Tesis Doctoral

Desarrollo del producto innovador verde desde sus antecedentes hasta el impacto: evidencia de acuerdo con la Encuesta Europea de Innovación en Producción

Jakeline Serrano García

Noviembre, 2022

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

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Jakeline Serrano García

Programa de Doctorado en Diseño, Fabricación
y Gestión de Proyectos Industriales

Supervisado por:
Directora: Andrea Bikfalvi Ph.D.
Director: Josep Llach Pagès Ph.D.
Tutor: Fernando Jiménez Sáez Ph.D.

Presentado para obtener el grado de Ph.D. de la Universitat Politècnica de València

Noviembre, 2022

Andrea Bikfalvi (Ph.D.), Josep Llach Pagès (Ph.D.), como Directores y Fernando Jiménez Sáez (Ph.D.), como Tutor

DECLARAN:

Que el trabajo *Desarrollo del producto innovador verde desde sus antecedentes hasta el impacto: evidencia de acuerdo con la Encuesta Europea de Innovación en Producción*, que presenta Jakeline Serrano García para obtener el título de doctora, se ha realizado bajo nuestra dirección y tutoría.

Y, para que así conste y surta los efectos oportunos, firmamos este documento.

Firmado:

Doctora, Andrea Bikfalvi
Directora

Doctor, Josep Llach Pagès
Director

Doctor, Fernando Jiménez Sáez
Tutor

En Valencia, noviembre 2022

La Doctora, Andrea Bikfalvi, como co-autora de los siguientes artículos:

- ✓ Orchestrating capabilities, organizational dimensions and determinants in the pursuit of green product innovation.
- ✓ Capabilities and organisational dimensions conducive to green product innovation: Evidence from Croatian and Spanish manufacturing firms.

Acepto que Jakeline Serrano García presente los artículos mencionados como autor principal y como parte de su tesis doctoral, y que estos artículos no puedan, por tanto, formar parte de ninguna otra tesis doctoral.

Y para que así conste y tenga los efectos oportunos, firmo este documento.

Firmado:

Doctora, Andrea Bikfalvi

En Girona, noviembre 2022

El Doctor, Josep Llach Pagès, como co-autor de los siguientes artículos:

- ✓ Orchestrating capabilities, organizational dimensions and determinants in the pursuit of green product innovation.
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Firmado:

Doctor, Josep Llach Pagès

En Girona, noviembre 2022

El señor, Juan José Arbeláez Toro, como co-autor de los siguientes artículos:

- ✓ Orchestrating capabilities, organizational dimensions and determinants in the pursuit of green product innovation.
- ✓ Capabilities and organisational dimensions conducive to green product innovation: Evidence from Croatian and Spanish manufacturing firms.

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Y para que así conste y tenga los efectos oportunos, firmo este documento.

Firmado:

Juan José Arbeláez Toro

En Medellín – Colombia, noviembre 2022

“Lo que distingue las mentes verdaderamente originales no es que sean las primeras en ver algo nuevo, sino que son capaces de ver como nuevo lo que es viejo, conocido, visto y menospreciado por todos”

-Friedrich Nietzsche-

“La creatividad, imaginación e intuición más que la base del medio juego, son indispensables, así como el carácter firme; el triunfo llega solamente con la lucha”

-Gari Kaspárov-

“Nunca dejes de sonreír, ni siquiera cuando estés triste, alguien podría enamorarse de tu sonrisa”

-Gabriel García Márquez-

Dedicatoria:

A mi madre Teresa García López, por su ejemplo, dedicación, persistencia y apoyo que siempre me ha demostrado. A ella, mi sentimiento de perenne gratitud y amor. Te llevo en mi alma.

A mis hermanos Cielo y Carlos Mario. No tendría sentido mi vida sin ustedes. ¡Los amo!

A mi sobrino Santiago. Gracias por llegar a nuestras vidas. Te amo niño hermoso.

A mi esposo hermoso, mi compañero de vida, de estudio, de sueños. Su apoyo y voz de aliento en estos estudios doctorales han sido fundamentales.

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Gracias a la Universitat Politècnica de València, por aceptarme y darme la oportunidad de realizar mis estudios doctorales en tan prestigiosa universidad. Al Profesor – Coordinador de la Comisión Académica de mi programa de doctorado, Miquel Ardid Ramírez, por sus valiosas orientaciones y apoyo en toda mi formación. Hago extensivo el agradecimiento a todo el personal de Ingenio de la Universitat Politècnica de València, pasar por estas instalaciones y compartir con sus integrantes me entregaron aprendizajes tanto a nivel académico como personal.

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Resumen

La esencia del presente trabajo radica en comprender el fenómeno del desarrollo del producto innovador verde y cómo se puede estar constituyendo a nivel de las empresas del sector manufacturero en beneficio del desempeño organizacional. Por tanto, desde una perspectiva teórico-exploratoria, con esta tesis doctoral se desea contribuir al conocimiento mediante una propuesta de reconfiguración sistémica organizacional enfocada a la creación del producto innovador verde, de tal manera que permita a las empresas del sector manufacturero mitigar y/o eliminar impactos negativos al medio ambiente, posibilitando, asimismo, la obtención de ganancias financieras, procurando el desarrollo sostenible.

Para los fines mencionados anteriormente, se constituyen tres rutas estratégicas. En primera medida, se constituye un *framework* que contempla a la organización como un sistema abierto interrelacionado, sobre la base de determinantes del producto innovador verde, de siete nuevas capacidades de innovación y de cinco dimensiones organizacionales. Seguidamente, se procede con el análisis con relación a qué configuración de capacidades de innovación verde y dimensiones organizacionales pueden explicar un mayor logro del producto innovador verde. Finalmente, a modo específico se prueba si la adopción y el uso alto de la capacidad de producción verde y la tecnología como puede estar afectando al desempeño organizacional.

Los análisis exploratorios parten de dos ediciones de la Encuesta Europea de Innovación en Producción, la cual es aplicada a empresas del sector manufacturero. En esta tesis, en un primer momento, se trabajan con las sub-muestras de España y Croacia, posteriormente, con las sub-muestras de Croacia, Lituania, España, Serbia, Eslovaquia, Eslovenia y Suecia.

La tesis está constituida por tres artículos, donde respectivamente se desarrollan los objetivos de investigación y se presentan los hallazgos que surgen a partir de los estudios. Los resultados advierten sobre la necesidad de una reconfiguración organizacional a nivel de empresas del sector productivo, estipulada sobre la base de las siete capacidades de innovación verde y las cinco dimensiones organizacionales analizadas, en procura de dar soporte a los determinantes del producto innovador verde, contribuyendo de forma directa al desempeño sostenible. Asimismo, se identifica como la capacidad de producción verde y la tecnología en su adopción y sus niveles de uso alto presentan un impacto significativo en el desempeño ambiental y en el financiero.

Por tanto, esta tesis de doctorado brinda aportes que confirman repercusiones teóricas y prácticas que pueden corresponder a oportunidades para académicos, profesionales y entidades gubernamentales. En consecuencia, esta investigación entrega orientaciones sobre cómo utilizar estos resultados en el desarrollo de futuros trabajos de investigación, planes estratégicos o gubernamentales.

Palabras clave: análisis *cluster*, capacidades de innovación verde, capacidad de producción verde, desarrollo sostenible, desempeño ambiental, desempeño financiero, determinantes, dimensiones organizacionales, empresas manufactureras, Encuesta Europea de Innovación en Producción, *framework*, matriz, producto innovador verde, regresión logística, taxonomía, tecnología.

Resum

L'essència del present treball radica a comprendre el fenomen del desenvolupament del producte innovador verd i com es pot estar constituint a nivell de les empreses del sector manufacturer en benefici de l'exercici organitzacional. Per tant, des d'una perspectiva teorico-exploradora, amb aquesta tesi doctoral es desitja contribuir al coneixement per mitjà d'una proposta de reconfiguració sistèmica organitzacional enfocada a la creació del producte innovador verd, de tal manera que permeta a les empreses del sector manufacturer mitigar i/o eliminar impactes negatius al medi ambient, possibilitant així mateix l'obtenció de guanys financers, procurant el desenvolupament sostenible.

Per als fins esmentats, es constitueixen tres rutes estratègiques. En primera mesura, es constitueix un *framework* que contempla a l'organització com un sistema obert interrelacionat, sobre la base de determinants del producte innovador verd, de set noves capacitats d'innovació i de cinc dimensions organitzacionals. A continuació, es procedeix amb l'anàlisi amb relació a quina configuració de capacitats d'innovació verda i dimensions organitzacionals poden explicar un major èxit del producte innovador verd. Finalment, a mode específic es prova si l'adopció i l'ús alt de la capacitat de producció verda i la tecnologia pot estar afectant l'exercici organitzacional.

Els anàlisis exploradores parteixen de dos edicions de l'Encuesta Europea de Innovación en Producción, la qual és aplicada a empreses del sector manufacturer. En aquesta tesi, en un primer moment, es treballen amb les submostres d'Espanya i Croàcia, posteriorment, amb les submostres de Croàcia, Lituània, Espanya, Sèrbia, Eslovàquia, Eslovènia i Suècia.

La tesi es constitueix de tres articles, on respectivament es desenvolupen els objectius d'investigació i es presenten les troballes que sorgeixen a partir dels estudis. Els resultats adverteixen sobre la necessitat d'una reconfiguració organitzacional a nivell d'empreses del sector productiu, estipulada sobre la base de les set capacitats d'innovació verda i les cinc dimensions organitzacionals analitzades, en procura de donar suport als determinants del producte innovador verd, contribuint de forma directa a l'exercici sostenible. Així mateix, s'identifica com la capacitat de producció verda i la tecnologia en la seua adopció i els seus nivells d'ús alt presenta un impacte significatiu en l'exercici ambiental i en l' financer.

Per tant, aquesta tesi de doctorat, brinda aportacions que confirmen repercussions teòriques i pràctiques que poden correspondre a oportunitats per a acadèmics, professionals i entitats governamentals. En conseqüència, aquesta investigació entrega orientacions sobre com utilitzar aquests resultats en el desenvolupament de futurs treballs d'investigació, plans estratègics o governamentals.

***Paraules clau**:* acompliment ambiental, anàlisi *cluster*, acompliment financer, capacitats d'innovació verda, capacitat de producció verda, determinants, dimensions organitzacionals, empreses manufactureres, Encuesta Europea de Innovación en Producción, *framework*, matriu, producte innovador verd, regressió logística, sustainable development, taxonomia, tecnologia.

Abstract

The essence of this work lies in understanding the phenomenon of the development of green product innovation and how it can be constituted at the level of companies in the manufacturing sector for the benefit of organizational performance. Therefore, from a theoretical-exploratory perspective, this doctoral thesis aims to contribute to knowledge through a proposal of organizational systematic reconfiguration focused on creating green product innovations, in such a way that it allows companies in the manufacturing sector to mitigate and/or eliminate negative impacts on the environment, also enabling the obtaining of financial profit, and seeking sustainable development.

For the above-mentioned purposes, three strategic routes are constituted. In the first place, a framework that contemplates the organization as an interrelated open system is constituted, based on determinants of the green product innovation, seven new innovation capabilities, and five organizational dimensions. Next, an analysis is made in relation to which configuration of green innovation capabilities and organizational dimensions can explain a greater achievement of green product innovation. Finally, it specifically tests whether the adoption and high use of green production capability and technology may be affecting organizational performance.

The exploratory analyses are based on two editions of the European Manufacturing Survey, which is applied to companies in the manufacturing sector. In this thesis, at first, the sub-samples of Spain and Croatia were used, and subsequently the ones from Croatia, Lithuania, Spain, Serbia, Slovakia, Slovenia, and Sweden.

The thesis consists of three articles, where the research objectives are respectively developed and the findings that arise from the studies are presented. The results warn of the need for an organizational reconfiguration at the level of enterprises in the productive sector, stipulated on the basis of the seven green innovation capabilities and the five analyzed organizational dimensions, in order to support the determinants of green product innovation, contributing directly to sustainable performance. Likewise, it is identified as the green production capacity and the technology in its adoption and its high levels of use present a significant impact on environmental and financial performance.

Therefore, this doctoral thesis provides contributions that confirm theoretical and practical reactions that may correspond to opportunities for academics, professionals, and government entities. Consequently, this research provides guidance on how to use these results in the development of future research work and strategic or governmental plans.

Keywords: cluster analysis, determinants, European Manufacturing Survey, environmental performance, financial performance, framework, green innovation capabilities, green production capability, green product innovation, logistics

regression, manufacturing companies, matrix, organizational dimensions, sustainable development, taxonomy, technology.

Tesis doctoral por compendio de artículos

Lista de trabajos - publicaciones previas y simultáneas que originan y contribuyen a la presente tesis doctoral:

<table>
<tr><th>Year</th><th>State</th><th>Journal</th><th>Index</th><th>Quartile</th><th>Subject Area</th></tr>
<tr><td colspan="6">1. Serrano García, J., & Robledo Velásquez, J. (2013). Methodology for evaluating Innovation capabilities at university institutions using a fuzzy system. Journal of Technology Management & Innovation, 8, 51-51. DOI 10.4067/s0718-27242013000300051</td></tr>
<tr><td rowspan="2">2013</td><td rowspan="2">Publicado</td><td rowspan="2">Journal of Technology Management & Innovation</td><td>SJR</td><td>JCR</td><td>Subject area and category</td></tr>
<tr><td>Q3</td><td></td><td>Business, Management and Accounting
*Management of Technology and Innovation</td></tr>
<tr><td colspan="6">2. García, J. S., Álvarez, C. A. A., Gómez, J. M. C., & Toro, J. J. A. (2017). Measuring organizational capabilities for technological innovation through a fuzzy inference system. Technology in Society, 50, 93-109. DOI 10.1016/j.techsoc.2017.05.005</td></tr>
<tr><td rowspan="2">2017</td><td rowspan="2">Publicado</td><td rowspan="2">Technology in Society</td><td>SJR</td><td>JCR</td><td>Subject area and category</td></tr>
<tr><td>Q1</td><td>Q1</td><td>Business, Management and Accounting
*Business and International Management

Social Sciences
*Education
*Human Factors and Ergonomics
*Sociology and Political Science</td></tr>
<tr><td colspan="6">3. Pérez-Pérez, J. F., Parra, J. F., & Serrano-García, J. (2021). A system dynamics model: transition to sustainable processes. Technology in Society, 65, 101579. DOI 10.1016/j.techsoc.2021.101579</td></tr>
<tr><td></td><td></td><td></td><td>SJR</td><td>JCR</td><td>Subject area and category</td></tr>
</table>

2021	Publicado	Technology in Society	Q1	Q1	Business, Management and Accounting *Business and International Management Social Sciences *Education *Human Factors and Ergonomics *Sociology and Political Science

Lista de publicaciones correspondientes a la presente tesis de doctorado

Del desarrollo de la presente tesis doctoral se ha originado las siguientes publicaciones en revistas indexadas:

<table>
<tr><th>Year</th><th>State</th><th>Journal</th><th>Index</th><th>Quartile</th><th>Subject Area</th></tr>
<tr><td colspan="6">1. Serrano-García, J., Bikfalvi, A., Llach, J., & Arbeláez-Toro, J. J. (2021). Orchestrating capabilities, organizational dimensions and determinants in the pursuit of green product innovation. Journal of Cleaner Production, 313, 2–18. https://doi.org/10.1016/j.jclepro.2021.127873</td></tr>
<tr><td rowspan="2">2021</td><td rowspan="2">Publicado</td><td rowspan="2">Journal of Cleaner Production</td><td>SJR</td><td>JCR</td><td>Subject area and category</td></tr>
<tr><td>Q1</td><td>Q1</td><td>Business, Management and Accounting *Strategy and Management

Energy *Renewable Energy, Sustainability and the Environment

Engineering *Industrial and Manufacturing Engineering

Environmental Science *Environmental Science (miscellaneous)</td></tr>
<tr><td colspan="6">2. Serrano-García, J., Bikfalvi, A., Llach, J., & Arbeláez-Toro, J. J. (2022). Capabilities and organisational dimensions conducive to green product innovation: Evidence from Croatian and Spanish manufacturing firms. Business Strategy and the Environment, 31(7), 2767–2785. https://doi.org/10.1002/bse.3014</td></tr>
<tr><td rowspan="2">2022</td><td rowspan="2">Publicado</td><td rowspan="2">Business Strategy and the Environment</td><td>SJR</td><td>JCR</td><td>Subject area and category</td></tr>
<tr><td>Q1</td><td>Q1</td><td>Business, Management and Accounting *Business and International Management
*Strategy and Management</td></tr>
</table>

					Environmental Science *Management, Monitoring, Policy and Law Social Sciences *Geography, Planning and Development
3. Serrano-García, J., Llach, J., Bikfalvi, A., & Arbeláez-Toro, J. J. (2022). Performance effects of green production capability and technology in manufacturing firms…					
2022	En proceso de aceptación por parte de la Revista, después de haber enviado la respuesta a las observaciones de los pares evaluadores del artículo.	Journal of Environmental Management	SJR	JCR	Subject area and category
			Q1	Q1	Environmental Science *Environmental Engineering *Management, Monitoring, Policy and Law *Waste Management and Disposal Medicine *Medicine (miscellaneous)

Contribuciones intermedias de la presente tesis de doctorado

A continuación, se evidencia la presentación de resultados originados de la presente tesis en revistas de menor impacto y en la participación en congresos internacionales:

<table>
<tr><th>Year</th><th>State</th><th>Journal</th><th>Index</th><th>Quartile</th><th>Subject Area</th></tr>
<tr><td colspan="6">1. Serrano-García, J., Bikfalvi, A., Llach, J., Arbeláez-Toro, J. J., García-Gómez, J.M. (2022). Orientaciones, dinámicas organizacionales y motivaciones para la obtención del producto innovador verde. Revista CEA, v.8, n.17, e2138.https://doi.org/10.22430/24223182.2138</td></tr>
<tr><td rowspan="2">2022</td><td rowspan="2">Publicado</td><td rowspan="2">Revista CEA</td><td>Publindex Colombia</td><td>Categoría B</td><td>Ciencias Sociales y Humanidades</td></tr>
<tr><td>Redalyc</td><td>N/A</td><td></td></tr>
</table>

Año	Conferencia	Nombre de la ponencia
2019	34th International Business Information Management Association IBIMA Conference Madrid, Spain 13-14 November 2019 https://ibima.org/conference/34th-ibima-conference/	Enfoques de Sostenibilidad Ambiental para Organizaciones del Sector Manufacturero”
2020	5th On/Off International Conference in Marketing Decision Making Medellín (Colombia) and Barcelona (Spain), 19-20th October 2020 Instituto Tecnológico Metropolitano (Medellín, Colombia) and University of Barcelona (Barcelona, Spain) http://www.ub.edu/grmark/mdm20/	Motivaciones de las empresas y los clientes para la constitución y adquisición del PIV. Una revisión de la literatura

Abreviaturas

CER	Corporate Environmental Responsibility
CPI	Conventional Product Innovation
DC	Dynamic Capability
EMS	European Manufacturing Survey
ER	Environmental regulation
GIC	Green Innovation Capability
GMC	Green Marketing Capability
GOIC	Green Organisational Innovation Capability
GOLRC	Green Organisational Learning and Relationship Capability
GPC	Green Production Capability
GPI	Green Product Innovation
GR&DC	Green Research and Development Capability
GRMC	Green Resource Management Capability
GSPC	Green Strategic Planning Capability
HR	Human Resource
IC	Innovation Capability
NRBV	Natural Resource-Based View
OB	Organisational Behaviour
OD	Organisational Dimension
RBV	Resource-Based View
ROS	Return of Sales
TIC	Technological Innovation Capability

NACE	European Classification of Economic Activities
TECH	Technology

Lista de figuras

Lista de tablas

Tabla de contenido

Capítulo 1. Introducción

En el presente capítulo se realiza la descripción de los antecedentes que representan las bases del desarrollo de la tesis, para continuar con los objetivos de la investigación, y, por último, se especifica la justificación y estructuración general del documento.

1.1. Antecedentes

Desde 1987 en Londres – Inglaterra la Comisión Mundial sobre el Medio Ambiente y el Desarrollo (WCED por sus siglas en inglés) presentó un informe poniendo de manifiesto alertas y propuestas para buscar soluciones contra la vulnerabilidad de las personas y el temible cambio climático que el hombre a través de sus múltiples actividades ha generado. No obstante, para plasmarlas identificaron la necesidad de un "nuevo concepto", en el cual abarcar la tendencia y el horizonte para el fomento del desarrollo social y económico, seleccionando uno de los principios del Movimiento Verde, el Desarrollo Sostenible:

> En esencia, es un desarrollo que satisface las necesidades y aspiraciones de la generación actual sin destruir los recursos necesarios para que las generaciones futuras satisfagan sus necesidades. Contiene dos conceptos clave: en primer lugar, la idea de satisfacer las necesidades, y en particular las necesidades de los pobres del mundo, mediante una distribución más equitativa de oportunidades y recursos; en segundo lugar, el concepto de las limitaciones del crecimiento y del agotamiento de los recursos que impone la capacidad del medio ambiente para satisfacer las necesidades futuras (Keeble, 1988, p. 20).

Lo anterior es significativo y ambicioso. Cada individuo, cada organización está en la obligación de aportar, ya que el alcance del desarrollo sostenible depende de la responsabilidad y contribución que cada uno haga. De lograrlo, la calidad y condiciones de los seres humanos y del planeta serían diferentes a las actuales.

Por tanto, un foco especial presenta las empresas del sector manufacturero, dado que pueden ser las más influyentes en la degradación del medio ambiente, pero a la vez, dependiendo de sus estrategias, las mayores contribuyentes para el desarrollo sostenible. En pleno siglo XXI cuando las empresas encuentran condiciones sofisticadas para el perfeccionamiento de su factoría, se continúa presentando de manera significativa organizaciones que no contribuyen con la mitigación o eliminación de materiales y procesos no respetuosos con el medio ambiental, limitando la creación de productos innovadores verdes, que puedan favorecer el impacto ambiental. Por tanto, una pieza clave es comprender y buscar soluciones a nivel organizacional de esta problemática que podría conllevar a la empresa al alcance de la ventaja competitiva.

Bowen et. al., (2001) llama la atención sobre las presiones sociales en las que se encuentran sumergidas las empresas buscando ser receptivas al medio ambiente. Igualmente, Quarshie, Salmi y Leuschner (2016) identifican como la sostenibilidad será cada vez más difícil de navegar debido al crecimiento de la población, los cambios en los patrones de consumo, entre otros factores, generando un ambiente de confusión, pero al mismo tiempo la necesidad de afrontar estas exigencias.

Por tanto, las empresas requieren reconfigurarse, prepararse e identificar cómo proceder y en qué dinámicas organizacionales incurrir para mitigar – eliminar el impacto ambiental, generando el producto innovador verde, y, a la vez, la rentabilidad económica. Lo anterior, mediante una postura ambiental corporativa proactiva (Bowen et al., 2001), debido a que con la situación ambiental actual las empresas "ya no pueden ignorar o retrasar el desarrollo de una estrategia de innovación ecológica" (Dangelico, Pujari y Pontrandolfo, 2016, pág. 2). Esta coyuntura ofrece nuevas oportunidades para las empresas, necesitando la identificación y articulación de determinantes constitutivos del producto innovador verde, así como, de ciertas capacidades y de dimensiones organizacionales que favorezcan a las empresas para abordar el desafío de la innovación sostenible.

Desglosando el precedente, ya no solo se requiere de las capacidades tradicionales y fundamentales, ahora se encuentra necesario reconfigurar y complementar con el concepto y apropiación hacia el verde. A la vez, dadas las afectaciones provocadas por los diferentes hechos generadores de contaminación, una de las necesidades es la renovación de la arquitectura organizacional, requiriendo la identificación y actualización de dimensiones organizacionales en el contexto de las demandas ambientales. Igualmente, como los determinantes del producto innovador verde involucran a diferentes habilidades y áreas organizacionales, éstos podrían estar afectando a la organización en función de la constitución de un producto ecológico.

Diversos esfuerzos se han llevado a cabo buscando dar solución a la constitución del producto innovador verde sin obtener unanimidad sobre cuál es el deber ser y cómo proceder a nivel de las empresas del sector manufacturero (Berchicci y Bodewes, 2005; Jasti, Sharma, y Karinka, 2015). Estudios identifican la importancia de las capacidades de innovación verde, pero se carece sobre la necesidad de su articulación con dimensiones organizacionales en procura de una mejor comprensión y adaptación de la empresa (Tariq, Badir, Tariq, y Bhutta, 2017). Asimismo, varias investigaciones se centran en la caracterización de determinantes del producto innovador verde, pero se identifica falencia en cuanto a su configuración a nivel organizacional y su efecto mediante la demostración empírica con la asociación de capacidades de innovación verde y dimensiones organizacionales como soporte para el desarrollo del producto innovador verde, a la vez, con la falta de evidencia empírica de su impacto a nivel del desempeño.

El contexto mencionado es la base de la presente investigación. Por tanto, partiendo de los trabajos previos de Serrano-García, Acevedo-Álvarez, Castelblanco-Gómez, y Arbeláez-Toro, (2017) y Serrano-García y Robledo-Velásquez (2013a), donde se constituye y se aplica respectivamente, una metodología para evaluar capacidades de innovación tecnológica en instituciones universitarias, estructurada a partir de una configuración conceptual basada en la perspectiva de recursos y capacidades y del modelo de congruencia sistémica de la organización. Asimismo, del trabajo de Pérez-Pérez, Parra, y Serrano-García, (2021), donde se desarrolla un modelo de simulación de dinámica de sistemas para medir procesos de eco-innovación a nivel de empresas del sector productivo. En esta tesis, teniendo presente las bases conceptuales estudiadas en las investigaciones mencionadas y articulándolas con los nuevos desafíos organizacionales en procura del desarrollo del producto innovador verde, se desea en esta oportunidad, contribuir al conocimiento con los siguientes tres aportes originales:

- ✓ El primero consiste en la identificación y categorización de veintidós conjuntos de determinantes del producto innovador verde. A partir de su enfoque conceptual se procede con una taxonomía para el análisis y repercusión al interior de la propuesta de siete nuevas capacidades de innovación verde y cinco dimensiones organizacionales adaptadas al contexto verde, donde se operacionalizan en una matriz para facilitar la definición de variables que evalúen el avance de la empresa en procura del producto innovador verde.
- ✓ El segundo aporte, a partir de la matriz donde se ilustra la relación estructural referente a la asociación de las capacidades de innovación verde y las dimensiones organizacionales con los determinantes, se pretende identificar qué configuración de capacidades de innovación verde y dimensiones organizacionales explican un mayor logro del producto innovador verde. Lo anterior, respaldado a través de un trabajo empírico bajo la técnica estadística del análisis *cluster*, teniendo presente las sub-muestras de España y Croacia de la Encuesta Europea de Innovación en Producción.
- ✓ El tercer aporte a partir del *zoom* realizado a la matriz y reconociendo la importancia específica de la capacidad de producción verde y la dimensión organizacional tecnología en procura de la constitución del producto innovador verde, se realiza la configuración de la capacidad de producción articulada con tecnología. De forma que, la mencionada asociación podría estar brindando soporte a determinantes del producto innovador verde como un escenario de referencia en la gestión de la innovación verde para impactar en el desempeño organizacional hacia la consecución del desarrollo sostenible. Para esta oportunidad, la evidencia empírica también es respaldada por Encuesta Europea de Innovación en Producción a partir de las sub-muestras de siete países europeos.

Por tanto, desde una perspectiva teórico-exploratoria con esta tesis doctoral desea contribuir al conocimiento mediante una propuesta de reconfiguración sistémica organizacional enfocada a la creación del producto innovador verde. De tal manera que permita a las empresas del sector manufacturero mitigar – eliminar impactos negativos al medio ambiente, posibilitando asimismo la obtención de ganancias financieras en procura del desarrollo sostenible.

1.2. Objetivos de investigación

A continuación, se relaciona el objetivo general y los específicos correspondientes a la presente tesis, donde se expone la forma como se abordan los planteamientos de los diferentes problemas de investigación detectados:

1.2.1. Objetivo general

Entender el fenómeno del desarrollo del producto innovador verde desde sus antecedentes hasta el impacto, relacionado con las capacidades de innovación verde en asocio con dimensiones organizacionales: evidencia de acuerdo con la Encuesta Europea de Innovación en Producción.

1.2.2. Objetivos específicos

Para el logro del objetivo general se llevan a cabo los siguientes objetivos específicos:

a) Establecer cuáles son los determinantes constitutivos del producto innovador verde.
b) Identificar cuál es la configuración de las capacidades de innovación verde, las dimensiones organizacionales y los determinantes en procura del producto innovador verde.
c) Determinar qué configuración de capacidades de innovación verde y dimensiones organizacionales conducen al logro del producto innovador verde.
d) Establecer el impacto de la asociación de la capacidad de producción verde y la dimensión organizacional tecnología en el desempeño organizacional.

1.3. Estructura y contenido de la presente tesis

La Universitat Politècnica de València tiene estipulado la posibilidad de presentar las tesis por formato tradicional o por compendio de artículos. Éste último es el caso de la presente tesis, la cual está conformada por tres artículos, dos de ellos ya publicados y uno en proceso de evaluación, todos en revistas diferentes e indexadas. No obstante, la presentación de esta tesis se estructura bajo un enfoque tradicional de investigación con el propósito de entregar un panorama claro y general. Por tanto, la tesis está distribuida como se presenta en la Tabla 1:

Tabla 1: Estructura y contenido de la presente tesis

Revisión de la literatura	Se analiza y se discute los principales tópicos tratados en la investigación. Se complementa con el planteamiento del problema, el estado del arte, la presentación de las brechas de investigación y la necesidad de ser analizadas.
Preguntas de investigación y desarrollo de hipótesis	Se presentan las preguntas e hipótesis de investigación y su conexión con los tres artículos realizados.
Metodología	Se relaciona la metodología efectuada en la tesis, la cual fue llevada a cabo bajo los enfoques metodológicos cualitativos y cuantitativos.
Resultados	Se presentan los tres artículos que corresponden al desarrollo de cada objetivo de la investigación y sus respectivos hallazgos. La recopilación de los tres artículos da respuesta a cada uno de los objetivos, así como a las preguntas de investigación formuladas en la tesis. Por tanto, los artículos se integran como capítulos, conservando la versión original de autor y el orden general de la tesis. Es decir, se adapta las fuentes, el tamaño, el consecutivo de las tablas e imágenes, entre otras. Asimismo, en el Anexo 1 y Anexo 2, respectivamente, se presentan las dos publicaciones correspondientes a la versión de cada revista.
Discusiones	Se exponen las reflexiones en función de los resultados obtenidos, interpretando su significado, los aportes y el alcance generado con el desarrollo de la presente tesis.
Conclusiones	Se confirma la necesidad e importancia de la creación y elaboración de la tesis, ratificando la relevancia de los hallazgos en función de la gestión de la innovación para la reconfiguración organizacional en procura de la constitución del producto innovador verde. Esta sección se complementa con las limitaciones, implicaciones y la relación de potenciales trabajos futuros.

A modo de síntesis en la Figura 1 se presenta un esquema donde se proyecta el alcance de cada artículo y en sí la proyección general de la tesis doctoral.

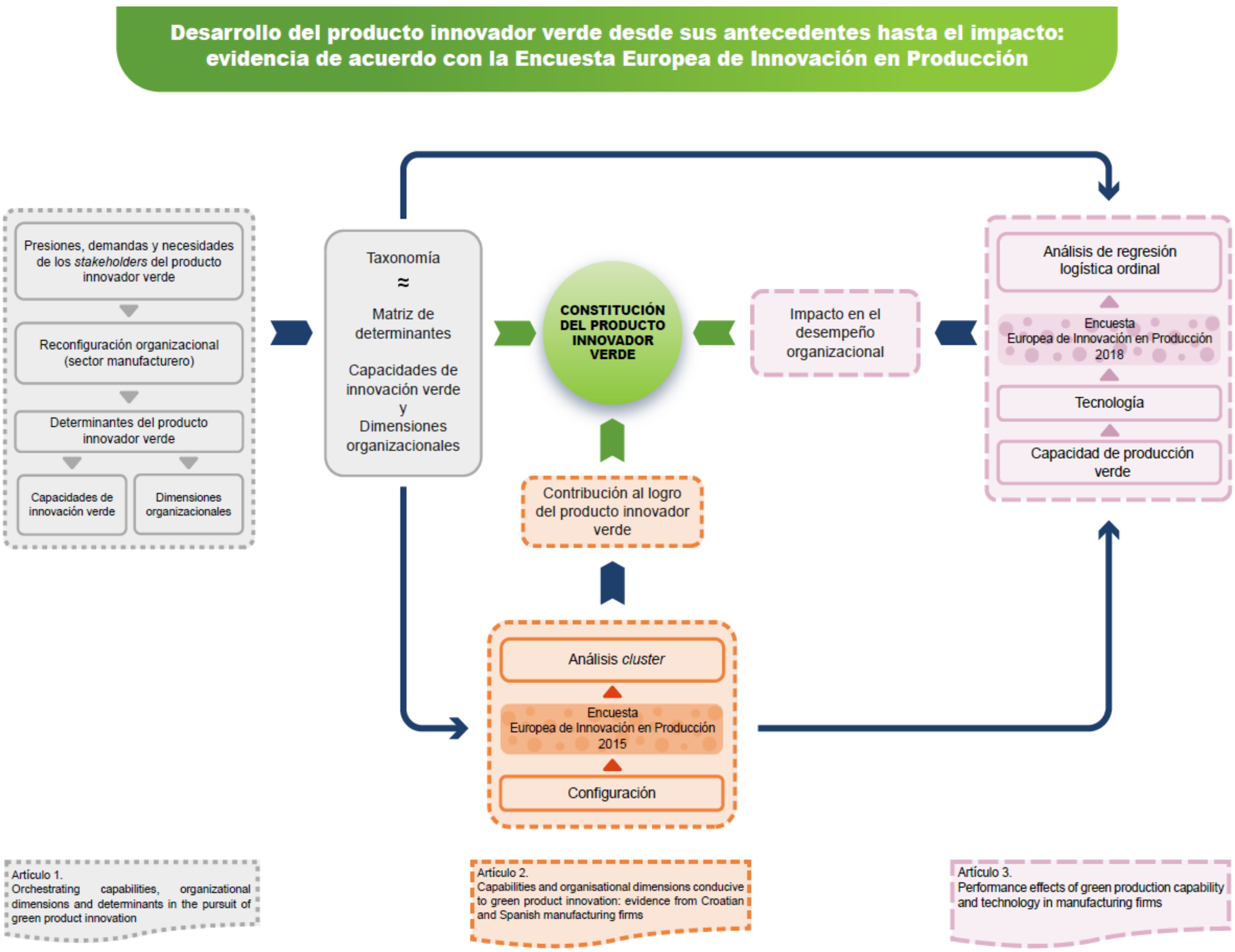


Figura 1. Esquema del alcance general de la tesis doctoral

Capítulo 2. Revisión de la literatura

En este capítulo se presenta el análisis de la literatura brindando una justificación general a los interrogantes e identificando los ámbitos potenciales del estudio en procura de dar una visión global de la tesis.

2.1. Capacidades de innovación de verde

La capacidad de innovación verde parte de la visión basada en los recursos – naturales, a la vez de las capacidades organizacionales y de gestión, para continuar con las capacidades dinámicas, de allí a las capacidades de innovación, transcendiendo al enfoque verde.

Por tanto, la visión basada en los recursos se reconoce por su facultad para convertir las habilidades internas de la organización en valiosas e inimitables (Barney, 1991). Esta teoría facilita la adaptabilidad de las organizaciones, de ahí su fortaleza para la implementación de acciones corporativas encausadas hacia el favorecimiento del medio ambiente (Hart, 1995). Por consiguiente, se trae a colación a la visión basada en los recursos naturales enfoque clave de articulación entre la actividad ambiental y económica de la organización, elevando a la visión basada en los recursos al contexto de la sostenibilidad ambiental. Lo anterior, remite a las capacidades organizativas y de gestión haciendo referencia a habilidades que facilitan movilizar y ejecutar los planes estratégicos de la organización (OECD/Eurostat, 2018), las cuales son caracterizadas por su constante evolución, adaptación y propiedades sistémicas (Renard y St-amant, 2003).

Al igual que la empresa al ser un sistema en constante evolución - interrelacionada - activa, se desprende de este punto el concepto de la capacidad dinámica, la cual corresponde a una variedad de la capacidad organizativa (Renard & St-amant, 2003) que facilita reconfigurar activos de la empresa (Teece, 2007, 2018a), estando a tono con la transformación y la innovación, facultando, entre otros, la creación de nuevos productos ecológicos (Teece, 2018b). En consecuencia, la capacidad dinámica impulsa a la modernización y el cambio de la organización, surgiendo la capacidad de innovación, que representa las habilidades organizativas para el logro de las estrategias de innovación tecnológica (Burgelman, Maidique, y Wheelwright, 2004; Serrano-García, Acevedo-Álvarez, Castelblanco-Gómez, y Arbeláez-Toro, 2017; Serrano-García y Robledo-Velásquez, 2013). A su vez, las capacidades de innovación son propicias para la adopción de tecnologías y la creación de nuevos productos a la luz de las necesidades actuales del mercado (Adler y Sbenbar, 1990; Guan y Ma, 2003).

Por tanto, para ir superando la situación climática actual una medida es la creación del producto innovador verde, y, para esto la empresa necesita apalancarse de capacidades de innovación orientadas al verde que les permita afrontar los desafíos ecológicos a nivel organizacional. En atención a lo cual surgen las capacidades de innovación verde que hacen referencia a las habilidades que la organización construye en procura de un mejor desempeño ecológico y sostenible a largo plazo (Tseng, Chang, y Chen, 2019), asimismo, están vinculadas con las oportunidades de mejora en la eficiencia ecológica (Jakhar, Mangla, Luthra, y Kusi-Sarpong, 2019), a su vez, favorecen la comprensión de aquéllas habilidades necesarias en procura de la reconfiguración organizacional que favorezcan el cumplimiento de determinantes del producto innovador verde (Tariq, Badir, Tariq, y Bhutta, 2017). De esta manera, se reconocen a las capacidades de innovación verde como un soporte organizacional que permite atender los actuales desafíos ecológicos a los cuales la empresa requiere hacer frente.

2.2. Dimensiones organizacionales

Las empresas manufactureras se caracterizan por poseer un entorno turbulento y desafiante. Quizás uno de los retos primordiales sea afrontar las actuales exigencias para ayudar a resolver la problemática medioambiental. Esto conlleva a repensar a la organización estratégicamente para la adaptación y para ser competente ante las condiciones cambiantes (Chiavenato, 2006; Nadler, Tushman, y Nadler, 2011; Teece, 2018a). Ante este panorama surgen las dimensiones organizacionales para ayudar a las empresas a personificar su arquitectura y dinamizar los procesos postulados de acuerdo al modelo y al diseño del negocio que la empresa requiera actualizar para hacer frente a estos nuevos desafíos que le favorezcan la captura y entrega de valor (Galbraith, 1982; Teece, 2018b).

Por tanto, un aspecto clave son las dimensiones organizacionales que ayudan a la transformación de la organización y a la generación de la propuesta de valor (Foss y Saebi, 2015; Huijben, Verbong, y Podoynitsyna, 2016). Es así como, las dimensiones organizacionales son conceptualizadas como los componentes o elementos que favorecen el cambio y la innovación, identificadas en las estructuras formales, representadas por ejemplo, en los procesos y las funciones, así como en las informales, relacionadas con el comportamiento organizacional, los valores, la cultura, entre otros (Daft, 2011; Herrera-Baltazar, 2015).

Sin embargo, describir cuáles son los componentes que la organización requiere actualizar representa un desafío (Nadler y Tushman, 1980). Tal vez, la misión sea entonces detectar aquéllas dimensiones organizacionales que le permita a las empresas del sector manufacturero responder estratégicamente a las actuales exigencias medioambientales que requieren afrontar (Bhaskar y Mishra, 2017; Lin, Tseng, Chen, y Chiu, 2011; Nadler et al., 2011).

2.3. El producto innovador verde y sus determinantes

Dada la actual situación ambiental uno de los desafíos para las empresas del sector manufacturero es encontrar soluciones donde les proporcione mitigar - eliminar impactos que debido a sus actividades económicas puedan estar generando al medioambiente. Por tanto, una posible solución es el diseño y la constitución del producto innovador verde (Salim, Ab Rahman, y Wahab, 2021), dado que es un producto con fuerte demanda por parte de clientes contemporáneos que cuidan de la salud ambiental, asimismo, es un motor que impulsa a las empresas para obtener por parte de las entidades gubernamentales subsidios y créditos fiscales (Long y Liao, 2021; Sana, 2020), los cuales se convierten en incentivos para las empresas procurando por la oferta de productos verdes, que les permita la ampliación de la cuota del mercado (Serrano-García, Bikfalvi, Llach, Arbeláez-Toro, y García-Gómez, 2022). Por tanto, el producto innovador verde, podría contribuir a la organización con las mejoras medioambientales que requieran solucionar y al mismo tiempo con la obtención de las ventajas competitivas.

Diversos autores reseñan el concepto del producto innovador verde como un proceso que involucra diferentes etapas destinadas a minimizar impactos ambientales (Lee y Kim, 2011), cobijando el ciclo de vida físico del producto - proceso de fabricación - uso del producto - eliminación, donde se involucra tres tipos clave de enfoque ambiental, como son: material, energía y contaminación (Dangelico y Pontrandolfo, 2010; Zhang y Li, 2019). Pese a que en la literatura se encuentran diferentes definiciones sobre el concepto y alcance del producto innovador verde, hasta el momento no se presenta un consenso a nivel mundial sobre su definición (Sdrolia y Zarotiadis, 2019). Sin embargo, se infiere como las descripciones que entrega la literatura van direccionadas a un enfoque similar: reducir y/o eliminar efectos ambientales en su producción, así como en su consumo y desecho.

Por otra parte, el producto de innovador verde para su constitución requiere de determinantes peculiares que lo hacen diferente a un producto innovador convencional. Estos determinantes están presentes en todas las etapas correspondientes al diseño, creación, fabricación, suministro y desecho del producto (Chkanikova, 2016; De Medeiros, Vidor, y Ribeiro, 2018; Jasti, Sharma, y Karinka, 2015). Los determinantes corresponden a argumentos - fundamentos categorizados a modo de atributos clave que obedecen a tener un producto innovación verde. Lo anterior, implica para las empresas tomar acciones encaminadas a dar respuesta a los determinantes de tal manera que los conduzca a originar productos ecológicos, y, en consecuencia, permita a la empresa mejorar su desempeño organizacional (Chen y Chang, 2013; Jasti et al., 2015; Tan, Ojo, y Thurasamy, 2019).

Del precedente se podría inferir como las capacidades de innovación verde, las dimensiones organizacionales y los determinantes del producto innovador verde, podrían ser enfoques clave y una oportunidad latente de brindar respuesta por parte de las empresas del sector manufacturero, a las necesidades actuales que requieren cubrir en materia de sostenibilidad ambiental, y, al mismo tiempo, impactar en el desempeño económico de la organización.

Sin embargo, al identificar el avance con relación a qué determinantes caracterizan a un producto innovador verde, se encuentran deficiencias sobre cómo se deben abordar y configurar a nivel organizacional (Jasti et al., 2015; Tariq et al., 2017), a pesar de los diferentes esfuerzos que se han hecho por configurarlos desde diversos tópicos realizados por múltiples investigadores (Albino, Balice, y Dangelico, 2009; Song, Ren, y Yu, 2018; Zhang, Liang, Feng, Yuan, y Jiang, 2020). Requiriendo, continuar la exploración sobre cuáles podrían ser las herramientas administrativas bajo una visión sistémica de la organización, que los puedan soportar en procura de la creación del producto innovador verde. Es así como, identificando la potestad que tienen las capacidades de innovación verde para responder al enfoque ecológico, se requiere detectar cuáles podrían ser esas nuevas capacidades que puedan brindar soporte a los determinantes en procura de la conformación del producto innovador verde (Mellett, Kelliher, y Harrington, 2018; Mousavi y Bossink, 2018). A su vez, dado que las capacidades se encuentran estrechamente relacionadas con el diseño y la operación de la empresa, necesitan del respaldo de dimensiones organizacionales que les permita obrar de forma apropiada, ya que ambas herramientas administrativas se consideran interdependientes (Teece, 2018a). En consecuencia, dados los efectos de su complementariedad, un desafío es la identificación de cuáles capacidades de innovación verde en conjunto con las dimensiones organizacionales, permitirían el razonamiento y ejecución de los determinantes a nivel organizacional que facilite la creación del producto innovador verde.

Adicional a lo anterior, se podría inferir que el logro del producto innovador verde estaría en línea con la gestión de la innovación que a nivel organizacional se pudiera llevar a cabo para dar respuesta a sus determinantes. En atención a lo cual, se requiere la comprobación a nivel experimental si la configuración de capacidades de innovación verde y dimensiones organizacionales, podrían ser un marco de referencia de gestión de innovación que favorezcan la creación de los productos innovadores verdes.

De acuerdo a la revisión de la literatura se detecta como varios investigadores han realizado esfuerzos para comprender como incorporar la sostenibilidad ambiental con el apoyo de capacidades (Andersén, 2021; Awan et al., 2020; Bhatia y Jakhar, 2021). Sin embargo, no se identifica estudio alguno sobre cómo abordar los determinantes bajo los pilares de las capacidades de innovación verde en conjunto con dimensiones organizacionales que faciliten acoplar de manera sistémica a la organización para brindar soporte a los determinantes del producto innovador verde. A la vez, en la revisión de la literatura se encuentran estudios a partir de conceptos gerenciales y apoyados por análisis cuantitativos con el propósito de comprender el producto innovador verde a nivel organizacional (Akhtar et al., 2021; Chen y Liu, 2020; Ogbeibu et al., 2020). No obstante, no se detectaron estudios exploratorios referentes a la configuración de las capacidades de innovación verde con las dimensiones organizacionales como soporte de los determinantes a nivel de la organización para enfrentar el desafío de la constitución del producto innovador verde.

2.4. Capacidad de producción verde

La razón de ser de las empresas del sector productivo es la creación y oferta de productos. Sin embargo, esta práctica puede estar ocasionando cantidades abundantes de residuos y polución (Mark, Nicholas, Chase, y Carretero Díaz, 2001), necesitando una reestructuración en la fabricación orientada hacia un enfoque verde como una forma de cuidar el medioambiente. Debido a que la fabricación verde está vinculada con la reducción y/o eliminación de factores dañinos, en minimizar el uso de los recursos naturales, a la vez, centrando la producción en la utilización de materias primas renovables y apoyadas de las tecnologías limpias (Vrchota, Pech, Rolínek, y Bednář, 2020), incentivando en este sentido a la creación del producto innovador verde.

Es así como, llevar a cabo prácticas en la producción para prevenir el despilfarro de los materiales, la reducción o eliminación de metales tóxicos, de sustancias cancerigenas o clorofluorocarburos; el ahorro adecuado del agua y de la energía; la creación de circuitos de reciclaje y la recuperación de recursos residuales para ser reutilizados en la fabricación; la continua ejecución del control de la calidad total enfocado en el verde; así como el uso de las tecnologías que favorezcan potenciar la fabricación, entre otros (Fiksel, 1996; Viñolas Marlet, 2005), representan capacidades en la producción significativas que la organización requiere poseer e impulsar en procura de marcar diferenciación, situación que podría estar impactando en el desempeño económico y ambiental. En consecuencia, y dados los desafíos actuales para poner en alcance la constitución del producto innovador verde, un enfoque clave es la posesión de la capacidad de producción verde a nivel de las organizaciones del sector productivo.

Por tanto, el implementar estrategias de innovación ecológica podría estar favoreciendo el desempeño de la organización, para lo cual las capacidades de producción verde serían factores clave dado su potencial para la reducción de costos de producción, del consumo de energía, la reutilización de materiales, impactando finalmente la eficiencia organizacional (Wang, Zhang, Zhang, y Wang, 2022). En ese sentido, la capacidad de producción verde podría estar directamente vinculada con la constitución del producto innovador verde, dado que facilitaría la ejecución de una producción eco-sostenible, al implicar la disminución en gastos y afectar los impactos ambientales, contribuyendo, por tanto, al mejoramiento de los estándares del desempeño ambiental y financiero.

2.5. Tecnología

De acuerdo con los fundamentos de la arquitectura organizacional es necesario tomar en consideración el modelo de congruencia organizacional, el cual se encuentra estructurado por dimensiones organizacionales que favorecen la transformación de los procesos de la empresa (David Nadler et al., 2011). Las dimensiones organizacionales hacen referencia a la estructura organizacional, a los procesos, a las personas que integran la organización, a la cultura y el comportamiento, así como a la tecnología, entre otros (Daft, 2011; David Nadler et al., 2011; Robledo-Velásquez, 2019), el reto es identificar de acuerdo a los desafíos actuales de la organización, cuáles pueden ser las dimensiones y su congruencia para contribuir a un mejor desempeño de la organización. Es así como una de las dimensiones organizacionales que puede estar cooperando para dar respuesta a nivel organizacional a los determinantes del producto innovador verde es la tecnología ecológica, identificada desde los dispositivos, métodos técnicos y sistemas.

Se identifica que el concepto de tecnologías y procesos verdes es establecido desde la década de 1960, resultado del movimiento ambiental de las naciones industrializadas en su afán por el cuidado con el medio ambiente (Vrchota et al., 2020). La tecnología verde "se refiere a la tecnología que puede ahorrar recursos y reducir la contaminación ambiental durante el proceso de producción" (Dong, Tan, Wang, Zheng, y Hu, 2021, p. 2). Está directamente relacionada con la producción verde al favorecer la reducción de emisiones de gases de efecto invernadero (Sun, Bi, y Yin, 2020), de los costos en la producción, de la optimización de las materias primas y del tiempo de la creación de los productos. Debido a lo cual, es necesario que la tecnología verde se pueda expandir a nivel de la gestión de la manufactura verde apoyada de los diseños eco-innovadores (Seth, Rehman, y Shrivastava, 2018) de manera que pueda impactar en el logro del producto innovador verde. Paralelamente, las tecnologías verdes podrían ser necesarias para los objetivos financieros y ambientales de la empresa (Palmer y Truong, 2017).

