance of the company can increase.

6. Conclusions

As implied by the research question, the relationship between the independent variable CKM and the dependent variable SPI is explained by the serial mediation effect of IWB constructs, emphasizing the critical role and impact of customer knowledge management in company performance through innovativeness.

An interesting takeaway from the research results is that not all the companies involved in the study had implemented a clear strategy related to sustainable innovation, rather, they chose to focus on long-term CSR actions, considering it difficult to incorporate this way of thinking into their present design process, portfolio, and business structure. In emerging economies, it is hard to maintain a sustainable business approach due to the rapid changes in volatility, financial barriers, and in particular to the Romanian market, political and institutional barriers. Nevertheless, managers and board members must appreciate the relevance of consumer knowledge in terms of resource mobilization and support for innovative activities, as well as their clear direction toward sustainable product innovation [47].

In addition, organizations must create in-house creative hubs and help employees in leveraging innovative behavior, relevant knowledge, and abilities to create and develop sustainable products, even if many environmentally optimized products may conflict with functional product requirements [123]. When making environmentally conscious decisions, many businesses consider the associated innovation costs to be a critical factor. Improving sustainable design requires not only discovering alternate solutions to technical challenges but also identifying multiple strong internal and external stimuli that are not obstructed by any no-go obstacles [124].

All the inferred correlations between factors and the serial mediation effect, as indicated by the empirical findings, have been supported by the data. In this regard, the validation of substantial relationships between the studied components was intended as a first-step attempt to decode the underlying interconnections that account for the relationship between customer knowledge management and sustainable product innovation. The current initiative is merely exploratory, intending to open up new research possibilities for an in-depth examination of finer-grained correlations between components. To offer

an accurate picture of the impact of customer knowledge management innovativeness trends on product sustainability, the use of more advanced statistics (e.g., structural equation modeling) is required. Comparing the findings with PROCESS, the use of PLS-SEM offers researchers even more highly complex models with multiple mediators [125] and it has become the method of choice proposed by the methodological researchers in the field [126,127]. The current study acknowledges its conceptual and methodological limitations, urging future empirical investigations not only of the postulated links but also of alternative hypotheses, covering elements such as customer experience, knowledge-sharing capacities, the circular economy, and so on.

Future research should investigate the relationship between CKM, innovative work behavior, and sustainable product innovation in different contexts, such as electronic industries, beauty, and cosmetics industries, or mobile and banking sectors in other countries. Furthermore, the effect of moderating variables like organizational learning, organizational structure, etc. could be studied in the future to complete the research model. Finally, this research did not consider the psychological characteristics of the customer or persona type. Because this element has an important impact on customers' willingness to share their knowledge, it is suggested that future research should consider it in a model.

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