Con base a los argumentos anteriores, se podría inferir como las organizaciones que puedan reconfigurar sus capacidades de producción verde en conjunto con la tecnología verde para la fabricación del producto ecológico, tendrían un potencial para ser sostenibles a largo plazo impactando en su desempeño ambiental y financiero. No obstante, se hace necesario la realización de más investigaciones que permitan tener una mejor perspectiva sobre como la tecnología ecológica puedan aportar a los procesos de producción verde contribuyendo al desempeño organizacional (Palmer y Truong, 2017). Asimismo, es necesaria la realización de más investigaciones para la configuración y articulación de las capacidades que ayuden a fortalecer la fabricación de productos innovadores verdes y que impacten en el desempeño de la organización (Qiu, Jie, Wang, y Zhao, 2020; Xie, Huo, y Zou, 2019).

En la revisión de la literatura se encuentran diferentes esfuerzos de investigación orientadas a las capacidades y a la tecnología como una medida que pueda favorecer el desarrollo del producto innovador verde para impactar en el desempeño de la organización (Chen y Chang, 2013; Dangelico et al., 2016; Huang y Chen, 2022; Wang, Li, Li, y Wang, 2021). Sin embargo, se evidencia la necesidad de realizar más investigaciones considerando a la capacidad de producción y la tecnología verde como competencias que conduzcan aún mejor desempeño organizacional.

2.6. Brechas de investigación de la tesis

Teniendo en cuenta todo el panorama anterior, se denota la existencia de brechas de investigación y su necesidad de ser analizadas. En primera medida, el requerimiento de realizar mayores esfuerzos para entender bajo cuáles herramientas administrativas se podría abordar y configurar a nivel organizacional a los determinantes que conduzcan a la creación de productos innovadores verdes. Segundo, verificar a partir de estudios exploratorios si la configuración de esas herramientas administrativas podría estar facultando a la organización de caras al producto verde. Tercero, se precisa de mayor investigación para establecer el impacto de la asociación de la capacidad de producción verde y la tecnología verde en el desempeño organizacional.

En atención a lo cual, en la Tabla 2 se describen los objetivos, las preguntas de investigación y las hipótesis que dieron lugar al desarrollo de la tesis, a la vez, el estudio donde se abordaron a cada en procura de superar las brechas identificadas.

Tabla 2. Objetivos, preguntas de investigación y desarrollo de hipótesis

Objetivo	Preguntas de investigación		Estudio	Título
Objetivo 1. Establecer cuáles son los determinantes constitutivos del producto innovador verde.	**Pregunta de investigación 1**	¿Cuáles son los determinantes constitutivos del producto innovador verde?	**Estudio 1**	Orchestrating capabilities, organizational dimensions and determinants in the pursuit of green product innovation.
Objetivo 2. Identificar cuál es la configuración de las capacidades de innovación verde, las dimensiones organizacionales y los determinantes en procura del producto innovador verde.	**Pregunta de investigación 2**	¿Cuál es la configuración de las capacidades de innovación verde, las dimensiones organizacionales y los determinantes en procura del producto innovador verde?		

Objetivo 3. Determinar qué configuración de capacidades de innovación verde y dimensiones organizacionales conducen al logro del producto innovador verde.	**Pregunta de investigación 3**	¿Qué configuración de capacidades de innovación verde y dimensiones organizacionales conducen al logro del producto innovador verde?	**Estudio 2**	Capabilities and organizational dimensions conducive to green product innovation: Evidence from Croatian and Spanish manufacturing firms
Objetivo 4. Establecer el impacto de la asociación de la capacidad de producción verde y la tecnología en el desempeño organizacional.	**Hipótesis 1**	La capacidad de producción verde tiene un efecto positivo en el desempeño.	**Estudio 3**	Performance effects of green production capability and technology in manufacturing firms
	Hipótesis 1a	Un alto grado de adopción de la capacidad de producción verde tiene un efecto positivo en el desempeño.		
	Hipótesis 2	La tecnología tiene un efecto positivo en el desempeño.		
	Hipótesis 2a	Un alto grado de adopción de tecnología tiene un efecto positivo en el desempeño.		

Capítulo 3. Metodología

En este capítulo se presenta la descripción metodológica llevada a cabo en la tesis, la cual se clasifica en dos componentes:

- ✓ Primer componente: metodología bajo un enfoque cualitativo que permitió la creación del modelo teórico-conceptual de la tesis. La metodología cualitativa está centrada especialmente en comprender las razones y opiniones sobre un tema, para ayudar a desarrollar ideas e hipótesis de investigaciones cuantitativas (Kukkamalla Kumar, 2020). La base de este tipo de investigación está focalizada en un proceso lógico e inductivo, el cual no sigue un rumbo claramente definido; así como la recolección de datos, no es un procedimiento estandarizado ni completamente previsto; a la vez, tiene un carácter interpretativo dado que procura brindar un sentido a los hallazgos en función de los significados, construyendo un conocimiento y ampliando las perspectivas teóricas (Sampieri Hernández, Fernández Collado, y Baptista Lucio, 2010).

- ✓ Segundo componente: metodología cuantitativa que facilitó la evaluación exploratoria del marco conceptual, así como probar las hipótesis planteadas. Por metodología cuantitativa se identifica como aquella que sigue una estructura lógico – conceptual permitiendo llevar a cabo un conjunto de procesos secuenciales y probatorios, buscando generalizar los hallazgos con el propósito de explicar y predecir los fenómenos investigados que contribuyan con la generación de nuevo conocimiento (Sampieri Hernández et al., 2010). Es decir, permite el planteamiento de un problema, que conduce a los objetivos y preguntas de investigación, para proseguir con la revisión de la literatura y la elaboración de una perspectiva teórica, continuando con la definición de variables e hipótesis, para ser probadas mediante métodos matemáticos - estadísticos que facultan desprender una serie conclusiones (Sampieri Hernández et al., 2010).

3.1. Proceso metodológico de la tesis

De acuerdo con las descripciones de los conceptos metodológicos y la realización de la metodología efectuada en los tres artículos, a continuación, se reseña el proceso metodológico llevado a cabo en la tesis.

3.1.1. Proceso metodológico para el desarrollo del primer artículo

Para responder a las preguntas de investigación formuladas en el primer estudio de la tesis, se procedió bajo una secuencia de etapas, las cuales se relacionan en la Figura **2**, para pasar a continuación a describir a cada una de ellas:

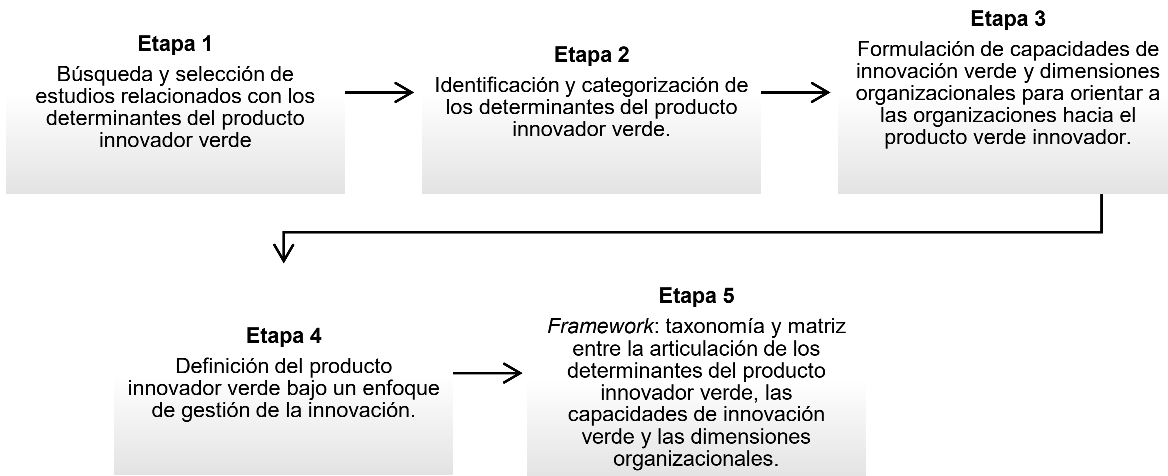


Figura 2. Etapas implementadas en el proceso metodológico del primer artículo

En este sentido, en este artículo se desarrolló una búsqueda exhaustiva en la literatura científica de determinantes correspondientes a un producto innovador verde. A continuación, estos determinantes fueron categorizados y compilados en veintidós conjuntos de acuerdo con la similaridad en su significado, características técnicas e impacto que presentaron en las diferentes áreas de la organización. Luego, se identificó la forma de dar respuesta a las necesidades de reconfiguración actuales de la organización en función de los conjuntos de determinantes identificados hacia el logro del producto innovador verde, al detectar y proponer siete nuevas capacidades de innovación verde en asocio con cinco dimensiones organizacionales. A la vez, dado que a nivel de la literatura se encontró definiciones del producto innovador verde sustentadas bajo las visiones técnicas, físicas y ambientales. En esta oportunidad, a partir de la identificación de los determinantes y de las capacidades de innovación verde y las dimensiones, se procedió a ampliar la definición con el propósito de vincular el concepto del producto innovador verde al interior de la gestión administrativa y de la innovación verde. El siguiente desafío fue como a través de una taxonomía se procedió con cada uno de los veintidós conjuntos de determinantes al establecer su impacto en una capacidad(s), en una dimensión(s), o en las diferentes combinaciones entre ellas, para reconfigurar la organización en procura de la constitución del producto innovador verde. Finalmente, todo lo anterior, fue articulado en un modelo teórico-conceptual que se operacionalizó en un matriz donde se articularon los determinantes, las capacidades de innovación verde y las dimensiones organizacionales, que permitan establecer de forma racional las variables (actividades) para evaluar el modelo de gestión de la innovación de la organización en función de la constitución de un producto innovador verde.

3.1.2. Proceso metodológico para el desarrollo del segundo y tercer artículo

Este desarrollo metodológico fue efectuado bajo dos secciones a correspondientes al levantamiento de la información y al proceso de análisis para la obtención de los resultados.

✓ **Levantamiento de la información**

El levantamiento de la información se realizó a partir de la Encuesta Europea de Innovación en Producción, propiedad de un consorcio formado por centros de investigación y universidades europeas, el cual es administrado por el Fraunhofer Institute for Systems and Innovation Research ISI. La encuesta es estructurada bajo bloques temáticos buscando indagar por la información de empresas manufactureras europeas referente a atributos y resultados a nivel organizacional y ambiental, que permitan la comprensión respecto a la mejora de procesos productivos, así como el uso de nuevas tecnologías y la aplicación de conceptos organizativos innovadores (Fraunhofer Institute for Systems and Innovation Research ISI, 2021). Por consiguiente, en la Tabla 3 se describe el proceso llevado a cabo para el levantamiento de la información en procura del desarrollo de los objetivos planteados.

Tabla 3. Descripción del levamiento de la información para el segundo y tercer artículo

Artículo	Recolección de los datos	Observaciones
Segundo	Los datos fueron recolectados a partir de la Encuesta Europea de Innovación en Producción, edición 2015.	• A partir de la muestra se recolectó información de empresas del sector manufacturero con al menos 20 empleados, correspondiente a dos países europeos: 101 de España y 105 de Croacia. • Las preguntas de la encuesta fueron las mismas para las empresas del sector manufacturero de ambos países. • El corte de los datos de la encuesta correspondió al año 2015, siendo aplicada en el año 2016. • Las empresas encuestadas hacen parte del sector industrial manufacturero listadas en NACE Rev. 2, códigos del 10 al 32.

Tercero	Los datos fueron recolectados a partir de la Encuesta Europea de Innovación en Producción, edición 2018.	• A partir de la muestra se recolectó información de empresas del sector manufacturero con al menos 20 empleados, correspondiente a siete países europeos: 101 de Croacia, 199 de Lituania, 81 de España, 235 de Serbia, 108 de Eslovaquia, 127 de Eslovenia y 167 de Suecia. • Las preguntas de la encuesta fueron formuladas y aplicadas de forma transversal a todas las empresas del sector manufacturero de los siete países en mención. • El corte de los datos de la encuesta correspondió al año 2018, siendo aplicada en el año 2019. • Las empresas encuestadas hacen parte del sector industrial manufacturero listadas en NACE Rev. 2, códigos del 10 al 33. • Las empresas fueron clasificadas de acuerdo con su intensidad tecnológica a partir de la escala propuesta por la Organización para la Cooperación y el Desarrollo Económico (OCDE).

- ✓ **Proceso de análisis para la obtención de resultados**

A nivel metodológico para el tratamiento de los datos se contó con el apoyo de las técnicas estadísticas referente al análisis *cluster* y a la regresión logística ordinal. En la Figura 3 se reseña las diferentes etapas que fueron implementadas, y, en la Tabla 4, se describe la forma como se desarrollaron las etapas para ambos artículos.

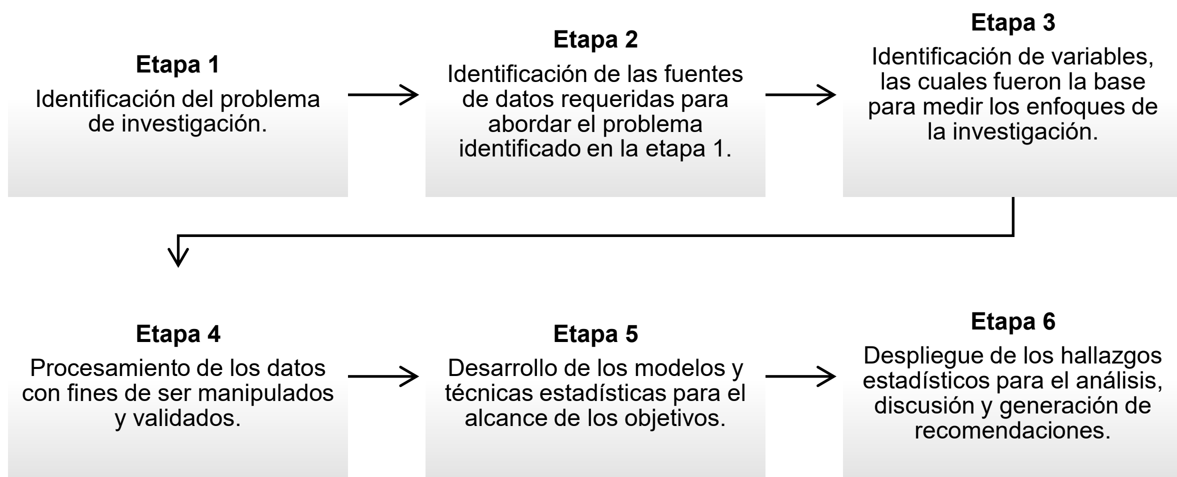


Figura 3. Etapas implementadas para la obtención de resultados del segundo y tercer artículo

Tabla 4. Descripción de las etapas implementadas correspondientes al segundo y tercer artículo

Etapa	Artículo 2	Artículo 3
1.	Determinar qué configuración de capacidades de innovación verde y dimensiones organizacionales explican un mayor logro del producto innovador verde.	Establecer el impacto de la asociación de la capacidad de producción verde y la tecnología en el desempeño organizacional.
2.	Los datos se tomaron de la Encuesta Europea de Innovación en Producción, edición 2015. Con una muestra total de 206 empresas correspondientes a dos países.	Los datos se tomaron de la Encuesta Europea de Innovación en Producción, edición 2018. Con una muestra total de 1.018 empresas correspondientes a siete países.
3.	Se seleccionaron las variables en representación de los determinantes del producto innovador verde, de acuerdo con una matriz donde se estableció el intercepto entre cada una de las capacidades de innovación verde y las dimensiones organizacionales.	Selección de las variables en representación de las capacidades de producción verde y la tecnología.
4.	Se prepararon los datos en el software licenciado SPSS y el software R Project, en los cuales se procesaron los datos.	Se preparan los datos en el software licenciado SPSS, en el cual se realizó el procesamiento de los datos.

5.	El modelamiento de los datos implicó el uso de una técnica estadística multivariada de correspondencias múltiples, resultando cuatro *cluster*.	Se empleó los métodos de regresión logística y logística ordinal para la ejecución de los modelos planteados.
6.	El despliegue final de los *cluster* permitió la explicación de los grupos, identificando la interrelación entre las variables y la incidencia de las capacidades de innovación verde y las dimensiones organizacionales para el logro del producto innovador verde.	Los resultados de los modelos se resumen en tablas, en las cuales se proyecta estadísticamente si cada variable explicativa tiene un efecto significativo en el rendimiento organizacional.

Capítulo 4. Orchestrating capabilities, organizational dimensions and determinants in the pursuit of green product innovation

Jakeline Serrano-García[a,b*], Andrea Bikfalvi[c], Josep Llach[c], and Juan José Arbeláez-Toro[d,e]

[a] Universitat Politècnica de València, Valencia – Spain

[b] Faculty of Economic and Administrative Sciences, Instituto Tecnológico Metropolitano, Medellín - Colombia

[c] Department of Business Administration and Product Design, Universitat de Girona, Girona, Spain

[d] AMADE, Polytechnic School, University of Girona, Girona – Girona - Spain

[e] Faculty of Engineering, Instituto Tecnológico Metropolitano, Medellín - Colombia

Abstract

There is now evidence of a growing demand for green product innovation (GPI), leading to reduced negative environmental effects. This context is an opportunity for the organizational reconfiguration of companies in the manufacturing sector to accommodate towards new product attributes and characteristics. Although the identification of the determinants of GPI has advanced, their integration is still fragmented and there is limited coherence in terms of the management approach leading to GPI development. The main purpose of this paper is the selection and configuration of the determinants of GPI and their organization into an innovation management framework. This is achieved by identifying and categorizing the determinants of GPI in association with green innovation capabilities (GIC) and organizational dimensions (OD). The results provide a set of determinants of GPI, paving the way for organizational challenges, the adaptation and definition of new GIC, and the selection of green-oriented OD. All the above is represented in a framework showing the structural relationships and operationalized in a matrix product of the taxonomy referring to how the determinants of GPI affect GIC and OD, thus facilitating the definition of the variables that assess the progress of the company in pursuit of GPI. This research contributes in the field of management and organizational theories for the managerial transition to sustainable development from the dynamics of innovation. It also widens the scope of study for researchers, manufacturing company managers, and governmental bodies responsible for environmental management.

* Corresponding author. Faculty of Economic and Administrative Sciences, Instituto Tecnológico Metropolitano, Cl. 54a #30-01, Medellín –Colombia; Department of Business Administration and Product Design, University of Girona, Campus Montilivi s/n, 17073. E-mail addresses: jakelineserrano@itm.edu.co - jserrano2005@gmail.com (J, Serrano); andrea.bikfalvi@udg.edu (A. Bikfalvi), josep.llach@udg.edu (J, Llach,), juanarbelaez@itm.edu.co – jjarbetoro@gmail.com (J. Arbeláez)

Keywords

Green innovation capabilities, organizational dimensions, determinants, green product innovation, taxonomy, matrix, manufacturing firms, sustainability, environment, framework.

4.1. Introduction

Political, institutional, and individual actors' growing interest in promoting environmental sustainability (Chang, 2017; Kong, Feng, & Ye, 2016; Su, Wang, & Ho, 2017) has put pressure on the market to design innovative products with minimal environmental impact (Hukkinen, 1995; Melander, 2018). These products, referred as green product innovation (GPI), can potentially become a novel business opportunity for manufacturing firms, helping them to meet these new demands and expectations.

GPI distinguishes itself from conventional innovative products (CIP) (Chen & Chang, 2013; Pons, Bikfalvi, & Llach, 2018) because the resulting products impact on socially conscious customers who are willing to pay a higher price for them (Niedermeier, Emberger-Klein, & Menrad, 2021; Sana, 2020). It also favors the potential motivations of governments by trying to offset the cost of achieving sustainable development (Sana, 2020; Jian Wang, Wan, & Yu, 2020). This is translated into a comparative and competitive advantage given that GPI brings benefits for firms while helping to preserve natural resources for future generations (Pérez-Pérez et al., 2021).

However, many organizations are not yet convinced about producing and developing green products for various reasons, including the high investment involved (Rehman Khan et al., 2018), the risk aversion when making financial investments (Stucki, 2019), and limited government support. Also relevant is the lack of studies aimed at consolidating GPI from organizational and management theories (Dangelico et al., 2016) and the lack of clarity on how to address its determinants at the organizational level (Jasti et al., 2015; Tariq et al., 2017). For GPI development, every area of the firm must be involved (Hukkinen, 1995) because the process of designing, creating, producing, and marketing green products requires an interdisciplinary approach (Ulrich & Eppinger, 2012).

Various studies report that there are certain determinants for the production and marketing of innovative green products (Chen & Chang, 2013; Dangelico & Pujari, 2010; Dangelico & Vocalelli, 2017; Lee & Kim, 2011; Melander, 2017; Tsai, 2012). These generally involve improving and using environmentally friendly materials (Ma et al., 2018); manufacturing products with recycled components; reducing energy consumption; using less packaging (Chen & Chang, 2013); and reusing, remanufacturing, and recycling inputs to reduce the harmful effects on the environment (Dangelico & Pujari, 2010).

Studies have been conducted in fields like innovation and environmental economics and management to identify the factors that drive organizations to develop GPI (Alharthey, 2019; Chang, 2016; Tan et al., 2019). However, there is still a fragmented and disconnected approach to this identification (Jasti et al., 2015; Tariq et al., 2017), hindering the achievement, shaping, and implementation of GPI at the organizational level (Chang, 2016; Jasti et al., 2015). Furthermore, there is no consistency among the different factors and theoretical approaches leading to its development (Dangelico et al., 2016; El-Kassar & Singh, 2019; Jasti et al., 2015; Sdrolia & Zarotiadis, 2019).

Analyses are required to examine how firms integrate corporate sustainability with the support of organizational management, under a systemic perspective and with a holistic vision (Engert, Rauter, & Baumgartner, 2016), thereby strengthening the different determinants to achieve environmental sustainability. In addition, given the need to evolve towards environmental protection, organizations must adopt new or significantly improved innovation management systems based on organizational support models to underpin the creation, design, and implementation of the required changes (Robledo-Velásquez, 2019).

The Resource-Based View (RBV) theory has so far been the most widely used to study how organizations manage green innovation (Tariq et al., 2017). According to this theory, firms with the best resources and capabilities (and their orchestration with the firms' activities) may gain comparative and competitive advantages in terms of environmental sustainability (Hart, 1995; Hart & Dowell, 2011; Leih, Linden, & Teece, 2015; Tariq et al., 2017; Teece, 2018a). Nonetheless, different research studies based on RBV have so far been unable to determine how companies maintain competitive advantages using resources and capabilities. Most works have focused on resources, while the use of green innovation capabilities (GIC) has been little studied (Tariq et al., 2017), even though firms that opt for GPI need new capabilities to coherently face the rigors inherent in environmental sustainability (Mellett et al., 2018; Mousavi & Bossink, 2018).

Such capabilities, in turn, impact on the business design and operation of firms and demand the support of the organizational dimensions (OD), given that they are interdependent (Teece, 2018a). There may therefore be complementary and interrelated effects between GIC and the organizational driving forces involved in environmental matters, directed towards the promotion of proactive corporate environmental practices (Bowen et al., 2001; Rodriguez & Wiengarten, 2017). In view of all the above, the organizational capabilities and dimensions through which innovation can be managed should be analysed to understand the determinants in pursuit of GPI at the organizational level.

Firms have become increasingly interested in gaining a greater understanding of the notion of innovation capabilities (GIC) related to environmental sustainability. Several studies from different areas of knowledge and application fields have been developed, especially in the productive sector (Amores-Salvadó, Martin-de Castro, & Navas-López, 2015;

Ardyan, Rahmawan, Tinggi, & Ekonomi, 2017; Dangelico et al., 2016; Fan, Liu, & Zhu, 2017; Fernando, Chiappetta Jabbour, & Wah, 2019; Gao & Zhang, 2013; Joo, Seo, & Min, 2018; Lin et al., 2011; Liu & Gong, 2018; Mellett et al., 2018; Ramanathan, Ramanathan, & Bentley, 2018; Saenz & Atoche-Kong, 2014; Wang & Zhang, 2018; Wu, 2014; Wu & Hu, 2015; Xu & Wang, 2018). However, to the best of the authors' knowledge, none of the research papers have constructed GIC or studied them under strategic functional skills and pillars directed towards the creation of GPI which, together with OD, can lead the organization to respond to the identified determinants.

Therefore, this study integrates the analysis of GIC and OD as a solution that could serve as a systemic approach to implementing the determinants of GPI. In addition, the research aims to intervene in the structuring of the IC functional approach with theories concerning green-oriented OD and associated with determinants that can direct the organization towards innovation management to generate GPI. This solution means strategically configuring the GIC, OD, and determinants to form a system of interrelated elements leading to GPI creation, which will show how they are interconnected and complement each other under a conceptual framework that favors GPI development for the purpose of improving firms' economic, social, and environmental performance.

This approach aims to provide solutions to reduce environmental impacts from a corporate perspective among manufacturing firms. Hence, the purpose of this paper, which has a conceptual focus, is to answer the following research questions: (1) What are the constitutive determinants of GPI? and (2) What is the configuration of the GIC, OD, and determinants in pursuit of GPI?

This paper is structured as follows. Section two provides a theoretical background, section three describes the methodology, section four presents the results, section five contains the discussions, and section six presents the conclusions, limitations, and future lines of work.

4.2. Theoretical background

4.2.1. Green innovation capabilities

In line with theoretical postulations, GIC characterization starts from the concept of resources and capabilities and continues with organizational and management capabilities towards dynamic capabilities, from where it moves towards IC with extension to the green approach. Capability refers to the ability, faculty, strength, or power to do something in light of the proposed objectives (Renard & St-amant, 2003), where strategic management is key to adapting, integrating, and reconfiguring these capabilities into the organization (Teece, Pisano, & Shuen, 1997). Strategy entails organizational and management capabilities that enable a firm's resources to be mobilized, commanded, and exploited to achieve its strategic objectives (OECD/Eurostat, 2018). These capabilities reflect the interactions between resources and capabilities, which are constantly evolving and framed in systemic properties (Renard & St-amant, 2003; Teece, 2018b).

As an interrelated and dynamic system, an organization is under constant evolution and adaptation, for which it requires certain capabilities. This is where Dynamic Capability (DC), a particular type of organizational capability, comes into play (Renard & St-amant, 2003). DC enables opportunities to be detected and configured, and the company's assets to be reconfigured (Teece, 2007, 2018a). At the same time, DC acknowledges the importance of innovation, facilitating the ability of organisations to produce new products in a more natural way and using a systemic approach (Teece, 2018b). Consequently, DC involves diversification and change, leading to the IC concept. According to Lahovnik & Breznik (2014), IC are acknowledged as the most relevant type of DC, enabling a competitive edge to be built and maintained.

For Burgelman, Maidique, & Wheelwright (2004), IC are an integral set of characteristics which support and make an organisation's technological innovation strategies flexible. IC are the organisational capabilities needed to consolidate innovation (Serrano-García et al., 2017; Serrano-García & Robledo-Velásquez, 2013a). According to Guan & Ma (2003) and Adler & Sbenbar (1990), IC allow new products to be created and processing and manufacturing technologies to be adopted, thus satisfying the current and future needs of the market. It is recommended that IC are defined in organizational levels to meet strategic needs and to adapt to environmental conditions (Guan et al., 2006).

An IC[1] extension is the green approach (Mellett et al., 2018). In this regard, GIC provide the industry with an opportunity to improve its ecological efficiency (Jakhar et al., 2019), linking the firm's environmental sustainability initiative with its performance through strategies designed for this purpose (Kim, Sheu, & Yoon, 2018). The development of higher levels of GIC helps organizations to elucidate processes, techniques, and products to reduce environmental damage (Tseng et al., 2019) since it facilitates their understanding and discernment of the specific aspects to be adapted and improved. GIC empower the organization to comply with environmental requirements and to become part of the emerging green economy (Mellett et al., 2018).

Thus, GIC are regarded as alternatives that support organizations to meet current ecological needs. From this, it may be inferred that GIC comprise organizational and dynamic capabilities that could foster GPI development and respond to the environmental sustainability challenge. Characterizing the term GIC, capability can be represented as an

[1]Although in the literature, "IC" and "TIC" are frequently used to refer to a similar set of capabilities and are considered equivalent terms, here "IC" will mostly be used to allude to innovation capabilities, in accordance with the terminology defined in the Oslo Manual 2018 (OECD/Eurostat, 2018).

organization's ability to become immersed in a green-oriented strategy; innovation, as an approach to change, evolve, and/or adapt to the green mindset; technology, as the tacit approach within innovation and the implicit and explicit knowledge contained in solutions to environmental problems; and last, the green approach, as the organization's involvement and commitment to environmental care. Corporate, business and functional units could be required to focus on a specific set of strategic green capabilities for the success of an organisation regarding environmental practices aimed at creating ecological value.

4.2.2. Organizational dimensions for green product innovation

The existence and survival of an organization depend on its performance and response to the requirements of its environment (Chiavenato, 2006). To this effect, the organization identifies the need to meet different challenges, among which are social responsibility, ethical issues and the demands of the environment, to be integrated as opportunities in their business design (Bocken, de Pauw, Bakker, & van der Grinten, 2016; Robbins & Coulter, 2014; Weerts, Vermeulen, & Witjes, 2018). One essential requirement may be the identification and creation of an architecture in the context of environmental demands, given the affectations triggered by different polluting factors. This paves the way for the need to strategically link the organization's response capacity and adaptation to the required adjustments (Chiavenato, 2006; David Nadler et al., 2011).

Managers need to reflect on and redesign the organisation, seeking to be competent in response to changing conditions (Teece, 2018a; Volberda, 1999). To this effect, the design of the business model is considered an inherent part of meeting the company's stated objectives (Foss & Saebi, 2015). The role of the design is to coordinate and control the OD to guarantee organisational development (Patrucco, Walker, Luzzini, & Ronchi, 2019). The OD, then, can be postulated in line with the business model and design and with the organisational and personified challenges in the institutional task, making organisations unique and distinct. The dimensions can facilitate the structure and stimulate the organisation to improve the processes that facilitate innovation of their goods and/or services (Galbraith, 1982; Teece, 2018b), favouring the capture, value delivery, and compliance with the conditions required by the environment (Chiavenato, 2006; Fjeldstad & Snow, 2018; Jaspers, Prencipe, & Van Den Ende, 2012).

In this regard, OD are a strategic point that enables value proposition activities and pragmatically supports evolution operations, thus allowing a process transformation for the generation of value in the community (Foss & Saebi, 2015; Huijben et al., 2016). This is how organizations may be considered to be a set of organizational dimensions, components, and/or elements (Huijben et al., 2016; David Nadler & Tushman, 1980; Patrucco et al., 2019) that represent the organizational design differentiation. OD may help to reduce complex phenomena and foster articulation within the organization in accordance with managerial needs when defining strategies (Daft, 2011; David Nadler & Tushman, 1980) that impact GPI facilitation at the organizational level.

Within organizational design, OD may comprise both formal and informal organizational structures for the transformation of processes and results (David Nadler et al., 2011) directed at the environmental approach, leading to the generation of green innovation (Herrera-Baltazar, 2015; Y. C. Liao & Tsai, 2019). Nevertheless, "at this point in the development of a science of organizations, we probably do not know the one right or best way to describe the different components of an organization" (David Nadler & Tushman, 1980, p. 43) or, notably, to develop GPI, due to the different organizational challenges firms face.

The task could be to identify the OD that are adaptable to new environmental demands and help to strategically describe organizations advocating GPI development (Bhaskar & Mishra, 2017; Lin et al., 2011; David Nadler et al., 2011), given that innovation requires a specifically designed organization (Galbraith, 1982; Song et al., 2018) where organizational dimensions, structures, and processes act as previous and enabling requirements of innovation (Armbruster, Bikfalvi, Kinkel, & Lay, 2008).

4.3. Methodology

To answer the research questions posed in this study, the methodology implemented here is intended to identify the determinants of GPI, GIC, and OD, and then reconfigure them into an innovation management framework that will serve as a proposal for organizations to deal with GPI. The stages outlined below are derived from the methodological designs proposed by Bolden, Waterson, Warr, Clegg, and Wall (1997) and Edison, Bin Ali, & Torkar, (2013).

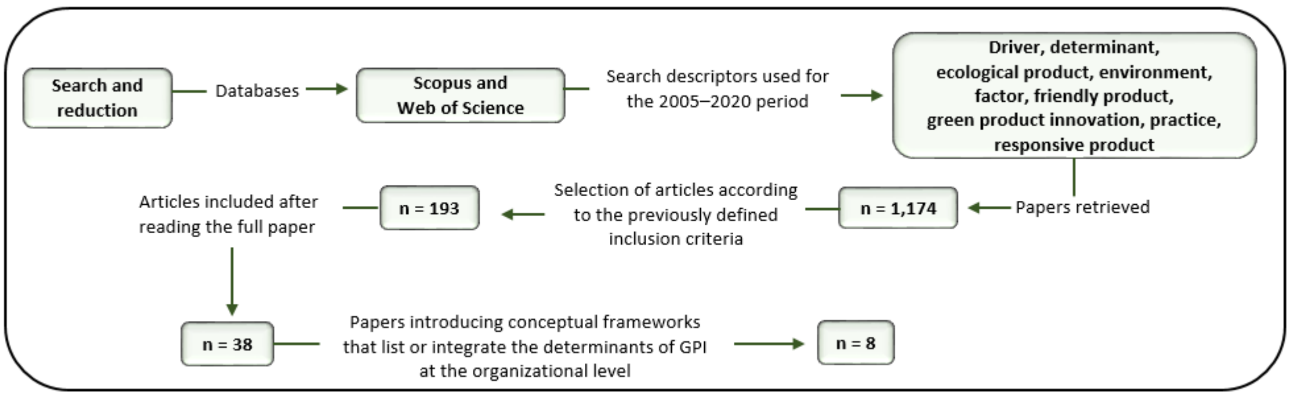
4.3.1. Search and selection of studies related to the determinants of green product innovation

Two specialized databases, Scopus and Web of Science, were used in the search for publications, which was limited to works published between 2005 and 2020 because a clear research trend into GPI is observed in this period. A search equation that ensured a consistent and comparable search in the two databases was designed using the following keywords: driver, determinant, ecological product, environment, factor, friendly product, green product innovation, and practice responsive product.

The studies were selected based on the following inclusion criteria: (i) language: works and/or literature reviews originally published in English; (ii) document availability; and (iii) topic: articles that debate or provide a definition of GPI; papers that include determinants, drivers, factors or practices affecting GPI development at the organizational level; and publications that present, list, or integrate determinants under conceptual frameworks in manufacturing firms, excluding those that propose frameworks as instruments to measure and validate their concepts and connections.

Of the 1,174 papers retrieved from the initial search, only 38 met the inclusion criteria. These articles served as the basis to generate the results and discussions on the determinants of GPI and the development of the concept. Following Khan et al., (2021), the diagram in Figure 4 summarizes the process described above.

Figure 4. Search and reduction of the determinants of green product innovation



Source: Authors' elaboration

4.3.2. Identification and categorization of the determinants of green product innovation

The 38 selected articles were analysed to identify the determinants, drivers, factors, and practices presented by the authors as elements leading to GPI. This identification is justified by the fact that these determinants are key attributes to achieve GPI. Once identified, these determinants were classified and grouped according to various aspects such as similarity in their meaning and purpose, technical and physical characteristics, and impact on the different organizational areas. This categorization is considered to helpful and reconfigure the organization to meet current demands regarding GPI.

4.3.3. Formulation of green innovation capability and organisational dimension to steer organizations towards green product innovation

Finding a way to respond to the identified sets of determinants of GPI at the organizational level was a challenging task. According to this study, organizations would need to structure GIC and OD under an innovation management approach to meet this innovative challenge. This is in line with the works of Robledo-Velásquez (2019), Robledo-Velásquez et al., (2011), Serrano-García and Robledo-Velásquez, (2013a), Serrano-García et al., (2017), which are based on the results of Guan and Ma, (2003), Yam et al., (2004) and Wang et al., (2008), who proposed and evaluated seven IC, and also on the theoretical foundations of the OD proposed by Nadler and Tushman, (1997), and the variant presented by Gouel, (2005) in support of the transformation processes of firms.

In accordance with the studies mentioned above and the identified sets of determinants, this study proposes extending seven GIC to GPI as a possible strategic form of organizational reconfiguration. Furthermore, since the configuration of OD depends on the context and the stages of organizational development (David Nadler et al., 2011), this work proposes five OD that are superimposed on the environmental context while keeping correspondence with the proposal of (Gouel, 2005; Nadler & Tushman, 1997). The selection of these OD is supported by previous research into different OD in the field of environmental sustainability, potentially helping to satisfy the current need for organizational reconfiguration considering the identified sets of determinants that favour GPI.

4.3.4. Defining green product innovation under an innovation management approach

The 38 selected articles included different definitions of GPI in technical, physical, and environmental areas, for instance, but not in the field of organizational management. This is explained by the fact that this concept is new and currently under development (Jasti et al., 2015; Sdrolia & Zarotiadis, 2019). Consequently, this study presents the proposal in relation to the understanding, description, and development of a GPI depending on the sets of determinants, GIC and DO, to characterize it within the field of business administration and innovation.

4.3.5. Framework: taxonomy and matrix of the determinants of green innovation capability and organisational dimension

Since the determinants of GPI involve different organizational skills and areas, the next step was to establish how these determinants could be affecting firms in terms of GPI development. Therefore, the impact of these determinants on each of the proposed GIC and OD was analysed, based on the theoretical and conceptual approach and together with the sets of categorized determinants. The result was a taxonomy and matrix framework. The first (taxonomy) clearly relates and defines the determinants of GPI within the different GIC and OD, establishing a comprehensive relationship that explains how the sets of identified determinants impact a given capability or dimension, or combinations of both, within organizations. The second (matrix) operationalizes the relationship between determinants, GIC and DO, and allows the organization to coherently and relationally define variables (activities) to assess its innovation management model in terms of GPI development.

The configuration of the taxonomy was carried out by each author considering their knowledge and experience in the area or research, after which a consensus was reached regarding their shared classification. Last, the taxonomy derived was refined by three business experts in green strategy and product innovation. The following factors were taken into consideration during this process: the theoretical and conceptual focus of each of the sets of determinants; the scope of the descriptions of the GIC, and the arguments of the DO; the theoretical referents upon which the organisation's capabilities and key components to develop green products were set forth; and the related key determinants to achieve this.

4.4. Results

The results obtained with the methodology implemented to address the research questions posed in this study are presented below.

4.4.1. Determinants of green product innovation

The determinants of GPI correspond to the antecedents, factors, drivers, and practices considered by the authors as key components leading to and preceding the development of GPI (Chen & Chang, 2013; Tariq et al., 2017). From the literature review, 266 proxies were found and grouped into twenty-two sets. Table 5 is an example of one of these sets of determinants and includes the source, proxys, a brief description of the set, and its concise name. In this specific case, the proxies are related to aspects such as energy, materials, waste, and reuse and are grouped into the reduced and efficient use of inputs and raw materials to achieve the GPI category. The process of identifying and grouping the twenty-two sets of determinants and their corresponding sources is presented in Table 8.

Table 5. Sample of a set of determinants

Authors	Proxys	Brief description	Determinant
(Albino et al., 2009)	Material eco-efficiency	*Intelligent use of resources, represented in the use of eco-efficient materials, their reuse and remanufacture, and the recycling of raw materials and consumables, impacting on the reduction of costs and favouring the creation of GPI.*	*Intelligent use of resources*
(Albino et al., 2009)	Energy efficiency		
(Dangelico & Pujari, 2010)	Reduced energy consumption		
(Dangelico & Pujari, 2010)	Reduced material use		
(Chung & Wee, 2010)	Smart use of resources		
(Chung & Wee, 2010)	Reuse, remanufacturing, and recycling of used products		

(Chan, Wang, White, & Yip, 2013)	Decisions regarding the type of raw materials, packaging, means of transport, and disposal	
(Dangelico, 2017)	Reduced costs, energy consumption, and material use to develop more innovative green products	
(Tariq et al., 2017)	Reduced use of valuable input resources	
(B. Y. Zhang & Li, 2019)	Low impact of renewable materials, recyclable materials, non-polluting materials, materials with low-energy content	

Source: Authors' elaboration

4.4.2. Adaptation and definition of seven new green innovation capability under the green approach

According to Joo et al. (2018, p. 6094) "the firm's environmental sustainability cannot be fully achieved without increasing technological innovation capabilities". Therefore, it is essential to understand, create, and protect these capabilities in agreement with the organization, its strategic plans, and the demands of its environment (Serrano-García & Robledo-Velásquez, 2013b).

In line with the definitions stated mainly in Dangelico et al. (2016), Hart (1995), Hart and Dowell (2011), Teece et al. (1997), Robledo-Velásquez et al. (2011), Serrano-García and Robledo-Velásquez (2013a), and Serrano-García et al. (2017) and the theoretical background presented in this paper regarding GIC, and in accordance with the identified sets of determinants, for the purpose of the present paper GIC are understood as: *organizational and dynamic abilities built and/or acquired by an organization in accordance with its strategic and operational management and aimed at developing GPI and contributing to solving the environmental challenges. GIC must be identified and integrated into each organizational function to respond to the new demands or necessary improvements within the context of GPI development. As a result, this would help firms to reduce and/or eliminate the pollution they cause, thus gaining comparative and competitive advantages.*

By extending this to the sphere of organizational functions, a proposal to select, adapt, and define the seven new GIC aimed at GPI development is presented in this study. Each GIC details the specific skills that organizations may need to reconfigure their capabilities to make progress in terms of innovation management, fostering the creation, development, and marketing of sustainable technological innovations to support firms' comparative and competitive advantage**.** Table 6 contains the name of the capability, the proposed definition, examples of responses, and relevant references.

Table 6. Adaptation and definition of seven new green innovation capability

Capability	Definition	Examples	References
GSPC: Green strategic planning capability	*Firms' abilities to define prospects, policies, programs, plans, and objectives to avoid, improve, and/or replace the use of nonrenewable materials (toxic materials) with cleaner resources and technologies, under a comprehensive approach and throughout the product's life cycle. Likewise, to promote composting, reuse, and recycling, thus preventing environmental pollution and fostering GPI development.*	• Green management programs and philosophy. • Guidelines for GPI development. • Organizational policies, plans, and objectives oriented towards environmental sustainability. • Planning of environmental activities and projects. • Programs regarding changes in the design, incubation, and development of green products.	(J. Guan & Ma, 2003), (Yam et al., 2004), (J Robledo-Velásquez et al., 2011), (Serrano-García & Robledo-Velásquez, 2013a), (Hart, 1995), (Block & Marash, 2002), (Ulrich & Eppinger, 2012), (Berry & Randinelli, 1998), (Prakash, 2000), (Ludevid, 2000), and (Dangelico & Pujari, 2010).
GOIC: Green organizational innovation capability	*Abilities defined in firms' business design and model, processes, management, and organizational and commercial structure. They focus on the assimilation, application, and acquisition of competencies to address new environmental opportunities and promote systemic capacity for GPI development.*	• Organizational values oriented towards environmental sustainability. • Management and staff's commitment to GPI development. • Green business model. • Management of radical and incremental innovation in environmental sustainability. • Coordination among and motivation of functional groups to design and develop green products.	(Yam et al., 2004), (J. Guan & Ma, 2003), (OECD/Eurostat, 2018), (Hart, 1995), (Van Hoof, 2014), (Dangelico et al., 2016), (Vickers & Cordey-Hayes, 1999), (Dangelico & Pujari, 2010), and (Wee & Quazi, 2005).
GR&DC: Green R&D capability	*Firms' abilities to create ideas, design prototypes, and develop technologies focused on reducing and/or eliminating the use of toxic resources and fostering the employment of eco-efficient materials and clean technologies, remanufacturing, and recycling, thus favouring the development of a new or improved green product.*	• R&D approach from the very design to the development of the green product prototype. • R&D activities to avoid the use of toxic materials in production. • R&D activities to create eco-friendly packaging and labels. • R&D activities to favour composting and/or recycling of containers and packaging.	(J. Guan & Ma, 2003), (Yam et al., 2004), (OCDE, 2015), (Leonidou, Katsikeas, & Morgan, 2013), (Chung & Wee, 2010), and (Albino et al., 2009).

GPC: Green production capability	*Firms' abilities to develop and manufacture GPI based on stakeholders' needs and R&D results aimed at preventing the generation of waste, minimizing the use of materials and inputs, and fostering the employment of eco-efficient materials and waste reuse.*	• Changes in and optimization of the resources used. • Sustainability of resources used in production. • Production inputs and healthy outputs. • Recycling and reuse of materials in production. • Safety, hygiene, and maintenance of local production machines and premises, generating the minimum waste. • Design of ecological processes.	(J. Guan & Ma, 2003), (Yam et al., 2004), (J Robledo-Velásquez et al., 2011), (Serrano-García & Robledo-Velásquez, 2013a), (Hart, 1995), (Ulrich & Eppinger, 2012), (Block & Marash, 2002), and (Dangelico & Pujari, 2010).
GOLRC: Green organizational learning and relationship capability	*Firms' abilities to learn about environmental sustainability with a focus on cleaner design, production, and packaging; remanufacturing; and recycling, among other aspects, through the collaboration of and continuous relationship with their stakeholders to improve their organizational actions and favor GPI development.*	• Participation of suppliers, customers, and the community in GPI development. • Brainstorming and exchange of information, techniques, and experiences with governments and/or nongovernmental organizations (NGOs) to learn about environmental solutions. • Organizational learning programs for compliance with environmental regulations.	(Yam et al., 2004), (J. Guan & Ma, 2003), (Yang, 2019), (Shevchenko, Lévesque, & Pagell, 2016), (Hart, 1995), (Nonaka, 1994), (Van Hoof, 2014), (Vickers & Cordey-Hayes, 1999), (Block & Marash, 2002), and (Albort-Morant, Leal-Millán, & Cepeda-Carrión, 2016).
GRMC: Green resource management capability	*Firms' abilities aimed at appropriately managing, obtaining, and allocating resources to implement R&D activities, thus favoring the invention of green products, the search and classification of ecological suppliers, the hiring of expert staff, the creation of learning and motivation programs concerning top environmental IC. Equally, the purchase of clean technologies and different inputs for production, the use of eco-friendly packaging, the identification of distribution channels, and recycling and potential remanufacturing, which, in turn, boosts the development and consolidation of GPI.*	• Strategic alliances between companies in the same sector for purchasing environmentally harmless inputs. • Negotiation agreements with suppliers certified in sustainability for the supply of raw materials. • Resource management for learning about and complying with environmental regulations. • Resource management for creating programs that foster the remanufacturing, recycling, and/or composting of products.	(J. Guan & Ma, 2003), (Yam et al., 2004), (Vickers & Cordey-Hayes, 1999), (Hart, 1995), (Serrano-García & Robledo-Velásquez, 2013a), (Block & Marash, 2002), (Chung & Wee, 2010), (Ludevid, 2000), (Chkanikova, 2016), and (Lee & Kim, 2011).

GMC: Green marketing capability	*Firms' abilities to redesign, publicize, and deliver products with a value offer based on environmental sustainability through using packaging, containers, and distribution channels that reduce and/or replace the use of nonrenewable resources (toxic resources) with light and/or recycled materials and components that can be reused and/or composted, thus facilitating the delivery of GPI to customers and consumers.*	• Availability of products with higher quality and preservation properties. • Offerings of products and packaging with reduced and/or zero harmful effects. • Product packaging that can be reused and recycled. • Final products' compliance with the ecological standards demanded by customers and consumers.	(Yam et al., 2004), (J. Guan & Ma, 2003), (OECD/Eurostat, 2005), (Prakash, 2000), (Vickers & Cordey-Hayes, 1999), (Ludevid, 2000), (Tsai, 2012), (P. C. Lin & Huang, 2012), and (Spack, Board, Crighton, Kostka, & Ivory, 2012).

Source: Authors' elaboration

4.4.3. Organisational dimension identification and selection for green product innovation

Companies could strategically reconfigure the following OD: organizational behaviour, human talent management, technology, environmental social responsibility, and environmental regulation. There are several other OD that organizations might consider. However, the proposed OD are based on Gouel (2005), Nadler and Tushman, (1980), and Nadler et al., (2011), but updated in light of organizational needs to manage innovation to achieve GPI triggers to benefit environmental sustainability. Seeking to respond to the challenges currently faced by companies developing GPI, definitions and characteristics of OD are given below.

4.4.3.1. Human Resources (HR)

Firms are made up of key elements to achieve profitability. One such element is human resources which, according to Chiavenato (2009), "are beings endowed with intelligence, knowledge, abilities, personality, aspirations, and perceptions, among others" (translation of the original in Spanish on p. 9).

In the context of compliance with environmental sustainability at the corporate level, HR Management is seen as a powerful area because of its strength and contribution (Chams & García-Blandón, 2019; Pellegrini, Rizzi, & Frey, 2018) to achieving the organizational objectives. In recent times, this area has undergone several adjustments to meet firms' current needs. In the words of Kramar, (2014), "sustainable HRM could be defined as the pattern of planned or emerging HR strategies and practices intended to enable the achievement of financial, social and ecological goals while simultaneously reproducing the HR base over a long term" (p. 1084). This area also includes actions and regulations that support greening activities (Jackson, Schuler, & Jiang, 2014). According to Yong et al. (2019), researchers suggest that this new scope may facilitate the transition towards sustainability by implementing a clear structure in the different stages (integration, organization, retention, development, and audit (Chiavenato, 2009), aimed at achieving environmental sustainability. For this purpose, interconnection between organizational functions, capabilities, and the environment is needed (Kramar, 2014).

4.4.3.2. Organizational Behaviour (OB)

Attitudes that safeguard individuals, groups, and organizations, supported by culture, motivation, leadership, change, and teamwork as independent factors that influence the action (Robbins & Judge, 2009). Therefore, a large number of individuals should become involved in coordinated actions to explore and execute activities to weaken or annihilate the impacts of organizations on climate change and other environmental problems (Geiger, Swim, & Glenna, 2019). The findings of Pellegrini et al., (2018) indicate that when organizations express their commitment to and promotion of sustainability, their members orient their efforts and behaviors to achieve this goal. Therefore, through their attitudes, convictions, and motivation, all members must work in favor of GPI development.

4.4.3.3. Technology (T)

Organizations need a technological basis to achieve their strategic and operational objectives. However, it should be noted that technology is not exclusively limited to the concept of hardware (i.e., artifacts and machines) (Robledo-Velásquez, 2019), but also includes a set of information which, once organized, becomes knowledge represented in practices, experiences, skills, devices, technical methods, and systems (OECD/Eurostat, 2018; Robledo-Velásquez, 2019) that promote its application to transform functional and organizational characteristics.

Therefore, given the current environmental demands and seeking to satisfy and attract new customers, an alternative could be to propose and adopt new green knowledge and technologies in product development manufacturing (Lisi, Zhu, & Yuan, 2019). This includes appropriate knowledge in the area of technology innovation and represented in "energy-saving, pollution-prevention, waste recycling, green product designs, or corporate environmental management" (Chen, Lai, & Wen, 2006, p. 332), requiring organizational support in terms of structure and strategy (Adler & Sbenbar, 1990). Consequently, by combining technology, innovation, and organizational systemic techniques under the green philosophy, improved products could be developed to satisfy the current needs of society and the environment (Jabbour, Jugend, De Sousa Jabbour, Gunasekaran, & Latan, 2015).

4.4.3.4. Corporate Environmental Responsibility (CER)

This approach is built upon social responsibility, which refers to the actions taken by firms for the benefit of their stakeholders, represented in their economic, legal, ethical, and philanthropic commitments (Archie & Carroll, 1991). This approach also currently encompasses environmental social responsibility (Siegel, 2009), which is carried out under socially responsible strategies that seek to adequately satisfy the pressures of protecting the environment. (López-Cabarcos, Pérez-Pico, & López-Pérez, 2019) and lead to the development of green products, among other actions. Organizations must have the required capabilities to evaluate this behaviour (Siegel, 2009) based on an articulated system that provides them with adequate support.

4.4.3.5. Environmental Regulation (ER)

Compliance with environmental regulations—which have been of paramount importance for decades—is a dynamic aspect needed for GPI development. To this effect, regulations force companies to implement ecological measures that favour the creation of GPI, thereby avoiding sanctions for non-compliance (Foo, Kanapathy, Zailani, & Shaharudin, 2019). Therefore, the environmental rules serve to make organisations realise and be aware of the environmental harm they are causing (Pérez-Pérez et al., 2021). As visionaries, Porter and Linde (1995) presented their hypothesis on how firms can respond to market needs in an eco-friendly way and how complying with environmental standards can become an extraordinary competitive advantage for them.

According to Majumdar and Marcus (2001), such regulations are classified as flexible and inflexible. Flexible regulations are willingly adopted by firms, based on their motivation and level of commitment to care for the environment, resulting in product innovation and compliance with environmental obligations. Inflexible regulations, on the other hand, include manuals and exact provisions that stifle innovation but fight against pollution. According to the results of Ramanathan et al. (2017), flexible regulations favor imagination, creation, and innovation within organizations, and are also essential as they can increase competitiveness at the industry level (Porter & Linde, 1995). Hence, depending on the firms' appropriation of IC, they may be able to assimilate and respond to environmental regulations by developing transformative solutions such as, in this case, GPI development, thus impacting on their economic profit (Saenz & Atoche-Kong, 2014).

4.5. Definition of green product innovation based on green innovation capability, organisational dimension, and its determinants.

Developing GPI is an opportunity for manufacturing firms to protect the environment due to their reduced environmental impacts. This alternative also favors firms' market share and comparative and competitive advantage (Lee & Kim, 2011; Tsai, 2012). Based on these assertions, Table 7 contains a sample of definitions of a green product (GP) and GPI.

Table 7. Green product and green product innovation definitions

Authors	Green product and green product innovation definition
(Albino et al., 2009)	A 'green product' is referred to as a product designed to minimize its environmental impacts during its whole life cycle.
(Huang & Wu, 2010)	Green new product success as the ability of a green new product or innovation to compete in the marketplace.
(Dangelico & Pujari, 2010)	Green product innovation is a multi-faceted process wherein three key types of environmental focus – material, energy, and pollution – are highlighted based on their major impact on the environment at different stages of the product's physical life cycle – manufacturing process, product use, and disposal. It is important to note that not all products have a significant environmental footprint at each stage of the physical product life cycle, and nor does the footprint stem from all aspects (material, energy, and pollution). However, almost all products have a significant environmental impact in at least one of the stages.
(Lee & Kim, 2011)	Green product innovation as a multi-faceted process aimed at minimizing environmental impacts while striving to protect and enhance the natural environment by conserving energy and resources.
(Tsai, 2012)	Green products are classified into the following seven categories based on the discussion of Grave (1992), Peattie (1992), Makower et al. (1993), Simon (1971) and Chen (2001): 1. It must be environmental protection certified by the government. 2. It must use fewer raw materials or be readily recyclable. 3. It must be harmless to animal and plant life or produce less pollution. 4. It must be capable of being repeatedly used, replenished or sustainable. 5. Its operation must consume less energy. 6. It must possess a function to reduce pollution. 7. Its manufacturing process must produce less pollution.
(Zhang & Li, 2019)	Green products are the kind of products that are designed in such a way as to have the least environmental impact during their production and consumption.
(Sdrolia & Zarotiadis, 2019)	Green is a product (tangible or intangible) that minimizes its environmental impact (direct and indirect) during its whole life cycle, subject to the present technological and scientific status.
(Long & Liao, 2021)	Eco-product innovation exerts the most significant influence on sustainability because it aims to reduce resource use and pollution throughout the entire product life cycle, from product design to disposal.

Source: Authors' elaboration

This table clearly shows that there are different definitions of GPI and there is no consensus on a globally accepted one for the general concept of green products (Sdrolia & Zarotiadis, 2019). "Being an entirely new industry, the designations 'green product 'or 'environmentally conscious product' cover a wide variety of different products with their own distinct characteristics" (Tsai, 2012, p. 117). However, all the definitions seem to have the same purpose: to reduce and/or eliminate the environmental impacts generated by products that supposedly improve quality of life.

According to the systematic review of the literature in Sdrolia (2019), GPI is given different names such as "environmentally conscious product", "environmental product", "ecological product", "environmentally correct" or "environmentally sustainable product", "eco-product", "green product", or "sustainable product." Based on these definitions of GPI and the sets of identified determinants, the GIC descriptions, and the DO arguments, and for the purpose of the present paper, what follows is the proposal regarding the understanding, description, and development of a GPI:

It is understood that the scope of green product innovation could represent a corporate commitment where a product is designed, created, produced, and traded with reduced or zero pollution or using non-renewable materials and light packaging. In addition, this commitment would encourage consumers and firms to recycle and reuse it. Development could require new innovation performance directed towards reconfiguring and strengthening the seven GIC and the five OD for GPI. In addition, it requires a systemic approach that enables the orchestration of the corporate ecosystem and contributes to the generation of value, corporate profits, community satisfaction, and the environment.

4.6. Framework: taxonomy and matrix

What follows is the framework, which is made up of two elements. The taxonomy, which is where the determinants of GPI in GIC and OD are located, and the matrix, which operationalises the taxonomy.

4.6.1. Taxonomy of determinants in green innovation capability and organisational dimension

The classification of determinants in GIC and OD may mean higher organizational and managerial understanding and may help to distinguish organizational factors where the determinant intervenes and should be available to channel and achieve GPI.

Continuing with the elements showed in Table 8, first there is a list of the seven GPI and five OD, and second there is a set of twenty-two associations with the respective capabilities and dimensions, given their organizational strategic extensions aimed at establishing GPI.

For instance, determinant *A, organizational policies, mission, plans, and objectives that favour GPI development,* shown in Table 8, falls within the *green strategic planning capability* because it represents a firm's ability to formulate and define organizational environmental strategies at the strategic, tactical, and operational levels. This determinant also impacts two organizational dimensions: *human resources,* since it is the staff themselves who carry out the planning activities and implement the strategies aimed at GPI development; and *environmental corporate responsibility,* because with these factor firms' efforts are directed towards reducing and/or eliminating their negative impacts on the environment which, in turn, yields benefits for their stakeholders.

Determinant Q*, green-oriented leadership and transformative behaviour translated into corporate ethic, monitoring and identification of new opportunities, cross-functional collaboration, and motivation and incentives for the development of green product offerings,* shown in Table 8, impacts two capabilities: *green organizational innovation*, which concerns the ability established in a firm's design, management, and structure to face new environmental opportunities and bring them to the organization for their transformation; and *green organizational learning and relationship*, which refers to a firm's ability to learn about environmental sustainability, thus favouring the monitoring and identification of new opportunities and the improvement of its environmental actions.

For its part, determinant Q falls within two organizational dimensions: *organizational behaviour and human resources.* The first is related to the members of the firm's commitment, culture, and behavioural and motivational efforts oriented towards GPI development. And the second is the beings endowed with faculties and intelligence that can execute and materialize tangible actions through cross-functional collaboration, motivation, and incentives.

With the aim of testing the suitability of the taxonomy presented in Table 8, and by means of example, some of the theoretical referents used by the authors for the association of the sets of determinants within GIC and OD are presented. The concise name of the drivers in italics belong to this paper, and those in inverted commas are their similes identified in the theoretical references.

To this effect, what follows are the drivers that associated with GMC: *advertising evidence of GPI* is related to the factor "clear communication of green products and brand characteristics to reduce information asymmetry" (Dangelico & Vocalelli, 2017); *monitoring the market* is associated with "conducting environmental benchmarketing" (Dangelico, 2016); *client demand* coincides with "purchase intention" and "consumer buying decision" (Alharthey, 2019); *packing, packaging and green labelling* is related to "ecolabels and packaging as key identifiers of green products" (Dangelico & Vocalelli, 2017) and "environmentally friendly packaging and labeling green packaging" (Jasti et al., 2015).

Similarly, the determinants associated with *GOLRC* compare with the key factors found in papers that develop the topic of learning and green collaboration. To this effect, *human talent with green oriented competencies* relates to "development of a set of green competences" (De Medeiros, Ribeiro, & Cortimiglia, 2014); *institutional relations* is associated with “relationship management” and “partner selection” (Melander, 2017); *client demand* relates to “customer demand” (Melander, 2017); *complying with environmental regulations* is related with “regulations” (Melander, 2017); and *acquiring knowledge* is related to “knowledge access” (Melander, 2017).

The determinants associated with the *HR* dimension in the classification of the present paper are related to the key factors stated in papers that develop themes associated with human resources. To this effect, *human talent with green oriented competences* is associated with the determinant “employees’ competence in environmental protection” (Chang, 2016); *ecological organisational leadership* with the driver “managers in the company can fully support their employees to achieve the goals of environmental protection” (Chang, 2016); and, *corporative green commitment* with “green values” (referring to individual and organizational values oriented to managing environmental sustainability) (Chams & García-Blandón, 2019). The link between the determinants *planning strategy oriented to GPI* and *the acquisition of knowledge* and *HR* is reinforced by the affirmations “human resources play a significant role in the strategic management of the organization” (Garavan, Morley, Gunnigle, & Mcguire, 2002, p. 1) and “HRM systems supporting knowledge-intensive teamwork are associated with greater team knowledge acquisition and team knowledge sharing” (Chuang, Jackson, & Jiang, 2013) and (Jackson et al., 2014), respectively.

Consequently, below is a description of how each determinant impacts organizational capabilities and dimensions and how they are related and interconnected. The analysis was carried out with each identified determinant because each of them impacts, involves, and is linked to the organization and its functions at the environmental level. Hence, the importance of their taxonomy and grouping, allowing them to be reconfigured and properly distributed to identify specific actions aimed at GPI development. Table 8 shows the results of the taxonomy of determinants in GPI and OD.

Table 8. Taxonomy of determinants in green innovation capabilities and organisational dimensions

				Green Innovation Capabilities (GIC)							**Organizational Dimensions (OD)**				
#	Authors	Brief description	Determinant	***GSPC***	***GOIC***	***GR&DC***	***GPC***	***GOLRC***	***GRC***	***GMC***	***HR***	***OB***	***T***	***CER***	***ER***
A.	(Albino et al., 2009), (Janine Fleth De Medeiros et al., 2018), (Leonidou et al., 2013), (Alharthey, 2019), (Dangelico, 2017), (Dangelico, 2016), (Lin & Huang, 2012), (Huang, Yang, & Wong, 2016), (Naga Vamsi Krishna Jasti et al., 2015), (Ilg, 2019), (Dangelico & Pujari, 2010), and (Melander, 2017).	*Formulation and implementation of short-, medium- and long-term policies, mission, programmes, strategies, and organizational objectives, aims and goals in procuring GPI.*	*Planning oriented at GPI*	*GSPC*							*HR*			*CER*	
B.	(Huang & Wu, 2010), (Wee & Quazi, 2005), (El-Kassar & Singh, 2019), (Dangelico, 2017), (Melander, 2017), and (Tariq et al., 2017).	*Philosophies, organizational commitment, identity, culture, and corporate environmental ethic leading to environmental management practices.*	*Corporate green commitment*	*GSPC*	*GOIC*						*HR*	*OB*		*CER*	
C.	(Albino et al., 2009), (Jasti et al., 2015), (Lee & Kim, 2011), and (Tsai, 2012).	*Planning, design, development, and control of green processes and products.*	*Design of green processes and products*	*GSPC*		*GR&DC*	*GPC*		*GRC*				*T*	*CER*	*ER*
D.	(Dangelico & Pujari, 2010), (Chung & Wee, 2010), (Lee & Kim, 2011), (Tsai, 2012), (Wee & Quazi, 2005), (Chan et al., 2013), (Jasti et al., 2015), (Dangelico, 2017), and (Oliveira, Tan, & Guedes, 2018)	*Organisational management in the supply chain, administrative and structural support in procuring the generation and adoption of green innovation, facilitating compliance with environmental regulations and social responsibility.*	*Organisational management directed at green innovation*		*GOIC*		*GPC*	*GOLRC*		*GMC*		*OB*		*CER*	*ER*

E.	(Huang et al., 2016), (Jasti et al., 2015), and (Tariq et al., 2017).	*Development and implementation of a certified environmental management system.*	*Environmental management system*	*GSPC*	*GOIC*		GPC		GRC				T	*CER*	*ER*
F.	(Albino et al., 2009), (Dangelico & Pujari, 2010), (Chung & Wee, 2010), (Tsai, 2012), (Tariq, Badir, & Chonglerttham, 2019), (Zhang & Li, 2019), (Jabbour et al., 2015), (Berchicci & Bodewes, 2005), (Tsai, 2012), (Tariq et al., 2019), (Song et al., 2018), (Chen & Chang, 2013), and (Jabbour et al., 2015).	*Manufacturing under the incorporation of practices for improving production and optimising processes, and for incorporating environmental attributes such as recyclable material, the use of eco efficient and less toxic material, the reuse and remanufacture of raw materials, using less quantity of resources, and/or eliminating contamination in procuring GPI.*	*Manufacturing under the incorporation of environmental practices and attributes*			*GR&DC*	*GPC*		*GRC*				*T*	*CER*	*ER*
G.	(Tsai, 2012), (Leonidou et al., 2013), (Dost, Pahi, Magsi, & Umrani, 2019), (Tariq et al., 2019), (De Medeiros et al., 2018), (Dangelico, 2017), (Berchicci & Bodewes, 2005), (Tariq et al., 2017), and (Chen & Chang, 2013).	*Development and use of green techniques and technologies that prevent pollution for the creation, manufacturing, distribution, and end-of-life of green new products.*	*Development of environmental technologies*		*GOIC*	*GR&DC*	*GPC*						*T*	*CER*	*ER*
H.	(Dangelico & Pujari, 2010), (Cheung & To, 2019), (Alharthey, 2019), (ShabbirHusain & Varshney, 2019), (Spack et al., 2012), and (Tan et al., 2019).	*Credible advertising on communication platforms, showing the characteristic and environmental benefits of the green products offered by the firm.*	*Evidential advertising of GPI*		*GOIC*			*GOLRC*		*GMC*			*T*		
I.	(Spack et al., 2012), (Leonidou et al., 2013), (Tan et al., 2019), (Chan et al., 2013), (Tariq et al.,	*Lighter, cleaner, and more environmentally friendly product*	*Packing, packaging, and green labelling*			*GR&DC*	*GPC*		*GRC*	*GMC*			*T*	*CER*	*ER*

	2019), (Zhang & Li, 2019), and (Alharthey, 2019).	*packaging that can be recycled or reused and/or can easily decompose.*													
J.	(Lin & Huang, 2012), (Tsai, 2012), (Leonidou et al., 2013), (Tan et al., 2019), (Yogananda & Nair, 2019), (Melander, 2017), (Alharthey, 2019), (Melander, 2018), (De Medeiros et al., 2014), (De Medeiros et al., 2018), (Tariq et al., 2017), and (Cheung & To, 2019).	*The demands and preferences of clients and consumers in terms of protecting the environment must be present and be complied with throughout the design, manufacturing, and distribution stages.*	*Customer demand*	*GSPC*		*GR&DC*	*GPC*	*GOLRC*		*GMC*				*CER*	ER
K.	(De Medeiros et al., 2018)	*Market monitoring after product launch to assess consumers' satisfaction.*	*Monitoring the market*							*GMC*	*HR*		*T*		
L.	(Huang & Wu, 2010), (Tsai, 2012), (Chen & Chang, 2013), (De Medeiros et al., 2018), (Tariq et al., 2017), (Berchicci & Bodewes, 2005), (Dangelico, 2016), (Dost et al., 2019), (Wee & Quazi, 2005), (Chan et al., 2013), and (Dangelico & Pujari, 2010).	*R&D directed at green product innovation under the generation and implementation of original, novel, useful ideas in the whole of the product lifestyle.*	*R&D directed at GPI*		*GOIC*	*GR&DC*	*GPC*	*GOLRC*				*OB*	*T*		*ER*
M.	(Albino et al., 2009), (Dangelico & Pujari, 2010), (Chung & Wee, 2010), (Chan et al., 2013), (Tariq et al., 2019), and (Zhang & Li, 2019).	*Intelligent use of resources represented in the implementation of eco efficient materials, reuse, remanufacturing, and the recycling of raw materials and consumables, impacting on the reduction of costs and facilitating the creation of GPI.*	*Intelligent use of resources*	*GSPC*			*GPC*		*GRC*		*HR*	*OB*	*T*	*CER*	*ER*

N.	(Wee & Quazi, 2005), (Chan et al., 2013), (De Medeiros et al., 2018), (De Medeiros et al., 2018), (Song et al., 2018), (Huang et al., 2016), (Chen & Chang, 2013), (Melander, 2017), and (Berchicci & Bodewes, 2005).	*Investment of resources to comply with social responsibility and environmental regulations. Investment in laboratories, in R&D, in cleaner technologies, in ecological modernization, in improvements in production systems, in infrastructure, in qualified human resources, in knowledge, in relationships, and in collective learning, aimed at supporting GPI.*	*Investment in resources directed at green product development*	*GSPC*					*GRC*					*CER*	*ER*
O.	(Lee & Kim, 2011), (Chkanikova, 2016), (Ilg, 2019), (Melander, 2018), (Dangelico, 2016), (Melander, 2017), (Dangelico, 2017), (De Medeiros et al., 2014), and (Tariq et al., 2017).	*Collaborative and communication relationships with suppliers, customers, consumers, environmental groups, universities, research institutions, and firms, among others, for the supply and use of environmentally friendly materials and the design of initiatives and developments in terms of research, innovation, technology transfer, and cleaner products and processes.*	*Institutional relations*		*GOIC*	*GR&DC*		*GOLRC*			*HR*	*OB*	*T*		
P.	(El-Kassar & Singh, 2019), (Ilg, 2019), (ShabbirHusain & Varshney, 2019), (Oliveira et al., 2018), (Melander, 2018), (De Medeiros et al., 2018), (Dangelico, 2017), (Dangelico, 2016), (Huang et al., 2016), (Melander, 2017), (De Medeiros et al., 2014), (Tariq et al., 2017), (Lee & Kim, 2011), and (Wee & Quazi, 2005).	*Response capacity and knowledge acquisition, dissemination, and exchange between employees and stakeholders, reflected in the elimination of cultural barriers, quality, best environmental practices, and new materials, technologies, and resources to favor GPI.*	*Acquiring knowledge*		*GOIC*	*GR&DC*		*GOLRC*			*HR*	*OB*	*T*		

Q.	(De Medeiros et al., 2018), (De Medeiros et al., 2018), (Dangelico, 2017), (Huang et al., 2016), (Chen & Chang, 2013), (De Medeiros et al., 2014), and (Tariq et al., 2017).	*Green-oriented leadership and transformative behaviour translated into corporate ethic, monitoring and identification of new opportunities, cross-functional collaboration, and motivation and incentives for the development of green product offerings.*	*Ecological organizational leadership*		*GOIC*			*GOLRC*			*HR*	*OB*			
R.	(Wee & Quazi, 2005), (El-Kassar & Singh, 2019), (De Medeiros et al., 2018), (De Medeiros et al., 2014), (Tariq et al., 2017), (Chen & Chang, 2013), (Melander, 2017), (Chang, 2016), (Song et al., 2018), (Melander, 2018), and (Huang et al., 2016).	*Human resources with extensive knowledge on environmental sustainability to promote the creation and alignment of teams and cross-functional procedures and their communication for GPI development.*	*Human talent with competences towards GPI*		*GOIC*			*GOLRC*			*HR*	*OB*			
S.	(Albino et al., 2009), (Huang & Wu, 2010), (Dangelico & Pujari, 2010), (El-Kassar & Singh, 2019), (Song et al., 2018), (ShabbirHusain & Varshney, 2019), (Chen & Chang, 2013), (Jasti et al., 2015), (Tariq et al., 2017), (Chang, 2016), and (Chung & Wee, 2010).	*Corporate social responsibility as a philosophy, an ethical act, and an environmental commitment that provides a sense of identity and allows firms to adapt to achieve their green objectives.*	*Environmental responsibility*	*GSPC*	*GOIC*							*OB*		*CER*	
T.	(Huang & Wu, 2010), (Dangelico & Pujari, 2010), (Tsai, 2012), (Chan et al., 2013), (Melander, 2018), and (Huang et al., 2016).	*Assessment practices, such as emission measurement, auditing, and environmental offset incentives at each stage of the product's life cycle.*	*Environmental auditing*		*GOIC*		*GPC*						*T*	*CER*	*ER*
U.	(Dangelico & Pujari, 2010), (Chung & Wee, 2010), (Zhang & Li, 2019), (Berchicci & Bodewes,	*Organizational responsibility from the product's design until the end of its life cycle, through the incorporation of*	*Responsibility throughout the life cycle of the product*		*GOIC*	*GR&DC*	*GPC*			*GMC*		*OB*		*CER*	

	2005), and (Leonidou et al., 2013).	*environmental attributes for GPI development.*													
V.	(Dangelico & Pujari, 2010), (Lee & Kim, 2011), (Tsai, 2012), (Chan et al., 2013), (Song et al., 2018), (De Medeiros et al., 2018), (Dangelico, 2017), (Dangelico, 2016), (Melander, 2017), (Tariq et al., 2017), and (De Medeiros et al., 2014).	*Awareness, identification, and compliance with environmental policies, laws, and regulations to favour the creation of green products.*	*Compliance with environmental regulations*		*GOIC*			*GOLRC*				*OB*			*ER*

Source: Authors' elaboration

4.6.2. Operationalisation matrix of the green innovation capability, organisational dimension and determinants

Taking as a reference the previous works of Robledo-Velásquez, (2020), Robledo-Velásquez et al. (2011), and Serrano-García and Robledo-Velásquez (2013a), and summarizing the results of the taxonomy of determinants in GIC and OD postulated in Table 9, a matrix was then proposed through which the taxonomy was operationalized, illustrating the interrelation between GIC, OD and the sets of the determinants presented in Table 9. The rows and columns represent GIC and OD, respectively, and show the location of each determinant within the intersection of GIC and OD, including the one it is related to, thus facilitating an eventual organizational performance that contributes to the determinants and fosters GPI development.

Table 9. Matrix of the determinants driving green product innovation development

Matrix of the determinants driving GPI development		**Organizational dimensions for GPI**				
		Human Resources (HR)	**Organizational Behaviour (OB)**	**Technology (T)**	**Corporate Environmental Responsibility (CER)**	**Environmental Regulation (ER)**
Green Innovation Capabilities (GIC)	Green Strategic Planning Capability (GSPC)	*[A, B, M]*	*[B, S]*	*[C, E, M]*	*[A, B, C, E, J, M, N, S]*	*[E, J, M, N]*
	Green Organizational Innovation Capability (GOIC)	*[B, O, P, Q, R]*	*[B, D, L, O, P, Q, R, U, S, U, V]*	*[E, G, H, L, O, P, T]*	*[B, D, E, G, S, T, U]*	*[C, D, E, G, L, T, V]*
	Green R&D Capacity (GR&DC)	*[O, P]*	*[L, O, P, U]*	*[C, F, G, I, L, O, P]*	*[C, F, G, I, J, U]*	*[C, F, G, I, J, L]*
	Green Production Capability (GPC)	*[M]*	*[D, L, U]*	*[C, E, F, G, I, L, M, T]*	*[C, D, E, F, G, I, J, M, T, U]*	*[C, D, E, F, G, I, J, L, M, T]*
	Green Organizational learning and relationship capability (GOLRC)	*[O, P, Q, R]*	*[D, L, O, P, Q, R]*	*[H, L, O, P]*	*[D]*	*[D, L]*
	Green Resources Capability (GRC)	*[M]*	*[M]*	*[C, E, F, I, M]*	*[C, E, F, I, M, N]*	*[C, E, F, I, M, N]*
	Green Marketing Capability (GMC)	*[K]*	*[D]*	*[H, I, K]*	*[D, I, J]*	*[D ,I, J]*

Source: Authors' elaboration

This matrix shows how the determinants involve a capability, a dimension, or different combinations of these within the organization. It evidences that the whole organization must work together in permanent interrelationship between its parts and using different abilities to achieve an adequate application of the determinants leading to

GPI. Accordingly, this matrix would favor the assessment of GPI development via a coherent definition of the variables representing the determinants which, in turn, would fulfill both GIC and OD.

In theory, firms should achieve all the determinants of GPI. However, making progress in each of them would allow them to gradually ascend the different levels and, at some point, fully develop GPI. Based on the proposed classification and grouping, it could be said that what is needed to comply with the determinants is a GIC strategic approach, together with green-oriented OD, since this provides the organization with support. This could lead to the commercial transformation and exploitation of firms by capturing and delivering value through GPI development. This, in turn, would encourage a context in which the organization is examined as an integral system that favors reciprocal connection and complementarity between the organization, the capabilities, the dimensions, and the determinants, thus boosting GPI development to have a positive impact on its economic, social, and environmental performance.

4.7. Discussion

The objective of this study was to identify the determinants and their configuration within GIC and OD for GPI development. Therefore, it moves towards the unification of the constituent elements of GPI, providing twenty-two sets of determinants and evincing a series of characteristics that specifically show the environmental factor being fostered by turning it into an organizational challenge. This is important because it enables the identification of which situation-capability-area each set of determinants is affecting at the organizational level to favor its interpretation and the performance/behavior placement being considered within the organization. Similarly, useful basic data are provided for future research to move forward in pursuit of improving the determinants needed in GPI configuration. Additionally, this study may serve as a starting point for the implementation of other frameworks in fields such as administration, innovation, and technology management under a green approach.

Furthermore, manufacturing companies currently need to update their capabilities to promote the achievement of GPI to continue acquiring competitiveness in the market (Salim, Rahman, Wahab, & Muhamed, 2020). At the same time, dynamic capabilities (DC) are necessary to favour innovation and allow companies to constantly evolve, facilitating their adaptation to environmental demands. To this effect, DC play a moderating role, intervening to create facilitate the creation of ecological product innovation (Long & Liao, 2021). Therefore, the present work considers the structure of DC, which relate properties that generate innovation such as the dynamism and evolution accomplished by means if IC.

The above explains the fact that the concepts and generalities of the seven IC are widely used nowadays to develop and define specific characteristics in each of these capabilities to provide a solution to CPI. Nonetheless, the descriptors of these seven IC in relation to the concept of GPI are unknown. Thus, one of the contributions of this paper is that it finds and connects these specific and unique elements, defining each of these already established capabilities but relocated to the green context which, to the best of the authors' knowledge and belief, has not been postulated and unified by any other author. More specifically, this study shows how the seven proposed GIC agree with key organizational abilities, which could jointly favor innovation management to respond to the green challenge. Furthermore, the form and scope of each GIC at the administrative and green technical levels are clearly described for easy understanding and application within the organization.

Moreover, this research proposes five OD that are part of an extension towards the green approach. Following Nadler et al. (2011) and Gouel (2005), the *formal organization* dimension is represented, in this study, in the *corporate environmental responsibility and environmental regulation* dimension, given that these two latter aspects correspond to organizational agreements subject to coordination and control to ensure they are complied with. The *informal organization* dimension is represented in the *organizational behaviour* dimension since it appears spontaneously but affects the behaviour and results of the firm in terms of sustainability. The *human talent* dimension comprises the individuals performing work activities, whose knowledge, abilities, expectations, and motivations regarding the environment must be considered. Last, the *technology* dimension is represented in the pooling of knowledge facilitating the creation of green products.

Regarding the understanding, definition and development of a GPI, we identified that to be classified as a green product it must have certain ecological, technical and organizational characteristics that make it different from a conventional innovative product. However, considering the findings of this paper, what is required to achieve GPI is a systemic orientation of the organization as the facilitating entity, supported by administrative pillars such as GIC and OD which, according to the set of determinants, could favor GPI configuration.

It is clear how the sets of determinants relate to the proposed GIC and OD, with their groupings and interconnections in terms of how each of them affects, involves, and relates to the organization and its role in the environmental field illustrated, thus facilitating the integrity and consistency of the determinants. Hence, the importance of their classification and grouping within GIC and OD, as this implies a better understanding for the organization and managers. The taxonomy proposed has practical value in terms of the identification of the existing relations between the GIC, DO and the determinants, to produce a global vision of the factors required for organizational reconfiguration towards GPI development.

Having shaped the taxonomy, the matrix that operationalized GIC, DO and the determinants was created, seeking to make the interrelations and interdependencies more evident and easily understandable. This will allow the corresponding variables to be selected and controlled in the future to measure and assess the aforementioned association in terms of innovation management oriented towards GPI development.

Therefore, the matrix was developed as a systemic tool, given that it illustrates the interrelation between GIC, DO and the determinants within the organisation. It is also dynamic because it can be adapted to the different variants and environments in which the company may find itself and it allows the variables to be updated and modified to reach a diagnosis that enables the strategy and the actions needed to procure achieving GPI to be defined. The matrix has been proposed from a general perspective of the organisation and based on the determinants identified. However, faced with specific conditions, the matrix can evolve to adapt to each problem and organizational dynamic. Consequently, the development and updating of the matrix will allow firms to move up through the different organizational levels, leading them at some point to the full configuration of GPI.

A series of frameworks based on determinants for facing GPI at the organizational level have been proposed in several research articles. Dangelico (2016) suggests a success factor framework for GPI development that includes four capabilities: external integrative, technological, internal integrative, and marketing. For his part, Melander (2018) combines the frameworks proposed by Dangelico (2016) and Melander (2017) under internal and external capabilities and focuses on firm collaboration in the lengthening of the supply chain with suppliers and clients for GPI development. Although there are groupings of determinants based on capabilities in these proposals, there was still need for a specific, holistic, and strategic approach capable of containing most of the determinants of GPI leading to organizational functions.

Tariq et al. (2017) propose a framework based on the identification of drivers (factors) and consequences (performance) for ecological processes and products. This interrelation is carried out from the identification of measuring and moderating variables, within which the framework resorts to linking certain capabilities and thematic organizational approaches. However, these authors call for the structuring of organizational factors using DC to advance in responding to the environmental challenges.

Berchicci & Bodewes (2005) present a framework that includes three organizational aspects: design specifications, coordination and alignment within teams, and project management support. This framework considers the lack of specificity, for instance the required research and development approach to contribute to determinants such as clean processes and technologies, and organizational learning, evidencing the need for knowledge regarding environmental sustainability and strategic planning linked to greening at the organizational level, among other necessary factors for the determinants of GPI.

Jasti et al. (2015) identify principles, tools, and techniques to develop green products. Their study includes up to 80 similar elements that are then grouped in eleven strategic organizational factors. However, no GIC and OD are considered which, according to our grouping and taxonomy, must be considered to support the determinants of GPI. Moreover, capabilities such as research and development, resource management, and organizational learning are not considered, and neither are dimensions such as human talent management, organizational behaviour, social responsibility, and environmental regulation.

The main focus of the study conducted by De Medeiros et al. (2018) is the planning, operation, and marketing of green product development. Nevertheless, aspects such as human talent management, organizational behavior, social responsibility, research and development, and organizational learning and relationships aimed at GPI are not considered in their proposal.

Ilg (2019) proposes an analytical framework in the form of a virtuous circle for the development of ecological materials and products in the construction industry, thus fostering ecological innovation by considering suitable organizational approaches. However, neither the GIC concept nor research and development capability, which contributes to research on new technologies in the construction field, are considered in these frameworks.

Considering the above, there is no conceptual scenario shown that displays how the determinants are organized under an integral approach, supported by the seven proposed GIC and the structuring of the five identified OD, to respond to the transformation of processes that favour innovation management oriented towards the green approach. To the best of the authors' knowledge and belief, this is the first research that postulates the articulation of GIC and OD to favour innovation management and its corresponding extension to GPI. Additionally, the authors would like to highlight that despite the number of proposed and related GIC and OD, they were brought about under the scrutiny of the identification, grouping, and taxonomy classification of the required determinants in pursuit of GPI.

The proposed framework, made up of the taxonomy and the matrix, considers the organization to be an interrelated system in which the proposed foundations adjust, mutually support, and continuously coordinate to achieve the innovation management objectives, according to the planned strategies (Nadler & Tushman, 1998). This framework provides a structural relation of the organizational elements, allowing the strategies, functions, and actions to be redirected to strengthen technological innovation management in pursuit of GPI creation and development. Therefore, the proposal to organizations to be able to reconfigure themselves to achieve GPI presented in this paper is the association of the determinants of GPI with GIC and OD, structured in the taxonomy and operationalized in the matrix, based on innovation management.

By way of analogy, and to visualize the proposal presented in this paper in a holistic and general way, the authors envisage the framework located in the organization as a tree, under which the structural relationship to achieve GPI is interpreted. The roots represent GIC, whose function is to absorb the nutrients to ensure its growth. Meanwhile, these roots connect to the trunk and the branches representing the five OD as a fundamental component, which themselves project out in a way that maximises the absorption of energy through the leaves, symbolising the determinants and, at the same time, satisfying the needs of the fruit, which represents the creation of GPI. In this analogy, the fruit depends on the leaves and the branches, and the branches strongly depend on the health of the tree trunk and the solid structural base provided by the roots. Similarly, given that the seven proposed GIC and five OD that make up the organizational reconfiguration make it easier for firms to adapt, the consistency and integrity of the determinants leading to GPI development are also facilitated.

4.8. Conclusions

Nowadays, firms have a tremendous opportunity to be competitive if they become involved in GPI. However, to do so, they need to change and reconfigure themselves based on certain organizational skills and dimensions that would then serve as the foundations for the determinants required for GPI development.

This paper proposes the extension and adjustment of seven GIC to create and develop green products based on the new demands of the environment. These GIC were carefully selected and arranged to guide firms to reconfigure themselves and optimize their environmental actions. Moreover, the proposed OD are regarded as constitutive and support elements associated with organizational changes, adaptation, and revitalization from an environmental perspective. Hence, GIC and OD together are factors that could shape a set of organizational adjustments required for firms to address their current responsibility in terms of developing green products.

Furthermore, after gathering and analyzing previous studies in the field, strategic determinants that influence the development and implementation of GPI were identified and thoroughly classified. These determinants refer to the attributes that firms should consider when they decide to address the challenge of GPI. In addition, they are factors that require a solid base at the organizational level, leading us to identify their required connection and association with the proposed GIC and OD.

Therefore, another outcome of this research is the classification and strategic association of the determinants of GPI within the different GIC and OD, showing how they relate to each other and facilitating the identification of actions inherent to innovation management to help organizations to face and address their needs in terms of GPI. Likewise, a matrix is established, which allows organizations to assess and monitor their progress in GPI management.

The proposed framework combines typical and necessary organizational factors. It could be seen as a roadmap for firms to understand their organizational redesign when they are adapting and being revitalized based on the scenarios, interdisciplinarity, and eventualities of the current context in terms of environmental sustainability. This framework fosters links in the evolution of the organization, supported by GIC and OD, which are represented in the innovative and technological transforming processes and abilities to meet the requirements of the determinants and to finally deliver a GPI.

In general, this framework regards organizations as open systems of interconnected parts that facilitate their constant adaptation to boost GPI development. Therefore, the proposed framework could become a tool for the transition and/or transformation of firms towards the development of environmentally friendly products from the innovative perspective of their new organizational commitment.

This study aims to contribute to the advancement in the organizational and technological innovation management theories towards GPI consolidation, as well as to the research on the structuring of environmental sustainability at the organizational level. It is especially intended for researchers, managers in the manufacturing sector, and government bodies interested in environmental sustainability, proposing a holistic and systematic approach that redefines the boundaries of opportunities for new competence and performance. Various studies have found all these aspects to be missing and necessary (Dangelico et al., 2016; Engert et al., 2016; Leih et al., 2015; Shevchenko et al., 2016; Teece, 2018a).

4.8.1. Limitations and future work

A series of limitations that can also be opportunities for further research were identified, the purpose of which is to encourage creativity in the debate and discussion generated by our work. The first is that we did not consider other organizational and technology management lines of theory that could also favour the strengthening and development of GPI. Second, future research should study each GIC separately in combination with each OD to favour GPI development, as well as design a conceptual framework from other perspectives and under different grouping and correlation criteria. Third, given that this work mainly focused on theoretical and conceptual aspects, it is recommended that further research converts the sets of determinants into variables that can be implemented and controlled by firms. Fourth, the framework developed could be applied in studies whose aim is to study the environments and the varied conditions in which the company can find itself, to ensure the advance towards the constitution of GPI. Fifth, one aspect to consider from the basis created is the development of future empirical research to analyze its validity and reliability in real settings, and to identify possible configurations and impacts on organizational performance.

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Conflicts of interest

The authors declare no conflict of interest.

Capítulo 5. Capabilities and organisational dimensions conducive to green product innovation: evidence from Croatian and Spanish manufacturing firms

Jakeline Serrano-García[a,b][2], **Andrea Bikfalvi**[c] **Josep Llach**[c,d], **and Juan José Arbeláez-Toro**[e,f]

[a]Universitat Politècnica de València, Valencia - Spain

[b]Faculty of Economic and Administrative Sciences, Instituto Tecnológico Metropolitano, Medellín - Colombia

[c]Department of Business Administration and Product Design, Universitat de Girona, Girona – Spain

[d]School of Management, Universitat Pompeu Fabra, Barcelona - Spain

[e]AMADE, Polytechnic School, Universitat de Girona, Girona – Spain

[f]Faculty of Engineering, Instituto Tecnológico Metropolitano, Medellín - Colombia

Abstract

This paper aims to determine which configuration of green innovation capabilities (GICs) and organisational dimensions (ODs) leads to achieving green product innovation (GPI). We used data collected through the European Manufacturing Survey (EMS) from manufacturing firms in Spain and Croatia considered to be innovators. After conducting a cluster analysis, we identified a group of firms that still develop conventional product innovations (CPIs) and three groups of firms at different stages of GPI development. The four clusters were characterised using different variables, or determinants of GPI, associated with seven GICs and five ODs that favour GPI. According to the findings, all the GICs and ODs under analysis have a positive impact on GPI development, which results in the consolidation of a framework that organisations could use to manage green

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[2]Corresponding author. Faculty of Economic and Administrative Sciences, Instituto Tecnológico Metropolitano, Cl. 54a #30-01, Medellín - Colombia; Department of Business Administration and Product Design, Universitat de Girona, Montilivi campus s/n, 17073. E-mail addresses: jakelineserrano@itm.educo - jserrano2005@gmail.com (J. Serrano), andrea.bikfalvi@udg.edu (A. Bikfalvi), josep.llach@udg.edu - josep.llach@bsm.upf.edu (J. Llach), juanarbelaez@itm.edu.co - jjarbetoro@gmail.com (J. Arbeláez)

Abbreviations: AMT-PROD additive manufacturing technologies for mass production; AUTOMAT control-automation systems for an energy efficient production; CER Corporate Environmental Responsibility; CERT-ENER certified energy management system (EN ISO 50001, previously EN 16001); CPIs conventional products innovation; DCs dynamic capabilities; EMS European Manufacturing Survey; ER Environmental Regulations; GICs Green Innovation Capabilities; GMC Green Marketing Capability; GOIC Green Organisational Innovation Capability; GOLRC Green Organisational Learning and Relationship Capability; GPC Green Production Capability; GPIs Green Product Innovations; GR&DC Green Research and Development Capability; GRMC Green Resource Management Capability; GSPC Green Strategic Planning Capability; HR Human Resources; IMP S-E impact and performance measurements of social and environmental corporate activities; INFORMAT use information gathered to develop or adapt current products, services or processes; INS-LIFECY instruments of life-cycle assessment (e.g., EU Ecolabel, C2C, ISO 14020); IT-TRAINING IT-based self-study programs (e-learning) for continuous training and evaluation of production employees; LINES customer- or product-oriented lines/cells in the factory; LOGISTIC practices to improve internal logistics (e.g., method of value stream mapping/design, changes in the spatial arrangement of the production chain); MACHINE upgrading existing machinery or equipment (e.g., premium efficient motors [IE3], attach insulation, recuperators); NRBV Natural Resource-Based View; OB Organisational Behaviour; ODs Organisational Dimensions; PLAN software for production planning and scheduling (e.g., ERP system); PLM product lifecycle management system (PLM) or product/process data management; R&D-COOPR&D cooperation with customers or suppliers; RBT Resource-Based Theory; SENSORS sensors or control elements for machines or components to allow delivery of remote services; SKILLS-PROG specific programs of competence development; TASK integration of tasks (planning, operating or controlling functions with the machine operator); VISUAL visual management (display board in production for work processes and work status); WORK Method of 5S ("workplace appearance and cleanliness").

innovation. By empirically showing the relevance of applying these constructs, this study makes contributions to the Resource-Based Theory (RBT), along with its extension to GICs, and points to the need to associate them with the ODs to achieve GPI towards the challenge of sustainable development.

Keywords

Determinants; green innovation capabilities; green product innovation; manufacturing firms; organisational dimensions; sustainable development

5.1. Introduction

The current environmental issues, which call for greater environmental awareness, have become one of the most pressing challenges faced by governments, institutions, and individuals. Firms, in particular, have had to re-evaluate their organisational strategies to lessen their negative environmental impact. A possible solution to this problem for manufacturing firms could be the development of green product innovations (GPIs) (Salim et al., 2021; Shahzad et al., 2021). These products seem to be key to achieve comparative and competitive advantages because they not only provide economic benefits but they also help to preserve natural resources for future generations (Pérez-Pérez, Serrano-García, & Arbeláez-Toro, 2020; Salim et al., 2021). In addition, GPIs could please socially-conscious consumers (Sana, 2020) while also serving as a stimulus for businesses, which could receive incentives such as direct subsidies and tax credits for their development (Long & Liao, 2021).

Many organisations, however, have not yet decided to develop GPI for several reasons: (i) ecological innovation is only considered after core business problems are addressed (Yin, Zhang, & Li, 2020); (ii) firms feel overwhelmed by the imposed environmental regulations, which limits their willingness to voluntarily participate in ecological activities (Collins, Lawrence, Pavlovich, & Ryan, 2007); (iii) small businesses believe that their contribution to the green economy is insignificant (Mellett et al., 2018); (iv) there is insufficient knowledge about why and how firms could foster corporate environmental sustainability to pursue GPI (Dangelico & Pujari, 2010); and (v) green innovation demands corporate commitment and the implementation of environmental policies and strategic guidelines to materialise ideas for green products (Dangelico & Pujari, 2010).

GPIs require certain determinants for their design, materialisation, production, distribution, and disposal, making them different from conventional product innovations (CPIs) (Chkanikova, 2016; De Medeiros et al., 2018; Jasti et al., 2015). Despite the substantial progress made in defining the determinants of GPI, their configuration at the organisational level is considered difficult (Jasti et al., 2015; Tariq et al., 2017) because they affect several organisational functions. Therefore, these determinants must be backed by organisational elements that enable innovation to be managed in a way that results in GPI (Serrano-García, Bikfalvi, Llach, & Arbeláez-Toro, 2021).

Various authors have studied how the determinants of GPI can be configured at the organisational level from a variety of research topics such as corporate environmental management (Wee & Quazi, 2005); environmental strategies and green product development (Albino et al., 2009); firms' motivations, environmental policies, goals, and challenges in developing and marketing GPI (Dangelico & Pujari, 2010); management of interorganisational relationships aimed at supplying materials for green products (Cheung & To, 2019); and reference models to develop green products at the corporate level (Berchicci & Bodewes, 2005; Ilg, 2019; Jasti et al., 2015; Tariq et al., 2017). Likewise, several theories have been used for this configuration, including organisational identity (Song et al., 2018), consumption values (Lin & Huang, 2012), the institutional theory (Zhang et al., 2020), stakeholder involvement (Zhao, Feng, & Shi, 2018), the contingency theory (Saengchai, Rodboonsong, & Jermsittiparsert, 2019), and the resource-based theory (RBT) using green capabilities (Aboelmaged & Hashem, 2019; Albort-Morant et al., 2016; Chen & Chang, 2013; Salim, Ab Rahman, & Abd Wahab, 2019). The RBT is well-known for its potential to support firms in developing green products (Tariq et al., 2017). However, there are still few theoretical and empirical studies on resource management and the use of capabilities oriented toward green innovation (Aboelmaged & Hashem, 2019; Qiu et al., 2020; Salim et al., 2019; Sirmon, Hitt, Ireland, & Gilbert, 2011; Tariq et al., 2017; Teece, 2018a).

Moreover, further research is needed on how organisations must restructure themselves to meet the challenge of sustainability and how the necessary adjustments can be made (Millar et al., 2012). In addition, more studies need to be developed to determine how firms' capabilities and the orchestration of organisational assets are the basis for efficiently managing various environmental challenges and implementing environmental sustainability plans at the corporate level (Annunziata, Pucci, Frey, & Zanni, 2018; Dangelico et al., 2016; Serrano-García et al., 2021; Sirmon et al., 2011). From the perspective of organisational management, much uncertainty still exists about how environmental protection or going green might become a core competence (Yusr et al., 2020). Furthermore, most analyses based on the Natural Resource-Based View (NRBV) theory have found gaps in empirical studies focused on product stewardship (Hart & Dowell, 2011), which refers to "practices that reduce environmental risks or problems resulting from the design, manufacturing, distribution, use, or disposal of products" (Berry & Rondinelli, 1998, p. 44)..

Therefore, GPI, which causes changes at the organisational level (Berchicci & Bodewes, 2005; Dugoua & Dumas, 2021), could be supported by the incorporation of differential green innovation capabilities (GICs) (Serrano-García et al., 2021), which are based on the RBT (Barney, 1991; Barney, Ketchen, & Wright, 2011), the NRBV (Hart, 1995), the dynamic capabilities (DCs) (Leih et al., 2015; Teece, 2007; Teece et al., 1997), and the innovation capabilities (ICs[3]) (Tariq, Badir, Safdar, Tariq, & Badar, 2020). Nevertheless, having GICs is not enough for firms to achieve a competitive advantage; they also need a variety of assets—or organisational dimensions (ODs)—

[3] Although, in the literature, "ICs" and "TICs" are frequently employed to refer to a similar set of capabilities, we consider them equivalent terms here. However, "ICs" will be mostly used to allude to innovation capabilities, in accordance with the terminology defined in the Oslo Manual 2018 (OECD/Eurostat, 2018).

(e.g., people and their knowledge, processes and procedures, strategies, environmental regulations, corporate environmental responsibility, a structure, and an organisational behaviour) to develop and deploy their technological capabilities (Adler & Sbenbar, 1990; David Nadler et al., 2011; Serrano-García et al., 2021; Sirmon et al., 2011; Teece, 2018a). Furthermore, within the ODs favouring innovation, the relevance of resources and capabilities must be acknowledged (Bogers, Sund, & Villarroel, 2015). A firm's environmental strategy and competitive advantage would therefore depend on how GPI is handled at the organisational level through the innovative management of its determinants, as well as on how the organisational capabilities and dimensions are intertwined to construct and achieve the organisation's strategic goals (Adler & Sbenbar, 1990; Leih et al., 2015; Serrano-García et al., 2021; Teece, 2018a; Tushman & Nadler, 1986).

All the above points to the need for more research and empirical validation on how to configure the GICs and the ODs so that they are integrated at the organisational level and recognised for their potential to support the determinants conducive to GPI. In the study by Serrano-García et al. (2021), this aspect is also outlined as future work. Based on the identified descriptions and difficulties, the purpose of this study is to analyse which GICs–ODs configuration leads to achieving GPI. The contribution of this research, therefore, is the practical and experimental orchestration of a complex structural relation between GICs, ODs and GPI to serve as a framework of reference for the management of green innovation in achieving sustainable development.

The rest of this paper is structured as follows. Section 2 provides a theoretical background on the matter. Section 3 describes the methodology we implemented. Section 4 presents the results. Section 5 discusses the findings. Last, Section 6 draws the conclusions and outlines the limitations and future lines of research.

5.2. Theoretical background and literature review

5.2.1. Literature review

Table 10 below is a review of the quantitative studies on managerial concepts towards an understanding of GPI.

Table 10. Review of quantitative studies on the topic of green product innovation

	Authors	Objective/questions	Theoretical perspectives	Methodology	Key findings
a.	(Bhatia & Jakhar, 2021)	Do environment regulations affect top management commitment towards GPI? Does organizational learning mediate between top management commitment and GPI practices?	Dynamic capabilities view and upper echelons theory	96 Indian car manufacturing firms, cross-sectional survey research with partial least squares.	Findings evidence how top management commitment and organizational learning are important when implementing GPI in response to regulations, seeking to achieve better environmental and economic performance. Findings also include how organizational

		Do GPI practices enhance performance?			learning is a mediator between top management commitment and GPI.
b.	(Awan et al., 2020)	How do buyer-driven knowledge transfer activities affect a firm's green product innovation via knowledge management capabilities? What is the impact of buyer-driven knowledge transfer activities on social performance improvement through knowledge management capabilities?	Absorptive capacity as a theoretical lens	Use of survey data collected from 239 Pakistani export-manufacturing companies, application of structural equation models.	Evidences how buyer-driven knowledge transfer activities contribute significantly to strengthening knowledge management capabilities in combination with resource acquisition capability to achieve GPI.
c.	(Zhao et al., 2018)	Investigate the impact of external involvement on green product innovation.	Contingency theory and organizational information processing theory	Employment of survey data collected from 198 Chinese manufacturing firms and use of hierarchical moderated regression analyses	Findings support the importance of client and supplier participation to achieve GPI. Results also show how technological uncertainty and demand positively affect GPI.
d.	(Andersén, 2021)	To contribute to the development of a relational NRBV (RNRBV) on product innovation by examining the relationships between GPI, green suppliers, and differentiation advantage.	To consider the extensions of the RBV in product innovation, the article applies a relational NRBV (RNRBV) on product innovation.	Employment of survey data collected from 305 small Swedish manufacturing firms.	Among the findings is a direct relationship between GPI and the performance of the organization, suggesting examining the influence of GPI through the creation of organizational strategies. The author also identifies how suppliers that focus on green provisions contribute with complementary resources that facilitate achieving GPI in the organization, making the relation between the organization and the green suppliers essential, thereby confirming the importance of the relation between NRBV and product innovation.
e.	(Zhang, Wenjuan, Kei Tse, & Wang, 2021)	"How does the inter-organizational control mechanism contribute to the development of GPI?" "How does the adoption of GPI impact on organizational performance?"	Inter-organizational control in the green context: formal structure and informal structure	Based on a sample of 239 senior managers and directors in the Chinese manufacturing industry, testing of the hypotheses using structural equation modelling.	The results show how the interaction between formal control and social control is positive and significant, making it essential to consider this interaction and to follow the philosophies to achieve a better GPI result. They also find how the effect of GPI on financial performance is mediated by environmental and social performance.
f.	(Chen & Liu, 2020)	To explore the coopting and enabling roles of customer participation in green product innovation in SMEs, and to uncover the indirect impact of customer participation through its influence on	stakeholder engagement literature	Analysis of a sample of 195 SMEs in China using regression analysis	The findings indicate how participation of the interested parties, including clients, is necessary to group and orchestrate resources that can improve green product innovation. Furthermore, they find that the client participation can facilitate the exploitation of opportunities, and improve creativity and the

		opportunity recognition and exploitation			capacity of the company towards producing green products.
g.	(Akhtar et al., 2021)	To answer the question of "how market orientation affects green product innovation with the mediating role of green self-efficacy and the moderating role of resource."	Market orientation	477 SMEs managing green production using structural equation modelling	The results show that the market orientation represented in the environmental practices affects green self-efficacy and GPI. Furthermore, their results indicate how green self-efficacy has a mediating role between the market orientation and GPIs.
h.	(Ogbeibu et al., 2020)	Investigation of the predictive powers of green human resource management (GHRM) bundles and green team creativity on green product innovation. Examine the roles of technological turbulence and environmental dynamic capability.	Green human resource management (GHRM)	A cross-sectional survey design with 229 leaders and subordinates in teams from the HRM and R&D departments of 31 manufacturing organizations in Malaysia. Employment of partial least square path modelling for data analysis.	The results indicate that green training, involvement and development is a more significant predictor of green team creativity than green recruitment and selection and technological turbulence. The study also shows how Green Team Creativity positively predicts GPI. However, environmental dynamic capability is identified as a negative predictor.
i.	(Agustia, Permatasari, Fauzi, & Sari, 2020)	Determine the effect of research and development intensity (RNDI) on firm performance (FP) with green product innovation (GPI) as an intervening variable.	Research and development	Uses 170 companies listed on the Indonesian Stock Exchange in the period 2013-2017, with regression analysis	The results show that the intensity of research and development and GPI present a significant effect on company performance. Likewise, the intensity of research and development presents a significant effect on GPI.
j.	(Zhang & Zhu, 2019)	Explore whether environmental pressures from different stakeholders influence green innovation differently and how this is further mediated by organizational learning.	Stakeholder theory and organizational learning theory	259 Chinese manufacturing firms, with confirmatory factor and regression analyses	The results of this work indicate how consumer pressure presents a major effect on GPI, while regulatory pressure is more linked to GPI. Furthermore, they show how organizational learning-exploration and exploitation approaches are necessary and are mediators between the pressures of the interested parties and green innovation.

These studies are examples of some relevant work done in the field of GPI. Previous studies, mainly using the theoretical lenses of RBV, identify some key elements such as green human resource management, research and development, stakeholders, formal and informal structure, market orientation, together with efforts framed within learning, environmental regulations, strengthening of capabilities, and understanding green innovation, in a context of technological turbulence, and with associated performance aims. The cited studies are illustrative of a clear interest and the significant advance made towards understanding the phenomenon of GPI at the organisational level. However, in line with the studies previously conducted, and according to our knowledge, there is a lack of research crossing the boundaries of the structural relation in this case of seven GICs associated with five ODs, such as the ones included in this research, which enables obstacles to be overcome and the promotion of a paradigm shift to pursue environmental strategies in the organisation of meeting the challenge of GPI.

5.2.2. Conventional product innovation vs. green product innovation

Innovation is defined as “a new or improved good or service that differs significantly from the firm's previous goods or services and that has been introduced on the market” (OECD/Eurostat, 2018, p. 21). When developing CPIs, several characteristics must be considered, including production capacity, product conceptualisation, organisational aptitude, and competition (Tsai, 2012). CPI, once conceived, could contribute to the creation of green products (Berchicci & Bodewes, 2005; Pérez-Pérez et al., 2021) because innovation leads to refining technical requirements or aligning them with consumer demands and preferences (such as overcoming current environmental issues) (Dangelico, Nonino, & Pompei, 2021; Niedermeier et al., 2021).

Conversely, GPI is a product with a lesser environmental impact during both its production and its consumption. This product is designed to consume less energy, generate less emissions and be produced with renewable and environmentally friendly raw materials (Melander, 2018). It is currently widely recognised as key in business expansion and competitiveness: society, customers, consumers, and governments perceive it as an effective alternative to improve environmental outcomes and, consequently, individuals’ quality of life (Tariq et al., 2017). It results from the interaction and coordination between innovation and sustainability (Dangelico & Pontrandolfo, 2010).

GPI represents a business opportunity for today's firms because it has evolved into a strategy for competitiveness and added-value incorporation and growth. Likewise, it allows organisations from the member states of the United Nations to contribute to the 2030 Agenda by directly tackling Sustainable Development Goal 9, which encourages sustainable industrialisation and fosters innovation (United Nations, 2018).

5.2.3. Determinants of green product innovation

When it comes to the need to protect the environment, firms must consider a number of determinants that enable them to eliminate barriers and paradigms and thus develop green products while also improving their environmental, economic, and social performance (Chen & Chang, 2013; Jasti et al., 2015; Tan et al., 2019). Serrano-García et al. (2021) made headway toward unifying the determinants that characterise and distinguish GPI and that are needed for its development and marketing. They proposed 22 sets of determinants that describe environmental characteristics in relation to organisational challenges. These determinants help firms to restructure themselves to meet current requirements in terms of GPI because the creation, production and commercialization of GPIs can facilitate the generation of businesses with the green focus that consider the strong relation with the preservation of the environment. While these previously analysed determinants will be further explored later in this study, they will be represented here as variables to assess their possible effect on firms' restructuring aimed at GPI development by means of an empirical analysis.

These determinants, however, are not enough to drive GPI; they require the support of certain organisational skills and components for their management (Serrano-García et al., 2021). This is where businesses could assess whether they need to restructure themselves to respond to the various determinants of GPI (Qiu et al., 2020). GICs and ODs become important here because they could help firms to adapt and update to promote a direct relationship with and respond to the determinants of GPI (Serrano-García et al., 2021).

5.2.4. The resource-based theory and the dynamic capability approach

The RBT is well-known for its exceptional and powerful ability to predict and explain organisational relationships (Barney et al., 2011). It mainly focuses on making an organisation's internal and coordinated factors valuable, rare, inimitable, and non-substitutable (Barney, 1991). This theory links the organization's resources, capacities and competitive advantage (Hart, 1995). Having said that, Renard & St-amant (2003) identify how capacity is related to organizational aptitude to carry out processes of value creation in combination with resources (Renard & St-amant, 2003) which, at the same time, facilitates organizational reconfiguration favouring competitive advantage.

With the support of organisational components, this theory favours the implementation of strategies focused on corporate environmental actions (Dangelico & Pujari, 2010; Teece, 2010) to achieve long-term advantages (Barney, 1991). Consequently, a current challenge to consider within the organizational context that could be addressed from RBT in association with organizational components with a green focus is the reduction of the negative environmental impact. Therefore, a particularly important pillar for the theoretical grounding of the present work is based on NRBV. According to Hart (1995), competitive strategy and competitive advantage based on the firm's capabilities and the natural environment would be key in promoting environmentally-sustainable economic activities. The NRBV therefore extends the RBT to the field of environmental sustainability.

DCs derive from the RBT (Teece, 2018a; Teece et al., 1997) and refer to the transformations causing changes in products (Albort-Morant et al., 2016). Creating a synergy for a more successful innovation performance, DCs favour knowledge transformation, particularly in the manufacture of green products (Salim et al., 2019). Hence, firms must build and strengthen the DCs associated with green innovation to make progress in addressing environmental concerns (Huang & Li, 2017), generating new and improved products and respecting the environment from their conception to the way they are eliminated.

5.2.5. Green innovation capabilities

The notion of IC derives from DC (Lahovnik & Breznik, 2014), a driver of innovation that enables organisations to adapt to the market (Teece et al., 1997). ICs refers to the capabilities linked to the organisation and its management that are coordinated to start, develop, and execute innovation (OECD/Eurostat, 2018) under a systemic corporate approach resulting from a strategic and operational management (Serrano-García et al., 2017; Serrano-García & Robledo-Velásquez, 2013a). ICs are considered a special organisational asset that allows firms to create and sustain a competitive advantage (Guan & Ma, 2003; Yam et al., 2004).

To tackle climate change especially through the creation of GPI, organisations must use certain capabilities that support them. Hence, the importance of the green-oriented ICs (GICs) because they could be considered as contributors when facilitating ecological innovation (Juanru Wang, Xue, & Yang, 2019). These capabilities enable businesses to transform their processes, thus allowing them to develop GPI (Tariq et al., 2020), as well as to comply with environmental obligations and engage in the emerging green economy (Mellett et al., 2018). In addition, they refer to a firm's ability to pursue an ecological and sustainable development (Tseng et al., 2019) in a challenging environment like the current one.

GICs focus on the integration, construction, and reconfiguration of a firms' resources related to environmental protection (Qiu et al., 2020). These capabilities, therefore, must be identified and integrated into each organisational function for organisations to respond to the demands and adjustments necessary to achieve GPI (Serrano-García et al., 2021). Progress in the adoption of GICs helps firms to clarify their processes, techniques, and products to reduce environmental damage (Tseng et al., 2019), as these capabilities allow them to better understand the specific aspects that must be adapted. In this case, these capabilities favour the incorporation of skills that lead to an organisational restructuring and that are centred on enabling compliance with the determinants of GPI.

In this research, we consider the seven GICs proposed (Serrano-García et al., 2021), which are: a) *Green Strategic Planning Capability (GSPC)*, b) *Green Organisational Innovation Capability (GOIC)*, c) *Green Research and Development Capability (GR&DC)*, d) *Green Production Capability (GPC)*, e) *Green Organisational Learning and Relationship Capability (GOLRC)*, f) *Green Resource Management Capability (GRMC)*, and g) *Green Marketing Capability (GMC)*. These capabilities are regarded as an alternative for organisations to respond to the determinants of GPI and to design, develop, produce, and market sustainable products. Their contribution to the development of GPI, however, must be empirically validated. Furthermore, GICs must be further explored with the help of organisational and managerial dimensions that allow firms to adapt to the requirements of environmental businesses (Salim et al., 2019; Teece, 2007), thus leading them to create GPI and achieve a sustainable competitive advantage.

5.2.6. Organisational dimensions

Innovation favours change within organisations (Damanpour, 1991). According to Nadler and Tushman (1999) and Nadler et al. (2011), firms need sufficient diversity and changes in their strategies, structures, people, processes, and organisational values to achieve different sorts of innovation. Consequently, developing GPI is a type of innovation that involves creating and taking organisational actions aimed at preventing, minimising, mitigating, or eliminating a firm's negative impact on the environment.

The challenge is, therefore, to create congruent organisational components that allow for the achievement of strategic objectives that drive innovation (David Nadler & Tushman, 1980; David Nadler et al., 2011). Based on this, firms are structured in such a way as to seek coherence between goals and innovation—a coherence that is supported by the ODs (Galbraith, 1982). These dimensions, which involve the entire organisation, represent the establishment of provisions concerning organisational characteristics of structure, processes, hierarchy, people, functions, and interdepartmental relationships (Daft, 2011). Likewise, they are shaped by aspects such as values, culture, the surroundings, and organisational behaviours (Herrera-Baltazar, 2015). Firms, therefore, should reconsider what types of ODs would allow them to efficiently manage their work to meet their strategic goals (David Nadler & Tushman, 1999) aimed at GPI development. By evaluating the ODs, managers can identify the means and possible pitfalls that could be avoided to implement the environmental strategy (Rothenberg, Maxwell, & Marcus, 1992).

Serrano-García et al., (2021) point out the need for organisations to have the following five ODs, which focus on the innovation requirements necessary to manage the determinants of GPI: a) *Human Resources (HR)*, b) *Organisational Behaviour (OB)*, c) *Technology (T)*, d) *Corporate Environmental Responsibility (CER)*, and e) *Environmental Regulations (ER)*. The authors also emphasise the importance of relating the various ODs with the GICs as a fundamental support and complement for firms to achieve innovation, in this case to achieve GPI.

Therefore, by means of an empirical analysis, we examine the contributions of the different ODs and GICs to the management of the determinants of GPI as a system that would facilitate the achievement of GPI. In formulating the environmental strategies, it is necessary to be consistent with the organisational characteristics, capacities and operational context of the company (Rothenberg et al., 1992).

5.3. Research methodology

To fulfil the objective set out in this paper, we use a combination of the approaches proposed in (Serrano-García et al., 2021), who created a matrix associating GICs-ODs to identify and select the variables representing the determinants. Bikfalvi, Lay, Maloca, & Waser (2013) used data collected by means of the same instrument and method, and conducted a similar analysis -but with a different purpose- classifying companies according to certain characteristics by means of forming clusters. From the EMS, each of the variables corresponding to the intersection between each capacity and dimension were then extracted. The items employed and the procedures followed are described below.

5.3.1. Data collection

We used data from the 2015 European Manufacturing Survey (EMS) to conduct the empirical and descriptive analysis. This survey is structured by thematic areas to measure characteristics and effects of organisational and environmental concepts in manufacturing firms. The purpose of the EMS is to collect up-to-date information from European firms to contribute to improving production processes. The survey's questions are developed by the members of a consortium made up of European research centres and universities and managed by the Fraunhofer Institute for Systems and Innovation Research (ISI) (Fraunhofer Institute for Systems and Innovation Research ISI, 2021).

The data provided by the EMS have been employed to analyse and execute projects under environmental approaches. This is the case of the study carried out by Pons, Bikfalvi, and Llach (2018), who characterised patterns between GPI and CPI in manufacturing firms. Likewise, Sartal, Llach, Vázquez, and de Castro (2017) demonstrated that the role of environmental and information technologies in the lean manufacturing capability can lead to a better industrial performance. For their part, Palčič and Prester (2020) showed that advanced manufacturing technologies can contribute to both firm performance and ecological innovation. Pons, Bikfalvi, Llach, and Palčič (2013) also mapped the adoption of technologies that help to reduce energy and resource consumption, verifying the relationship between their implementation and the performance of manufacturing firms.

5.3.2. Sample

The data used in this study comes from 101 and 105 firms in Spain and Croatia, respectively, representing the business population of the two nations. The samples were addressed under the same approach for three main reasons: a) the EMS questions were equally applied in both countries, and the same criteria were considered to select the samples; b) in 2015, Spain and Croatia were classified as *moderate innovators* by the European Innovation Scoreboard, which assesses research and innovation performance across the member states of the European Union (EU) (Hollanders et al., 2015), and c) in 2014, Spain and Croatia fell into the *Average Eco-I performers group*, with scores of 111 and 91, respectively (close to the average EU score of 100), according to the results of the Eco-Innovation Index, which evaluates eco-innovation performance in the EU member states and promotes a holistic view of economic, environmental, and social performance (European Commission, 2021).

The set of firms analysed here carry out the industrial manufacturing activities listed in NACE Rev. 2 (codes 10 to 32) and have at least 20 employees, see Table 11.

Table 11. Geographical, sectoral, and firm size distribution of the sample

	Frequency	Percentage
Country		
Spain	101	49.0
Croatia	105	51.0
Total	206	
Manufacturing industry		
Food products and beverages	39	18.9
Textiles, wearing apparel, leather, and related products	22	10.7
Furniture, products of wood, and articles of straw and plaiting materials	14	6.8
Paper and paper products; printing and reproduction of recorded media	15	7.3
Chemicals, rubber and plastic products, and other non-metallic mineral products	36	17.5
Basic pharmaceutical products and pharmaceutical preparations	2	1.0
Basic metals and fabricated metal products	37	18.0
Manufacture of computer, electronic, electrical, and optical equipment	10	4.9
Machinery and equipment n.e.c.	23	11.2
Motor vehicles, trailers and semi-trailers, and other transport equipment	7	3.4
Other manufacturing industries	1	0.5
Total	206	100.0
Number of employees		
Up to 49	77	37.4
From 50 to 249	84	40.8
250 and more	45	21.8
Total	206	100.0

5.3.3. Green innovation capability – dimension organisational matrix and selection of variables representing the determinants of green product innovation

Given the several relationships between the various definitions of GICs and ODs, they must be structured using a graphical and descriptive approach. For this reason, we constructed a matrix that established the relationship between each GIC (in rows) and OD (in columns), extracting 61 dichotomous measurable variables from the EMS and analytically placing them at the intersections between each GIC and OD. These variables represent the determinants necessary for an organisational restructuring aimed at developing GPI, as proposed by (Serrano-García et al., 2021). For a more thorough understanding of the process of creating the matrix, Appendix A shows the classification of variables (in representation of the determinants) within a specific GIC and related to each of the five proposed ODs, where the typology of each variable is binary (Yes/No).

5.3.4. Green product innovation - specific attributes

To evaluate GPI development, we only considered the firms that claim to have introduced completely new products or significant technological improvements in existing products, resulting in a drop from 206 to 140 firms. We analysed whether the new or improved products cause a lesser environmental impact when used or discarded, as well as the environmental improvements they deliver in relation to six attributes: a) reduction of health risks for users; b) reduction of energy consumption when in use; c) easier to maintain or to retrofit; d) extended product lifetime; e) reduction of environmental pollution when in use; and f) improved recycling, redemption, or disposal properties.

Firms were given a score ranging from 0 to 100 based on how many environmental improvements they achieved. A score of 100 indicated that they had achieved all the improvements, while a score of 0 meant they had achieved none. The *GPI achievement* variable was thereby created, which assigns each firm a score depending on the number of environmental improvements it achieves in its GPI. The purpose of these attributes is to identify which firms already create products with GPI-specific characteristics.

5.3.5. Statistical method

The next step was to perform a cluster analysis, which is a multivariate statistical technique that organises input data by categorising cases (individuals) into homogeneous groups and delivers results from the cases that share similar content characteristics and are classified into the four clusters (Pérez-López, 2008). As a result, it is possible to obtain as many clusters as similarities are contained and identified in the analysed data (Pérez-López, 2008).

The six attributes of *GPI achievement* were studied using multiple correspondence analysis (MCA), given that by their very nature the data are qualitative. The MCA results sought to study the association between the companies, or which of them had similar responses in the six attributes. The results of the associations between companies were used to form the clusters. The possibility of creating six groups of companies was considered, but it was decided to stay with four groups because of the homogeneity they presented. The clusters are shown in the dendrogram. The data were processed using the statistics software *R-Project*. Subsequently, the 61 variables identified in the matrix and representing the determinants necessary for an organisational restructuring aimed at developing GPI were integrated into each cluster. The aim was to identify which variables were more closely related to GPI development, as well as to determine the relevance or involvement of each GIC and OD.

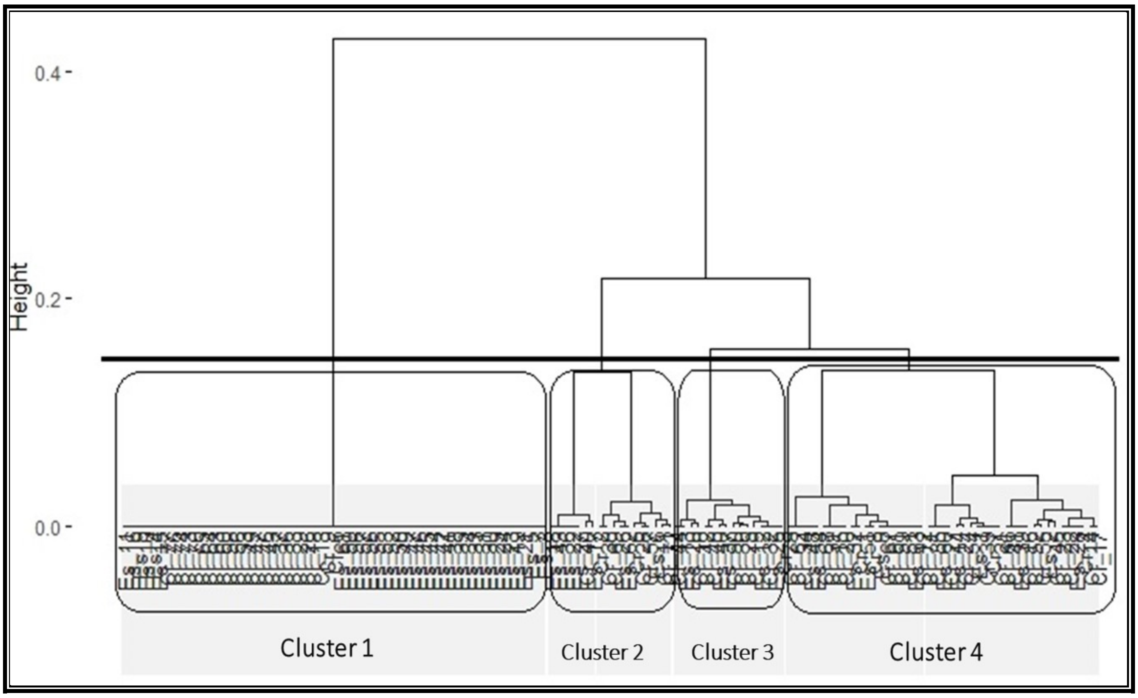
Additionally, we identified the main differences between the clusters and intra-clusters, in addition to the influence of the industrial sector in the clusters to further characterise them.

5.4. Results

The results are organised below in five stages. First, the dendrogram is presented, followed by the content of the four resulting clusters and of the determinants of GPI with GICs and ODs. Next, each of the groups and the influence of the industrial sector in the clusters are characterised.

Following the result of the statistical process, Figure 5 is the dendrogram resulting from the hierarchical analytical analysis of the six attributes of *GPI achievement.*

Figure 5. Dendrogram of clusters, in accordance with green product innovation achievement



From the statistical analysis, four clusters were formed based on the number of average environmental improvements (AEI) that the firms had implemented. *Cluster 1* includes firms that had not achieved environmental improvements in their new or improved products and that were considered to develop CPI. Although classified as innovative, CPI do not favourably contribute to the environment. For their part, *Clusters 2*, *3*, and *4* comprise firms that had achieved some type of environmental improvement in their new or improved products and that are considered to be developing GPI. The AEI of *Clusters 1*, *2*, *3*, and *4* were 0 (0 improvements), 1.6 (between 1 and 2), 3.0 (all with three improvements) and 4.4 (between 4 and 5), respectively.

Afterwards, the 61 matrix variables related to the GICs, the ODs, and the determinants of GPI were incorporated into the clusters. From Table 12, in 18 of the 61 variables we observed a tendency in which the percentage of firms that use the resource described by the variable increases as the AEI value increases.

Table 12. Cluster analysis results

Variable	Dimension-Capability	CPI Cluster 1 *(AEI=0)*	GPI Cluster 2 *(AEI=1.6)*	 Cluster 3 *(AEI=3.0)*	 Cluster 4 *(AEI=4.4)*
		AEI →			
		Variable →			
VISUAL: Visual management (display board in production for work processes and work status)	*OB/GPC*	80%	80%	88%	94%
TASK: Integration of tasks (planning, operating or controlling functions with the machine operator)	*HR/GSPC*	53%	79%	75%	83%
R&D-COOP: R&D cooperation with customers or suppliers	*OB/GR&DC*	60%	64%	75%	94%
WORK: Method of 5S ("workplace appearance and cleanliness")	*HR/GOIC*	57%	66%	88%	83%
INFORMAT: Use information gathered to develop or adapt current products, services or processes	*CER/GOLRC*	50%	72%	93%	82%
SKILLS-PROG: Specific programs of competence development	*HR/GOLRC*	53%	68%	73%	72%
LOGISTIC: Practices to improve internal logistics (e.g. method of value stream mapping / design, changes in the spatial arrangement of the production chain)	*OB/GSPC*	50%	59%	75%	83%
PLAN: Software for production planning and scheduling (e.g. ERP system)	*T/GSPC*	58%	51%	75%	72%
LINES: Customer- or product-oriented lines/cells in the factory	*CER/GMC*	47%	50%	69%	83%
IMP S-E: Impact and performance measurements of social and environmental corporate activities	*CER/GSPC*	30%	53%	67%	67%
MACHINE: Upgrading existing machinery or equipment (e.g. premium efficient motors (IE3), attach insulation, recuperators)	*T/GRC*	45%	44%	50%	53%
IT-TRAINING: IT-based self-study programs (e-learning) for continuous training and evaluation of production employees	*HR/GMC*	37%	50%	56%	56%
AUTOMAT: Control-automation systems for an energy efficient production	*ER/GRC*	18%	30%	38%	44%
AMT-PROD: Additive manufacturing technologies for mass production	*T/GPC*	10%	9%	25%	50%
PLM: Product lifecycle management system (PLM) or product/process data management	*ER/GSPC*	12%	16%	19%	28%
INS-LIFECY: Instruments of life-cycle assessment (e.g. EU Ecolabel, C2C, ISO 14020)	*ER/GPC*	9%	12%	13%	28%
SENSORS: Sensors or control elements for machines or components to allow delivery of remote services	*T/GMC*	9%	11%	20%	24%
CERT-ENER: Certified energy management system (EN ISO 50001, previously EN 16001)	*ER/GOIC*	4%	14%	20%	22%
N		61	45	16	18
%		44%	32%	11%	13%

Figure 6 shows the overall percentage of firms (from the sample addressed in this study) that implemented and did not implement each variable. As can be observed, *visual management (display board in production for work processes and work status) and integration of tasks (planning, operating or controlling functions with the machine* *operator)* was the most implemented practice or resource, while *certified energy management systems (ISO 50001)* was the least implemented one.

Figure 6. Concepts contributing to green product innovation development

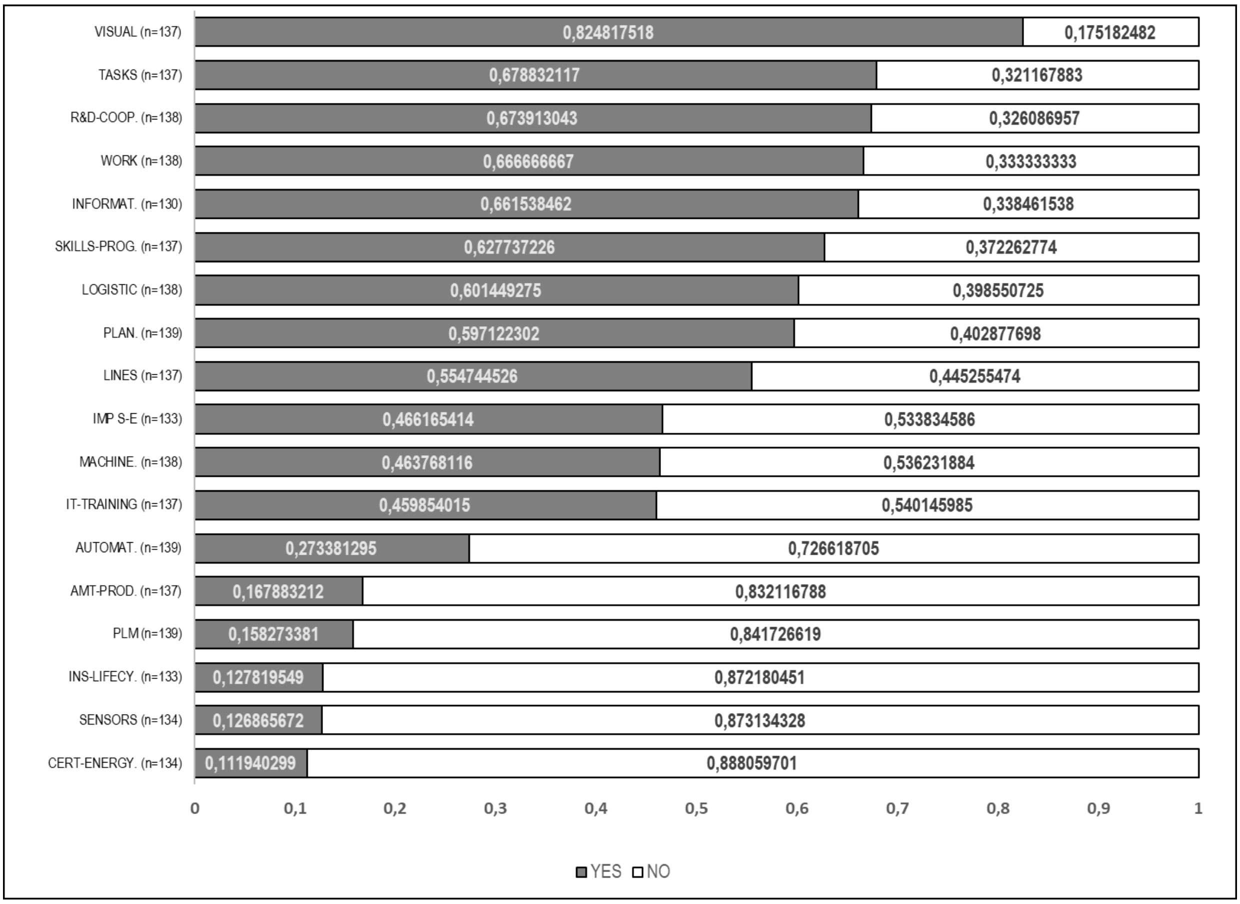


Table 13 presents the configuration matrix that relates the determinants of GPI to each GIC and OD. In this matrix, each of the identified 18 variables representing the determinants are placed at the intersections between each GIC and OD, thus showing the existing interrelationships between the components.

Table 13. Configuration matrix between the determinants of green product innovation, the green innovation capabilities, and the organisational dimensions

		Organisational Dimensions ODs					
		HR	**OB**	**T**	**CER**	**ER**	**No. of variables - GICs**
Green Innovation capabilities (GICs)	**GSPC**	TASKS.	LOGISTICS.	PLAN.	IMP S-E.	PLM	**5**
	GOIC	WORK.				CERT-ENER.	**2**
	GR&DC		R&D-COOP.				**1**
	GPC		VISUAL.	AMT-PRODU.		INS-LIFECY.	**3**
	GOLRC	SKILLS-PROG.			INFORMAT.		**2**
	GRMC			MACHINE.		AUTOMAT.	**2**

GMC	IT-TRAINING.		SENSORS.	LINES.		**3**
No. of variables - ODs	**4**	**3**	**4**	**3**	**4**	

Table 14 shows the practices or resources (variables) involved in each of the clusters, ordered from the highest to the lowest percentage of companies that use or implement them, identifying the most outstanding in each group.

Table 14. Characterisation of each cluster

CPI		GPI					
Cluster 1 (AEI=*0.0*)		**Cluster 2 (AEI=*1.6*)**		**Cluster 3 (AEI=*3.0*)**		**Cluster 4 (AEI=*4.4*)**	
%	***Low implementation of practices or resources***	**%**	***Limited implementation of practices or resources***	**%**	***Moderated implementation of practices or resources***	**%**	***High implementation of practices or resources***
	VISUAL		**VISUAL**		**INFORMAT.**		**R&D-COOP.**
	R&D-COOP.		**TASKS**		**WORK**		**VISUAL**
	PLAN.		INFORMAT.		**VISUAL**		**TASKS**
	WORK		SKILLS-PROG.		**TASKS**		**LOGISTIC**
	TASKS		WORK		**LOGISTIC**		**WORK**
	SKILLS-PROG.		R&D-COOP.		**PLAN.**		**LINES**
	LOGISTIC		LOGISTIC		**R&D-COOP.**		**INFORMAT.**
	INFORMAT.		IMP S-E		SKILLS-PROG.		PLAN.
	LINES		PLAN.		LINES		SKILLS-PROG.
	MACHINE.		IT-TRAINING		IMP S-E		IMP S-E
	IT-TRAINING		LINES		IT-TRAINING		IT-TRAINING
	IMP S-E		MACHINE.		MACHINE.		MACHINE.
	AUTOMAT.		AUTOMAT.		AUTOMAT.		AMT-PROD.
	PLM		PLM		AMT-PROD.		AUTOMAT.
	AMT-PROD.		CERT-ENER.		CERT-ENER.		PLM
	INS-LIFECY.		INS-LIFECY.		SENSORS		INS-LIFECY.
	SENSORS		SENSORS		PLM		SENSORS
	CERT-ENER.		AMT-PROD.		INS-LIFECY.		CERT-ENER.

Each cluster was named according to the average number of variables (which include resources or and practices) implemented by firms, and the percentage of firms that use each variable. *Cluster 1*, which comprises firms that develop CPI, was called *Low implementation of practices or resources* because firms in this cluster used an average of 6.10 of the 18 resources or practices under analysis. Additionally, in this cluster, only the *visual management (display board in production for work processes and work status)* variable is in the fourth quartile of the data (75–100%), while the other variables have less percentages of firms that implement the resource or practice.

The other three clusters, which include firms geared towards GPI development, were characterised in an equivalent manner. *Cluster 2* was named *Limited implementation of practices or resources* because the average number of resources or practices used by firms in this cluster was 7.31. Only the *visual management (display board in production for work processes and work status)* and i*ntegration of tasks (planning, operating or controlling functions with the machine operator)* variables were found to have an implementation above 75% in this cluster. *Cluster 3* was called *Moderate implementation of practices or resources*, with firms in this cluster using an average of 9.19 resources or practices and with the *integration of tasks (planning, operating or controlling functions with the machine operator), practices to improve internal logistics (e.g. method of value stream mapping / design, changes in the spatial arrangement of the production chain), software for production planning and scheduling (e.g. ERP system), method of 5S ("workplace appearance and cleanliness"), R&D cooperation with customers or suppliers, visual management (display board in production for work processes and work status, and, use information gathered to develop or adapt current products, services or processes* variables having an implementation above 75%. Last, *Cluster 4* was named *High implementation of practices or resources,* with firms in this cluster using an average of 10.28 resources or practices and with the *integration of tasks (planning, operating or controlling functions with the machine operator*, *practices to improve internal logistics (e.g. method of value stream mapping / design, changes in the spatial arrangement of the production chain), method of 5S ("workplace appearance and cleanliness"), R&D cooperation with customers or suppliers, visual management (display board in production for work processes and work status), use information gathered to develop or adapt current products, services or processes, and, customer- or product-oriented lines/cells in the factory* variables having an implementation above 75% of all the firms under analysis.

Table 14 also shows three behaviours referring to the implementation of these concepts at the inter-cluster level. To this effect, the variables *visual management (display board in production for work processes and work status), R&D cooperation with customers or suppliers, method of 5S ("workplace appearance and cleanliness"), integration of tasks (planning, operating or controlling functions with the machine operator), practices to improve internal logistics (e.g. method of value stream mapping / design, changes in the spatial arrangement of the production chain), specific programs of competence development, software for production planning and scheduling (e.g. ERP system),* and*, use information gathered to develop or adapt current products, services or processes* present an implementation of practices or improvements in greater percentages in all four clusters, with the greatest proportion generally in clusters three and four.

At an intermediate level of implementation *customer- or product-oriented lines/cells in the factory, upgrading existing machinery or equipment (e.g. premium efficient motors (IE3), attach insulation, recuperators), IT-based self-study programs (e-learning) for continuous training and evaluation of production employees, impact and* *performance measurements of social and environmental corporate activities* stand out, while the variables *control-automation systems for an energy efficient production, product lifecycle management system (PLM) or product/process data management, additive manufacturing technologies for mass production, instruments of life-cycle assessment (e.g. EU Ecolabel, C2C, ISO 14020), sensors or control elements for machines or components to allow delivery of remote services, and, certified energy management system (ISO 50001)* present an implementation in lower proportions in all the clusters, and especially in clusters 1 and 2.

In accordance with the hierarchical clustering of the companies in the four groups, and illustrated in Table 12 and Table 14, differences are presented regarding the implementation of practices and resources at the level of industrial sectors. The companies in the sectors *basic pharmaceutical products and pharmaceutical preparations* are all in cluster 1, or in other words they have a low implementation of practices and resources. Around 90% of the companies in the sectors *food products and beverages* have low and limited levels (clusters 1 and 2) and 10% moderate and high levels (clusters 3 and 4). Regarding companies in the sectors *textiles, wearing apparel, leather, and related products, furniture, products of wood, and articles of straw and plaiting materials, paper and paper products, printing, and reproduction of recorded media, chemicals, rubber and plastic products and other non-metallic mineral products, machinery and equipment n.e.c.,* some 80% have a low or limited implementation and 20% moderate or high levels. Around 65% of the companies in the sectors *basic metals and fabricated metal products* have low and moderate levels, and 35% have high levels. Half (50%) of the companies in the sectors *motor vehicles, trailers and semi-trailers, and other transport equipment* have low levels and the other half have moderate levels. Some 30% of the companies in the sectors *manufacture of computer, electronic, electrical, and optical equipment* have low and limited levels, while 80% have moderate and high levels.

5.5. Discussion

In this paper, we aim to analyse which GIC–OD configuration leads to a better GPI development. Because each determinant of GPI, depending on its nature, is associated with each GIC and OD, and based on the result given by the statistical process, we identify 18 key determinants. In addition, we show which GICs and ODs are the most closely related to GPI development.

According to the results obtained in this study, the *Environmental Regulations* dimension is strongly associated with GPI development. In particular, the group of firms that are in the most advanced stage of GPI are found to highly implement practices or resources such as *product lifecycle management (PLM) systems or product/process data management*, *instruments of lifecycle assessment (ISO 14020 or Ecolabel)*, *certified energy management systems (ISO 50001)*, and *control-automation systems for an energy efficient production*, while these resources are less implemented in firms in the CPI group. This is in line with the findings of Comoglio and Botta (2012), who find that flexible environmental regulations, such as *environmental management systems*, have a positive effect on firms' environmental performance because they increase firms' commitment to environmental improvement.

The *Human Resources* dimension also proves to be key in organisations seeking to restructure themselves to achieve GPI. In fact, several firms in the group with the greatest advance in GPI follow practices like *Integration of tasks (planning, operating or controlling functions with the machine operator)* and implement resources such as the *method of 5S ("workplace appearance and cleanliness")*, *specific programs of competence development,* and *IT-based self-study programs (e-learning) for continuous training and evaluation of production employees* more than those in the CPI group. This finding is consistent with that of Del Giudice and Della Peruta (2016), who report that green human resource management (GHRM) influences firms' environmental progress. Additionally, this result corroborates the ideas of Úbeda-García et al. (2021) and Zhang, Wang, and Zhao (2019), who state that GHRM has a positive impact on environmental management. In light of the above, firms' personnel must be qualified in green matters and organisational practices geared towards environmental innovation management so that organisations can strengthen skills and take on environmental management as a responsibility.

Furthermore, the *Technology* dimension, which includes practices like *upgrading existing machinery or equipment*, as well as resources such as *Software for production planning and scheduling (e.g. ERP system), additive manufacturing technologies for mass production*, and s*ensors or control elements for machines or components to allow delivery of remote services,* is shown to have a higher implementation in firms with the greatest progress in GPI. According to Palčič and Prester (2020), some of these technologies, which are considered to be advanced manufacturing technologies, are positively related to the development of green products. This is in agreement with the findings of Jabbour, Jugend, De Sousa Jabbour, Gunasekaran, and Latan (2015), who find that the various technological advances favourably influence GPI.

The *Corporate Environmental Responsibility* dimension is also found to be necessary for GPI. It is supported by practices such as *impact and performance measurements of social and environmental corporate activities, use information gathered to develop or adapt current products, services or processes;* and *customer- or product-oriented lines/cells in the factory.* This result is in line with that of Awan, Kraslawski, and Huiskonen (2017), who demonstrate that social development programs and practices such as assessing the impact of processes and management actions on the environment lead to a higher market share and an improved environmental performance. Likewise, this corroborates the ideas of Shahzad et al. (2020), who conclude that, by efficiently managing information or knowledge, firms can achieve greater corporate sustainability. Additionally, as stated by Abbas (2020), corporate social responsibility integrates social and environmental concerns and is crucial to achieve a better environmental performance.

Last, the O*rganisational Behaviour* dimension also proves to be an important organisational aspect in boosting environmental innovation. Resources such as *practices to improve internal logistics (e.g. method of value stream* *mapping / design, changes in the spatial arrangement of the production chain)*, *R&D cooperation with customers or suppliers*, and *visual management (display board in production for work processes and work status)* stand out in this dimension. This finding is in agreement with that of Isensee, Teuteberg, Griese, and Topi (2020), who state that there is a high interdependence between organisational behaviour and firms' level of environmental sustainability. Hence, the need for an organisational approach towards environmental protection. This is also supported by the study of Hallstedt, Ny, Robèrt, and Broman (2010), who confirm that creating an environmentally sustainable culture within organisations is key to making progress in developing green products.

Regarding GICs, the G*reen Strategic Planning Capability* is shown to be the most closely related to GPI development. This points to the need to define aspects such as goals, programs, projects, activities, tasks, and deadlines that lead firms to an organisational restructuring focused on sustainability. According to Landrum (2018), since business-oriented corporate sustainability is not enough to address the environmental crisis, environmental science and ecology must be integrated into firms' strategic planning to achieve progress in managing corporate sustainability.

The G*reen Production Capability* is found to be the second most related aspect to GPI development. This suggests that organisations should maintain or increase their productivity levels while using biodegradable raw materials and generating less waste and pollution (Bogue, 2014). Moreover, based on our results, the *Green Marketing Capability* also influences the development of green products. This is confirmed by the study of Guoyou, Saixing, Chiming, Haitao, and Hailiang (2013), who demonstrate that marketing pressures drive corporate sustainability.

Likewise, the *Green Organisational Innovation Capability*, which is concerned with a firm's operations, is found to help to respond to environmental concerns by incorporating and implementing GPI. This finding is in line with that of Qiu et al. (2020), who state that GPI can be consolidated at the organisational level through its institutionalisation, thus encouraging and leading to an organisational restructuring.

Furthermore, the *Green Organisational Learning and Relationship Capability* shows a positive effect on GPI development, which concurs with the results of Karman and Savanevičienė (2020), who report that gaining knowledge and skills in environmental matters, cooperating with partners, and developing employee best practices influence firms' environmental performance. Since creating GPI is often new to most organisations, the role of organisational learning in achieving this type of innovation should be given considerable attention (Qiu et al., 2020).

The G*reen Resource Management Capability* also proves to influence the development of green products because investing, for instance, in resources to strengthen ecological skills, laboratories, equipment, qualified personnel, and the research and development of cleaner technologies could favour the creation of GPI (Chen & Chang, 2013; De Medeiros et al., 2014).

Last, the *Green Research and Development Capability* is also found to have a favourable impact on the development of green products. This is consistent with the findings of Liao (2017), who state that green-oriented R&D positively influences firms' environmental development. R&D plays a key role in helping firms to exploit their existing invention skills and explore new technological creations (Tushman, 2017) that could lead to GPI.

Although some of the proposed capabilities and dimensions stand out more than the others, it does not mean that some are more important than the others. In other words, this paper does not try to analyse the contribution of each OD and GIC but rather their overall configuration as a systemic approach aimed at achieving GPI. In light of the above, all the ODs (i.e., *ER*, *HR*, *T*, *OB*, and *CER*) and GICs (i.e., *GSPC*, *GOIC*, *GPC*, *GOLRC*, *GRC*, *GMC*, and *GR&DC*) proposed by (Serrano-García et al., 2021) play a part, from their own perspective and technical nature, in the management of the determinants leading to GPI. This results in a system of interrelated elements, each of which contributes to the organisational restructuring necessary to transform processes and direct them towards an innovation management conducive to GPI.

During the characterisation of the clusters, firms that already implement environmental improvements in their products are shown to better manage their work compared to those that have not yet implemented environmental improvements. In fact, the former extensively employ strategies such as planning, logistics, and order at work; R&D cooperation; development of specific new production lines; and learning from accumulated experience and errors. However, we also find that even firms with better environmental management still need to strengthen those green-oriented determinants-variables that could lead them to better respond to GPI. Regarding the influence of the industrial sector, differences were found in the sense that within and between sectors the companies presented low, limited, moderate and high levels of environmental practices and improvements. More specifically, no sector stands out in any of these levels.

5.6. Conclusions

In this paper, we analyse how the GIC–OD configuration proposed by (Serrano-García et al., 2021) serves as a reference framework for managing innovation, in an attempt to respond to the green-oriented determinants and thereby encourage an organisational restructuring focused towards GPI development. By means of a matrix, we establish a connection between the different GIC and OD to build a structural relationship associated with the determinants of GPI in a practical and experimental way.

Our findings empirically confirm the positive impact of each GIC and OD on GPI development. Hence, the framework proposed in (Serrano-García et al., 2021) is found to influence the environmental management of the firms under analysis. For an innovation management focused on GPI development, organisations should be considered under a systemic approach that encompasses each of the aforementioned capabilities and dimensions and directs them towards the green purpose.

5.6.1. Theoretical and management implications

These findings evidence a series of theoretical repercussions and managerial practices that could be useful for academics, government entities, and professionals in different fields. From an academic perspective, this research makes contributions to the RBT, the NRBV, and the DCs, along with their extension to the GICs, and supports the need to associate them with the ODs. Moreover, all the proposed GICs and ODs are found to be necessary and to contribute to the design of a governance mechanism focused on an innovation management aimed at achieving the determinants of GPI to favour environmental sustainability. This study also demonstrates that the configuration of the seven GICs and five ODs constitutes a means to achieve GPI. It therefore opens up new fields of research for academia to explore and further examine the relationship between GICs and ODs and green innovation management.

Last, from the perspective of managers of manufacturing firms and government organisations interested in environmental sustainability, we found how, as firms boost GPI development at the organisational level under the strategic support of the different GICs and ODs, they could reduce their negative impacts and help to solve the environmental problems they cause. This would, indeed, encourage a transition from CPI to GPI.

5.6.2. Limitations and future work

Although this study proposes and empirically validates a GIC–OD configuration for GPI development, it has various limitations. The EMS provides representative empirical evidence and evaluates key variables in the field of environmental management. However, since the data collected comes from a survey, the variables under analysis are not measured directly but are limited to the responses provided by respondents. Additionally, even though large-scale surveys can contribute to the validity and strength of the evidence in this strategic matter, it would be interesting to include data from other countries where the EMS has also been applied, as each country may have unique characteristics that could lead to differences in the results, to discover patterns of as yet unobserved behaviour in the companies and industrial sectors analysed in the present document.

Furthermore, we identify a number of possible future works that could significantly contribute to this line of research. On the basis of the link between GICs and ODs, future studies could use other variables that can be operated and controlled by organisations to represent the determinants of GPI. Moreover, further research might consider addressing GPI development under other conceptual perspectives (e.g., the stakeholder, contingency, value chain, and business model theories) in combination with the GICs and the ODs. Likewise, it would be interesting to extend the association between the GICs and green-oriented ODs to other economic sectors, such as the construction, health, tourism, and education sectors, which are also seeking to reduce their environmental impact. Last, it is recommended that future studies consider different variables or criteria to evaluate the characteristics of a constituted GPI to assess firms' environmental performance and their impact on financial performance.

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5.7. Appendix A

Green Innovation Capabilities (GIC) and Organisational Dimensions (OD): a selection of variables in the representation of the determinants of Green Product Innovation (GPI)

Construct		Operationalization	
GIC	**OD**	#	**Variables encuesta EMS-2015**
Green Strategic Planning Capability (GSPC)	**HR**	1	Integration of tasks (planning, operating or controlling functions with the machine operator)
		2	Is there a separate area of responsibility for competence development and training?
	OB	3	Virtual-reality- or augmented-reality-applications for services (e.g. services supporting the product, remote-training, product design for services, product presentation etc.)
		4	Method of Value Stream Mapping/Design
	T	5	Software for production planning and scheduling (e.g. ERP system)
	CER	6	Impact and performance measurements of social and environmental corporate activities
	ER	7	Product-Lifecycle-Management-System (PLM) or Product/Process Data Management

Green Organizational Innovation Capability (GOIC)	HR	8	Method of 5S ("work place appearance and cleanliness")
	OB	9	Impulses / ideas for innovations by CEO or plant management in new organizational concepts
		10	Impulses / ideas in production to innovate in new organizational concepts.
	T	11	Systems for automation and management of internal logistics (e.g. RFID, warehouse management systems)
	CER	12	Methods of assuring quality in production (e.g. preventive maintenance, Total Quality Management, Total Productive Maintenance)
	ER	13	Certified energy management system (EN ISO 50001, previously EN 16001)
Green Research and Development Capability (GR&DC)	HR	14	Impulses / ideas in R&D /engineering for generation of new products
	OB	15	R&D co-operation with customers or suppliers
		16	R&D co-operation with research organizations or research entities (e.g. universities/institutes)
		17	R&D co-operation with other companies (customers or suppliers excluded)
	T	18	Nano-technological production processes (e.g. surface processing)
	CER	19	Did your factory perform Research and Development (R&D) or order R&D activities from external partners?
	ER	20	Capacity expansion in R&D
Green Production Capability (GPC)	HR	21	Are existing competences of employees in production captured systematically?
		22	Impulses / ideas in production for generation of new technical production processes
		23	Impulses / ideas in production for generation of new products
	OB	24	In the production area, are job specifications developed for specific areas of responsibilities?
		25	Visual Management (Display board in production for work processes and work status)
		26	Production/assembly of the product is carried out against the customer's order (make to order)
		27	Production controlling by pull principles (e.g. Internal zero-buffer principle, KANBAN)
	T.	28	Industrial robots for manufacturing processes (e.g. welding, painting, cutting)
		29	Industrial robots for handling processes (e.g. depositing, assembling, sorting, packing processes)
		30	Additive manufacturing technologies for mass production (incl. single unit production, small batches, spares, etc.).
	CER	31	Methods of continuous improvement of production processes (CIP, KAIZEN, quality circle, PDCA, Deming circle/cycle, etc.)

	ER	32	Instruments of life-cycle assessment (e.g. EU Ecolabel, C2C, ISO-14020)
Green Organizational Learning and Relationship Capability (GOLRC)	HR	33	Do specific programs of competence development exit for single areas of responsibilities?
		34	Seminars, training opportunities with interdisciplinary focus (e.g. language courses, team leadership)
	OB	35	On-the-job training (e.g. job rotation, workplace instructions, organized exchange of experience with colleagues)
		36	Digital Exchange of product/process data with suppliers / customers (Supply chain management)
	T	37	Seminars, training opportunities with activity-specific (e.g. machine maintenance)
		38	Information offers (e.g. specialized trade fairs, external databases)
	CER	39	Do you use information gathered by applying digital technology further to develop or adapt current products, services or processes?
		40	The creation and development of the product is according to customers' specification
	ER	41	Participation on measures for continual quality improvement (e.g. quality circles, groups for CIP)
Green Resource Management Capability (GRMC)	HR	42	Broad-based employee financial participation schemes (e.g. employee share, profit sharing, performance related payments)
		43	Instruments to maintain elderly employees or their knowledge in the factory (e.g. training programs, incentive systems, or similar)
	OB	44	Production co-operation (e.g for capacity compensation or for joint utilization of machinery)
		45	Purchasing co-operation
	T	46	Premature substitution of existing machinery or equipment by new machinery or equipment
		47	Forecast of the replacement of existing machinery or equipment with new machinery or equipment
	CER	48	Switching off components, machinery or equipment when not in use (e.g. switching off compressed air supply, ambient light sensors to regulate lighting)
		49	Technologies for recuperation of kinetic and process energy (e.g. waste heat recovery, combined cold, heat and power generation)
	ER	50	Method for optimizing of change-over time (e.g. SMED, QCO)
		51	Control-automation systems for an energy efficient production
Green Marketi	HR	52	Ideas and impulses in customer service for the generation of new products.
		53	IT-based self-learning programs (e-learning)

OB	54	Sales / distribution co-operation
	55	Service co-operation
T	56	Usage of the internet to support service activities (e.g. for training, documentation, defect explanation).
	57	Remote support for clients (User Helpdesk, Service Hotline, web platform)
	58	Sensors or control elements for machines or components to allow delivery of remote services
CER	59	Customer- or product-oriented lines/cells in the factory (instead of task-/operation-structured shop floors)
ER	60	End of life services (e.g. recycling, disposal, taking back)
	61	Provides its customers with maintenance and repair related to the product offered.

Note: Human Resources (HR); Organizational Behavior (OB); Technology (T); Corporate Environmental Responsibility (CER); Environmental Regulations (ER);

Capítulo 6. Performance effects of green production capability and technology in manufacturing firms

Jakeline Serrano-García[a,b4], Josep Llach[c,d], Andrea Bikfalvi[c], and Juan José Arbeláez-Toro[e,f]

[a] Universitat Politècnica de València, Valencia - España

[b] Faculty of Economic and Administrative Sciences, Instituto Tecnológico Metropolitano, Medellín - Colombia

[c] Department of Business Administration and Product Design, Universitat de Girona, Girona – España

[d] UPF Barcelona, School of Management, Universitat Pompeu Fabra, Barcelona, España

[e] AMADE, Polytechnic School, Universitat de Girona, Girona – España

[f] Faculty of Engineering, Instituto Tecnológico Metropolitano, Medellín - Colombia

Abstract

The proclamation of the sustainable development goals is driving companies to implement protective measures that favour the environment, thereby occupying a strategic place in the creation of green product innovation (GPI). This new management paradigm could be impacting capabilities, techniques, technologies, efficient energy use, and green-oriented production policies and systems. Therefore, one of the challenges is to configure green production capabilities (GPC) coordinated with the technology dimension (TECH), because the design of ecological products and their manufacture requires the backup of capabilities and possibly the support of green technology. To this effect, this article aims to establish the impact of the association of GPC and TECH on organisational performance. To do so, we test whether the adoption and high implementation of GPC and TECH affect environmental and financial performance. Empirical evidence is supported by the European Manufacturing Survey (EMS), using a sample of 1,018 manufacturing companies from seven European countries. Our results show that the adoption of GPC and TECH and their high levels of implementation have a significant impact on environmental and financial performance. Regarding the association between the implementation of GPC and TECH, its contribution to environmental performance but not financial performance is evidenced. Furthermore, at high levels of implementation of this association, there is no significant effect on either environmental or financial performance. These findings drive theoretical and practical implications and provide opportunities for academics, managers, and government bodies.

[4] Corresponding author. Faculty of Economic and Administrative Sciences, Instituto Tecnológico Metropolitano, Cl. 54a #30-01, Medellín – Colombia.

E-mail addresses: jakelineserrano@itm.edu.co - jserrano2005@gmail.com; josep.llach@udg.edu - josep.llach@bsm.upf.edu; andrea.bikfalvi@udg.edu; juanarbelaez@itm.edu.co - jjarbetoro@gmail.com

Keywords
financial performance, environmental performance, green production capability, green product innovation, manufacturing companies, technology.

6.1. Introduction

"*Advances in technology and science have left no aspect of life untouched. The fourth industrial revolution has been deeply transformative, connecting and networking the world in hitherto unimaginable ways, generating innovation and being a driver of progress for sustainable development […] Let us not have any illusions. It would be easy to assume that "business as usual" would simply mean continuing as we are. That is not what will happen. A business-as-usual approach will produce […] disaster. […] We need more innovation […] and the need to work and act together will help us seize the opportunity to correct course and shape a better future"* (United Nations, 2022). These are the words and vision statement formulated by the current secretary of the UN, an institution that has become the flagship of sustainable development. Collective action calls for all actors of regional, national, and international eco-systems to contribute to this cause, business being highly relevant due to its capacity for innovation. Greening innovation -in both product and process- is both a challenge and an opportunity for the sustainability agenda.

The proclamation of the UN's Sustainable Development Goal (United Nations, 2015), already almost a decade ago, together with stakeholders' increasing environmental awareness and pressure, is prompting companies to implement environmental prevention and protection measures. Sustainable orientation is gradually being considered as crucial, followed by a potential inclusion in the area of strategic management (He, Ding, & Yang, 2021; Suganthi, 2019) and operations. Its most material and visible effect is the creation of green product innovation.

With business practice finding opportunities in green production techniques and products with positive environmental impact, academic research is also devoting attention to the field. A recent trend in this field, with a growing body of knowledge and research (Begum, Ashfaq, Xia, & Awan, 2022), suggests that green innovation could be considered a critical factor of productivity since its creation harmonizes with the reduction of costs and greenhouse gas emissions, energy savings, use of clean technologies, and production and processing making better use of the raw material (Dost et al., 2019; He et al., 2021). Therefore, green product innovation should favour a company's progress towards sustainable development (Chen et al., 2006; Lin, Tan, & Geng, 2013), which would further contribute to reducing environmental impacts and, in consequence, favour the company's image, business objectives and competitive advantage.

However, many companies are still hesitant about or distrust the value that the development of green product innovation can provide. The literature suggests different reasons to explain this lack of conviction: (i) lack of experience in green issues, causing core competencies to be neglected and competitiveness to be lost (Vrchota et al., 2020); (ii) dealing with new paradigms in terms of changes in technologies, operations management and commercial strategies (Suganthi, 2019), with a focus on the reorganization of resources and capabilities, generating additional costs; or (iii) limiting responsiveness on the part of the company given the production conditions, the economic situation and the real value of the integration of technologies and organizational and operational systems (Yan & Zhang, 2021). Based on these reasons, the reorganization of resources and capabilities seems to be a common concern to adopt this new management paradigm, although some authors (Ikram, Sroufe, Awan, & Abid, 2021) even formulate and suggest a roadmap for green technology explicitly making reference to organisational structure, in the first stage, and implementation, afterwards.

To gain knowledge of the management approach leading to GPI development, Serrano-Garcia et al. (2021) identified and categorized the determinants of GPI in association with green capabilities (GIC) and organizational dimensions (OD). Specifically, they identified seven GICs: green strategic planning capability, green organisational innovation capability, green research and development capability, green production capability, green organisational learning and relationship capability, green resource management capability, and green marketing capability; and five ODs: human resources, organisational behaviour, technology, corporate environmental responsibility, and environmental regulation. Later on, the same authors (Serrano-García et al., 2022) demonstrated how these capabilities and dimensions form a system of interrelated elements contributing to the restructuring of organizational processes in favour of the creation of GPI. Therefore, companies that have the ability to reconfigure their capabilities to meet the challenges of the natural environment in conjunction with green technology could thrive in the long term by achieving sustainable competitive advantage (Celikyay & Adiguzel, 2020; Hart, 1995; Teece, 2007). The inclusion of green technologies contributes to reducing ecological degradation, driven by efficient production modes that contribute to the elimination of non-ecological products (Ahmad & Wu, 2022), shaping a more efficient, ecological, and sustainable product in the long term (Lopes, Gomes, Pacheco, Monteiro, & Santos, 2022).

Having recognized that GICs are a strategic factor for creating GPI, one of the challenges is to reconfigure green production capability (GPC) and interrelate it with the technology organizational dimension (TECH) (Serrano-García et al., 2021) because the design of ecological products and their manufacture and production require the support of capabilities (Hartmann & Germain, 2015). There is a lack of research on the challenges of integrating technologies at the organizational level for the manufacture of green products (Khan, Dhir, Parida, & Papa, 2021). There is also a demand for more research and empirical studies that describe how green technology influences financial and environmental performance (Li, Dai, & Cui, 2020). Few studies have considered organizational factors that link innovation in green technology to performance (Xie et al., 2019). Furthermore, it is necessary to respond to environmental challenges vis-à-vis green technology innovation and the mechanisms that intervene to achieve business performance (Wang et al., 2021). A recent and comprehensive review published by (Jasti, Jha, Chaganti, & Kota, 2022) analysing more than 900 articles on the topic of sustainable production system, identify a series of gaps such as the need of sustainable constructs' implementation as a coherent set instead of individual constructs, relating them to sustainable performance, as well as providing sound evidence from multiple sectors and several countries. However, a previous step to implementation and an important predecessor of green manufacturing are drivers. In the list published by Mittal & Sangwan (2014) technology and organisational resources appear as selected drivers, but they do not rank among priorities as incentives, public pressure, present and future legislation, and public image. Positioned at the confluence of these gaps, our study aims to describe performance effects of the association between GPC and TECH on performance, considering different nuances of implementation. More concretely, mere implementation or rather high adoption of separate or combined practices are tested in European companies surveyed. The empirical context for the study is built using first-hand information provided by companies covering the entire manufacturing range of economic activities with data from seven European countries included in the European Manufacturing Survey (EMS). The structure of this international survey is based on thematic blocks designed to obtain information on the respective characteristics and effects at the level of organizational and environmental concepts. Data from different rounds of the EMS have already been used in several works under environmental approaches, including the study performed by (Gerstlberger, Praest Knudsen, & Stampe, 2014; Palčič & Prester, 2020; Pons et al., 2018, 2013; Šebo, Šebová, & Palčič, 2021).

This study's overall contribution is the experimental orchestration of the relationship between green production capability and technology in the pursuit of organizational performance, further detailed for ecological and financial performance perspectives. The ultimate aim is to contribute to the emerging and growing body of knowledge on green innovation, a key ingredient and a crucial mechanism towards the achievement of sustainable development.

The article is structured as follows. In section two, the theoretical background is presented, and the hypotheses developed. Section three describes the methodology. The results and discussions are presented in section four. And last, in section five, the conclusions, implications, limitations and future lines of research are considered.

6.2. Theoretical background and hypothesis development

6.2.1. Literature review

This purpose of this review is to examine previous research papers in chronological order since the theory of resource-based view (RBV) and its variants and from the theoretical approach of green technology, to understand the progress of how to create GPI in pursuit of organizational performance. See Table 15 .

Table 15. Review of quantitative studies on the topic of GPI performance

Author(s)	Objective/questions	Theoretical perspectives	Methodology	Key findings
(Chen & Chang, 2013)	To explore the influences of green dynamic capabilities and green transformational leadership on green product development performance.	Dynamic capabilities theory	Taiwan's electronics industry using structural equation modelling	Support for how green dynamic capabilities and green transformational leadership are positively related to green product development performance.
(Hartmann & Germain, 2015)	To understand the relationships between integration capabilities, ecological product design, and manufacturing performance	RBV	769 Russian manufacturers and use of structural equation modelling	Identification of how integration capabilities can be exploited to help improve the effects of ecological product design in pursuit of manufacturing performance.
(Dangelico et al., 2016)	Which sustainability-oriented dynamic capability SODC are needed to develop green innovation and eco-design capabilities? Which of these capabilities leads to the better market performance of green products?	Sustainability-oriented dynamic capability	Use of survey data collected from 189 Italian manufacturing firms, with confirmatory factor analysis and structural equation modelling.	Indicates how the creation and reconfiguration of sustainability-oriented dynamic capabilities affect market performance; and how external resource integration, internal resource integration, and resource building and reconfiguration affect capacity for ecological design and, consequently, market performance. Also identified is how the integration of external resources is the only factor that impacts capability for ecological innovation and intervenes in the link between the integration of external resources and market performance.
(Andersén, 2021)	To contribute to the development of a relational NRBV (RNRBV) on product innovation by examining the relationships between GPI, green suppliers, and differentiation advantage	The natural-resource-based view (N-RBV)	305 Swedish small manufacturing firms using structural equation modelling.	Identifies a direct relationship between GPI and organizational performance. Likewise, it identifies how suppliers that contribute green inputs facilitate the achievement of GPI, generating an essential alliance and confirming the importance of the relationship between NRBV and product innovation.

(Huang & Chen, 2022)	Evaluate the coercive, normative, mimetic institutional pressures and the "green firm's slack", referring to the excess of resources available for the implementation of green alternatives, identifying these resources from the perspective of the resource-based view (RBV) for green product innovation success. The company's green slack is also examined as a mediator between institutional pressures and GPI.	Institutional theory and resource-based perspective.	A sample of 170 Taiwanese high-tech firms, including electrical and electronics manufacturers, with confirmatory factor analysis and structural equation modelling	Verifies a positive relationship between the analysed variables affecting company performance, identifying that the greater the environmental pressure and the extra availability of resources, the more likely the company is to develop successful green products, resulting in better environmental and economic performance.
(Xie et al., 2019)	What are the relationships between green process innovation, green product innovation, and firms' financial performance?	Green technology innovation	209 companies that belong to polluting manufacturing industries, using regression analysis.	Identifies how green process innovation has a positive impact on green product innovation and how the two can contribute to financial performance, needing to complement each other to ensure benefits from green technology innovation.
(Afum, Sun, Agyabeng-Mensah, & Baah, 2021)	Are there any significant interrelationships between green lean production systems, green technology adoption, green product innovation, social sustainability performance and green competitiveness? Do green technology adoption and green product innovation play mediation roles between lean production systems, social sustainability performance and green competitiveness?	Green technology	197 managers of manufacturing firms in Ghana, using structural equation modelling	Findings support how green as lean production systems present a positive effect on the interrelationships between green technology adoption, green product innovation and green competitiveness, but not so much on social sustainability performance.
(Wang et al., 2021)	To test the relationships between different types of green technology innovation and the similarities and differences of their transmission paths in economic performance.	Green technology innovation	642 industrial enterprises in China with exploratory factor analysis.	Verifies how green technology innovation can effectively improve the economic performance of enterprises.

Although there are valuable studies investigating how alternatives that may favour the development of GPI to impact organizational performance are interrelated, the need for additional research from the RVB perspective with its extension to GIC is identified, and particularly in this case from GPC and from the perspective of the TECH organizational dimension, given that various studies identify technology as a tool, thus limiting its scope and strategic position in the organization. Therefore, the original contribution we make with this research is the association of GPC and TECH in pursuit of the development of GPI that facilitates organizational performance.

6.2.2. Green production capability

The post-industrial system based on mass production (Mark et al., 2001) is undoubtedly an advantage for the company. However, this behaviour may be far from compatible with the environment. In its need to offer products, the company may be transforming its production into an excessive use of resources, converting them into massive amounts of waste and pollution (Mark et al., 2001). Considering that current profit margins are very narrow, failure to address environmental challenges could also lead to difficulties in surviving (Shete, Ansari, & Kant, 2020). It is therefore necessary to opt for sustainable production, under the protection of a diligent organization and with a strategic focus on green innovation, especially since green manufacturing consists in the creation of products whose essence lies in the reduction and/or elimination of harmful substances and use of natural resources, focusing production on renewable raw materials and clean technologies (Vrchota et al., 2020). Further, green production involves the ecological design and use of packaging that is respectful to the environment, and involves putting the 6 Rs - reduce, reuse, recycle, recover, redesign, and remanufacturing resources conservation (Seth et al., 2018)- into practice. To this effect, green production is explicitly focused on maximizing efficiency, which impacts on operations and productivity, favouring the creation of green products aimed at creating customer satisfaction in pursuit of financial profit (Ikram et al., 2021; Le, 2022).

Since production is directly related to eco-efficiency, the company could acquire a competitive advantage over traditional manufacturing industries given that green production facilitates the creation of GPI, which contributes to environmental protection and is a competitive factor aligned with adaptation and resilience (Forés, 2019; Serrano-García, Bikfalvi, Llach, Arbeláez-Toro, et al., 2022). Consequently, companies may currently require the design and development of green processes and products, which have a positive effect on the environment and at the same time preserve the sustainable operation of the organization (Wang et al., 2022).

Production practices to avoid material losses due to leakage or overuse to reduce or eliminate the presence of heavy metals, carcinogenic substances or chlorofluorocarbons; the use of technologies that help to optimize production, control overall quality, and save water and energy; and the creation of recycling circuits and the recovery of residual resources to be used in production, among others (Fiksel, 1996; Viñolas Marlet, 2005), are valuable production capabilities currently needed by the organization in pursuit of the competitive advantage that allows financial and environmental performance to be impacted, since the creation and implementation of environmental solutions depends significantly on the capabilities possessed by the organization (Bhupendra & Sangle, 2016). This is consistent with Barney (1991), whose RBV identifies resources and capabilities as valuable and determinants of competitive advantage, facilitating the formulation and implementation of strategies that lead to process efficiency and effectiveness, thereby empowering the bases for creating GPI.

From the RBV perspective, when creating GPI the company can accumulate unique and valuable knowledge resources, giving them the advantage and creating difficulties for competitors, consequently impacting on the performance of the company (Barney, 1991; Xie et al., 2019). In this regard, it is key to involve the natural resource-based view (NRBV) (Hart, 1995), which identifies how resources and capabilities oriented towards green production could be an organizational tool that favours environmental protection, meaning a future competitive advantage. A necessary feature to this effect is the dynamism focused on green innovation, calling on dynamic capabilities (DCs) that represent the potential for adapting resources and competencies to the companies' various evolution and developmental challenges (Teece, 2007). Next, and with the aim of responding to the challenge of innovation, innovation capabilities (ICs) emerge from DCs, corresponding to the integration of technological innovation and capability (Rhodes, 2018), as commented in (Yoo, Choo, & Lee, 2018). According to the Oslo Manual, ICs are the organizational and managerial capabilities to mobilize, command and exploit resources in pursuit of the creation, development and introduction of technological innovations in new or improved products (goods or services), production processes, and company marketing and organization (OECD/Eurostat, 2005, 2018).

Therefore, and given the current challenge of companies to take environmental sustainability on board, a strategic approach of ICs is their orientation towards the green (GIC). In light of the determinants of GPI, Serrano-García et al., (2021) propose an original notion about GICs:

> *"[GICs] are understood as organisational and dynamic abilities built and/or acquired by an organization in accordance with its strategic and operational management and aimed at developing GPI and contributing to solving the environmental challenges. GIC must be identified and integrated into each organisational function to respond to the new demands or necessary improvements within the context of GPI development. As a result, this would help firms to reduce and/or eliminate the pollution they cause, thus gaining comparative and competitive advantages"* (p. 5).

GICs influence sustainable competitive advantages (Mellett et al., 2018). To this effect, from the manufacturing function, the deployment of GPC could be required to facilitate the redesign, transformation and support of resources and processes towards formulating the organization's environmental strategy in pursuit of the development of GPI, hence the need for and importance of distinguishing and possessing GPC. Serrano-García et al., (2021) propose an original notion about GPC: "firms' abilities to develop and manufacture GPI based on stakeholders' needs and R&D results aimed at preventing the generation of waste, minimizing the use of materials and inputs, and fostering the employment of eco-efficient materials and waste reuse" (p. 6); and in a way where manufacturing executives and the company management identify GPC as a strategic tool and generator of competitive advantage in the current environment.

Previous research by Andersén, (2021) and Hartmann & Germain, (2015) identifies the probability of financial and environmental performance being associated with companies' capabilities to innovate in pursuit of green development. Similarly, previous studies highlight the substantial benefits of the green innovation strategy, boosting performance and represented in green production capacity that facilitates reduced production costs and energy consumption and the reuse of materials, ultimately impacting on organizational efficiency (Wang et al., 2022). Since green innovation is considered an organizational phenomenon that involves the potential to design, develop and launch new sustainable products in the market, GPC could be directly linked to the development of GPI because this would facilitate the operability of an eco-sustainable production, meaning lowered expenses and environmental impacts, thereby contributing to the improvement of environmental and financial performance standards. To this effect, in line with the previous approach, we believe that GPC is associated with the performance of the organization and the following hypothesis is formulated:

H1: The adoption of green production capability has a positive effect on performance.

To complement the above hypothesis, we want to distinguish between different degrees of adoption regarding the capabilities implemented. This may be possible because the EMS categorizes the estimate of the degree of adoption of capabilities as "low" (recently introduced, without reaching full potential), "medium" (partial adoption) or "high" (adoption close to total potential), allowing the company to identify the degree of actual adoption of capabilities in relation to the level identified as potential for the company. Based on adoption categories and emerging from this approach, we would expect to confirm H1a:

H1a: A high degree of adoption of green production capability has a positive effect on performance.

6.2.3. Technology

Under the notion of organizational architecture, the manager is required to consider a model of organizational congruence supported by organizational dimensions that facilitates the transformation of processes in the company (David Nadler et al., 2011). Organizational dimensions are made up of people, the structure, processes, technology, culture, and organizational behaviour (Daft, 2011; David Nadler et al., 2011; Robledo-Velásquez, 2019). Therefore, the challenge is to detect what dimensions and their congruence improve company performance (David Nadler et al., 2011). In line with the results of Serrano-García et al., (2021) and Serrano-García et al., (2022) on the characterization of the five organizational dimensions, in this article we focus on TECH from devices, technical methods and systems as part of an organizational strategy vis-à-vis the challenge of responding to the constitutive determinants of GPI. To this effect, and in brief, in pursuit of implementing green product design and creation strategies, the use of technology coordinated with the company structure, system, resources, and capacities is essential (Celikyay & Adiguzel, 2020).

The catastrophic increase in environmental pollution in recent decades, the use of energy inefficient technologies (Khan, Kaur, Jabeen, & Dhir, 2021) and managers' understanding of reliance on current technologies may be generating incompatibility in terms of advancing towards the manufacture of green products (Dost et al., 2019). In turn, technology should not be considered strictly as the net description of the "artifact", but as the sum of knowledge and skills that enables the transformation of organizational processes to modify traditional manufacturing in an approach of separation and unpacking, enabling recycling, waste management, reuse, and a reduction in energy consumption, harmful substances and materials (Fiksel, 1996), all key determinants in the achievement of GPI (Albino et al., 2009; Berchicci & Bodewes, 2005; Jabbour et al., 2015). The transfer and acquisition of clean technology and environmentally friendly management methods are also needed (Viñolas Marlet, 2005), identifying technology as a strategic factor for optimizing the design, production, and development of green products; requiring the establishment of a planning system to understand the importance of the transfer of green technology and the identification of possible financial effects (Ikram et al., 2021); and, given that the implementation of green technology could be impacting on improving the corporate image, reducing the environmental impact, increasing participation in the capital market and boosting corporate financing (Ma, Zhang, & Yin, 2021). The research by Shahzad, Qu, Rehman, & Zafar, (2022) suggests how innovative green technology can be a simple process for implementation, facilitating the capacities required in green production and enabling long-term financial results.

The concept of green technologies and processes was introduced in the 1960s, emerging from the international activism of the environmental movements of industrialized nations, and gaining popularity thanks to the Kyoto Protocol, the Copenhagen Conferences, and the Paris Agreement of the United States Nations Framework Convention on Climate Change (Vrchota et al., 2020). Green technology "refers to technology that can save resources and reduce environmental pollution during the production process" (Dong et al., 2021, p. 2). Furthermore, technological orientation could be interpreted as the possibility of opening companies up to new ideas and the tendency to adopt technologies for the development of ecological products (Celikyay & Adiguzel, 2020). For its part, ecological technology is directly related to the application of green innovation to launch the resulting ecological products in the market, in line with the concept of sustainable development (Wang et al., 2021). The use of green technologies therefore enables the introduction of green processes in production, favouring the environmental impact (Vrchota et al., 2020). Green technology innovation is recognized as a necessary and contributing factor for the reduction of greenhouse gas emissions (Sun et al., 2020), and implementing innovation in pollution prevention technologies can impact on achieving green products (Dost et al., 2019). In synchronicity with the current dynamic environment, not considering the development of technology would be disastrous for the viability of businesses that seek to take care of the environment with their actions (Le, 2022). Thus, the role of technology must be further expanded to facilitate the management of green manufacturing, from eco-innovative designs to the reduction and recycling of waste, emissions, and energy, among others (Seth et al., 2018). Similarly, green technologies could play a vital role in balancing the economic objectives of the company and environmental protection (Palmer & Truong, 2017). There is an imperative need to develop clean and ecological technologies that lead to the reduction of pollution and emissions, favouring production processes (Erzurumlu & Erzurumlu, 2013; S. J. Khan, Kaur, et al., 2021).

Palmer & Truong (2017) identify the lack of attention to understanding how upgrades in green technology can contribute in a commercially and environmentally viable approach. From the financial perspective of innovation, green technology can also achieve an unprecedented level of performance in reducing resources, production and operating costs; improving the quality of processes, the manufactured product, and the scalability and response of new products; achieving more efficient management of manufacturing data; improving communication between departments; and increasing market share, which could lead to an impact on productivity resulting in production efficiency (Llach Pagès, Bikfalvi, & de Castro Vila, 2009; Wang et al., 2021), prompting the creation of a market accepted offer of GPI that can impact the environmental and financial performance of the company. According to Yin, Zhang, Li, & Dong (2021), "systematic innovation of green technology is the key to implement green manufacturing, and it is hugely significant to promote high-quality financial development" (p. 1).

Therefore, in light of the above, we believe that TECH is associated with organizational performance, implying the following hypothesis:

H2: The adoption of technology has a positive effect on performance.

To complement the above hypothesis, we want to distinguish between the different degrees of adoption of the technologies implemented, in which case we expect the following hypothesis to be confirmed:

H2a: A high degree of adoption of technology has a positive effect on performance.

6.3. Methodology and measurement

6.3.1. Data collection

For the evaluation and empirical analysis, we proceeded using data collected from the EMS 2018 edition, which is the sum of thematic blocks that seek to measure attributes and impacts at the level of organizational, environmental, and technological concepts. The objective of the survey is to obtain information on production processes, asking companies in the manufacturing sector about the use of new technologies and innovative organizational concepts. The survey questions are decided by the participants of a consortium made up of European research centres and universities, administered by the Fraunhofer Institute for Systems and Innovation Research ISI. EMS-2018 was answered by approximately 3,250 manufacturing companies from 15 European countries: Germany, Switzerland, Austria, Croatia, Slovenia, Spain, the Netherlands, Denmark, Portugal, Sweden, Serbia, Lithuania, Slovakia, the Czech Republic, and Norway (Fraunhofer Institute for Systems and Innovation Research ISI, 2021).

Various research projects associated with environmental approaches have been carried out based on the data gathered in different versions of the EMS. Under empirical evidence, and using a sample of manufacturing companies in Spain, Llach, Castro, Bikfalvi, & Marimon (2012) present the relationship between implementing the environmental management system and organizational innovations. From a sample of 335 manufacturing companies in Denmark, Gerstlberger, Praest Knudsen, & Stampe (2014) study the interaction between product innovation and energy efficiency measures in pursuit of the generation of strategies for sustainable development. Using the Spain and Slovenia samples, Palčič, Pons, Bikfalvi, Llach, & Buchmeister (2013) map the relationship between the adoption of technologies in pursuit of energy reduction and the consumption of resources in the production of the manufacturing companies evaluated. Based on the samples from France, the Netherlands, Slovenia, Spain and Croatia, with a total of 763 firms, Sartal, Llach, Vázquez, & de Castro (2017) investigate the contribution of environmental and information technologies to lean manufacturing (LM) capability to achieve better performance. Under the empirical evidence of a sample of 206 manufacturing companies in Spain and Croatia, Serrano-García et al., (2022) analyse what configuration of green innovation capabilities and organizational dimensions leads to achieving green product innovation.

6.3.2. Sample

The data sample in this article is represented by n = 1,018 companies, corresponding to the sub-samples of Croatia (101), Lithuania (199), Spain (81), Serbia (235), Slovakia (108), and Slovenia (127), and Sweden (167). Five criteria were considered in selecting and organising the samples of the seven countries under study: a) the sample selection approach and the EMS questions were applied across the board to all seven countries; b) according to the result of the Global Innovation Index, which calculates the indices referring to inputs - capabilities for the generation of innovation, and the results for innovation of the economies of 126 countries analyzed in the 2018 version, which found how in Europe, and specifically at the level of the countries observed in this paper (Sweden, Spain, Slovenia, Slovakia, Lithuania, Croatia and Serbia with efficiency ratios of 0.82, 0.7, 0.74, 0.74, 0.63, 0.7, 0.63, respectively), the countries present scores close to each other, exceeding the median 0.61 for efficiency in innovation of the evaluated countries, which is above 50% of the efficiency of the group of evaluated countries (Cornell University; INSEAD; WIPO, 2018); c) according to the European Innovation Scoreboard, which presents the comparative results classified into four categories- leader, strong, moderate and modest - in terms of research and innovation in European countries. For the year 2018, Sweden ranks as a leader in innovation; Slovenia is in the range of strong innovators; and Croatia, Slovakia, Spain, Lithuania, and Serbia are moderate innovators (Hollanders & Es-Sadki, 2018), showing how the seven countries evaluated are located in the upper ranks of innovative countries, positioning them as promoters of innovation in favor of economic development at European level; d) according to the results of the Environmental Performance Index, which measures the behavior of 180 countries based on two environmental policy objectives, divided into ten thematic categories and projected onto 24 indicators with a score from 0 to 100, where 0 indicates the worst performance and 100 the best performance. Thus, for the year 2018, Sweden ranks fifth with a score of 80.51, Spain 12th with 78.39, Slovakia 28th with 70.60, Lithuania 29th with 69.33, Slovenia 34th with 67.57, Croatia 41st with 65.45, and Serbia 84th with 57.49. These results show how the countries in question occupy important positions in the achievement of the established objectives in pursuit of a good general environmental performance (Wendling, Emerson, Esty, Levy, & de Sherbinin, 2018); e) the total number of companies analyzed is located within the manufacturing industrial sector listed in NACE Rev. 2, codes 10 to 33, with at least 20 employees.

Table 16 relates the descriptive statistics of the sample, following the Organization for Economic Cooperation and Development classification and according to the technological intensity identified based on the investment in R&D of the manufacturing industries (Galindo-Rueda & Verger, 2016). It is inferred that the companies with the largest participation, both at the industrial sector level and in terms of the number of samples, are located in low-technology followed by medium-low-technology industries. The highest number of average employees is in the medium-high-technology sector, denoting a lower share of the classification of industrial sectors with respect to medium-low and low-technology industries. Manufacturing industries that have medium-high intensity and high-technology industries are only minimally different from medium-low and low-technology Industries in the adoption of GPC. Companies that have high-technology industries present a better TECH than the industrial sectors that have a greater number of average employees and a greater grouping of manufacturing sectors. Furthermore, it is inferred how investment in R&D of companies that are classified in the different levels of technological intensity is also reflected positively in both GPC and TECH.

Table 16. Descriptive features of the sample by technological intensity

	Low-technology Industries	Medium-low-technology industries	Medium-high-technology industries	High-technology industries
NACE	10-18, 31	19, 22-25, 32, 33	20, 27-30	21, 26
N	339	291	211	40
Average number of employees	142	119	188	130
Average green production capability	4	4	5	5
Average TECH organisational dimension	3	4	4	5

6.3.3. The measures

6.3.3.1. Dependents variables: environmental performance and financial performance

In this study, organizational performance was determined via the measurement of environmental performance and financial performance. To measure environmental performance, objectives need to be identified and the execution of green processes and products needs to be monitored. The variable used to measure environmental performance was *whether new or improved products generate an improvement in environmental impact during use or when discarded*, with the option of a dichotomous response corresponding to a *YES / NO* selection. Environmental performance can refer to actions such as the selection and use of clean raw materials in the production process; the maximization of materials; energy and water; the control of atmospheric emissions and the reduction of hazardous substances; the prolongation of the useful life of the product; and the coherent management of waste, among others (Asociación Española de Normalización y Certificación - EANOR, 2010; Madden, Young, Kevin, & Hall, 2006).

For financial performance, the variable considered was return of sales (ROS), which corresponds to the ratio that calculates the profitability related to sales operations, allowing the operational efficiency of the company to be evaluated. ROS is calculated as the net profit divided by sales for the period assessed and expressed as a percentage. A positive ROS shows how the company is moving towards its operational efficiency since it shows the amount of profitability obtained by each unit of sales revenue (Llach Pagès et al., 2009). Since the EMS asked about the value of ROS in ranges and not in unit values, for the object of this study ROS was preserved in a categorized way in the ranges of 1 for ROS 0%-2%, 2 for ROS > 2%-5%, 3 for ROS 5%-10%, and 4 for ROS > 10%.

6.3.3.2. Independent variables: green production capability and technology

The variables referring to the organization of production and management/-controlling were considered to measure GPC. The variables related to production control, automation and robotics, additive manufacturing technologies, and energy efficiency technologies were used to measure TECH. The list of variables is presented in Table 17. For both GPC and TECH, the variables are a dichotomous response corresponding to the selection of *YES / NO* and are characterized in terms of the utilization of levels of potential use corresponding to *low*, medium, or high use, only for when the answer is *YES*.

Table 17. Green production capability and technology incluidas en European Manufacturing Survey

Green production capability		Technology	
1.	STANDARDIZED INSTRUCTIONS: Standardized and detailed work instructions (e.g., standard operation procedures SOP, MOST).	1.	DEVICES: Mobile/wireless devices for programming and controlling facilities and machinery (e.g., tablets).
2.	MEASURES TO IMPROVE: Measures to improve internal logistics (e.g., Value Stream Mapping/Design, changed spatial arrangements of production steps).	2.	DIGITAL SOLUTIONS: Digital solutions to provide drawings, work schedules or work instructions directly on the shop floor.
3.	FIXED PROCESS: Fixed process flows to reduce setup time or optimize change-over time (e.g., SMED, QCO).	3.	PLAN: Software for production planning and scheduling
4.	(e.g., ERP system).		
5.	TASK: Integration of tasks (planning, operating, or controlling functions with the machine operator)	4.	DIGITAL EXCHANGE: Digital Exchange of product/process data with suppliers / customers (Electronic Data Interchange EDI).
6.	PRODUCTION CONTROLLING: Production controlling following the Pull principle (e.g., KANBAN, Internal zero-buffer principle).	5.	CONTROL SYSTEM: Near real-time production control system (e.g., Systems of centralized operating and machine data acquisition, MES).
7.	DISPLAY: Display boards in production to illustrate work processes and work status (e.g., Visual Management).	6.	LOGISTIC: Systems for automation and management of internal logistics (e.g., Warehouse management systems, RFID).
8.	METHODS OF ASSURING: Methods of assuring quality in production (e.g., CIP, TQM, SixSigma, preventive maintenance).	7.	VIRTUAL REALITY: Virtual Reality or simulation for product design or product development (e.g., FEM, Digital Prototyping, computer models).
9.	CERTIFIED QUALITY: Certified quality standards (e.g., ISO 900xx)	8.	INDUSTRIAL ROBOTS MANUFACTURING: Industrial robots for manufacturing processes (e.g., welding, painting, cutting).
10.	CERTIFIED ENERGY: Certified energy management system (e.g., EN ISO 50001)	9.	INDUSTRIAL ROBOTS ASSEMBLING: Industrial robots for handling processes (e.g., depositing, assembling, sorting, packing processes, AGV).
11.	METHODS MATHEMATICAL: Methods of operation management for mathematical analyses of production (e.g., regression analysis, queening models).	10.	TECHNOLOGIES FOR PROTOTYPING: 3D printing technologies for prototyping (prototypes, demonstration models, 0 series).
12.	CERTIFIED ENVIRONMENTAL: Certified environmental management system (e.g., EN ISO 14001).	11.	TECHNOLOGIES FOR MANUFACTURING: 3D printing technologies for manufacturing of products, components and forms, tools, etc.
	PLM: Product-Lifecycle-Management-Systems (PLM) or Product/Process Data Management	12.	TECHNOLOGIES RE-USE: Technologies for recycling and re-use of water (e.g., water recirculating system).
		13.	TECHNOLOGIES RECUPERATE: Technologies to recuperate kinetic and process energy (e.g., waste heat recovery, energy storage).

Likewise, and following the methodology proposed by Llach Pagès et al (2009) and Pons et al., (2013), Table 18 presents the variable SUM_GPC, which takes values between zero and twelve and corresponds to the count of the total capabilities applied. We proceeded in a similar way for the levels of SUM_TECH, the high levels of SUMHIGH_GPC and SUMHIGH_TECH.

Table 18. Description of SUM_GPC – SUMHIGH_GPC and SUM_TECH – SUMHIGH_TECH

Variables	Construction Variable	Values
SUM_GPC	Total capabilities used, representing the number of chosen green capabilities that the company has implemented.	For N = 12, which is the maximum number of capabilities analyzed
SUMHIGH_GPC	Total capabilities that have a high level of use, representing the number of chosen capabilities that have a high level of adoption in the enterprise.	
SUM_TECH	Total technologies used, representing the number of chosen technologies that the company has implemented.	For N = 13, which is the maximum number of technologies analyzed
SUMHIGH_TECH	Total technologies that have a high level of use, representing the number of technologies chosen that have a high level of adoption in the enterprise.	

6.3.3.3. Control variables

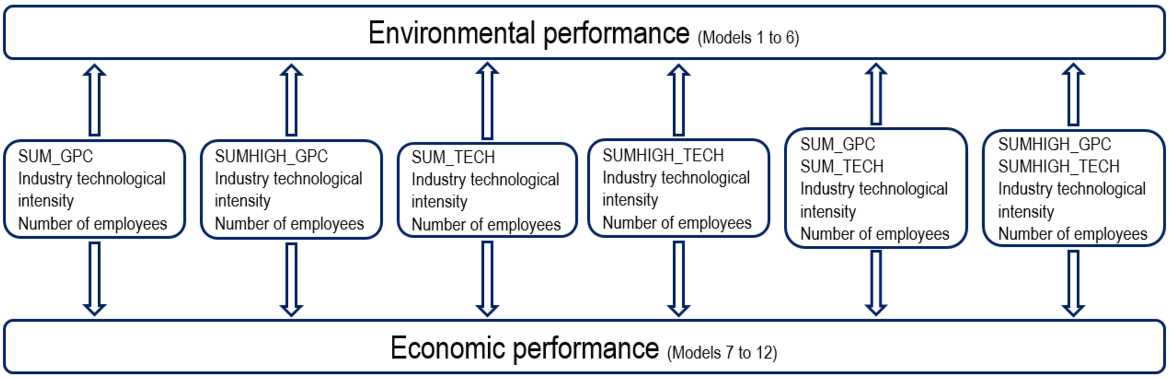
Seeking to control the heterogeneity of the industry and the company (Dangelico et al., 2016), two control variables were present in the model: the number of employees and the technological intensity of the industry. The size of the company was selected given that it may be impacting productivity and therefore technological innovation and financial performance (Bridoux & Stoelhorst, 2014). Its measurement was calculated from the number of employees. The classifications listed in NACE Rev. 2, codes 10 to 33, were taken to identify the technology-intensive industry, since this reflects the classification regarding technological development and structural changes in the European community (Eurostat European Commission, 2008). Its measurement was projected according to the level of intensity of research and development, in line with the classification reported by the Organization for Economic Co-operation and Development corresponding to the year 2016 (Galindo-Rueda & Verger, 2016).

6.3.3.4. Statistical modelling

The environmental variable was labeled with the values *YES* and *NO*, applying binary logistic regression, with SUM_GPC, SUM_TECH, SUMHIGH_GPC, SUMHIGH_TECH as the independent and the control variables. ROS was categorized in the previously described ranges, and for this dependent variable the ordinal logistic regression was executed. For both types of regression, the pseudo R^2 was used, following the method proposed by Cox and Snell and Nagelkerke, since the higher the result of R^2, the degree to which the independent variables explain the dependent variable is determined. Statistical modeling was performed with the original data from the samples of the seven countries, using SPSS Statistics version 24®.

Figure 7 presents the analytical framework where modeling is projected in six sequences for both environmental and financial performance.

Figure 7. Analytical framework of the research



6.4. Results and discussion

6.4.1. Descriptive analysis

Figure 8 of implementation of GPC in the companies surveyed. *Standardized and detailed work instructions (e.g., standard operation procedures SOP, MOST)* with 77%, followed by *Certified quality standards (e.g., ISO 900xx)* with 69%, *Methods of assuring quality in production* with 61% and *Display boards in production to illustrate work processes and work status* with 53%, show that of the twelve capabilities for the GPC these four are the most implemented in organizations. The opposite occurs with capabilities: *Production controlling following the Pull principle (e.g., KANBAN, Internal zero-buffer principle), Product-Lifecycle-Management-Systems (PLM) or Product/Process Data Management*, *Certified energy management system (e.g., EN ISO 50001)* do not exceed 30% in their implementation, which draws attention considering that they could be strategic capabilities in pursuit of GPI.

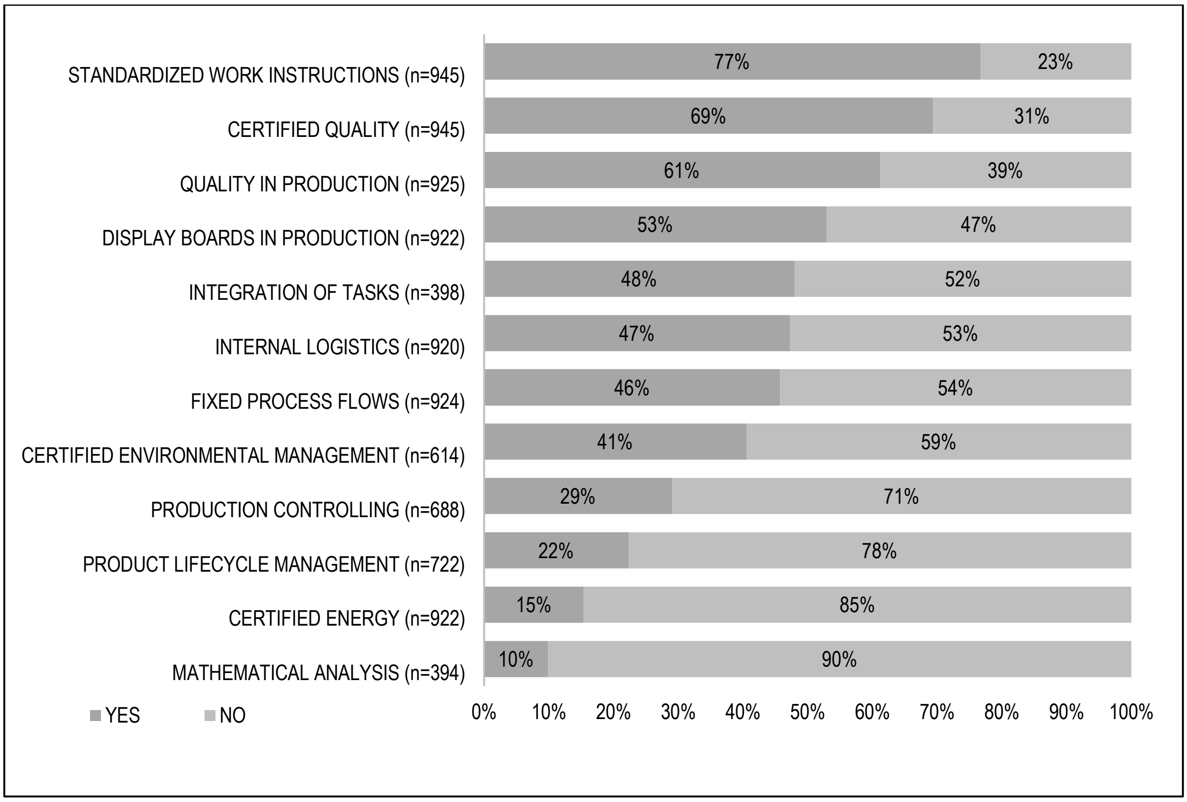


Figure 8. Used of green production capability

Regarding the levels of the use of GPC (low, medium, and high) presented in Figure 9 it is identified how some capabilities that have a high implementation are related to a high level of use. To this effect, *Certified quality standards (e.g., ISO 900xx)* presents a high level of use of 66% compared to the implementation of GPC at 61%, followed by *Certified environmental management system (e.g., EN ISO 14001)* with a 61% level of implementation compared to the implementation of GPC, at 69%. Furthermore, Figure 8 shows that 69% of companies implement *Certified quality standards (e.g., ISO 900xx),* and of these 66% implement it at a high level, as identified in Figure 9, observing a correspondence between implementation and use at high levels.

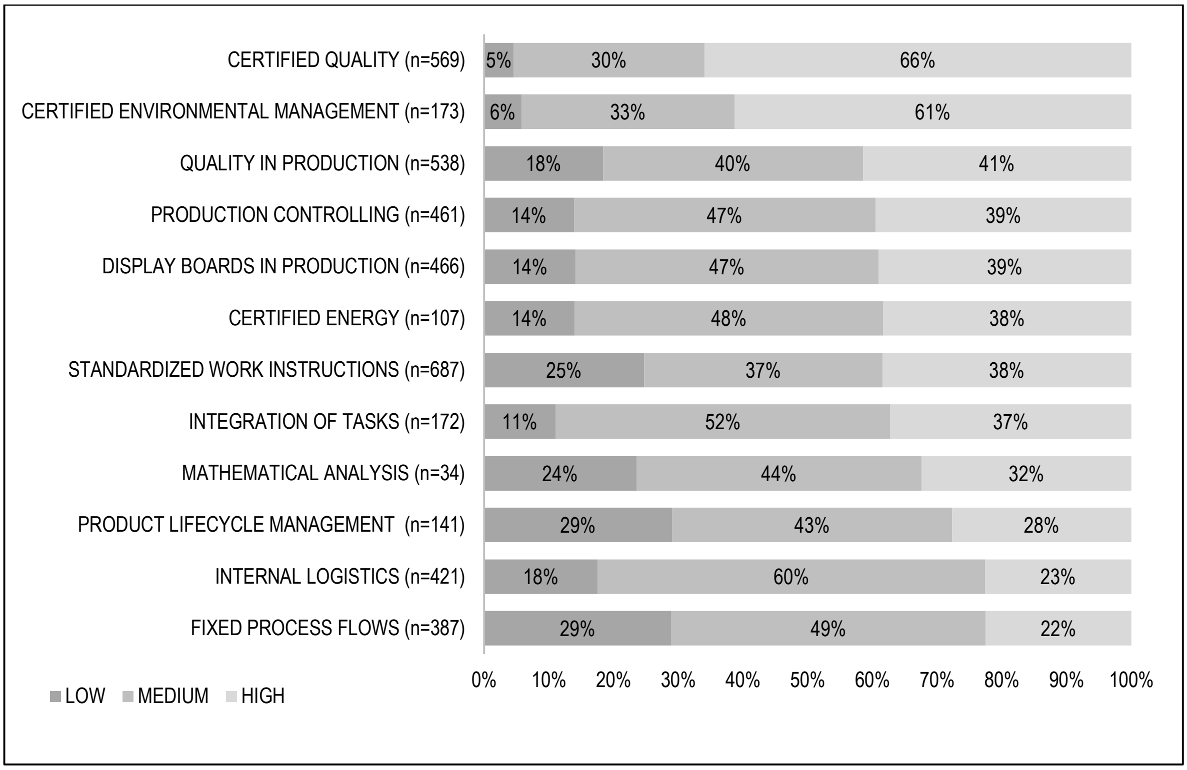


Figure 9. Implementation degree of green production capability

Figure 10 lists the percentages of TECH implementation. *Software for production planning and scheduling* (e.g., ERP system) ranks as the most implemented at 60%, followed by *Digital solutions to provide drawings, work schedules or work instructions directly on the shop floor* with 46%, and *Digital Exchange of product/process data with suppliers/customers with* 44%. *3D printing technologies for prototyping* with 18% and *3D printing technologies for manufacturing of products, components and forms,* tools, *etc.,* with 12%, are the least implemented.

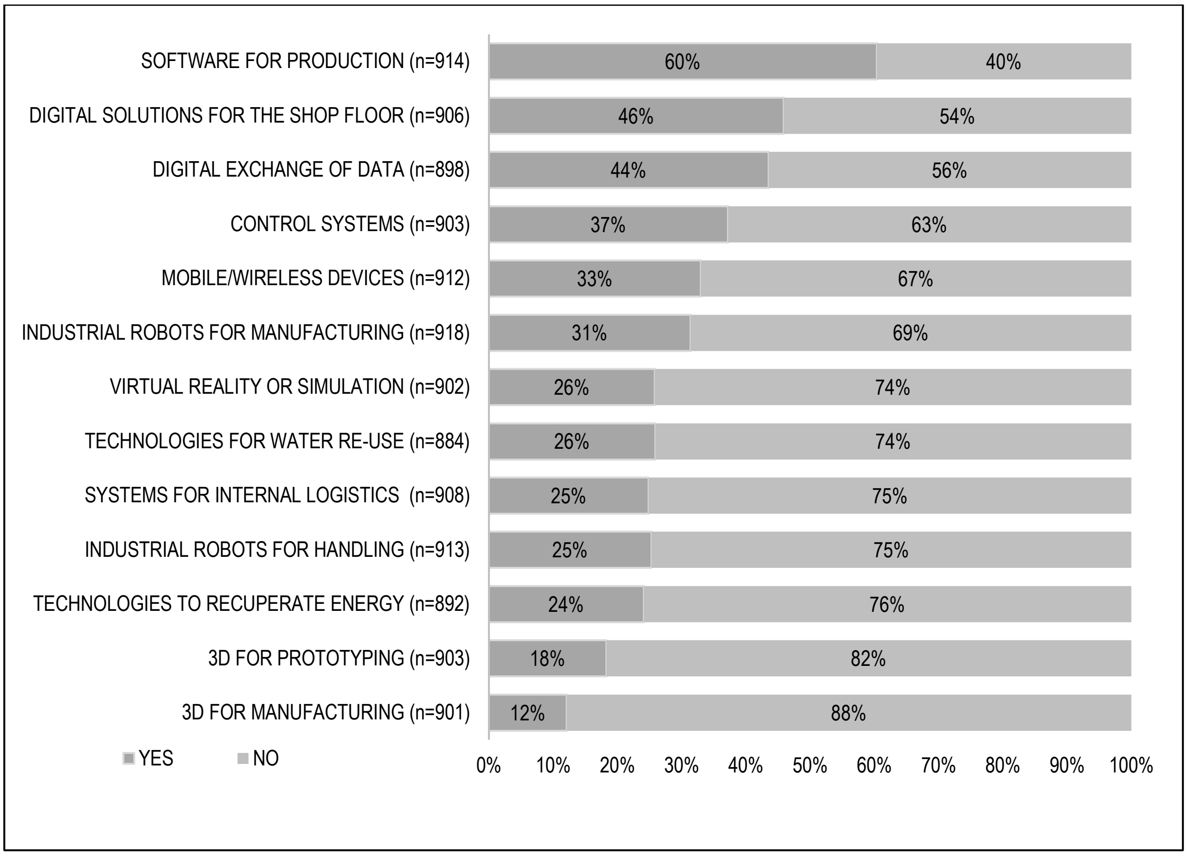


Figure 10. Used of technology

Regarding the results of the use of TECH corresponding to low, medium, and high presented in Figure 11, it is observed that *Software for production planning and scheduling (e.g., ERP system)* presents the highest level of use with 57%, compared to the lowest percentage of 19% corresponding to *3D printing technologies for the manufacturing of products, components, and forms, tools, etc.* Retaining a high level, *Industrial robots for manufacturing processes* and *Digital solutions to provide drawings, work schedules or work instructions directly on the shop floor* take second place in terms of the technology most used in companies, with 42%.

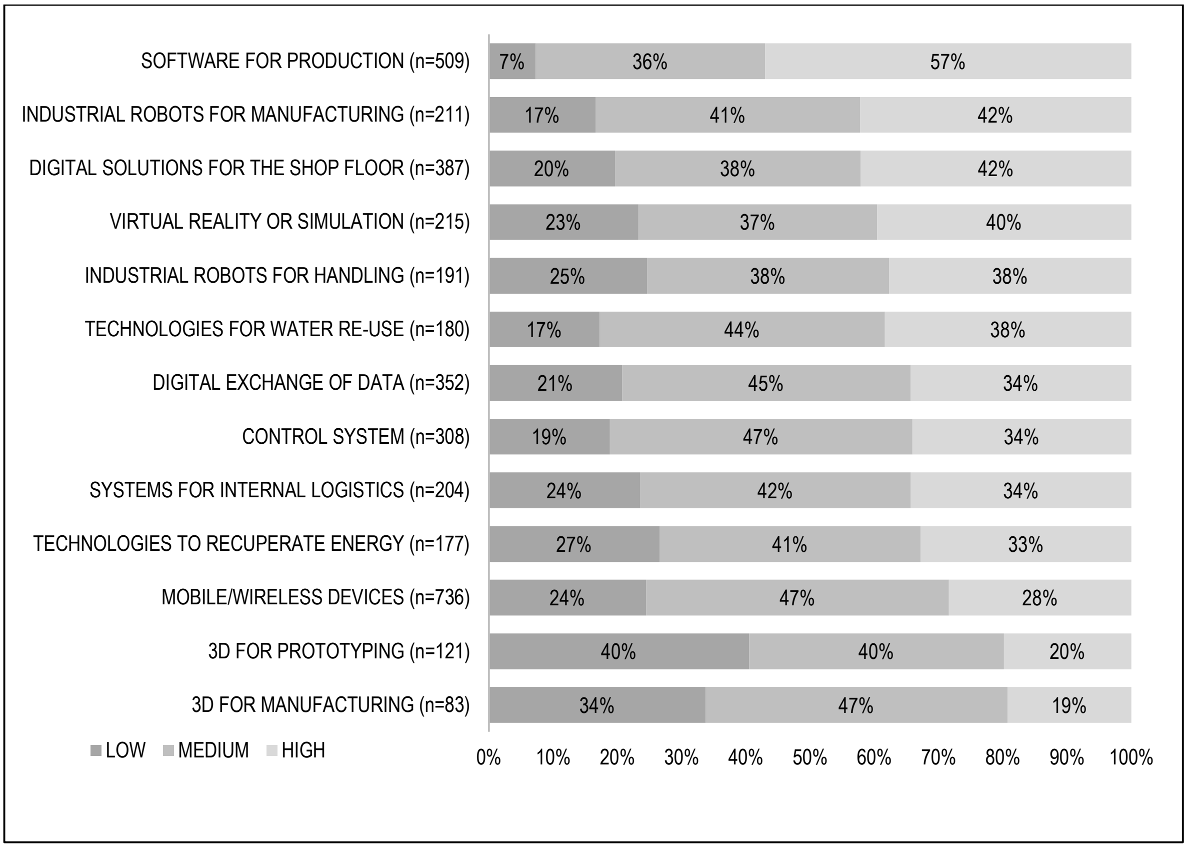


Figure 11. Implementation degree of technology

6.4.2. Impact of green production capability and technology on organizational performance

The following section presents the results and discussion, with the aim of contributing with new knowledge relating to the adoption of green production capability and technology, together with their high levels of implementation, to know their contribution to organizational performance.

6.4.2.1. Exploring the relationship between green production capability, technology, their level of usage and environmental performance

Table 19 presents the results of the models implemented to test the relationship between green production capability, technology and their levels of usage, in conjunction with the control variables, to determine the impact on environmental performance, taking into account the significant value of * *p* value <0.1, ** value of $p<0.05$, and *** value of $p<0.01$, which determine the explanation of the dependent variable with respect to the independent ones. The results given using the SPSS® software in terms of beta values (β), β index values, the constant for the analysis and interpretation of the results of the models are also presented.

Model 1 includes the SUM_GPC variable, while model 2 includes the variable SUMHIGH_GPC, and both models integrate the control variables. The results show that the values of the exponentials of β in SUM_GPC and

SUMHIGH_GPC are 1.1751 and 1.1609, respectively, indicating that these variables have a significant impact on environmental performance. In both models, the control variable industry technological intensity explains the impact with respect to the dependent variable since it is significant at $p<0.01$. As for the values of R^2 Cox and Snell and NagelKerke, Model 1 behaves better than Model 2, which means that Model 1 has greater goodness of fit with respect to the dependent variable. These results support how GPC is a key factor in the development of GPI, showing that manufacturing products with renewable materials and minimizing the use of inputs has a positive impact on environmental performance. These findings are consistent with Wang et al. (2021), who find that design and manufacturing in an ecological way are key business processes in pursuit of organizational performance. Therefore, having a high use of SUM_GPC positively impacts the implementation of a coherent environmental strategy.

The SUM_TECH and SUMHIGH_TECH variables were processed in Model 3 and Model 4, together with the control variables. The two variables have a respective incidence of 1.1317 and 1.1045 times more likely to have a significant impact on environmental performance. For both models, the variable industry technological intensity has a significant impact on this performance $p<0.01$. The goodness of fit values of Cox and Snell and Nagelkerke that best describe the dependent variables are the ones presented in Model 3, as opposed to Model 4, indicating that this model explains to a greater degree the behaviour of environmental performance. The results obtained indicate how innovation in technologies aimed at prevention and the reduction of non-renewable resources implies the production of green products. This means that the sustainable innovation measures that organizations can implement to reduce their environmental impact also improve the company's production processes (Wei, Li, Liu, & Du, 2022). These findings also coincide with Forés (2019), who identifies how several empirical studies find a positive impact of green technology on environmental performance, derived from the measures developed based on the prevention of pollution and the healthy use of resources. Therefore, considering these results, the implementation of a high level of green technologies contributes to the reduction of environmentally destructive substances by linking green technology in the manufacture of products.

Last, Model 5 is presented, which includes the variables SUM_GPC, SUM_TECH and the control variables, showing that SUM_GPC and SUM_TECH are 1.1334 and 1.0768 times more likely, respectively, to have a significant impact on environmental performance. Another variable that has a significant effect on both models is industry technological intensity. Following the sequence, the SUMHIGH_GPC variable of Model 6 is 1.1441 times more likely to significantly impact environmental performance. To this effect, the variables used in Model 5 explain to a greater degree the percentage of independent variables that impact environmental performance, based on the significant values presented in the model. These relationships are most significant in the case of the implementation of SUM_GPC and SUM_TECH, as with industry technological intensity.

In summary, regarding the goodness of fit delivered by all the models, the one with the best R^2 values is Model 5, indicating that this model better explains the behavior of the dependent variable. Therefore, considering our results, it is identified that high levels of adoption of green technologies in combination with green innovation capabilities may be causing the deviation of important resources and capabilities in core areas of the business, causing a lower impact on environmental performance.

Table 19. Environmetal performance - regression models SUM_GPC, SUM_TECH, SUMHIGH_GPC and SUMHIGH_TECH

Model 1	*β*	Exp(*β*)	Model 2	*β*	Exp(*β*)
SUM_GPC	0.1614***	1.1751	SUMHIGH_GPC	0.1492***	1.1609
Industry technological intensity	0.2470***	1.2802	Industry technological intensity	0.2858***	1.3309
Number of employees	0.0005	1.0005	Number of employees	0.0005*	1.0005
Constant	-1.5740***		Constant	-1.2378***	
R^2 Cox y Snell	0.0699		R^2 Cox y Snell	0.0564	
R^2 NagelKerke	0.0939		R^2 NagelKerke	0.0757	
Model 3	*β*	Exp(*β*)	**Model 4**	*β*	Exp(*β*)
SUM_TECH	0.1237***	1.1317	SUMHIGH_TECH	0.0994**	1.1045
Industry technological intensity	0.2610***	1.2982	Industry technological intensity	0.3071***	1.3595
Number of employees	0.0005	1.0005	Number of employees	0.0007**	1.0007
Constant	-1.4023***		Constant	-1.1820	
R^2 Cox y Snell	0.0611		R^2 Cox y Snell	0.0430	
R^2 NagelKerke	0.0820		R^2 NagelKerke	0.0578	
Model 5	*β*	Exp(*β*)	**Model 6**	*β*	Exp(*β*)
SUM_GPC	0.1252***	1.1334	SUMHIGH_GPC	0.1346***	1.1441
SUM_TECH	0.0740**	1.0768	SUMHIGH_TECH	0.0313	1.0318
Industry technological intensity	0.2358**	1.2659	Industry technological intensity	0.2938***	1.3415
Number of employees	0.0003	1.0003	Number of employees	0.0005	1.0005
Constant	-1.6760***		Constant	-1.2758***	
R^2 Cox y Snell	0.0776		R^2 Cox y Snell	0.0565	
R^2 NagelKerke	0.1042		R^2 NagelKerke	0.0759	

Significant in * p<0.1 value; ** p<0.05 value; p<0.01 value.

It is generally observed that the variables evaluated are identified as predictors contributing to environmental performance, except for number of employees, the impact of which is only identified in Models 2 and 4. How the implementation of SUM_GPC, SUMHIGH_GPC, SUM_TECH and SUMHIGH_TECH is an excellent measure in pursuit of a good environmental performance is inferred. This result agrees with the findings of Seth et al., (2018), who identify that by understanding and applying drivers of green manufacturing and green technology, strategic organizational benefits manifested in eco-efficiency can be obtained. Our result also concurs with Afum et al., (2021), who identify a unique contribution made by developing ecological products, improved corporate image and the generation of ecological competitiveness.

Regarding the association of SUMHIGH_GPC, Industry technological intensity and SUMHIGH_TECH, it is observed that this does not contribute to the model for good environmental performance. This result is in line with the findings of Forés, (2019), who identifies how high levels of adoption of ecological technologies can affect production capabilities that are respectful of the environment, but do not generate a significant impact on environmental performance.

Therefore, we can conclude that for environmental performance the adoption of GPC and its high level of implementation, even when in association with TECH, satisfy hypotheses H1 and H1a; the adoption of SUM_TECH, its high implementation and its association with SUM_GPC satisfy hypotheses H2 and H2a; but the association between SUMHIGH_GPC and SUMHIGH_TECH does not satisfy hypothesis H2a.

In summary, this study contributes to the literature and to practice with new knowledge about the association of green production capability, technology, and their levels of implementation in environmental performance. In this regard, the adoption of green production capability in association with technology contributes directly to environmental performance. However, and as we explore next in the association of high levels of implementation, it is observed that technology does not have a significant impact on environmental performance.

6.4.3. Exploring the relationship between green production capability, technology, their level of usage and financial performance

Next, Table 20, Table 21 y Table 22 present the results of the models that seek to test the relationship between green production capability, organizational dimension technology and their levels of usage, in conjunction with the control variables, to determine the impact on financial performance.

Model 7 includes the SUM_GPC variable and the control variables as predictors of ROS. It can be observed that SUM_GPC increases the probability of having a ROS greater than 5% and greater than or equal to 10%, while the control variables reveal that they are weak predictors of financial performance. In terms of SUM_GPC, which has a positive effect on ROS, this result confirms the arguments presented by Hartmann & Germain, (2015) and Wang et al., (2021), who identify that reconfiguring capacities for the design and manufacture of green products leads to the strengthening of the organization, whose reputation, economic performance, and ecological image improve.

The opposite happens in Model 8, where the technological industry intensity is a contributing variable for financial performance; that is, the greater the participation of industrial sectors, the greater the probability of having a better performance in ROS greater than or equal to 10%. A similar thing happens with SUMHIGH_GPC, where it is identified that the greater the use, the higher the percentage of the achievement of ROS $p<0.1$; that is, it is possible to show how the implementation of green production capabilities can be an influential factor in the pursuit of good financial performance. These results are consistent with the findings of Clarkson, Li, Richardson, & Vasvari, (2011), who identify how companies that choose to improve their capabilities towards green development can experience improvements in their financial resources. This is how companies with high capabilities focused on a proactive environmental strategy are associated with better financial performance (Clarkson et al., 2011).

Table 20. Financial performance - regression models SUM_GPC and SUMHIGH_GPC

ROS Ranges	(2%-5%)		(5%-10%)		(>10%)	
Model 7	*β*	Exp(*β*)	*β*	Exp(*β*)	*β*	Exp (*β*)
SUM_GPC	0.0658	1.10680	0.1089*	1.1151	0.1021*	1.1075
Industry technological intensity	0.0153	1.0154	0.1034	1.1089	0.2291	1.2574
Number of employees	-0.0002	0.9998	-0.0003	0.9997	-0.0007	0.9993
Constant	-0.0646		-0.1583		-0.7729	
R^2 Cox y Snell	0.0184					
R^2 NagelKerke	0.0197					
Model 8	*β*	Exp(*β*)	*β*	Exp(*β*)	*β*	Exp (*β*)
SUMHIGH_GPC	0.0537	1.0552	01569**	1.1698	0.1299*	1.1387
Industry technological intensity	0.0374	1.0382	0.1232	1.1311	0.2522*	1.2869
Number of employees	-0.0002	0.9998	-0.0003	0.9997	-0.0007	0.9993
Constant	0.0587		-0.0245		-0.6210	
R^2 Cox y Snell	0.0224					
R^2 NagelKerke	0.0240					

Reference category, ROS (0-2%). Significant in * p<0.1 value; ** p<0.05 value; *** p<0.01 value.

Table 21 presents Model 9, which includes the variable SUM_TECH, which affects ROS with an incidence of occurrence of 1.13 times in the range of 5% to 10%, and 1.10 times when the range is greater than or equal to 10%. However, the control variables for this model show that they are not a good predictor for higher performance. Furthermore, Table 21 presents Model 10, where it is observed that increasing SUMHIGH_TECH increases the probability of having a ROS greater than 5%, while having a high industrial-technological intensity increases the probability of having an impact greater than or equal to 10% in ROS. This result is consistent with the studies by Forés, (2019) and He et al., (2021), which identify that beyond a certain level of adoption, green technology can represent a high cost of implementation, which can make it difficult to manage, requiring high investment and extensive financial support.

Table 21. Financial performance - regression models SUM_TECH and SUMHIGH_TECH

ROS Ranges	(2%-5%)		(5%-10%)		(>10%)	
Model 9	*β*	Exp(*β*)	*β*	Exp(*β*)	*β*	Exp (*β*)
SUM_TECH	0.0857*	1.0895	0.1222***	1.1300	0.1002**	1.1053
Industry technological intensity	-0.0258	0.9746	0.0751	1.0780	0.2111	1.2351
Number of employees	-0.0003	0.9997	-0.0004	0.9996	-0.0007	0.9993
Constant	0.0493		0.0006		-0.6034	
R^2 Cox y Snell	0.0218					
R^2 NagelKerke	0.0234					
Model 10	*β*	Exp(*β*)	*β*	Exp(*β*)	*β*	Exp(*β*)
SUMHIGH_TECH	-0.0059	0.9942	0.1209*	1.1285	0.1106	1.1170
Industry technological intensity	0.0343	1.0349	0.1359	1.1455	0.2651*	1.3036
Number of employees	-0.0001	0.9999	-0.0002	0.9998	-0.0007	0.9993
Constant	0.2211		0.1477		-0.4965	
R^2 Cox y Snell	0.0202					
R^2 NagelKerke	0.0216					

Reference category, ROS (0-2%). Significative in * value of p<0.1; ** value of p<0.05; *** value of p<0.01.

Last, Table 22 shows the results of the association of the SUM_GPC variables, SUM_TECH, and their levels of implementation together with the control variables. Model 11, which includes the sum of green production capability and technology, shows that the variable SUM_TECH increases the probability of having an impact on ROS greater than 5% and up to 10%, because innovation in green technology can contribute to improving energy efficiency (Shahzad et al., 2022). These technologies also play an important role among the financial objectives, with the requirement of protecting the natural world (Palmer & Truong, 2017). These results show that SUM_GPC and the control variables are not significant contributors to the model. It can be identified how, regarding the variables SUM_GPC and the industry technological intensity, the greater the participation in these, the greater the possibility of increasing ROS, thereby improving financial performance. Therefore, we can conclude that only the variable SUM_TECH contributes to the model. Similarly, in Model 12, when changing from the sums to a high level of implementation together with the control variables, there is a minimal difference compared to Model 11, wherein only the variable industry technological intensity is significant for a ROS of over 10%.

Considering the results, the combination of SUM_GPC, and SUM_TECH was expected to have a significant impact on financial performance. We believe that this combination could be affected by various factors such as the need for production capacities that the company needs to reconfigure oriented to green development; the implementation of programs related to the minimization of waste; the consumption of natural resources and energy; the cost of renewable raw materials; and the acquisition of insurance premiums and environmental regulations (Viñolas Marlet, 2005). At the same time, for the organization the complexity involved in the management of green technology implies a change of customs and paradigms, as well as high investment to acquire technology and the organizational reconfiguration of its capabilities. All the above affects financial performance. SUMHIGH_GPC and SUMHIGH_TECH together do not have a positive effect either, showing coherence with the previous results.

Table 22. Financial performance - regression models SUM_GPC, SUM_TECH, SUMHIGH_GPC and SUMHIGH_TECH

Rangos del ROS	(2%-5%)		(5%-10%)		(>10%)	
Model 11	*β*	Exp(*β*)	*β*	Exp(*β*)	*β*	Exp(*β*)
SUM_GPC	0.0159	1.0161	0.0359	1.0366	0.0449	1.0459
SUM_TECH	0.0790	1.0822	0.1102**	1.1164	0.0807	1.0841
Industry technological intensity	-0.0309	0.9695	0.0571	1.0588	0.1984	1.2195
Number of employees	-0.0004	0.9996	-0.0005	0.9995	-0.0008	0.9992
Constant	0.0139		-0.0787		-0.6817	
R^2 Cox y Snell	0.0237					
R^2 NagelKerke	0.0254					
Model 12	*β*	Exp(*β*)	*β*	Exp(*β*)	*β*	Exp(*β*)
SUMHIGH_GPC	0.0546	1.0561	0.1077	1.1137	0.0757	1.0786
SUMHIGH_TECH	-0.0360	0.9646	0.0755	1.0785	0.0726	1.0753
Industry technological intensity	0.0260	1.0263	0.1112	1.1176	0.2520*	1.2866
Number of employees	-0.0002	0.9998	-0.0003	0.9997	-0.0008	0.9992
Constant	0.1862		0.0651		-0.5326	
R^2 Cox y Snell	0.0260					
R^2 NagelKerke	0.0278					

Reference category, ROS (0-2%). Significant in * p<0.1 value; ** p<0.05 value; *** p<0.01 value.

Therefore, we can conclude that H1 and H1a, contrasted in Models 7 and 8, are accepted. Likewise, Models 9 and 10 confirm H2 and H2a. Regarding the association of SUM_GPC and SUM_TECH, contrasted in Model 11, H1 is not accepted, whereas H2 is. The opposite result is obtained for the association of high implementation contrasted in Model 12, the findings of which indicate that H1a and H2a cannot be accepted.

In conclusion, the present study makes an important contribution to the knowledge of green production capabilities, technology and their levels of implementation in pursuit of better financial performance, allowing us to show that these factors are contributing positively in this respect. Regarding the association of green production capabilities and technology, it is shown how only the adoption of the latter contributes to improved financial performance, while the association of its high implementation does not contribute significantly.

6.5. Conclusions and theoretical and management implications

Following the suggestions for future research raised in Serrano-García et al., (2021) and Serrano-García et al., (2022) in relation to the separate analysis and statistical validation of each of the seven green innovation capabilities in association with each of the five organizational dimensions to identify their impact on organizational performance, in this research we carried out an exploratory analysis of the association of green production capability, the technology organizational dimension and their respective levels of implementation, seeking to determine their impact on environmental and economic performance. We did so by recognizing the need for a series of determinants focused on the green. This in turn implies the reconfiguring of capabilities and dimensions that allow green innovation to be managed in pursuit of improving organizational performance, leading to competitive advantage.

According to the evidence collected by the European Manufacturing Survey 2018 edition, referring to the manufacturing companies studied in Croatia, Lithuania, Spain, Serbia, Slovakia, Slovenia, and Sweden, we identified how, based on the percentage of implementation of green production capability, technology, and their level of implementation, the variables are being adopted at different levels to improve environmental and financial performance. This fact is especially relevant because greater implementation could be aimed at improving financial performance, in particular given that, based on the percentages identified when analysing the most implemented variables, an impact on environmental performance is generally reflected. This suggests that, as a strategic resource, companies in the manufacturing sector are earmarking financial resources for the creation and adoption of green technologies, both software and/or hardware, and for investment to constitute or reconfigure their current green production capacity, as a dynamic approach that will lead their improved organizational performance.

One of the outstanding findings of the present study is the decisive relationship between technology and environmental and financial performance. This is because ecological technologies can be a fundamental tool for implementing strategies relating to green production processes in line with the financial and ecological aims of companies in the manufacturing sector.

The same can be said for green production capability, which is being adopted in most manufacturing companies given that it significantly impacts on environmental and financial performance. Our results show how green production capability is relevant for achieving organizational performance, suggesting the need for its implementation in processes related to the reduction and/or elimination of harmful materials and to the use and optimization of renewable raw materials to ensure alignment with the constitution of GPI in pursuit of competitive advantage.

Another aspect to highlight is the result regarding high levels of implementation, which shows how the high implementation of green production capability has a significant impact on both environmental and financial performance. This finding has important implications given that it shows how the perspective of the resource-based view is an excellent framework for implementing environmental solutions in manufacturing firms, confirming its potential as a facilitator for reconfiguring green creation and production processes in relation to the performance of the organization. The same happens with the high implementation of technology, which has a significant impact on both environmental and financial performance. This finding, therefore, is a challenge for companies, academia, and government agents in pursuit of ongoing incentivization towards an increased implementation of green technology as a contribution to the creation of green production innovation, which resonates on financial performance. Consequently, and in accordance with the findings of Begum, Ashfaq, Xia, & Awan, (2022), a key aspect for the question in hand is the ongoing and adequate training of human talent in the area of environmental sustainability and the management of green technologies, such that employees can become more involved and play a greater and more effective part in the creation of green processes and products, with the support of a higher degree of implementation of green technology, which will impact positively on financial performance.

Another finding is how the association of the adoption of green production capability and technology is contributing to better environmental performance. This is especially relevant given that it confirms how production capabilities aimed at preventing the generation of waste, the use of eco-efficient materials and the reuse of waste (Serrano-García et al., 2021) lead to the creation of green production innovation. Furthermore, technology intervenes in reducing the resources used and pollution, decreasing environmental impacts and favouring the green production process, which merges with reputation and organizational image, as well as with green competitiveness.

Contrarily, and again in regard to the association of green production capability and technology, it can be seen how this does not contribute significantly to improving financial performance, having detected the weakness that the only significant variable is technology. Nonetheless, the possibility of this performance impacting positively, though to a lesser degree, only by improving the percentage of implementation of green production capability is presented. In this regard, how to seek the strengthening of green production capability in association with the organizational dimension of technology is an outstanding contribution, as both alternatives tend to become key organizational tools, facilitating manufacturing processes and reducing pollution, the cost of materials and even taxes, and formulating environmental regulations to support sustainable competitive advantage, resulting in financial impact.

The present research, based on a subsample of 1,018 companies in the manufacturing sectors of seven European countries and structured under a statistical model, makes relevant contributions to the field of management and organizational theories, as well as to business practice for managerial reconfiguration and transition directed towards sustainable development from the authentic operation of green innovation. In summary, we have tested and proven the following assumption: the adoption and high level of implementation of green production capability and technology has a positive effect on environmental and financial performance. In association, this adoption also has a significant impact on environmental performance but not on financial performance. However, for high levels of implementation it was identified that this association is not decisive for the two types of performance given that only green production capability contributes to environmental performance.

6.6. Implications for scholars, managers, and policy makers

Our findings confirm theoretical and practical implications that may correspond to opportunities for academics, practitioners, and government entities. Regarding the theoretical contributions of this research, the theoretical approach of green production capability and the approach of green technology are analysed, identifying them as necessary to study the achievement of green product innovation. In turn, these theoretical approaches shed light on how green technology is contributing to the impact on environmental and financial performance. Notably, the radicality of green production capability is identified as a support for the determinants of green product innovation, benefiting environmental and financial performance. Therefore, from an academic perspective, this article contributes to the resource-based view, the natural resource-based view, and dynamic capabilities, with its extension to green innovation capabilities and more specifically to green production capabilities, providing solid exploratory evidence of their positive relationship with organizational performance. This was achieved by verifying how production capabilities directed towards reducing/eliminating the use of elements that are harmful to the environment, no longer using natural resources and optimizing the use of biodegradable raw materials, among others, favour the achievement of sustainable production and impact organizational performance. This research also contributes to advancing knowledge about how technology is an essential resource in the pursuit of financial performance.

In terms of contributions for managers of manufacturing companies, the results of this study show the need to implement green innovation capabilities. Specifically, and according to the present results, it is identified how green production capability impacts on organizational performance. Therefore, it is recommended that managers continue to strengthen the implementation and high use of this capability to continue with the good environmental and financial performance that allows them to strengthen the positioning of their comparative and competitive advantages. In addition, and with respect to technology, it is identified that its implementation is necessary to achieve environmental and financial performance, but that special care must be taken in terms of its high level of implementation since at a certain level of adoption technology does not significantly contribute to performance. Based on these findings, a call is made for manufacturing companies to continue implementing green production capability and technology as strategic and differentiating factors that advance organizational performance.

Our findings are valuable for formulating government policies since they identify the need for manufacturing companies to persist with the promotion of green production capability and technology as a solution to reducing harm to the environment. In this regard, governments must offer incentives so that companies can acquire green production capabilities and the necessary technology to proceed towards the creation of green production innovation, with a view to improving organizational performance and impacting on sustainable development. This promotion is also in line with environmental regulations and is therefore a way for companies, society and the state to comply with and benefit from them.

6.7. Limitations and future work

A series of research opportunities are identified from the limitations presented by the current research, calling for future studies to pursue creativity and debate for the creation of green product innovation directed towards organizational performance:

a) In this research, we worked under the theoretical contextualization of green production capability and technology. Other theoretical lenses of industrial organization and technology management could also be considered. b) In this research, the variable *number of employees* only contributed to environmental performance in statistical models two and four. Therefore, more studies are required to evaluate the contribution of this variable to organizational performance. c) The hypotheses of the present paper were accepted. However, it was not statistically evident that the overall effect of the association between green production capability and the adoption of technology have a significative impact on economic performance. Furthermore, it was shown how, at high levels of use, this association does not have a significant impact on environmental and financial performance since it was observed in the association to determine environmental performance that only green production capability significantly contributes to the model. Therefore, more research is required to corroborate or contradict these results, and other statistical and analytical methods that can account for different options that allow the framework proposed in this research to be tested must be considered. d) In this research, we focus on several existing technologies and capabilities. Consequently, new research should include new technologies and capabilities that emerge in the market to identify whether they also have an impact on organizational performance. e) Globally, sustainability is regarded from social, ecological and economic perspectives (Mittal and Sangwan, 2014). The current research covers only the last two, while do not disposing of social sustainability measures -as other authors Awan et al., 2018; Awan, 2019- although do recognising their high importance, relevance and value. f) In this research we collect data on the manufacturing sector, so future studies could consider other sectors to broaden the context of this investigation and to verify further sectoral patterns. g) Although we worked with the sub-samples of seven European countries, a subsequent investigation could include data from the other eight sub-samples of the EMS to have a more robust sample that further enhances the research and allows the results of the first seven countries to be transposed to the other eight countries to carry out comparative analyses. h) Data collection from companies is a complex process and companies are invited to identify the importance of reporting the information consulted and to increase participation by providing effective responses. In this way, information systems are strengthened, and academics can process these data to generate recommendations for companies in the productive sector more effectively, to contribute to sustainable progress.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Capítulo 7. Discusión

En la siguiente sección se relacionan las contribuciones correspondientes a cada uno de los tres artículos que conforman la presente tesis:

7.1. Contribución del primer artículo

En el primer artículo se explora cuáles son los determinantes constitutivos del producto innovador verde y cuál es la configuración de capacidades de innovación verde, dimensiones organizacionales y determinantes en búsqueda del producto innovador verde.

En consecuencia, se aporta con la identificación y unificación de veintidós conjuntos de determinantes del producto innovador verde a partir de los cuales se hace referencia a qué aspecto medioambiental se está promoviendo, transformados en desafíos organizacionales. En este sentido, se amplía el campo del conocimiento al determinar características propias de la innovación, articulada, asimismo, con los factores inherentes de la sostenibilidad ambiental de forma que conlleven a la constitución de un producto verde.

Seguidamente, se aporta con la actualización y definición de siete nuevas capacidades de innovación orientadas al verde. Más estratégicamente, las siete capacidades propuestas son adaptadas y definidas a las diferentes competencias de la organización, donde se caracteriza la forma y alcance tanto a nivel administrativo y en sí el tecnicismo verde, de tal manera que puedan ser asimiladas y puestas en funcionamiento dentro de la organización, facilitando la concreción del planteamiento ecológico. Bajo este enfoque se amplía el campo del conocimiento a la teoría de la visión basada en los recursos, la visión basada en los recursos naturales y a las capacidades dinámicas, con su extensión en las capacidades de innovación verde, al extender y robustecer las diferentes definiciones y aplicaciones de las capacidades hacia la innovación y al verde, para sopesar el rigor de la ecologización a nivel organizacional.

A continuación, se ensamblan cinco dimensiones organizacionales que forman parte de una extensión hacia el verde, propuestas bajo un modelo de congruencia sistémica para ayudar hacia la reconfiguración organizacional. Este ensamble de dimensiones organizacionales proviene de los argumentos sobre como la organización es vista a través de un sistema de elementos interrelacionados que mediante la congruencia permiten la transformación de los procesos. En la presente tesis son actualizadas bajo el contexto contemporáneo de la organización de caras a la creación del producto innovador verde, como una forma de contribuir al fortalecimiento de la competitividad en procura del desarrollo sostenible.

De acuerdo con lo anterior, se contribuye con una taxonomía donde se presenta una relación que explica cómo los conjuntos de determinantes impactan a una capacidad, una dimensión o a las diferentes combinaciones de éstas al interior de la organización. Por tanto, con la taxonomía se suministra una visión global de factores requeridos para la reconfiguración organizacional hacia el desarrollo del producto innovador verde, brindándole una pauta al administrador desde qué área de la organización puede actuar para responder a los determinantes y, de esta manera tener una mayor factibilidad para crear el producto innovador verde.

Del resultado de la taxonomía se deriva una matriz, la cual se constituye como una herramienta administrativa y de carácter sistémico, que permite operacionalizar las relaciones entre las capacidades de innovación verde, dimensiones organizacionales y los determinantes, facultando la selección y el control de variables, para medir y evaluar la asociación en términos de gestión de la innovación orientada al desarrollo de producto innovador verde.

Todo lo anterior, genera un framework que contempla a la organización como un sistema abierto interrelacionado, donde cada uno de los fundamentos propuestos se ajustan, se apoyan y se coordinan. Por tanto, se aporta con un novedoso modelo administrativo enfocado en la gestión de la innovación verde bajo un enfoque sistémico, buscando dar respuesta a los requerimientos de los determinantes del producto innovador verde. Con este *framework* se contribuye al conocimiento, así como al personal del rediseño y tomadores de decisiones, una relación estructural de elementos de la organización que le permite redireccionar las estrategias, las funciones y las acciones, para fortalecer la gestión de la innovación tecnológica en el interés de la creación y desarrollo del producto innovador verde.

7.2. Contribución del segundo artículo

En el segundo artículo se determina qué configuración de capacidades de innovación verde y dimensiones organizacionales conduce al logro del producto innovador verde. Es así como, partiendo de la operacionalización de la matriz y con apoyo del trabajo exploratorio, con el cual se identificó a un grupo de empresas que desarrollan aún innovaciones de productos convencionales y tres grupos de empresas en diferentes etapas de desarrollo del producto innovador verde. Se permitió reconocer dieciocho determinantes clave del producto ecológico donde se muestra qué capacidades de innovación verde y dimensiones organizacionales están asociadas con la obtención del producto innovador verde.

Por tanto, en esta investigación se evidencia cómo todas las siete nuevas capacidades de innovación verde: *capacidad de planeación estratégica verde, capacidad de innovación organizacional verde, capacidad de producción verde, capacidad de investigación y desarrollo verde, capacidad de aprendizaje y relacionamiento organizacional verde, capacidad de gestión de recursos y capacidad de marketing verde,* en conjunto con las cinco dimensiones organizacionales: *regulación ambiental, recursos humanos, tecnología, comportamiento organizacional y responsabilidad ambiental corporativa*, aportan cada una, desde su óptica y condición técnica, a la gestión de los determinantes conducentes a la concepción del producto innovador verde.

En consecuencia, esta investigación revela un sistema de elementos interrelacionados donde se evidencia como cada una de sus partes aportan a la reconfiguración organizacional para responder a la transformación de los procesos encaminados a la gestión de innovación del producto innovador verde. Por tanto, se revela como el *framewok* propuesto en Serrano-García et al., (2021) es un instrumento administrativo que permite aportar a la gestión de la innovación hacia la constitución de la gestión ambiental. Esto conlleva a identificar cómo es necesario tomar en consideración a la organización bajo un enfoque sistémico, donde se tenga en cuenta a cada una de las capacidades de innovación verde y dimensiones organizacionales analizadas, para la gestión de innovación enfocada hacia el desarrollo del producto innovador verde.

7.3. Contribución del tercer artículo

En el tercer artículo se establece si la adopción y el uso alto de la capacidad de producción verde y tecnología afectan al desempeño ambiental y al financiero. En atención a lo cual, a partir de una submuestra de empresas manufactureras de siete países europeos y con el apoyo del análisis exploratorio, se identifica como las hipótesis formuladas fueron aceptadas.

Por tanto, el desarrollo de la investigación permitió evidenciar como la adopción de la capacidad de producción verde y sus altos niveles de uso sí contribuyen al desempeño ambiental y económico, respaldando de esta manera la comprensión e importancia del fenómeno de la capacidad de producción verde para las empresas del sector manufacturero. Es así como, se revela que contar con una capacidad de producción enfocada en la disminución o eliminación de sustancias cancerígenas, de recursos naturales, de desechos, por una forma de producción limpia, donde se optimicen los recursos, el uso de materiales renovables, la puesta en marcha de las 6 Rs, permiten la constitución del producto innovador verde, impactando de forma directa al desempeño organizacional. En consecuencia, consolidándose la capacidad de producción verde como una capacidad clave para los procesos de producción verde en procura del desarrollo sostenible.

Asimismo, se evidencia como la adopción de la tecnología y sus niveles de uso alto aportan hacia el desempeño ambiental y financiero, mostrando la trascendencia de las tecnologías verdes para los procesos productivos ecológicos. Por tanto, se confirma con esta investigación como disponer de tecnologías contribuye a la transformación de los procesos tradicionales hacia el diseño y creación procesos de producción ecológicos, contribuyendo al ahorro de recursos, aminorar o reducir los efectos ambientales y los desechos, facilitando un uso correcto y el reciclaje de materiales, la reducción de recursos y costos en la manufactura, entre otros, facultando el diseño y la fabricación de productos verdes. Debido a lo cual, se constata a la tecnología verde como un componente estratégico organizacional que influye en la mejora del desempeño ambiental, en la imagen de la empresa, en ganar cuota de mercado, redundando de forma significativa en el desempeño de la empresa.

Respecto a la asociación, otra evidencia que entrega la presente tesis es como la articulación en la adopción de la capacidad de producción verde y la tecnología sí contribuyen a un mejor desempeño ambiental. Este resultado es un punto determinante para la gestión de la innovación verde, ya que se demuestra como la asociación de estos dos factores son necesarios para la optimización del proceso de fabricación, favoreciendo el despliegue de condiciones de eficiencia y eficacia en la producción verde para impactar en el desempeño ambiental.

Sin embargo, la asociación en la adopción de la capacidad de producción verde y la tecnología no contribuyen de manera significativa al desempeño financiero. Asimismo, se revela como la asociación en sus usos altos no muestran un impacto significativo en el desempeño ambiental y en el financiero. Lo anterior significando la necesidad de continuar esta línea de estudio para identificar de qué manera la asociación en mención podría estar afectando de manera positiva al desempeño de la organización.

Capítulo 8. Conclusiones, implicaciones, limitaciones y trabajo futuro

Dada la actual situación ambiental, las empresas del sector manufacturero tienen un gran desafío, pero a la vez, una gran oportunidad de ser más competitivas mediante la incursión al mercado de productos innovadores verdes. Una forma posible de lograrlo podría ser mediante la reconfiguración de las capacidades y dimensiones organizacionales, sirviendo de cimientos para los determinantes orientados al desarrollo de productos verdes. Por tanto, con esta tesis se pretende *entender el fenómeno del desarrollo del producto innovador verde desde sus antecedentes hasta el impacto relacionado con las capacidades de innovación verde en asocio con dimensiones organizacionales: evidencia desde la Encuesta Europea de Innovación en Producción.* Es así cómo, en búsqueda de este objetivo general se desarrollan tres objetivos específicos de investigación a partir de los cuales, se presentan las respectivas conclusiones. Para finalizar este capítulo, se exponen las limitaciones, las implicaciones y los trabajos futuros.

Por consiguiente, a partir de una búsqueda cautelosa de trabajos de investigación se identificó como varios artículos proponen una serie de *framework* basados en determinantes para respaldar a nivel organizacional la creación del producto innovador verde. Sin embargo, no se evidencia un escenario donde se identifique cómo se podría organizar determinantes de dicho producto sujeto a un enfoque sistémico, apoyado en las siete capacidades de innovación verde y la estructuración de las cinco dimensiones organizacionales identificadas. Por tanto, esta es la primera investigación en articular las siete nuevas capacidades de innovación verde y la estructuración de las cinco dimensiones organizacionales postuladas en beneficio de la creación del producto ecológico. Lo anterior, estratégicamente desarrollado a partir de la identificación, agrupación y taxonomía de los determinantes requeridos para el desarrollo del producto innovador verde.

Del precedente se deriva una matriz, la cual se operacionaliza al extraer de la Encuesta Europea de Innovación en Producción sesenta y un variables medibles en representación de los determinantes del producto innovador verde, y ubicadas analíticamente en las intersecciones de cada capacidad de innovación verde y dimensión organizacional, lo cual empíricamente se evidencia bajo la conformación de cuatro *cluster* y la identificación de 18 determinantes clave, donde hace presencia las siete capacidades de innovación verde en conjunto con las cinco dimensiones organizacionales, confirmando su impacto positivo para el desarrollo del producto innovador verde. Lo anterior, constata cómo esta configuración es un marco de referencia sistémico para la gestión de la innovación verde. Por tanto, se concluye como las nuevas siete nuevas capacidades de innovación verde y las cinco dimensiones organizacionales son un soporte estratégico de los determinantes causando una reconfiguración organizacional para contribuir en la creación del producto innovador verde.

Realizando un *zoom* de la matriz respecto de la asociación de determinantes, las capacidades de innovación verde y las dimensiones organizacionales, y de acuerdo con las sugerencias de trabajos futuros propuestos en

Serrano-García et al., (2021) and Serrano-García et al., (2022), con relación al análisis por separado y de forma empírica de cada una de las capacidades de innovación verde en combinación con cada una de las dimensiones organizacionales. Se procede a seleccionar el intercepto de la capacidad de producción verde y la dimensión organizacional tecnología con el propósito de identificar su impacto en el desempeño organizacional. Por tanto, con el apoyo del modelo estadístico de regresión logística y las sub-muestras representativas de siete países europeos, donde cada país entrega características y comportamientos únicos y diferentes, se identifica como la capacidad de producción verde y la tecnología contribuyen de manera directa al desempeño de la organización. A la vez, la asociación de la capacidad de producción verde y la tecnología en su adopción presentan impacto positivo en el desempeño ambiental, pero se constata que no tiene impacto en el financiero. Igualmente, la asociación de la capacidad de producción verde y la tecnología en sus usos altos no presentan un impacto positivo en el desempeño ambiental y en el financiero.

8.1. Implicaciones

A continuación, se formulan implicaciones para empresas del sector manufacturero, creadores de políticas gubernamentales y la academia.

8.1.1. Implicaciones para las empresas manufactureras

La problemática ambiental es uno de los desafíos imperiosos que las empresas del sector manufacturero requieren afrontar actualmente, viendo la necesidad de reevaluar sus estrategias organizacionales, volcándose a considerar la creación y comercialización del producto innovador verde. Estos productos revelan ser esenciales cuando de ventajas comparativas y competitivas se refiere, debido a que contribuyen al cuidado de los recursos naturales, y, a la vez, generan recursos financieros para la empresa. Por tanto, a la luz de los hallazgos de esta investigación, implica por parte de las empresas, repensar - incorporar una nueva reconfiguración organizacional sistémica, apoyada estratégicamente de las nuevas siete capacidades de innovación verde y las cinco dimensiones organizacionales en procura de la constitución del producto innovador verde. Convirtiendo esta reconfiguración en una herramienta administrativa para la transición y/o transformación hacia la gestión de la innovación verde, de manera que se vea reflejado como una solución para reducir problemas medioambientales, impactando, asimismo, al desempeño ambiental y al financiero.

8.1.2. Implicaciones para la academia

El escenario actual medioambiental manifiesta una necesidad urgente de poner en marcha prácticas organizacionales que conduzcan a la constitución de productos ecológicos. Para este reto es fundamental los aportes que los académicos pueden brindar al respecto. En consecuencia, es vital continuar con la conformación de evidencias que faciliten comprender cómo rediseñar, qué gestión realizar, cómo cambiar los paradigmas comportamentales y qué ajustar a nivel organizacional para abordar la innovación verde en procura de un desempeño sostenible. En ese sentido, de acuerdo con los resultados de la presente investigación, se evidencia empíricamente contribuciones a la *Resource - Based Theory*, a la *Natural - Resource-Based View* y a las *Dynamics Capabilities*, enfocadas con su extensión a las capacidades de innovación verde, y, sustentando, asimismo, el requerimiento de asociarlas a las dimensiones organizacionales, como un mecanismo que favorece cumplir con los determinantes del producto innovador verde. Por tanto, se abre un sin número de posibilidades y nuevos campos de investigación para que la academia continúe explorando la relación entre cada una de las capacidades de innovación verde y las dimensiones organizacionales buscando comprender su tecnicismo, comportamiento y qué otros aportes podrían brindar en procura de satisfacer a los determinantes del producto innovador verde, y, al desempeño de la organización impactando amigablemente al medioambiente.

8.1.3. Implicaciones para los creadores de políticas gubernamentales

Las entidades gubernamentales a nivel mundial son una pieza clave para el favorecimiento de la protección del medioambiente. A este respecto, son los llamados a continuar la formulación e impulso de políticas gubernamentales que ayuden a las empresas a crear los productos innovadores verdes. Por tanto, el presente trabajo trae consigo perspectivas necesarias de reconfiguración organizacional a nivel de las empresas del sector productivo, donde los gobiernos podrían estar promoviendo la constitución del producto innovador verde. En ese sentido, implica por parte de las entidades gubernamentales ampliar los beneficios financieros de forma que las empresas del sector en mención, puedan acceder a estos estímulos, permitiéndoles aumentar las inversiones necesarias que faculte la reconfiguración organizacional enfocada al verde. Asimismo, mediante la creación de políticas referentes a la formulación de capacitaciones que puedan ayudar a las empresas a identificar y llevar a cabo la forma en cómo deben reconfigurarse hacia la creación del producto ecológico.

8.1.4. Limitaciones y trabajo futuro

A continuación, se presenta una sucesión de limitaciones convertidas en oportunidades. La finalidad es promover la inventiva para la discusión y puesta en marcha de investigaciones futuras a partir del trabajo realizado.

En esta investigación no se experimentó con otras orientaciones teóricas organizacionales y de gestión tecnológica que podrían estar favoreciendo la constitución del producto ecológico, dado que se trabajó con un ambicioso abanico de capacidades de innovación verde y dimensiones organizacionales, las cuales fueron propuestas y relacionadas bajo la identificación, agrupación y taxonomía de determinantes requeridos para el logro del producto innovador verde. Por tanto, incorporar más enfoques teóricos en la presente investigación, se hubiese convertido es un desafío superior y con un alcance que la tesis no lograría cobijar. Es así cómo, para futuras investigaciones se recomienda abordar el desarrollo de producto innovador verde en combinación o de forma individual con las siete capacidades de innovación verde y las cinco dimensiones organizacionales propuestas en esta tesis, acompañadas de otras perspectivas conceptuales, por ejemplo, las teorías de las partes interesadas, la teoría de la contingencia, la teoría institucional, la cadena de valor y el modelo de negocio, entre otras, que puedan contribuir hacia el avance del desarrollo sostenible.

Por otra parte, se logró identificar cómo la asociación de las siete capacidades de innovación verde con cada una de las dimensiones organizacionales favorece a la constitución del producto innovador verde. Por tanto, se propone continuar la investigación en forma separada con cada una de ellas, tanto para la innovación de productos, así como su ampliación para el análisis de los procesos ecológicos. Asimismo, el *framework* propuesto se sugiere ser aplicado en aquellas investigaciones que desee estudiar el entorno y variaciones internas de la empresa en procura de la constitución de productos ecológicos, utilizando a la vez, otras técnicas estadísticas diferentes a las aplicadas en la presente investigación. Asimismo, se sugiere que el *framework* se estudie-actualice a partir de otras agrupaciones teóricas y enlaces estructurales.

Sobre la base creada en el primer artículo, un aspecto a considerar es la realización de mayor cantidad de investigación empírica para identificar las posibles configuraciones y su impacto respectivo en el desempeño ambiental y económico. Asimismo, y de acuerdo al vínculo identificado entre capacidades de innovación verde y dimensiones organizacionales, se recomienda a investigaciones futuras, experimentar con otras variables-enfoques que las organizaciones requieran operar y controlar simulando así a los determinantes constitutivos del producto innovador verde. Igualmente, sería aportante para el desarrollo sostenible, estudiar la asociación entre las capacidades de innovación verde y las dimensiones organizacionales en diferentes renglones económicos como el de agricultura, la ganadería, la construcción, el comercio, la salud, el turismo, entre otros, los cuales poseen también afán en reducir su impacto ambiental.

Referente al apoyo empírico, este trabajo se basa a partir de la Encuesta Europea de Innovación en Producción que entrega evidencia empírica representativa, facultando la evaluación de variables clave en el campo de la administración de la empresa, la producción y la gestión ambiental. Sin embargo, la recolección de información referente a la medición de las variables se procesa directamente con el director de la empresa o del director de producción, no contando con la participación directa de los empleados. Por tanto, un aspecto a recomendar sería mayor partición de empleados que estén directamente involucrados con cada uno de los procesos evaluados, dado que así posiblemente entregarían mayores aportes y una mejor visión del desempeño de las empresas respecto a las variables consultadas, facultando lo anterior, a obtener resultados más significativos a las diferentes investigaciones que se apoyen en Encuesta Europea de Innovación en Producción.

En la misma línea, la cantidad de países y el número de empresas que cobija las diferentes versiones de Encuesta Europea de Innovación en Producción, podría estar generando validez y solidez acerca de los resultados de las respectivas variables evaluadas. No obstante, y aun cuando se combinan los datos de los diferentes países, se encuentra un número limitado de respuestas por parte de las empresas consultadas, generando posibles limitaciones en los resultados. Por tanto, se recomienda que las empresas en la medida de lo posible hacer un mayor esfuerzo en el momento de diligenciar la información solicitada en la Encuesta Europea de Innovación en Producción, dado que esto podría reducir los posibles sesgos y los datos faltantes, ayudando por tanto a la academia para dar origen a interpretaciones y recomendaciones más elocuentes con la realidad.

Referencias

Abbas, J. (2020). Impact of total quality management on corporate green performance through the mediating role of corporate social responsibility. *Journal of Cleaner Production*, *242*. https://doi.org/10.1016/j.jclepro.2019.118458

Aboelmaged, M., & Hashem, G. (2019). Absorptive capacity and green innovation adoption in SMEs: The mediating effects of sustainable organisational capabilities. *Journal of Cleaner Production*, *220*, 853–863. https://doi.org/10.1016/j.jclepro.2019.02.150

Adler, P., & Sbenbar, A. (1990). Adapting your technological base: the organizational challenge. *Sloan Management Review*, *32*, 25–37.

Afum, E., Sun, Z., Agyabeng-Mensah, Y., & Baah, C. (2021). Lean production systems, social sustainability performance and green competitiveness: the mediating roles of green technology adoption and green product innovation. *Journal of Engineering, Design and Technology*, *ahead-of-p*(ahead-of-print). https://doi.org/10.1108/JEDT-02-2021-0099

Agustia, D., Permatasari, Y., Fauzi, H., & Sari, M. N. A. (2020). Research and development intensity, firm performance, and green product innovation. *Journal of Security and Sustainability Issues*, *9*, 1039–1049. https://doi.org/10.9770/jssi.2020.9.3(27)

Ahmad, M., & Wu, Y. (2022). Combined role of green productivity growth, economic globalization, and eco-innovation in achieving ecological sustainability for OECD economies. *Journal of Environmental Management*, *302*, 113980. https://doi.org/10.1016/j.jenvman.2021.113980

Akhtar, S., Martins, J. M., Mata, P. N., Tian, H., Naz, S., Dâmaso, M., & Santos, R. S. (2021). Assessing the Relationship between Market Orientation and Green Product Innovation: The Intervening Role of Green Self-Efficacy and Moderating Role of Resource Bricolage. *Sustainability*, *13*(20), 1–15. https://doi.org/10.3390/su132011494

Albino, V., Balice, A., & Dangelico, R. M. (2009). Environmental strategies and green product development: An overview on sustainability-driven companies. *Business Strategy and the Environment*, *18*(2), 83–96. https://doi.org/10.1002/bse.638

Albort-Morant, G., Leal-Millán, A., & Cepeda-Carrión, G. (2016). The antecedents of green innovation performance: A model of learning and capabilities. *Journal of Business Research*, *69*(11), 4912–4917. https://doi.org/10.1016/j.jbusres.2016.04.052

Alharthey, B. K. (2019). Impact of green marketing practices on consumer purchase intention and buying decision with demographic characteristics as moderator. *International Journal of ADVANCED AND APPLIED SCIENCES*, *6*(3), 62–71. https://doi.org/10.21833/ijaas.2019.03.010

Amores-Salvadó, J., Martin-de Castro, G., & Navas-López, J. E. (2015). The importance of the complementarity between environmental management systems and environmental innovation capabilities: A firm level approach to environmental and business performance benefits. *Technological Forecasting and Social Change*, *96*, 288–297. https://doi.org/10.1016/j.techfore.2015.04.004

Andersén, J. (2021). A relational natural-resource-based view on product innovation: The influence of green product innovation and green suppliers on differentiation advantage in small manufacturing firms. *Technovation*, *104*, 102254. https://doi.org/10.1016/j.technovation.2021.102254

Annunziata, E., Pucci, T., Frey, M., & Zanni, L. (2018). The role of organizational capabilities in attaining corporate sustainability practices and economic performance: Evidence from Italian wine industry. *Journal of Cleaner Production*, *171*, 1300–1311. https://doi.org/10.1016/j.jclepro.2017.10.035

Archie, C. B., & Carroll, A. B. (1991). The Pyramid of Corporate Social Responsibility: Toward the Moral Management of Organizational Stakeholders. *Business Horizons*, *34*(August), 39–48.

https://doi.org/doi:10.1016/0007-6813(91)90005-g

Ardyan, E., Rahmawan, G., Tinggi, S., & Ekonomi, I. (2017). Green innovation capability as driver of sustainable competitive advantages and smes marketing performance. *International Journal of Civil Engineering and Technology (IJCIET)*, *8*(September), 1114–1122.

Armbruster, H., Bikfalvi, A., Kinkel, S., & Lay, G. (2008). Organizational innovation: The challenge of measuring non-technical innovation in large-scale surveys. *Technovation*, *28*(10), 644–657. https://doi.org/10.1016/j.technovation.2008.03.003

Asociación Española de Normalización y Certificación - EANOR. (2010). UNE-EN ISO 14015:2010. Gestión ambiental. Evaluación ambiental de sitios y organizaciones (EASO). Retrieved from https://www.une.org/encuentra-tu-norma/busca-tu-norma/norma?c=N0046419

Awan, U., Kraslawski, A., & Huiskonen, J. (2017). Understanding the Relationship between Stakeholder Pressure and Sustainability Performance in Manufacturing Firms in Pakistan. *Procedia Manufacturing*, *11*(June), 768–777. https://doi.org/10.1016/j.promfg.2017.07.178

Awan, U., Nauman, S., & Sroufe, R. (2020). Exploring the effect of buyer engagement on green product innovation: Empirical evidence from manufacturers. *Business Strategy and the Environment*, (August), 1–15. https://doi.org/10.1002/bse.2631

Barney, J. B. (1991). Firm Reources ad Sustained Competitive Advantege. *Journal of Management*, *17*(1), 99–120. https://doi.org/https://doi.org/10.1177/014920639101700108

Barney, J. B., Ketchen, D. J., & Wright, M. (2011). The future of resource-based theory: Revitalization or decline? *Journal of Management*, *37*(5), 1299–1315. https://doi.org/10.1177/0149206310391805

Begum, S., Ashfaq, M., Xia, E., & Awan, U. (2022). Does green transformational leadership lead to green innovation? The role of green thinking and creative process engagement. *Business Strategy and the Environment*, *31*(1), 580–597. https://doi.org/10.1002/bse.2911

Berchicci, L., & Bodewes, W. (2005). Bridging environmental issues with new product development. *Business Strategy and the Environment*, *14*(5), 272–285. https://doi.org/10.1002/bse.488

Berry, M. A., & Randinelli, D. A. (1998). Proactive corporate Environmental Management: A new industrial revolution. *Academy of Management Executive*, *2*, 39–50.

Berry, M. A., & Rondinelli, D. A. (1998). Proactive corporate environmental management: A new industrial revolution. *Academy of Management Executive*, *12*(2), 38–50. https://doi.org/10.5465/ame.1998.650515

Bhaskar, A. U., & Mishra, B. (2017). Exploring relationship between learning organizations dimensions and organizational performance. *International Journal of Emerging Markets*, *12*(3), 593–609. https://doi.org/10.1108/IJoEM-01-2016-0026

Bhatia, M. S., & Jakhar, S. K. (2021). The effect of environmental regulations, top management commitment, and organizational learning on green product innovation: Evidence from automobile industry. *Business Strategy and the Environment*, *30*(8), 3907–3918. https://doi.org/10.1002/bse.2848

Bhupendra, K. V., & Sangle, S. (2016). Strategy to derive benefits of radical cleaner production, products and technologies: a study of Indian firms. *Journal of Cleaner Production*, *126*, 236–247. https://doi.org/10.1016/j.jclepro.2016.03.115

Bikfalvi, A., Lay, G., Maloca, S., & Waser, B. R. (2013). Servitization and networking: Large-scale survey findings on product-related services. *Service Business*, *7*(1), 61–82. https://doi.org/10.1007/s11628-012-0145-y

Block, M. R., & Marash, R. (2002). *Integración de la ISO 14000 en un sistema de gestión de la calidad*. (FC Editorial. Fundación Confemetal, Ed.) (3ª). Madrid - España.

Bocken, N. M. P., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, *33*(5), 308–320. https://doi.org/10.1080/21681015.2016.1172124

Bogers, M., Sund, K. J., & Villarroel, J. A. (2015). The Organizational Dimension of Business Model Exploration. In *Business Model Innovation: The Organizational Dimension* (pp. 603–610). https://doi.org/10.1093/acprof:oso/9780198701873.001.0001

Bogue, R. (2014). Sustainable manufacturing: A critical discipline for the twenty-first century. *Assembly Automation*, *34*(2), 117–122. https://doi.org/10.1108/AA-01-2014-012

Bolden, R., Waterson, P., Warr, P., Clegg, C., & Wall, T. (1997). A new taxonomy of modern manufacturing practices. *International Journal of Operations and Production Management*, *17*(11), 1112–1130. https://doi.org/10.1108/01443579710177879

Bowen, F. E., Cousins, P. D., Lamming, R. C., & Faruk, A. C. (2001). The role of supply management capabilities in green supply. *Production and Operations Management*, *10*(2), 174–189. https://doi.org/10.1111/j.1937-5956.2001.tb00077.x

Bridoux, F., & Stoelhorst, J. W. (2014). Microfoundations for stakeholder theory: Managing stakeholders with heterogeneous motives. *Strategic Management Journal*, *35*(1), 107–125. https://doi.org/10.1002/smj.2089

Burgelman, R., Maidique, M., & Wheelwright, S. (2004). *Strategic Management of Technology and Innovation*. McGraw-Hill.

Celikyay, M., & Adiguzel, Z. (2020). Analysis of Product Innovation Performances in Terms of Competitive Strategies of Companies in Production Sector Under the Influence of Technology Orientation. *International Journal of Organizational Leadership*, *8*(3), 43–59. https://doi.org/10.33844/ijol.2020.60480

Chams, N., & García-Blandón, J. (2019). On the importance of sustainable human resource management for the adoption of sustainable development goals. *Resources, Conservation and Recycling*, *141*(October 2018), 109–122. https://doi.org/10.1016/j.resconrec.2018.10.006

Chan, H. K., Wang, X., White, G. R. T., & Yip, N. (2013). An extended fuzzy-AHP approach for the evaluation of green product designs. *IEEE Transactions on Engineering Management*, *60*(2), 327–339. https://doi.org/10.1109/TEM.2012.2196704

Chang, C. H. (2016). The Determinants of Green Product Innovation Performance. *Corporate Social Responsibility and Environmental Management*, *23*(2), 65–76. https://doi.org/10.1002/csr.1361

Chang, C. H. (2017). How to Enhance Green Service and Green Product Innovation Performance? The Roles of Inward and Outward Capabilities. *Corporate Social Responsibility and Environmental Management*, *425*(December 2017), 411–425. https://doi.org/10.1002/csr.1469

Chen, J., & Liu, L. (2020). Customer participation, and green product innovation in SMEs: The mediating role of opportunity recognition and exploitation. *Journal of Business Research*, *119*, 151–162. https://doi.org/10.1016/j.jbusres.2019.05.033

Chen, Y.-S., & Chang, C.-H. (2013). The Determinants of Green Product Development Performance: Green Dynamic Capabilities, Green Transformational Leadership, and Green Creativity. *Journal of Business Ethics*, *116*(1), 107–119. https://doi.org/10.1007/s10551-012-1452-x

Chen, Y.-S., Lai, S.-B., & Wen, C.-T. (2006). The influence of green innovation performance on corporate advantage in Taiwan. *Journal of Business Ethics*, *67*(4), 331–339. https://doi.org/10.1007/s10551-006-9025-5

Cheung, M. F. Y., & To, W. M. (2019). An extended model of value-attitude-behavior to explain Chinese consumers' green purchase behavior. *Journal of Retailing and Consumer Services*, *50*(February), 145–153. https://doi.org/10.1016/j.jretconser.2019.04.006

Chiavenato, I. (2006). *Introducción a la teoría general de la administración*. (McGraw-Hill Interamericana, Ed.) (Séptima ed). México: McGraw-Hill Interamericana.

Chiavenato, I. (2009). *Administración de recursos humanos. El capital humano de las organizaciones*. (S. A. McGraw-Hill/Interamericana Editores, Ed.) (Octava). México: McGraw-Hill Interamericana.

Chkanikova, O. (2016). Sustainable Purchasing in Food Retailing: Interorganizational Relationship Management to Green Product Supply. *Business Strategy and the Environment*, *25*(7), 478–494. https://doi.org/10.1002/bse.1877

Chuang, C. H., Jackson, S. E., & Jiang, Y. (2013). *Can Knowledge-Intensive Teamwork Be Managed? Examining the Roles of HRM Systems, Leadership, and Tacit Knowledge*. *Journal of Management* (Vol. 42). https://doi.org/10.1177/0149206313478189

Chung, C. J., & Wee, H. M. (2010). Green-product-design value and information-technology investment on replenishment model with remanufacturing. *International Journal of Computer Integrated Manufacturing*, *23*(5), 466–485. https://doi.org/10.1080/09511921003667714

Clarkson, P. M., Li, Y., Richardson, G. D., & Vasvari, F. P. (2011). Does it really pay to be green? Determinants and consequences of proactive environmental strategies. *Journal of Accounting and Public Policy*, *30*(2), 122–144. https://doi.org/10.1016/j.jaccpubpol.2010.09.013

Collins, E., Lawrence, S., Pavlovich, K., & Ryan, C. (2007). Business networks and the uptake of sustainability practices: the case of New Zealand. *Journal of Cleaner Production*, *15*(8–9), 729–740. https://doi.org/10.1016/j.jclepro.2006.06.020

Comoglio, C., & Botta, S. (2012). The use of indicators and the role of environmental management systems for environmental performances improvement: A survey on ISO 14001 certified companies in the automotive sector. *Journal of Cleaner Production*, *20*(1), 92–102. https://doi.org/10.1016/j.jclepro.2011.08.022

Cornell University; INSEAD; WIPO. (2018). *The Global Innovation Index 2018: Energizing the World with Innovation.* (11TH Editt). Ithaca, Fontainebleau, and Geneva. Retrieved from http://creativecommons.org/licenses/by-nc-nd/3.0/igo/.%0Ahttps://www.globalinnovationindex.org/gii-2018-report

Daft, R. L. (2011). *Teoría y diseño organizacional*. (S. A. de C. V. Cengage Learning Editores, Ed.) (Décima). Cengage Learning Editores.

Damanpour, F. (1991). Organizational Innovation: A Meta-Analysis Of Effects Of Determinants and Moderators. *Academy of Management Journal*, *34*(3), 555–590. https://doi.org/10.5465/256406

Dangelico, R. M. (2016). Green Product Innovation: Where we are and Where we are Going. *Business Strategy and the Environment*, *25*(8), 560–576. https://doi.org/10.1002/bse.1886

Dangelico, R. M. (2017). What Drives Green Product Development and How do Different Antecedents Affect Market Performance? A Survey of Italian Companies with Eco-Labels. *Business Strategy and the Environment*, *26*(8), 1144–1161. https://doi.org/10.1002/bse.1975

Dangelico, R. M., Nonino, F., & Pompei, A. (2021). Which are the determinants of green purchase behaviour? A study of Italian consumers. *Business Strategy and the Environment*, (December 2020), 1–21. https://doi.org/10.1002/bse.2766

Dangelico, R. M., & Pontrandolfo, P. (2010). From green product definitions and classifications to the Green Option Matrix. *Journal of Cleaner Production*, *18*(16–17), 1608–1628. https://doi.org/10.1016/j.jclepro.2010.07.007

Dangelico, R. M., & Pujari, D. (2010). Mainstreaming green product innovation: Why and how companies integrate environmental sustainability. *Journal of Business Ethics*, *95*(3), 471–486. https://doi.org/10.1007/s10551-010-0434-0

Dangelico, R. M., Pujari, D., & Pontrandolfo, P. (2016). Green Product Innovation in Manufacturing Firms: A Sustainability-Oriented Dynamic Capability Perspective. *Business Strategy and the Environment*, *26*(4), 490–506. https://doi.org/10.1002/bse.1932

Dangelico, R. M., & Vocalelli, D. (2017). “Green Marketing”: An analysis of definitions, strategy steps, and tools through a systematic review of the literature. *Journal of Cleaner Production*, *165*, 1263–1279. https://doi.org/10.1016/j.jclepro.2017.07.184

De Medeiros, Janine Fleith, Ribeiro, J. L. D., & Cortimiglia, M. N. (2014). Success factors for environmentally sustainable product innovation: A systematic literature review. *Journal of Cleaner Production*, *65*, 76–86. https://doi.org/10.1016/j.jclepro.2013.08.035

De Medeiros, Janine Fleith, Vidor, G., & Ribeiro, J. L. D. (2018). Driving factors for the success of the green innovation market: A relationship system proposal. *Journal of Business Ethics*, *147*(2), 327–341. https://doi.org/10.1007/s10551-015-2927-3

De Medeiros, Janine Fleth, Lago, N. C., Colling, C., Ribeiro, J. L. D., Marcon, A., Duarte Ribeiro, J. L., & Marcon, A. (2018). Proposal of a novel reference system for the green product development process (GPDP). *Journal of Cleaner Production*, *187*, 984–995. https://doi.org/10.1016/j.jclepro.2018.03.237

Del Giudice, M., & Della Peruta, M. R. (2016). The impact of IT-based knowledge management systems on internal venturing and innovation: a structural equation modeling approach to corporate performance. *Journal of Knowledge Management*, *20*(3), 484–498. https://doi.org/10.1108/JKM-07-2015-0257

Dong, Z., Tan, Y., Wang, L., Zheng, J., & Hu, S. (2021). Green supply chain management and clean technology innovation: An empirical analysis of multinational enterprises in China. *Journal of Cleaner Production*, *310*, 127377. https://doi.org/10.1016/j.jclepro.2021.127377

Dost, M., Pahi, M. H., Magsi, H. B., & Umrani, W. A. (2019). Influence of the best practices of environmental management on green product development. *Journal of Environmental Management*, *241*, 219–225. https://doi.org/10.1016/j.jenvman.2019.04.006

Dugoua, E., & Dumas, M. (2021). Green product innovation in industrial networks: A theoretical model. *Journal of Environmental Economics and Management*, *107*, 102420. https://doi.org/10.1016/j.jeem.2021.102420

Edison, H., Bin Ali, N., & Torkar, R. (2013). Towards innovation measurement in the software industry. *Journal of Systems and Software*, *86*(5), 1390–1407. https://doi.org/10.1016/j.jss.2013.01.013

El-Kassar, A. N., & Singh, S. K. (2019). Green innovation and organizational performance: The influence of big data and the moderating role of management commitment and HR practices. *Technological Forecasting and Social Change*, *144*(December 2017), 483–498. https://doi.org/10.1016/j.techfore.2017.12.016

Engert, S., Rauter, R., & Baumgartner, R. J. (2016). Exploring the integration of corporate sustainability into strategic management: A literature review. *Journal of Cleaner Production*, *112*, 2833–2850. https://doi.org/10.1016/j.jclepro.2015.08.031

Erzurumlu, S. S., & Erzurumlu, Y. O. (2013). Development and deployment drivers of clean technology innovations. *The Journal of High Technology Management Research*, *24*(2), 100–108. https://doi.org/10.1016/j.hitech.2013.09.001

European Commission. (2021). The eco-innovation scoreboard and the eco-innovation index. Retrieved March 22, 2021, from https://ec.europa.eu/environment/ecoap/indicators/index_en

Eurostat European Commission. (2008). NACE Rev. 2 – Statistical classification of economic activites in the European Community. *Official Publications of the European Communitie*. Retrieved from http://ec.europa.eu/eurostat

Fan, X., Liu, W., & Zhu, G. (2017). Scientific linkage and technological innovation capabilities: international comparisons of patenting in the solar energy industry. *Scientometrics*, *111*(1), 117–138. https://doi.org/10.1007/s11192-017-2274-5

Fernando, Y., Chiappetta Jabbour, C. J., & Wah, W. X. (2019). Pursuing green growth in technology firms through the connections between environmental innovation and sustainable business performance: Does service capability matter? *Resources, Conservation and Recycling*, *141*(October 2018), 8–20.

https://doi.org/10.1016/j.resconrec.2018.09.031

Fiksel, J. (1996). Achieving eco-efficiency through design for environment. *Environmental Quality Management*, *5*(4), 47–54. https://doi.org/10.1002/tqem.3310050407

Fjeldstad, Ø. D., & Snow, C. C. (2018). Business models and organization design. *Long Range Planning*, *51*(1), 32–39. https://doi.org/10.1016/j.lrp.2017.07.008

Foo, M. Y., Kanapathy, K., Zailani, S., & Shaharudin, M. R. (2019). Green purchasing capabilities, practices and institutional pressure. *Management of Environmental Quality: An International Journal*, *30*(5), 1171–1189. https://doi.org/10.1108/MEQ-07-2018-0133

Forés. (2019). Beyond Gathering the 'Low-Hanging Fruit' of Green Technology for Improved Environmental Performance: an Empirical Examination of the Moderating Effects of Proactive Environmental Management and Business Strategies. *Sustainability*, *11*(22), 6299. https://doi.org/10.3390/su11226299

Foss, N. J., & Saebi, T. (2015). Business Models and Business Model Innovation Bringing Organization into the Discussion. In *Business Model Innovation: The Organizational Dimension* (pp. 1–26). Oxford: Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198701873.001.0001

Fraunhofer Institute for Systems and Innovation Research ISI. (2021). European Manufacturing Survey (EMS) 2015. Retrieved from https://www.isi.fraunhofer.de/en/themen/industrielle-wettbewerbsfaehigkeit/fems.html

Galbraith, J. R. (1982). Designing the innovating organization. *Organizational Dynamics*, 5–25.

Galindo-Rueda, F., & Verger, F. (2016). *OECD Taxonomy of Economic Activities Based on R&D Intensity* (No. 2016/04). *OECD Science, Technology and Industry Working Papers,*. París. https://doi.org/10.1787/5jlv73sqqp8r-en.

Gao, X., & Zhang, W. (2013). Foreign investment, innovation capacity and environmental efficiency in China. *Mathematical and Computer Modelling*, *58*(5–6), 1040–1046. https://doi.org/10.1016/j.mcm.2012.08.012

Garavan, T. N., Morley, M., Gunnigle, P., & Mcguire, D. (2002). Human resource development and workplace learning: Emerging theoretical perspectives and organisational practices. *Journal of European Industrial Training*, *26*(2/3/4), 60–71. https://doi.org/10.1108/03090590210428133

Geiger, N., Swim, J. K., & Glenna, L. (2019). Spread the Green Word: A Social Community Perspective Into Environmentally Sustainable Behavior. *Environment and Behavior*, *51*(5), 561–589. https://doi.org/10.1177/0013916518812925

Gerstlberger, W., Praest Knudsen, M., & Stampe, I. (2014). Sustainable Development Strategies for Product Innovation and Energy Efficiency. *Business Strategy and the Environment*, *23*(2), 131–144. https://doi.org/10.1002/bse.1777

Gouel, P. (2005). *Theories of Organization. Industrial and Operations Engineering, Course IOE 421 Work Organizations. Michigan, USA.* Michigan, USA.

Guan, J. C., Yam, R. C. M., Mok, C. K., Ma, N., Kam, C., & Ma, N. (2006). A study of the relationship between competitiveness and technological innovation capability based on DEA models. *European Journal of Operational Research*, *170*(3), 971–986. https://doi.org/10.1016/j.ejor.2004.07.054

Guan, J., & Ma, N. (2003). Innovative capability and export performance of Chinese firms. *Technovation—The International Journal of Technological Innovation and Entrepreneurship*, *23*, 737–747.

Guoyou, Q., Saixing, Z., Chiming, T., Haitao, Y., & Hailiang, Z. (2013). Stakeholders' Influences on Corporate Green Innovation Strategy: A Case Study of Manufacturing Firms in China. *Corporate Social Responsibility and Environmental Management*, *20*(1), 1–14. https://doi.org/10.1002/csr.283

Hallstedt, S., Ny, H., Robèrt, K. H., & Broman, G. (2010). An approach to assessing sustainability integration in strategic decision systems for product development. *Journal of Cleaner Production*, *18*(8), 703–712.

https://doi.org/10.1016/j.jclepro.2009.12.017

Hart, S. L. (1995). a Natural-Resource-Based View of the Firm. *Academy of Management Review*, *20*. https://doi.org/10.5465/AMR.1995.9512280033

Hart, S. L., & Dowell, G. (2011). A natural-resource-based view of the firm: Fifteen years after. *Journal of Management*, *37*(5), 1464–1479. https://doi.org/10.1177/0149206310390219

Hartmann, J., & Germain, R. (2015). Understanding the relationships of integration capabilities, ecological product design, and manufacturing performance. *Journal of Cleaner Production*, *92*, 196–205. https://doi.org/10.1016/j.jclepro.2014.12.079

He, Y., Ding, X., & Yang, C. (2021). Do environmental regulations and financial constraints stimulate corporate technological innovation? Evidence from China. *Journal of Asian Economics*, *72*, 101265. https://doi.org/10.1016/j.asieco.2020.101265

Herrera-Baltazar, M. E. (2015). Creating competitive advantage by institutionalizing corporate social innovation. *Journal of Business Research*, *68*(7), 1468–1474. https://doi.org/10.1016/j.jbusres.2015.01.036

Hollanders, H., & Es-Sadki, N. (2018). European Innovation Scoreboard. *European Commission*, 1–104. https://doi.org/10.2873/447902

Hollanders, H., Es-Sadki, N., Kanerva, M., By:, C. and guided, Garcia-Porras, B., Licciardello, A., & Nicklas, M. (2015). *Innovation Union Scoreboard 2015*. https://doi.org/10.2769/247779

Huang, J., & Li, Y. (2017). Green Innovation and Performance: The View of Organizational Capability and Social Reciprocity. *Journal of Business Ethics*, *145*(2), 309–324. https://doi.org/10.1007/s10551-015-2903-y

Huang, Y.-C., & Chen, C. T. (2022). Exploring institutional pressures, firm green slack, green product innovation and green new product success: Evidence from Taiwan's high-tech industries. *Technological Forecasting and Social Change*, *174*, 121196. https://doi.org/10.1016/j.techfore.2021.121196

Huang, Y. C., & Wu, Y. C. J. (2010). The effects of organizational factors on green new product success: Evidence from high-tech industries in Taiwan. *Management Decision*, *48*(10), 1539–1567. https://doi.org/10.1108/00251741011090324

Huang, Y. C., Yang, M. L., & Wong, Y. J. (2016). The effect of internal factors and family influence on firms' adoption of green product innovation. *Management Research Review*, *39*(10), 1167–1198. https://doi.org/10.1108/MRR-02-2015-0031

Huijben, J. C. C. M., Verbong, G. P. J., & Podoynitsyna, K. S. (2016). Mainstreaming solar: Stretching the regulatory regime through business model innovation. *Environmental Innovation and Societal Transitions*, *20*, 1–15. https://doi.org/10.1016/j.eist.2015.12.002

Hukkinen, J. (1995). Green virus: exploring the environmental product concept. *Business Strategy and the Enuironment*, *4*, 135–144.

Ikram, M., Sroufe, R., Awan, U., & Abid, N. (2021). Enabling Progress in Developing Economies: A Novel Hybrid Decision-Making Model for Green Technology Planning. *Sustainability*, *14*(1), 258. https://doi.org/10.3390/su14010258

Ilg, P. (2019). How to foster green product innovation in an inert sector. *Journal of Innovation & Knowledge*, *4*(2), 129–138. https://doi.org/10.1016/j.jik.2017.12.009

Isensee, C., Teuteberg, F., Griese, K. M., & Topi, C. (2020). The relationship between organizational culture, sustainability, and digitalization in SMEs: A systematic review. *Journal of Cleaner Production*, *275*. https://doi.org/10.1016/j.jclepro.2020.122944

Jabbour, C. J. C., Jugend, D., De Sousa Jabbour, A. B. L., Gunasekaran, A., & Latan, H. (2015). Green product development and performance of Brazilian firms: Measuring the role of human and technical aspects.

Journal of Cleaner Production, *87*(1), 442–451. https://doi.org/10.1016/j.jclepro.2014.09.036

Jackson, S. E., Schuler, R. S., & Jiang, K. (2014). An Aspirational Framework for Strategic Human Resource Management. *Academy of Management Annals*, *8*(1), 1–56. https://doi.org/10.1080/19416520.2014.872335

Jakhar, S. K., Mangla, S. K., Luthra, S., & Kusi-Sarpong, S. (2019). When stakeholder pressure drives the circular economy: Measuring the mediating role of innovation capabilities. *Management Decision*, *57*(4), 904–920. https://doi.org/10.1108/MD-09-2018-0990

Jaspers, F., Prencipe, A., & Van Den Ende, J. (2012). Organizing interindustry architectural innovations: Evidence from mobile communication applications. *Journal of Product Innovation Management*, *29*(3), 419–431. https://doi.org/10.1111/j.1540-5885.2012.00915.x

Jasti, N.V.K., Jha, N. K., Chaganti, P. K., & Kota, S. (2022). Sustainable production system : literature review and trends. *Management of Environmental Quality*, (2021). https://doi.org/10.1108/MEQ-11-2020-0246

Jasti, Naga Vamsi Krishna, Sharma, A., & Karinka, S. (2015). Development of a framework for green product development. *Benchmarking: An International Journal*, *22*(3), 426–445. https://doi.org/10.1108/BIJ-06-2014-0060

Joo, H. Y., Seo, Y. W., & Min, H. (2018). Examining the effects of government intervention on the firm's environmental and technological innovation capabilities and export performance. *International Journal of Production Research*, *56*(18), 6090–6111. https://doi.org/10.1080/00207543.2018.1430902

Karman, A., & Savanevičienė, A. (2020). Enhancing dynamic capabilities to improve sustainable competitiveness: insights from research on organisations of the Baltic region.pdf. *Baltic Journal of Management Emerald Publishing Limited*. https://doi.org/10.1108/BJM-08-2020-0287

Keeble, B. R. (1988). The Brundtland Report: "Our Common Future." *Medicine and War*, *4*(1), 17–25. https://doi.org/10.1080/07488008808408783

Khan, S. A. R., Yu, Z., Golpira, H., Sharif, A., & Mardani, A. (2021). A state-of-the-art review and meta-analysis on sustainable supply chain management: Future research directions. *Journal of Cleaner Production*, *278*, 123357. https://doi.org/10.1016/j.jclepro.2020.123357

Khan, S. J., Dhir, A., Parida, V., & Papa, A. (2021). Past, present, and future of green product innovation. *Business Strategy and the Environment*, *30*(8), 4081–4106. https://doi.org/10.1002/bse.2858

Khan, S. J., Kaur, P., Jabeen, F., & Dhir, A. (2021). Green process innovation: Where we are and where we are going. *Business Strategy and the Environment*, bse.2802. https://doi.org/10.1002/bse.2802

Kim, M. K., Sheu, C., & Yoon, J. (2018). Environmental sustainability as a source of product innovation: The role of governance mechanisms in manufacturing firms. *Sustainability (Switzerland)*, *10*(7). https://doi.org/10.3390/su10072238

Kong, T., Feng, T., & Ye, C. (2016). Advanced manufacturing technologies and green innovation: The role of internal environmental collaboration. *Sustainability (Switzerland)*, *8*(10), 9–11. https://doi.org/10.3390/su8101056

Kramar, R. (2014). Beyond strategic human resource management: Is sustainable human resource management the next approach? *International Journal of Human Resource Management*, *25*(8), 1069–1089. https://doi.org/10.1080/09585192.2013.816863

Kukkamalla Kumar, P. (2020). *Orchestrating organisational transformation for business model innovation Towards servitization in the automotive industry*. Universitat de Girona.

Lahovnik, M., & Breznik, L. (2014). Technological innovation capabilities as a source of competitive advantage: A case study from the home appliance industry. *Transformations in Business and Economics*, *13*(2), 144–160.

Landrum, N. E. (2018). Stages of Corporate Sustainability: Integrating the Strong Sustainability Worldview. *Organization and Environment*, *31*(4), 287–313. https://doi.org/10.1177/1086026617717456

Le, T. T. (2022). How do corporate social responsibility and green innovation transform corporate green strategy into sustainable firm performance? *Journal of Cleaner Production*, *362*, 132228. https://doi.org/10.1016/j.jclepro.2022.132228

Lee, K. H., & Kim, J. W. (2011). Integrating suppliers into green product innovation development: An empirical case study in the semiconductor industry. *Business Strategy and the Environment*, *20*(8), 527–538. https://doi.org/10.1002/bse.714

Leih, S., Linden, G., & Teece, D. J. T. (2015). Business Model Innovation and Organizational Design. A Dynamic Capabilities Perspective. In *Business Model Innovation: The Organizational Dimension* (Scholarshi, pp. 1–23). Oxford. https://doi.org/10.1093/acprof

Leonidou, C. N., Katsikeas, C. S., & Morgan, N. A. (2013). "Greening" the marketing mix: Do firms do it and does it pay off? *Journal of the Academy of Marketing Science*, *41*(2), 151–170. https://doi.org/10.1007/s11747-012-0317-2

Li, Y., Dai, J., & Cui, L. (2020). The impact of digital technologies on economic and environmental performance in the context of industry 4.0: A moderated mediation model. *International Journal of Production Economics*, *229*, 1–13. https://doi.org/10.1016/j.ijpe.2020.107777

Liao, W. W. (2017). A study on the correlations among environmental education, environment-friendly product development, and green innovation capability in an enterprise. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(8), 5435–5444. https://doi.org/10.12973/eurasia.2017.00841a

Liao, Y. C., & Tsai, K. H. (2019). Innovation intensity, creativity enhancement, and eco-innovation strategy: The roles of customer demand and environmental regulation. *Business Strategy and the Environment*, *28*(2), 316–326. https://doi.org/10.1002/bse.2232

Lin, P. C., & Huang, Y. H. (2012). The influence factors on choice behavior regarding green products based on the theory of consumption values. *Journal of Cleaner Production*, *22*(1), 11–18. https://doi.org/10.1016/j.jclepro.2011.10.002

Lin, R. J., Tan, K. H., & Geng, Y. (2013). Market demand, green product innovation, and firm performance: Evidence from Vietnam motorcycle industry. *Journal of Cleaner Production*, *40*, 101–107. https://doi.org/10.1016/j.jclepro.2012.01.001

Lin, Y., Tseng, M. L., Chen, C. C., & Chiu, A. S. F. (2011). Positioning strategic competitiveness of green business innovation capabilities using hybrid method. *Expert Systems with Applications*, *38*(3), 1839–1849. https://doi.org/10.1016/j.eswa.2010.07.113

Lisi, W., Zhu, R., & Yuan, C. (2019). Embracing green innovation via green supply chain learning: The moderating role of green technology turbulence. *Sustainable Development*, (April), 1–14. https://doi.org/10.1002/sd.1979

Liu, Z., & Gong, Y. (2018). The threshold effect of environmental regulation on green technology innovation capability: An empirical test of Chinese manufacturing industries. *Ekoloji*, *27*(106), 503–516.

Llach, J., Castro, R. de, Bikfalvi, A., & Marimon, F. (2012). The relationship between environmental management systems and organizational innovations. *Human Factors and Ergonomics in Manufacturing & Service Industries*, *22*(4), 307–316. https://doi.org/10.1002/hfm.20275

Llach Pagès, J., Bikfalvi, A., & de Castro Vila, R. (2009). The use and impact of technology in factory environments: evidence from a survey of manufacturing industry in Spain. *The International Journal of Advanced Manufacturing Technology*, *47*(1–4), 181–190. https://doi.org/10.1007/s00170-009-2184-7

Long, S., & Liao, Z. (2021). Are fiscal policy incentives effective in stimulating firms' eco-product innovation? The moderating role of dynamic capabilities. *Business Strategy and the Environment*, (February), 1–10.

https://doi.org/10.1002/bse.2791

Lopes, J. M., Gomes, S., Pacheco, R., Monteiro, E., & Santos, C. (2022). Drivers of Sustainable Innovation Strategies for Increased Competition among Companies. *Sustainability*, *14*(9), 5471. https://doi.org/10.3390/su14095471

López-Cabarcos, M. Á., Pérez-Pico, A. M., & López-Pérez, M. L. (2019). Does social network sentiment influence S & P 500 Environmental & Socially Responsible Index? *Sustainability (Switzerland)*, *11*(2). https://doi.org/10.3390/su11020320

Ludevid, M. (2000). *La gestión ambiental de la empresa*. (Ariel Economía, Ed.) (Primera ed). Ariel Economía.

Ma, Y., Yin, Q., Pan, Y., Cui, W., Xin, B., & Rao, Z. (2018). Green product innovation and firm performance: Assessing the moderating effect of novelty-centered and efficiency-centered business model design. *Sustainability (Switzerland)*, *10*(6). https://doi.org/10.3390/su10061843

Ma, Y., Zhang, Q., & Yin, Q. (2021). Top management team faultlines, green technology innovation and firm financial performance. *Journal of Environmental Management*, *285*, 112095. https://doi.org/10.1016/j.jenvman.2021.112095

Madden, K., Young, R., Kevin, B., & Hall, J. (2006). *Eco-efficiency learning module*. Geneva, Switzerland: World Business Council for Sustainable Development (WBCSD), Five Winds International. Retrieved from https://www.wbcsd.org/Projects/Education/Resources/Eco-efficiency-Learning-Module

Majumdar, S. K., & Marcus, A. a. (2001). Rules versus discretion: The productivity consequences of flexible regulation. *Academy of Management Journal*, *44*(1), 170–179. https://doi.org/10.2307/3069344

Mark, D., Nicholas, A., Chase, R., & Carretero Díaz, L. E. (2001). *Fundamentos de Dirección de Operaciones*. Madrid - España: McGraw Hill.

Melander, L. (2017). Achieving Sustainable Development by Collaborating in Green Product Innovation. *Business Strategy and the Environment*, *26*(8), 1095–1109. https://doi.org/10.1002/bse.1970

Melander, L. (2018). Customer and Supplier Collaboration in Green Product Innovation: External and Internal Capabilities. *Business Strategy and the Environment*, *27*(6), 677–693. https://doi.org/10.1002/bse.2024

Mellett, S., Kelliher, F., & Harrington, D. (2018). Network-facilitated green innovation capability development in micro-firms. *Journal of Small Business and Enterprise Development*, *25*(6), 1004–1024. https://doi.org/10.1108/JSBED-11-2017-0363

Millar, C., Hind, P., Millar, C., Hind, P., Millar, C., & Magala, S. (2012). Sustainability and the need for change: Organisational change and transformational vision. *Journal of Organizational Change Management*, *25*(4), 489–500. https://doi.org/10.1108/09534811211239272

Mittal, V. K., & Sangwan, K. S. (2014). Prioritizing Drivers for Green Manufacturing : Environmental , Social and Prioritizing Drivers for Green Manufacturing : Environmental , Social and Economic Perspectives. *Procedia CIRP*, *15*(December 2014), 135–140. https://doi.org/10.1016/j.procir.2014.06.038

Mousavi, S., & Bossink, B. A. G. (2018). Firms' capabilities for sustainable innovation: The case of biofuel for aviation. *Journal of Cleaner Production*, *167*, 1263–1275. https://doi.org/10.1016/j.jclepro.2017.07.146

Nadler, D. A., & Tushman, M. L. (1997). *Competing by Design: The Power of Organizational Architecture*. *Competing by Design*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195099171.001.0001

Nadler, D., & Tushman, M. (1998). A model for diagnosing organizational behavior. *Organizational Dynamics*.

Nadler, David, & Tushman, M. (1980). A model for diagnosing organizational behavior. *Organizational Dynamics*, *9*(2), 35–51. https://doi.org/10.1016/0090-2616(80)90039-X

Nadler, David, & Tushman, M. (1999). The organization of the future: Strategic Imperatives and Core Competencies for the 21st Century. *Organisational Dynamics*, *28*(1), 45–60. Retrieved from http://ac.elscdn.com.ezp01.library.qut.edu.au/S0090261600800066/1-s2.0-S0090261600800066-main.pdf?_tid=4c2b9c28-29fd-11e6-8fa3-00000aab0f6b&acdnat=1465008036_042e31e8f936f5bd459f36b1ef17ea93

Nadler, David, Tushman, M., & Nadler, M. (2011). Chapter 3: Mapping the Organizational Terrain University. In *Competing by Design: The Power of Organizational* (pp. 603–610). Oxford Scholarship: Oxford Scholarship Online. https://doi.org/10.1093/acprof:oso/9780195099171.001.0001

Niedermeier, A., Emberger-Klein, A., & Menrad, K. (2021). Drivers and barriers for purchasing green Fast-Moving Consumer Goods: A study of consumer preferences of glue sticks in Germany. *Journal of Cleaner Production*, *284*, 124804. https://doi.org/10.1016/j.jclepro.2020.124804

Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. *Organization Science*, *5*(1), 14–37. https://doi.org/10.1287/orsc.5.1.14

OCDE. (2015). *Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development, The Measurement of Scientific, Technological and Innovation Activities*. (P. OECD Publishing, Ed.), *The Measurement of Scientific, Technological and Innovation Activities.* París. https://doi.org/10.1787/9789264239012-en

OECD/Eurostat. (2005). *Manual de Oslo, Guía para la recogida e interpretación de datos sobre innovación*. (O. y Eurostat, Ed.) (Tercera). Luxembourg. https://doi.org/10.1787/9789264065659-es

OECD/Eurostat. (2018). *Oslo Manual: Guidelines for Collecting, Reporting and Using Data on Innovation* (4th Editio). Paris/Eurostat, Luxembourg. https://doi.org/https://doi.org/10.1787/9789264304604-en

Ogbeibu, S., Emelifeonwu, J., Senadjki, A., Gaskin, J., & Kaivo-oja, J. (2020). Technological turbulence and greening of team creativity, product innovation, and human resource management: Implications for sustainability. *Journal of Cleaner Production*, *244*, 118703. https://doi.org/10.1016/j.jclepro.2019.118703

Oliveira, G. A., Tan, K. H., & Guedes, B. T. (2018). Lean and green approach: An evaluation tool for new product development focused on small and medium enterprises. *International Journal of Production Economics*, *205*(August), 62–73. https://doi.org/10.1016/j.ijpe.2018.08.026

Palčič, I., Pons, M., Bikfalvi, A., Llach, J., & Buchmeister, B. (2013). Analysing Energy and Material Saving Technologies' Adoption and Adopters. *Strojniški Vestnik – Journal of Mechanical Engineering*, *57*(06), 409–417. https://doi.org/10.5545/sv-jme.2012.830

Palčič, I., & Prester, J. (2020). Impact of advanced manufacturing technologies on green innovation. *Sustainability (Switzerland)*, *12*(8). https://doi.org/10.3390/SU12083499

Palmer, M., & Truong, Y. (2017). The Impact of Technological Green New Product Introductions on Firm Profitability. *Ecological Economics*, *136*, 86–93. https://doi.org/10.1016/j.ecolecon.2017.01.025

Patrucco, A. S., Walker, H., Luzzini, D., & Ronchi, S. (2019). Which shape fits best? Designing the organizational form of local government procurement. *Journal of Purchasing and Supply Management*, *25*(3), 100504. https://doi.org/10.1016/j.pursup.2018.06.003

Pellegrini, C., Rizzi, F., & Frey, M. (2018). The role of sustainable human resource practices in influencing employee behavior for corporate sustainability. *Business Strategy and the Environment*, *27*(8), 1221–1232. https://doi.org/10.1002/bse.2064

Pérez-López, C. (2008). *Técnicas de análisis multivariante de datos*. (P. Educación, Ed.). Madrid - España. Retrieved from http://bit.ly/1JzSD8y

Pérez-Pérez, J. F., Parra, J. F., & Serrano-García, J. (2021). A system dynamics model : Transition to sustainable processes. *Technology in Society*, *65*, 1–16. https://doi.org/10.1016/j.techsoc.2021.101579

Pérez-Pérez, J. F., Serrano-García, J., & Arbeláez-Toro, J. J. (2020). Methods to Analyze Eco-innovation Implementation: A Theoretical Review. *Advances in Intelligent Systems and Computing*, *894*, 153–168. https://doi.org/10.1007/978-3-030-15413-4

Pons, M., Bikfalvi, A., & Llach, J. (2018). Clustering product innovators: a comparison between conventional and green product innovators. *International Journal of Production Management and Engineering*, *6*(1), 37. https://doi.org/10.4995/ijpme.2018.8762

Pons, M., Bikfalvi, A., Llach, J., & Palcic, I. (2013). Exploring the impact of energy efficiency technologies on manufacturing firm performance. *Journal of Cleaner Production*, *52*, 134–144. https://doi.org/10.1016/j.jclepro.2013.03.011

Porter, M. E., & Linde, C. van der. (1995). Toward a New Conception of the Environment-Competitiveness Relationship. *Journal of Economic Perspectives*, *9*(4), 97–118. https://doi.org/10.1257/jep.9.4.97

Prakash, A. (2000). *Greening the firm: The politics of corporate environmentalism*. (Cambridge University Press, Ed.). Cambridge: Cambridge University Press.

Qiu, L., Jie, X., Wang, Y., & Zhao, M. (2020). Green product innovation, green dynamic capability, and competitive advantage: Evidence from Chinese manufacturing enterprises. *Corporate Social Responsibility and Environmental Management*, *27*(1), 146–165. https://doi.org/10.1002/csr.1780

Quarshie, A. M., Salmi, A., & Leuschner, R. (2016). Sustainability and corporate social responsibility in supply chains: The state of research in supply chain management and business ethics journals. *Journal of Purchasing and Supply Management*, *22*(2), 82–97. https://doi.org/10.1016/j.pursup.2015.11.001

Ramanathan, R., He, Q., Black, A., Ghobadian, A., & Gallear, D. (2017). Environmental regulations, innovation and firm performance: A revisit of the Porter hypothesis. *Journal of Cleaner Production*, *155*, 79–92. https://doi.org/10.1016/j.jclepro.2016.08.116

Ramanathan, R., Ramanathan, U., & Bentley, Y. (2018). The debate on flexibility of environmental regulations, innovation capabilities and financial performance – A novel use of DEA. *Omega (United Kingdom)*, *75*, 131–138. https://doi.org/10.1016/j.omega.2017.02.006

Rehman Khan, S. A., Zhang, Y., Anees, M., Golpîra, H., Lahmar, A., & Qianli, D. (2018). Green supply chain management, economic growth and environment: A GMM based evidence. *Journal of Cleaner Production*, *185*, 588–599. https://doi.org/10.1016/j.jclepro.2018.02.226

Renard, L., & St-amant, G. E. (2003). Capacité, capacité organisationnelle et capacité dynamique : une proposition de définitions. *Les Cahiers Du Management Technologique*, *13*(1), 43–56.

Robbins, S. P., & Coulter, M. (2014). *Administración*. (Pearson, Ed.) (Decimosegu). México.

Robbins, Stephen P, & Judge, T. A. (2009). *Comportamiento organizacional*. (P. Education, Ed.). México.

Robledo-Velásquez, J. (2019). *Introducción a la Gestión de la Tecnología y la Innovación Empresarial*. (Universidad Nacional de Colombia - Sede Medellín, Ed.) (Segunda). Medellín: Universidad Nacional de Colombia - Sede Medellín.

Robledo-Velásquez, J, Aguilar-Zambrano, J., & Pérez-Vélez, J. (2011). Methodological Tool for Measurement and Assessment of Technological Innovation Capabilities. *Technologiy Management in the Energy Smart World (PICMET)*, 1–8.

Robledo-Velásquez, Jorge. (2020). *Introducción a la gestión de la tecnología y la innovación empresarial* (Primera). Medellín: Universidad Nacional de Colombia. Facultad de Minas.

Rodriguez, J. A., & Wiengarten, F. (2017). The role of process innovativeness in the development of environmental innovativeness capability. *Journal of Cleaner Production*, *142*, 2423–2434. https://doi.org/10.1016/j.jclepro.2016.11.033

Rothenberg, S., Maxwell, J., & Marcus, D. A. (1992). Issues in the implementation of proactive environmental strategies. *Business Strategy and the Environment*, *1*(4), 1–12. https://doi.org/10.1002/bse.3280010402

Saengchai, S., Rodboonsong, S., & Jermsittiparsert, K. (2019). Environmental regulation, green product innovation and performance: Do the environmental dynamics matter in thai sports industry? *Journal of*

Human Sport and Exercise, *14*(Proc5), S2276–S2289. https://doi.org/10.14198/jhse.2019.14.Proc5.44

Saenz, S., & Atoche-Kong, C. (2014). Profiting from environmental economic regulations: The mediating role of innovation capabilities. *Management of Engineering Technology (PICMET), 2014 Portland International Conference On*, 1626–1632.

Salim, N., Ab Rahman, M. N., & Abd Wahab, D. (2019). A systematic literature review of internal capabilities for enhancing eco-innovation performance of manufacturing firms. *Journal of Cleaner Production*, *209*, 1445–1460. https://doi.org/10.1016/j.jclepro.2018.11.105

Salim, N., Ab Rahman, N. M., & Wahab, D. A. (2021). Enhancing Green Product Competitiveness through Proactive Capabilities of Manufacturing Firms. *Jurnal Kejuruteraan*, *33*(1). https://doi.org/https://doi.org/10.17576/jkukm-2020-33(1)-08 Enhancing

Salim, N., Rahman, M. N. A., Wahab, D. A., & Muhamed, A. A. (2020). Influence of social media usage on the green product innovation of manufacturing firms through environmental collaboration. *Sustainability (Switzerland)*, *12*(20), 1–17. https://doi.org/10.3390/su12208685

Sampieri Hernández, R., Fernández Collado, C., & Baptista Lucio, M. del P. (2010). *Metodología de la investigación*. (S. A. D. C. . McGraw-Hill / Interamericana Editores, Ed.) (Quinta).

Sana, S. S. (2020). Price competition between green and non green products under corporate social responsible firm. *Journal of Retailing and Consumer Services*, *55*(February), 102118. https://doi.org/10.1016/j.jretconser.2020.102118

Sartal, A., Llach, J., Vázquez, X. H., & de Castro, R. (2017). How much does Lean Manufacturing need environmental and information technologies? *Journal of Manufacturing Systems*, *45*, 260–272. https://doi.org/10.1016/j.jmsy.2017.10.005

Sdrolia, E., & Zarotiadis, G. (2019). A comprehensive review for green product term : from definition to evaluation. *Journal of Economic Surveys*, *33*(1), 150–178. https://doi.org/10.1111/joes.12268

Šebo, J., Šebová, M., & Palčič, I. (2021). Implementation of Circular Economy Technologies : An Empirical Study of Slovak and Slovenian Manufacturing Companies. *Sustainability*, *13*. https://doi.org/doi.org/10.3390/su132212518

Serrano-García, J., Acevedo-Álvarez, C. A., Castelblanco-Gómez, J. M., & Arbeláez-Toro, J. J. (2017). Measuring organizational capabilities for technological innovation through a fuzzy inference system. *Technology in Society*, *50*, 93–109. https://doi.org/10.1016/j.techsoc.2017.05.005

Serrano-García, J., Bikfalvi, A., Llach, J., & Arbeláez-Toro, J. J. (2021). Orchestrating capabilities, organizational dimensions and determinants in the pursuit of green product innovation. *Journal of Cleaner Production*, *313*(September), 2–18. https://doi.org/10.1016/j.jclepro.2021.127873

Serrano-García, J., & Robledo-Velásquez, J. (2013a). Methodology for evaluating Innovation Capabilities at university institutions using a fuzzy system. *Journal of Technology Management and Innovation*, *8*(SPL.ISS.3), 246–259. https://doi.org/10.4067/s0718-27242013000300051

Serrano-García, J., & Robledo-Velásquez, J. (2013b). Variables para la medicion de las capacidades de innovación tecnológica en instituciones universitarias. *Ciencias Estratégicas*, *22*(30), 267–284.

Serrano-García, J., Bikfalvi, A., Llach, J., & Arbeláez-Toro, J. J. (2022). Capabilities and organisational dimensions conducive to green product innovation: Evidence from Croatian and Spanish manufacturing firms. *Business Strategy and the Environment*, (January), 1–19. https://doi.org/10.1002/bse.3014

Serrano-García, J., Bikfalvi, A., Llach, J., Arbeláez-Toro, J. J., & García-Gómez, J. M. (2022). Orientaciones, dinámicas organizacionales y motivaciones para la obtención del producto innovador verde. *Revista CEA*, *8*, 1–19. https://doi.org/https://doi.org/10.22430/24223182.2138

Seth, D., Rehman, M. A. A., & Shrivastava, R. L. (2018). Green manufacturing drivers and their relationships for small and medium(SME) and large industries. *Journal of Cleaner Production*, *198*, 1381–1405.

https://doi.org/10.1016/j.jclepro.2018.07.106

ShabbirHusain, R. V., & Varshney, S. (2019). Is Current Way of Promoting Sustainability, Sustainable? *Journal of Nonprofit and Public Sector Marketing*, *31*(1), 84–113. https://doi.org/10.1080/10495142.2018.1526735

Shahzad, M., Qu, Y., Rehman, S. U., & Zafar, A. U. (2022). Adoption of green innovation technology to accelerate sustainable development among manufacturing industry. *Journal of Innovation & Knowledge*, *7*(4), 100231. https://doi.org/10.1016/j.jik.2022.100231

Shahzad, M., Qu, Y., Ur Rehman, S., Zafar, A. U., Ding, X., & Abbas, J. (2020). Impact of knowledge absorptive capacity on corporate sustainability with mediating role of CSR: analysis from the Asian context. *Journal of Environmental Planning and Management*, *63*(2), 148–174. https://doi.org/10.1080/09640568.2019.1575799

Shahzad, M., Qu, Y., Zafar, A. U., & Appolloni, A. (2021). Does the interaction between the knowledge management process and sustainable development practices boost corporate green innovation? *Business Strategy and the Environment*, *30*(8), 1–17. https://doi.org/10.1002/bse.2865

Shete, P. C., Ansari, Z. N., & Kant, R. (2020). A Pythagorean fuzzy AHP approach and its application to evaluate the enablers of sustainable supply chain innovation. *Sustainable Production and Consumption*, *23*, 77–93. https://doi.org/10.1016/j.spc.2020.05.001

Shevchenko, A., Lévesque, M., & Pagell, M. (2016). Why Firms Delay Reaching True Sustainability. *Journal of Management Studies*, *53*(5), 911–935. https://doi.org/10.1111/joms.12199

Siegel, D. S. (2009). Green Management Matters Only If It Yields More: An Economic/Strategic Perspective. *Academy of Management Perspectives*, *23*(3), 5–17. Retrieved from https://www.jstor.org/stable/27747522

Sirmon, D. G., Hitt, M. A., Ireland, R. D., & Gilbert, B. A. (2011). Resource orchestration to create competitive advantage: Breadth, depth, and life cycle effects. *Journal of Management*, *37*(5), 1390–1412. https://doi.org/10.1177/0149206310385695

Song, W., Ren, S., & Yu, J. (2018). Bridging the gap between corporate social responsibility and new green product success: The role of green organizational identity. *Business Strategy and the Environment*, *28*(1), 88–97. https://doi.org/10.1002/bse.2205

Spack, J. A., Board, V. E., Crighton, L. M., Kostka, P. M., & Ivory, J. D. (2012). It's easy being green: The effects of argument and imagery on consumer responses to green product packaging. *Environmental Communication*, *6*(4), 441–458. https://doi.org/10.1080/17524032.2012.706231

Stucki, T. (2019). What hampers green product innovation: the effect of experience. *Industry and Innovation*, *26*(10), 1242–1270. https://doi.org/10.1080/13662716.2019.1611417

Su, J. C. P., Wang, L., & Ho, J. C. (2017). The timing of green product introduction in relation to technological evolution. *Journal of Industrial and Production Engineering*, *34*(3), 159–169. https://doi.org/10.1080/21681015.2016.1233911

Suganthi, L. (2019). Green Product Introduction: The Ultimate Challenge for Sustainable Business. *JOURNAL OF SOCIOLOGY AND SOCIAL ANTHROPOLOGY*, *10*(1–3). https://doi.org/10.31901/24566764.2019/10-1-3.293

Sun, Y., Bi, K., & Yin, S. (2020). Measuring and Integrating Risk Management into Green Innovation Practices for Green Manufacturing under the Global Value Chain. *Sustainability*, *12*(2), 545. https://doi.org/10.3390/su12020545

Tan, C. N. L., Ojo, A. O., & Thurasamy, R. (2019). Determinants of green product buying decision among young consumers in Malaysia. *Young Consumers*, *20*(2), 121–137. https://doi.org/10.1108/YC-12-2018-0898

Tariq, A., Badir, Y., & Chonglerttham, S. (2019). Green innovation and performance: moderation analyses from Thailand. *European Journal of Innovation Management*, *22*(3), 446–467. https://doi.org/10.1108/EJIM-07-

2018-0148

Tariq, A., Badir, Y. F., Safdar, U., Tariq, W., & Badar, K. (2020). Linking firms' life cycle, capabilities, and green innovation. *Journal of Manufacturing Technology Management*, *31*(2), 284–305. https://doi.org/10.1108/JMTM-08-2018-0257

Tariq, A., Badir, Y. F., Tariq, W., & Bhutta, U. S. (2017). Drivers and consequences of green product and process innovation: A systematic review, conceptual framework, and future outlook. *Technology in Society*, *51*, 8–23. https://doi.org/10.1016/j.techsoc.2017.06.002

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*(August), 1319–1350. https://doi.org/10.1002/smj.640

Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, *43*(2–3), 172–194. https://doi.org/10.1016/j.lrp.2009.07.003

Teece, D. J. (2018a). Business models and dynamic capabilities. *Long Range Planning*, *51*(1), 40–49. https://doi.org/10.1016/j.lrp.2017.06.007

Teece, D. J. (2018b). Dynamic capabilities as (workable) management systems theory. *Journal of Management and Organization*, *24*(3), 359–368. https://doi.org/10.1017/jmo.2017.75

Teece, D. J., Pisano, G., & Shuen, A. (1997). Strategic Management. *Strategic Management*, *18*(7), 77–115. https://doi.org/10.1007/978-1-137-03545-5

Tsai, C. C. (2012). A research on selecting criteria for new green product development project: Taking Taiwan consumer electronics products as an example. *Journal of Cleaner Production*, *25*, 106–115. https://doi.org/10.1016/j.jclepro.2011.12.002

Tseng, C. H., Chang, K. H., & Chen, H. W. (2019). Strategic orientation, environmental innovation capability, and environmental sustainability performance: The case of Taiwanese suppliers. *Sustainability (Switzerland)*, *11*(4). https://doi.org/10.3390/su11041127

Tushman, M. (2017). Innovation Streams and Executive Leadership: R&D leadership plays a central role in shaping a firm's ability to both exploit existing capabilities and explore new technological domains. *Research Technology Management*, *60*(6), 42–47. https://doi.org/10.1080/08956308.2017.1373050

Tushman, M., & Nadler, D. (1986). Organizing for Innovation. *California Management Review*, *28*(3), 74–92. https://doi.org/10.2307/41165203

Úbeda-García, M., Claver-Cortés, E., Marco-Lajara, B., & Zaragoza-Sáez, P. (2021). Corporate social responsibility and firm performance in the hotel industry. The mediating role of green human resource management and environmental outcomes. *Journal of Business Research*, *123*(September 2020), 57–69. https://doi.org/10.1016/j.jbusres.2020.09.055

Ulrich, K. T., & Eppinger, S. D. (2012). *Diseño y desarrollo de productos*. (S. A. McGraw-Hill Interamericana Editorres, Ed.) (Quinta edi).

United Nations. (2015). *Transforming our world: the 2030 agenda for sustainable development*.

United Nations. (2018). *The 2030 Agenda and the Sustainable Development Goals An opportunity for Latin America and the Caribbean*. Santiago de Chile. Retrieved from www.cepal.org/en/suscripciones

United Nations. (2022). *Restoring trust and inspiring hope. The Next Five Years For The United Nations.*

Van Hoof, B. (2014). Organizational learning in cleaner production among Mexican supply networks. *Journal of Cleaner Production*, *64*, 115–124. https://doi.org/10.1016/j.jclepro.2013.07.041

Vickers, I., & Cordey-Hayes, M. (1999). Cleaner production and organizational learning. *Technology Analysis and Strategic Management*, *11*(1), 75–94. https://doi.org/10.1080/095373299107591

Viñolas Marlet, J. (2005). *Diseno Ecologico*. (S. L. Art Blume, Ed.) (1st ed.).

Volberda, H. W. (1999). Chapter 6: The Organization Design Task: Reducing Organizational Barriers. In O. S. Online (Ed.), *Building the Flexible Firm: How to Remain Competitive* (pp. 1–68). https://doi.org/10.1093/acprof

Vrchota, J., Pech, M., Rolínek, L., & Bednář, J. (2020). Sustainability Outcomes of Green Processes in Relation to Industry 4.0 in Manufacturing: Systematic Review. *Sustainability*, *12*(15), 5968. https://doi.org/10.3390/su12155968

Wang, C. H., Lu, I. Y., & Chen, C. B. (2008). Evaluating firm technological innovation capability under uncertainty. *Technovation*, *28*(6), 349–363. https://doi.org/10.1016/j.technovation.2007.10.007

Wang, Jian, Wan, Q., & Yu, M. (2020). Green supply chain network design considering chain-to-chain competition on price and carbon emission. *Computers and Industrial Engineering*, *145*(August 2019), 106503. https://doi.org/10.1016/j.cie.2020.106503

Wang, Juanru, Xue, Y., & Yang, J. (2019). Boundary-spanning search and firms' green innovation: The moderating role of resource orchestration capability. *Business Strategy and the Environment*, *29*(2), 361–374. https://doi.org/10.1002/bse.2369

Wang, M., Li, Y., Li, J., & Wang, Z. (2021). Green process innovation, green product innovation and its economic performance improvement paths: A survey and structural model. *Journal of Environmental Management*, *297*, 113282. https://doi.org/10.1016/j.jenvman.2021.113282

Wang, N., Zhang, J., Zhang, X., & Wang, W. (2022). How to Improve Green Innovation Performance: A Conditional Process Analysis. *Sustainability*, *14*(5), 2938. https://doi.org/10.3390/su14052938

Wang, W., & Zhang, C. (2018). Evaluation of relative technological innovation capability: Model and case study for China's coal mine. *Resources Policy*, *58*(April), 144–149. https://doi.org/10.1016/j.resourpol.2018.04.008

Wee, Y. S., & Quazi, H. A. (2005). Development and validation of critical factors of environmental management. *Industrial Management and Data Systems*, *105*(1), 96–114. https://doi.org/10.1108/02635570510575216

Weerts, K., Vermeulen, W., & Witjes, S. (2018). On corporate sustainability integration research: Analysing corporate leaders' experiences and academic learnings from an organisational culture perspective. *Journal of Cleaner Production*, *203*, 1201–1215. https://doi.org/10.1016/j.jclepro.2018.07.173

Wei, J., Li, Y., Liu, X., & Du, Y. (2022). Enterprise characteristics and external influencing factors of sustainable innovation: Based on China's innovation survey. *Journal of Cleaner Production*, *372*, 133461. https://doi.org/10.1016/j.jclepro.2022.133461

Wendling, Z. A., Emerson, J. W., Esty, D. C., Levy, M. A., & de Sherbinin, A. (2018). Environmental Performance Index. Retrieved from https://epi.yale.edu/

Wu, C. Y. (2014). Comparisons of technological innovation capabilities in the solar photovoltaic industries of Taiwan, China, and Korea. *Scientometrics*, *98*(1), 429–446. https://doi.org/10.1007/s11192-013-1120-7

Wu, C. Y., & Hu, M. C. (2015). The development trajectory and technological innovation capabilities in the global renewable energy industry. *Portland International Conference on Management of Engineering and Technology*, *2015-Septe*, 2574–2580. https://doi.org/10.1109/PICMET.2015.7273069

Xie, X., Huo, J., & Zou, H. (2019). Green process innovation, green product innovation, and corporate financial performance: A content analysis method. *Journal of Business Research*, *101*, 697–706. https://doi.org/10.1016/j.jbusres.2019.01.010

Xu, J. Z., & Wang, M. M. (2018). Empirical research on green innovation capability evaluation of China's manufacturing enterprises based on principal component and cluster analysis. *International Conference on Management Science and Engineering - Annual Conference Proceedings*, *2017-Augus*(71273072), 304–312. https://doi.org/10.1109/ICMSE.2017.8574432

Yam, R., Guan, J. C., Pun, K. F., & Tang, E. P. Y. (2004). An audit of technological innovation capabilities in Chinese firms: Some empirical findings in Beijing, China. *Research Policy*, *33*(8), 1123–1140. https://doi.org/10.1016/j.respol.2004.05.004

Yan, X., & Zhang, Y. (2021). The effects of green innovation and environmental management on the environmental performance and value of a firm: an empirical study of energy-intensive listed companies in China. *Environmental Science and Pollution Research*, *28*(27), 35870–35879. https://doi.org/10.1007/s11356-021-12761-9

Yang, D. (2019). What should SMEs consider to introduce environmentally innovative products to market? *Sustainability (Switzerland)*, *11*(4). https://doi.org/10.3390/su11041117

Yin, S., Zhang, N., & Li, B. (2020). Enhancing the competitiveness of multi-agent cooperation for green manufacturing in China: An empirical study of the measure of green technology innovation capabilities and their influencing factors. *Sustainable Production and Consumption*, *23*, 63–76. https://doi.org/10.1016/j.spc.2020.05.003

Yin, S., Zhang, N., Li, B., & Dong, H. (2021). Enhancing the effectiveness of multi-agent cooperation for green manufacturing: Dynamic co-evolution mechanism of a green technology innovation system based on the innovation value chain. *Environmental Impact Assessment Review*, *86*, 106475. https://doi.org/10.1016/j.eiar.2020.106475

Yogananda, A. P. Y., & Nair, P. B. (2019). Green Food Product Purchase Intention: Factors Influencing Malaysian Consumers. *Pertanika Journal of Social Science and Humanities*, *27*(2), 1131–1144.

Yong, J. Y., Yusliza, M. Y., Ramayah, T., & Fawehinmi, O. (2019). Nexus between green intellectual capital and green human resource management. *Journal of Cleaner Production*, *215*, 364–374. https://doi.org/10.1016/j.jclepro.2018.12.306

Yoo, W.-J., Choo, H., & Lee, S. (2018). A Study on the Sustainable Growth of SMEs: The Mediating Role of Organizational Metacognition. *Sustainability*, *10*(8), 2829. https://doi.org/10.3390/su10082829

Yusr, M. M., Salimon, M. G., Mokhtar, S. S. M., Abaid, W. M. A. W., Shaari, H., Perumal, S., & Saoula, O. (2020). Green innovation performance! How to be achieved? A study applied on Malaysian manufacturing sector. *Sustainable Futures*, *2*(August), 100040. https://doi.org/10.1016/j.sftr.2020.100040

Zhang, B. Y., & Li, J. (2019). Design for environmental protection: Measuring the appeal factors of green product for consumers. *Ekoloji*, *28*(107), 1699–1707.

Zhang, F., & Zhu, L. (2019). Enhancing corporate sustainable development: Stakeholder pressures, organizational learning, and green innovation. *Business Strategy and the Environment*, *28*(6), 1012–1026. https://doi.org/10.1002/bse.2298

Zhang, Liang, G., Feng, T., Yuan, C., & Jiang, W. (2020). Green innovation to respond to environmental regulation: How external knowledge adoption and green absorptive capacity matter? *Business Strategy and the Environment*, *29*(1), 39–53. https://doi.org/10.1002/bse.2349

Zhang, M., Wenjuan, Z., Kei Tse, Y., & Wang, Y. (2021). Examining the antecedents and consequences of green product innovation. *Industrial Marketing Management*, *93*, 413–427. https://doi.org/10.1016/j.indmarman.2020.03.028

Zhang, S., Wang, Z., & Zhao, X. (2019). Effects of proactive environmental strategy on environmental performance: Mediation and moderation analyses. *Journal of Cleaner Production*, *235*, 1438–1449. https://doi.org/10.1016/j.jclepro.2019.06.220

Zhao, Y., Feng, T., & Shi, H. (2018). External involvement and green product innovation: The moderating role of environmental uncertainty. *Business Strategy and the Environment*, *27*(8), 1167–1180. https://doi.org/10.1002/bse.2060

Anexos

Anexo 1. Artículo 1. Orchestrating capabilities, organizational dimensions and determinants in the pursuit of green product innovation

Anexo 2. Artículo 2. Capabilities and organisational dimensions conducive to green product innovation: Evidence from Croatian and Spanish manufacturing

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Orchestrating capabilities, organizational dimensions and determinants in the pursuit of green product innovation

Jakeline Serrano-García[a,b,*], Andrea Bikfalvi[c], Josep Llach[c], Juan José Arbeláez-Toro[d,e]

[a] Universitat Politècnica de València, Valencia, Spain
[b] Faculty of Economic and Administrative Sciences, Instituto Tecnológico Metropolitano, Medellín, Colombia
[c] Department of Business Administration and Product Design, Universitat de Girona, Girona, Spain
[d] AMADE, Polytechnic School, Universitat de Girona, Girona, Spain
[e] Faculty of Engineering, Instituto Tecnológico Metropolitano, Medellín, Colombia

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ABSTRACT

There is now evidence of a growing demand for green product innovation (GPI), leading to reduced negative environmental effects. This context is an opportunity for the organizational reconfiguration of companies in the manufacturing sector to accommodate these new product attributes and characteristics. Although the identification of the determinants of GPI has improved, its characterization is still fragmented and there is limited coherence in terms of the administrative approach leading to GPI development. The main purpose of this paper is the selection and configuration of the determinants of GPI and their organization into an innovation management model. This is achieved by identifying and categorizing the determinants of GPI in association with green innovation capabilities (GIC) and organizational dimensions (OD). The results provide a set of determinants of GPI, paving the way for organizational challenges, the adaptation and definition of new GIC, and the selection of green-oriented OD. All the above is represented in a framework showing the structural relationships and operationalized in a matrix product of the taxonomy referring to how the determinants of GPI affect GIC and OD, thus facilitating the definition of the variables that assess the progress of the company in pursuit of GPI. This research contributes in the field of management and organizational theories for the managerial transition to sustainable development from the dynamics typical of innovation. It also widens the scope of study for researchers, manufacturing company managers, and governmental bodies responsible for environmental management.

1. Introduction

Political, institutional, and individual actors' growing interest in promoting environmental sustainability (Chang, 2017; Kong et al., 2016; Su et al., 2017) has put pressure on the market to design innovative products with minimal environmental impact (Hukkinen, 1995; Melander, 2018). These products, referred to as green product innovation (GPI), can potentially become a novel business opportunity for manufacturing firms, helping them to meet these new demands and expectations.

GPI distinguishes itself from conventional innovative products (CIP) (Chen and Chang, 2013; Pons et al., 2018) because the resulting products impact on socially conscious customers who are willing to pay a higher price for them (Niedermeier et al., 2021; Sana, 2020). It also favors the potential motivations of governments by trying to offset the cost of achieving a sustainable development (Sana, 2020; Wang et al., 2020). This is translated into a comparative and competitive advantage given that GPI brings benefits for firms while helping to preserve natural resources for future generations (Pérez-Pérez et al., 2021).

However, many organizations are not yet convinced about producing and developing green products for various reasons, including the high investment involved (Rehman Khan et al., 2018), the risk aversion when making financial investments (Stucki, 2019), and limited government support. Also relevant is also the lack of studies aimed at consolidating GPI from organizational and management theories (Dangelico et al., 2016) and the lack of clarity on how to address its determinants at the organizational level (Jasti et al., 2015; Tariq et al., 2017). For GPI development, every area of the firm must be involved (Hukkinen, 1995)

* Corresponding author. Faculty of Economic and Administrative Sciences, Metropolitan Technological Institute, Cl. 54a #30-01, Medellín, Colombia.
E-mail addresses: jakelineserrano@itm.edu.co, jserano2005@gmail.com (J. Serrano-García), andrea.bikfalvi@udg.edu (A. Bikfalvi), josep.llach@udg.edu (J. Llach), juanarbelaez@itm.edu.co, jjarbetoro@gmail.com (J.J. Arbeláez-Toro).

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because the process of designing, creating, producing, and marketing green products requires an interdisciplinary approach (Ulrich and Eppinger, 2012).

Various studies report that there are certain determinants for the production and marketing of innovative green products (Chen and Chang, 2013; Dangelico and Pujari, 2010; Dangelico and Vocalelli, 2017; Lee and Kim, 2011; Melander, 2017; Tsai, 2012). These generally involve improving and using environmentally friendly materials (Ma et al., 2018); manufacturing products with recycled components; reducing energy consumption; using less packaging (Chen and Chang, 2013); and reusing, remanufacturing, and recycling inputs to reduce the harmful effects on the environment (Dangelico and Pujari, 2010).

Studies have been conducted in fields like innovation and environmental economics and management to identify the factors that drive organizations to develop GPI (Alharthey, 2019; Chang, 2016; Tan et al., 2019). However, there is still a fragmented and disconnected approach to this identification (Jasti et al., 2015; Tariq et al., 2017), hindering the achievement, shaping, and implementation of GPI at the organizational level (Chang, 2016; Jasti et al., 2015). Furthermore, there is no consistency among the different factors and theoretical approaches leading to its development (Dangelico et al., 2016; El-Kassar and Singh, 2019; Jasti et al., 2015; Sdrolia and Zarotiadis, 2019).

Further analyses are required to examine how firms integrate corporate sustainability with the support of organizational management, under a systemic perspective and with a holistic vision (Engert et al., 2016), thereby strengthening the different determinants to achieve environmental sustainability. Furthermore, given the need to evolve towards environmental protection, organizations must adopt new or significantly improved innovation management systems based on organizational support models to underpin the creation, design, and implementation of the required changes (Robledo-Velásquez, 2019).

The Resource-Based View (RBV) theory has so far been the most widely used to study how organizations manage green innovation (Tariq et al., 2017). According to this theory, firms with the best resources and capabilities (and their orchestration with the firms' activities) may gain comparative and competitive advantages in terms of environmental sustainability (Hart, 1995; Hart and Dowell, 2011; Leih et al., 2015; Tariq et al., 2017; Teece, 2018a). Nonetheless, different research studies based on RBV have so far been unable to determine how companies maintain competitive advantages using resources and capabilities. Most works have focused on resources, while the use of green innovation capabilities (GIC) has been little studied (Tariq et al., 2017), even though firms that opt for GPI need new capabilities to coherently face the rigors inherent in environmental sustainability (Mellett et al., 2018; Mousavi and Bossink, 2018).

Such capabilities, in turn, impact on the business design and operation of firms and demand the support of the organizational dimensions (OD), given that they are interdependent (Teece, 2018a). There may therefore be complementary and interrelated effects between GIC and the organizational driving forces involved in environmental matters, directed towards the promotion of proactive corporate environmental practices (Bowen et al., 2001; Rodriguez and Wiengarten, 2017). In view of all the above, the organizational capabilities and dimensions through which innovation can be managed should be analysed to understand the determinants in pursuit of GPI at the organizational level.

Firms have become increasingly interested in gaining a greater understanding of the notion of innovation capabilities (IC) related to environmental sustainability. Several studies from different areas of knowledge and application fields have been developed, especially in the productive sector (Amores-Salvadó et al., 2015; Ardyan et al., 2017; Dangelico et al., 2016; Fan et al., 2017; Fernando et al., 2019; Gao and Zhang, 2013; Joo et al., 2018; Lin et al., 2011; Liu and Gong, 2018; Mellett et al., 2018; Ramanathan et al., 2018; Saenz and Atoche-Kong, 2014; Wang and Zhang, 2018; Wu, 2014; Wu and Hu, 2015; Xu and Wang, 2018). However, to the best of the authors' knowledge, none of the research papers have constructed GIC or studied them under strategic functional skills and pillars directed towards the creation of GPI which, together with OD, can lead the organization to respond to the identified determinants.

Therefore, this study integrates the analysis of GIC and OD as a solution that could serve as a systemic approach to implementing the determinants of GPI. In addition, the research aims to intervene in the structuring of the IC functional approach with theories concerning green-oriented OD and associated with determinants that can direct the organization towards innovation management to generate GPI. This solution means strategically configuring the GIC, OD, and determinants to form a system of interrelated elements leading to GPI creation, which will show how they are interconnected and complement each other under a conceptual framework that favors GPI development for the purpose of improving firms' economic, social, and environmental performance.

This approach aims to provide solutions to reduce environmental impacts from a corporate perspective among manufacturing firms. Hence, the purpose of this paper, which has a conceptual focus, is to answer the following research questions: (1) what are the constitutive determinants of GPI? and (2) What is the configuration of the GIC, OD, and determinants in pursuit of GPI?

This paper is structured as follows. Section two provides a theoretical background, section three describes the methodology, section four presents the results, section five contains the discussions, and last section six presents the conclusions, limitations, and future lines of work.

2. Theoretical background

2.1. Green innovation capabilities

In line with theoretical postulations, GIC characterization starts from the concept of resources and capabilities and continues with organizational and management capabilities towards dynamic capabilities, from where it moves towards IC with extension to the green approach. Capability refers to the ability, faculty, strength, or power to do something in light of the proposed objectives (Renard and St-amant, 2003), where strategic management is key to adapting, integrating, and reconfiguring these capabilities into the organization (Teece et al., 1997). Strategy entails organizational and management capabilities that enable a firm's resources to be mobilized, commanded, and exploited to achieve its strategic objectives (OECD/Eurostat, 2018). These capabilities reflect the interactions between resources and capabilities, which are constantly evolving and framed in systemic properties (Renard and St-amant, 2003; Teece, 2018b). As an interrelated and dynamic system, an organization is under constant evolution and adaptation, for which it requires certain capabilities. This is where Dynamic Capability (DC), a particular type of organizational capability, comes into play (Renard and St-amant, 2003). DC enables opportunities to be detected and configured, and the company's assets to be reconfigured (Teece, 2007, 2018a). At the same time, DC acknowledges the importance of innovation, facilitating the ability of organizations to produce new products in a more natural way and using a systemic approach (Teece, 2018b). Consequently, DC involves diversification and change, leading to the IC concept. According to Lahovnik and Breznik (2014), IC are acknowledged as the most relevant type of DC, enabling a competitive edge to be built and maintained.

For Burgelman, Maidique and Wheelwright (2004), IC are an integral set of characteristics which support and make an organization's technological innovation strategies flexible. IC are the organizational capabilities needed to consolidate innovation (Serrano-García et al., 2017; Serrano-García and Robledo-Velásquez, 2013a). According to Guan and Ma (2003) and Adler and Sbenbar (1990), IC allow new products to be created and processing and manufacturing technologies to be adopted, thus satisfying the current and future needs of the market. It is recommended that IC are defined in organizational levels to meet strategic needs and to adapt to environmental conditions (Guan et al., 2006).

An IC extension is the green approach (Mellett et al., 2018). In this regard, GIC[1] provide the industry with an opportunity to improve its ecological efficiency (Jakhar et al., 2019), linking the firm's environmental sustainability initiative with its performance through strategies designed for this purpose (Kim et al., 2018). The development of higher levels of GIC helps organizations to elucidate processes, techniques, and products to reduce environmental damage (Tseng et al., 2019) since it facilitates their understanding and discernment of the specific aspects to be adapted and improved. GIC empower the organization to comply with environmental requirements and to become part of the emerging green economy (Mellett et al., 2018).

Thus, GIC are regarded as alternatives that support organizations to meet current ecological needs. From this, it may be inferred that GIC comprise organizational and dynamic capabilities that could foster GPI development and respond to the environmental sustainability challenge. Characterizing the term GIC, capability can be represented as an organization's ability to become immersed in a green-oriented strategy; innovation, as an approach to change, evolve, and/or adapt to the green mindset; technology, as the tacit approach within innovation and the implicit and explicit knowledge contained in solutions to environmental problems; and last, the green approach, as the organization's involvement and commitment to environmental care. Corporate, business and functional units could be required to focus on a specific set of strategic green capabilities for the success of an organization regarding environmental practices aimed at creating ecological value.

2.2. Organizational dimensions for GPI

The existence and survival of an organization depend on its performance and response to the requirements of its environment (Chiavenato, 2006). To this effect, the organization identifies the need to meet different challenges, among which are social responsibility, ethical issues and the demands of the environment, to be integrated as opportunities in their business design (Bocken et al., 2016; Robbins and Coulter, 2014; Weerts et al., 2018). One essential requirement may be the identification and creation of an architecture in the context of environmental demands, given the affectations triggered by different polluting factors. This paves the way for the need to strategically link the organization's response capacity and adaptation to the required adjustments (Chiavenato, 2006; Nadler et al., 2011). Managers need to reflect on and redesign the organization, seeking to be competent in response to changing conditions (Teece, 2018a; Volberda, 1999). To this effect, the design of the business model is considered an inherent part of meeting the company's stated objectives (Foss and Saebi, 2015). The role of the design is to coordinate and control the OD to guarantee organizational development (Patrucco et al., 2019). The OD, then, can be postulated in line with the business model and design and with the organizational and personified challenges in the institutional task, making organizations unique and distinct. The dimensions can facilitate the structure and stimulate the organization to improve the processes that facilitate innovation of their goods and/or services (Galbraith, 1982; Teece, 2018b), favouring the capture, value delivery, and compliance with the conditions required by the environment (Chiavenato, 2006; Fjeldstad and Snow, 2018; Jaspers et al., 2012).

In this regard, OD are a strategic point that enables value proposition activities and pragmatically supports evolution operations, thus allowing a process transformation for the generation of value in the community (Foss and Saebi, 2015; Huijben et al., 2016). This is how organizations may be considered to be a set of organizational dimensions, components, and/or elements (Huijben et al., 2016; Nadler and Tushman, 1980; Patrucco et al., 2019) that represent the organizational design differentiation. OD may help to reduce complex phenomena and foster articulation within the organization in accordance with managerial needs when defining strategies (Daft, 2011; Nadler and Tushman, 1980) that impact GPI facilitation at the organizational level.

Within organizational design, OD may comprise both formal and informal organizational structures for the transformation of processes and results (Nadler et al., 2011) directed at the environmental approach, leading to the generation of green innovation (Herrera-Baltazar, 2015; Liao and Tsai, 2019). Nevertheless, "at this point in the development of a science of organizations, we probably do not know the one right or best way to describe the different components of an organization" (Nadler and Tushman, 1980, p. 43) or, notably, to develop GPI, due to the different organizational challenges firms face.

The task could be to identify the OD that are adaptable to new environmental demands and help to strategically describe organizations advocating GPI development (Bhaskar and Mishra, 2017; Lin et al., 2011; Nadler et al., 2011), given that innovation requires a specifically designed organization (Galbraith, 1982; Song et al., 2018) where organizational dimensions, structures, and processes act as previous and enabling requirements of innovation (Armbruster et al., 2008).

3. Methodology

To answer the research questions posed in this study, the methodology implemented here is intended to identify the determinants of GPI, GIC, and OD, and then reconfigure them into an innovation management framework that will serve as a proposal for organizations to deal with GPI. The stages outlined below are derived from the methodological designs proposed by Bolden et al. (1997) and Edison et al. (2013).

3.1. Stage 1. Search and selection of studies related to the determinants of GPI

Two specialized databases, Scopus and Web of Science, were used in the search for publications, which was limited to works published between 2005 and 2020 because a clear research trend into GPI is observed in this period. A search equation that ensured a consistent and comparable search in the two databases was designed using the following keywords: driver, determinant, ecological product, environment, factor, friendly product, green product innovation, and practice responsive product.

The studies were selected based on the following inclusion criteria: (i) language: works and/or literature reviews originally published in English; (ii) document availability; and (iii) topic: articles that debate or provide a definition of GPI; papers that include determinants, drivers, factors or practices affecting GPI development at the organizational level; and publications that present, list, or integrate determinants under conceptual frameworks in manufacturing firms, excluding those that propose frameworks as instruments to measure and validate their concepts and connections.

Of the 1174 papers retrieved from the initial search, only 38 met the inclusion criteria. These articles served as the basis to generate the results and discussions on the determinants of GPI and the development of the concept. Following Khan et al. (2021), the diagram in Fig. 1 summarizes the process described above.

3.2. Stage 2. Identification and categorization of the determinants of GPI

The 38 selected articles were analysed to identify the determinants, drivers, factors, and practices presented by the authors as elements leading to GPI. This identification is justified by the fact that these determinants are key attributes to achieve GPI. Once identified, these determinants were classified and grouped according to various aspects such as similarity in their meaning and purpose, technical and physical characteristics, and impact on the different organizational areas. This

[1] Although in the literature, "IC" and "TIC" are frequently used to refer to a similar set of capabilities and are considered equivalent terms, here "IC" will mostly be used to allude to innovation capabilities, in accordance with the terminology defined in the Oslo Manual 2018 (OECD/Eurostat, 2018).

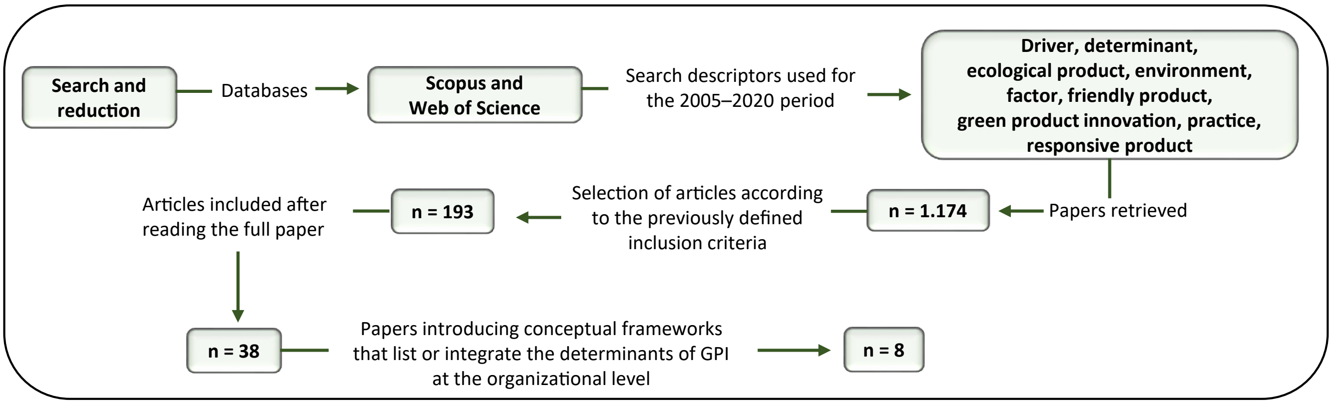

Fig. 1. Search and reduction of the determinants of GPI.
Source: Authors' elaboration

categorization is considered to help direct and reconfigure the organization to meet current demands regarding GPI.

3.3. Stage 3. Formulation of GIC and OD to steer organizations towards GPI

Finding a way to respond to the identified sets of determinants of GPI at the organizational level was a challenging task. According to this study, organizations would need to structure GIC and OD under an innovation management approach to meet this innovative challenge. This is in line with the works of Robledo-Velásquez (2019), Robledo-Velásquez et al. (2011), Serrano-García and Robledo-Velásquez (2013a), Serrano-García et al. (2017), which are based on the results of Guan and Ma (2003), Yam et al. (2004) and Wang et al. (2008), who proposed and evaluated seven IC, and also on the theoretical foundations of the OD proposed by Nadler and Tushman (1997), and the variant presented by Gouel (2005) in support of the transformation processes of firms.

In accordance with the studies mentioned above and the identified sets of determinants, this study proposes extending seven GIC to GPI as a possible strategic form of organizational reconfiguration. Furthermore, since the configuration of OD depends on the context and the stages of organizational development (Nadler et al., 2011), this work proposes five OD that are superimposed on the environmental context while keeping correspondence with the proposal of (Gouel, 2005; Nadler and Tushman, 1997). The selection of these OD is supported by previous research into different OD in the field of environmental sustainability, potentially helping to satisfy the current need for organizational reconfiguration considering the identified sets of determinants that favor GPI.

3.4. Stage 4. Defining GPI under an innovation management approach

The 38 selected articles included different definitions of GPI in technical, physical, and environmental areas, for instance, but not in the field of organizational management. This is explained by the fact that this concept is new and currently under development (Jasti et al., 2015; Sdrolia and Zarotiadis, 2019). Consequently, this study presents the proposal in relation to the understanding, description, and development of a GPI depending on the sets of determinants, GIC and OD, to characterize it within the field of business administration and innovation.

*3.5. **Stage 5.** Framework: taxonomy and matrix **of the determinants of GIC and OD***

Since the determinants of GPI involve different organizational skills and areas, the next step was to establish how these determinants could be affecting firms in terms of GPI development. Therefore, the impact of these determinants on each of the proposed GIC and OD was analysed, based on the theoretical and conceptual approach and together with the sets of categorized determinants. The result was a taxonomy and matrix framework. The first (taxonomy) clearly relates and defines the determinants of GPI within the different GIC and OD, establishing a comprehensive relationship that explains how the sets of identified determinants impact a given capability or dimension, or combinations of both, within organizations. The second (matrix) operationalizes the relationship between determinants, GIC and OD, and allows the organization to coherently and relationally define variables (activities) to assess its innovation management model in terms of GPI development.

The configuration of the taxonomy was carried out by each author considering their knowledge and experience in the area or research, after which a consensus was reached regarding their shared classification. Last, the taxonomy derived was refined by three business experts in green strategy and product innovation. The following factors were taken into consideration during this process: the theoretical and conceptual focus of each of the sets of determinants; the scope of the descriptions of the GIC, and the arguments of the OD; the theoretical referents upon which the organization's capacities and key components to develop green products were set forth; and the related key determinants to achieve this.

4. Results

The results obtained with the methodology implemented to address the research questions posed in this study are presented below.

4.1. Determinants of GPI

The determinants of GPI correspond to the antecedents, factors, drivers, and practices considered by the authors as key components leading to and preceding the development of GPI (Chen and Chang, 2013; Tariq et al., 2017). From the literature review, 266 proxies were found and grouped into 22 sets. Table 1 is an example of one of these sets of determinants and includes the source, proxys, a brief description of the set, and its concise name. In this specific case, the proxies are related to aspects such as energy, materials, waste, and reuse and are grouped into the reduced and efficient use of inputs and raw materials to achieve the GPI category. The process of identifying and grouping the 22 sets of determinants and their corresponding sources is presented in Table 4.

4.2. Adaptation and definition of seven new GIC under the green approach

According to Joo et al. (2018, p. 6094) "*the firm's environmental sustainability cannot be fully achieved without increasing technological*

Table 1
Sample of a set of determinants.

Authors	Proxys	Brief description	Determinant
Albino et al. (2009)	Material eco-efficiency	Intelligent use of resources, represented in the use of eco-efficient materials, their reuse and remanufacture, and the recycling of raw materials and consumables, impacting on the reduction of costs and favouring the creation of GPI.	Intelligent use of resources
Albino et al. (2009)	Energy efficiency		
Dangelico and Pujari (2010)	Reduced energy consumption		
Dangelico and Pujari (2010)	Reduced material use		
Chung and Wee (2010)	Smart use of resources		
Chung and Wee (2010)	Reuse, remanufacturing, and recycling of used products		
Chan et al. (2013)	Decisions regarding the type of raw materials, packaging, means of transport, and disposal		
Dangelico (2017)	Reduced costs, energy consumption, and material use to develop more innovative green products		
Tariq et al. (2017)	Reduced use of valuable input resources		
Zhang and Li (2019)	Low impact of renewable materials, recyclable materials, non-polluting materials, materials with low-energy content		

Source: Authors' elaboration.

innovation capabilities". Therefore, it is essential to understand, create, and protect these capabilities in agreement with the organization, its strategic plans, and the demands of its environment (Serrano-García and Robledo-Velásquez, 2013b).

In line with the definitions stated mainly in Dangelico et al. (2016), Hart (1995), Hart and Dowell (2011), Teece et al. (1997), Robledo-Velásquez et al. (2011), Serrano-García and Robledo-Velásquez, 2013a, and Serrano-García et al. (2017) and the theoretical background presented in this paper regarding GIC, and in accordance with the identified sets of determinants, for the purpose of the present paper GIC are understood as *organizational and dynamic abilities built and/or acquired by an organization in accordance with its strategic and operational management and aimed at developing GPI and contributing to solving the environmental challenges. GIC must be identified and integrated into each organizational function to respond to the new demands or necessary improvements within the context of GPI development. As a result, this would help firms to reduce and/or eliminate the pollution they cause, thus gaining comparative and competitive advantages.*

By extending this to the sphere of organizational functions, a proposal to select, adapt, and define the seven new GIC aimed at GPI development is presented in this study. Each GIC details the specific skills that organizations may need to reconfigure their capabilities to make progress in terms of innovation management, fostering the creation, development, and marketing of sustainable technological innovations to support firms' comparative and competitive advantage. Table 2 contains the name of the capability, the proposed definition, examples of responses, and relevant references.

4.3. OD identification and selection for GPI

Companies could strategically reconfigure the following OD: organizational behavior, human talent management, technology, environmental social responsibility, and environmental regulation. There are several other OD that organizations might consider. However, the proposed OD are based on Gouel (2005), Nadler and Tushman (1980), and Nadler et al. (2011), but updated in light of organizational needs to manage innovation to achieve GPI triggers to benefit environmental sustainability. Seeking to respond to the challenges currently faced by companies developing GPI, definitions and characteristics of OD are given below.

4.3.1. Human resources (HR)

Firms are made up of key elements to achieve profitability. One such element is human resources which, according to Chiavenato (2009), "are beings endowed with intelligence, knowledge, abilities, personality, aspirations, and perceptions, among others" (translation of the original in Spanish on p. 9).

In the context of compliance with environmental sustainability at the corporate level, HR Management is seen as a powerful area because of its strength and contribution (Chams and García-Blandón, 2019; Pellegrini et al., 2018) to achieving the organizational objectives. In recent times, this area has undergone several adjustments to meet firms' current needs. In the words of Kramar (2014), "sustainable HRM could be defined as the pattern of planned or emerging HR strategies and practices intended to enable the achievement of financial, social and ecological goals while simultaneously reproducing the HR base over a long term" (p. 1084). This area also includes actions and regulations that support greening activities (Jackson et al., 2014). According to Yong et al. (2019), researchers suggest that this new scope may facilitate the transition towards sustainability by implementing a clear structure in the different stages (integration, organization, retention, development, and audit (Chiavenato, 2009)), aimed at achieving environmental sustainability. For this purpose, interconnection between organizational functions, capabilities, and the environment is needed (Kramar, 2014).

4.3.2. Organizational behavior (OB)

Attitudes that safeguard individuals, groups, and organizations, supported by culture, motivation, leadership, change, and teamwork as independent factors that influence the action (Robbins and Judge, 2009). Therefore, a large number of individuals should become involved in coordinated actions to explore and execute activities to weaken or annihilate the impacts of organizations on climate change and other environmental problems (Geiger et al., 2019). The findings of Pellegrini et al. (2018) indicate that when organizations express their commitment to and promotion of sustainability, their members orient their efforts and behaviors to achieve this goal. Therefore, through their attitudes, convictions, and motivation, all members must work in favor of GPI development.

4.3.3. Technology (T)

Organizations need a technological basis to achieve their strategic and operational objectives. However, it should be noted that technology is not exclusively limited to the concept of hardware (i.e., artifacts and machines) (Robledo-Velásquez, 2019), but also includes a set of information which, once organized, becomes knowledge represented in practices, experiences, skills, devices, technical methods, and systems (OECD/Eurostat, 2018; Robledo-Velásquez, 2019) that promote its application to transform functional and organizational characteristics.

Therefore, given the current environmental demands and seeking to satisfy and attract new customers, an alternative could be to propose and adopt new green knowledge and technologies in product development manufacturing (Lisi et al., 2019). This includes appropriate knowledge in the area of technology innovation and represented in "energy-saving, pollution-prevention, waste recycling, green product designs, or corporate environmental management" (Chen et al., 2006, p. 332), requiring organizational support in terms of structure and strategy (Adler and Sbenbar, 1990). Consequently, by combining technology,

Table 2
Adaptation and definition of seven new GIC.

Capability	Definition	Examples	References
GSPC: Green strategic planning capability	*Firms' abilities to define prospects, policies, programs, plans, and objectives to avoid, improve, and/or replace the use of nonrenewable materials (toxic materials) with cleaner resources and technologies, under a comprehensive approach and throughout the product's life cycle. Likewise, to promote composting, reuse, and recycling, thus preventing environmental pollution and fostering GPI development.*	• Green management programs and philosophy. • Guidelines for GPI development. • Organizational policies, plans, and objectives oriented towards environmental sustainability. • Planning of environmental activities and projects. • Programs regarding changes in the design, incubation, and development of green products.	(Guan and Ma, 2003), (Yam et al., 2004), (Robledo-Velásquez et al., 2011), (Serrano-García and Robledo-Velásquez, 2013a), (Hart, 1995), (Block and Marash, 2002), (Ulrich and Eppinger, 2012), (Berry and Randinelli, 1998), (Prakash, 2000), (Ludevid, 2000), and (Dangelico and Pujari, 2010).
GOIC: Green organizational innovation capability	*Abilities defined in firms' business design and model, processes, management, and organizational and commercial structure. They focus on the assimilation, application, and acquisition of competencies to address new environmental opportunities and promote systemic capacity for GPI development.*	• Organizational values oriented towards environmental sustainability. • Management and staff's commitment to GPI development. • Green business model. • Management of radical and incremental innovation in environmental sustainability. • Coordination among and motivation of functional groups to design and develop green products.	(Yam et al., 2004), (Guan and Ma, 2003), (OECD/Eurostat, 2018), (Hart, 1995), (Van Hoof, 2014), (Dangelico et al., 2016), (Vickers and Cordey-Hayes, 1999), (Dangelico and Pujari, 2010), and (Wee and Quazi, 2005).
GR&DC: Green R&D capability	*Firms' abilities to create ideas, design prototypes, and develop technologies focused on reducing and/or eliminating the use of toxic resources and fostering the employment of eco-efficient materials and clean technologies, remanufacturing, and recycling, thus favouring the development of a new or improved green product.*	• R&D approach from the very design to the development of the green product prototype. • R&D activities to avoid the use of toxic materials in production. • R&D activities to create eco-friendly packaging and labels. • R&D activities to favor composting and/or recycling of containers and packaging.	(Guan and Ma, 2003), (Yam et al., 2004), (OCDE, 2015), (Leonidou et al., 2013), (Chung and Wee, 2010), and (Albino et al., 2009).
GPC: Green production capability	*Firms' abilities to develop and manufacture GPI based on stakeholders' needs and R&D results aimed at preventing the generation of waste, minimizing the use of materials and inputs, and fostering the employment of eco-efficient materials and waste reuse.*	• Changes in and optimization of the resources used. • Sustainability of resources used in production. • Production inputs and healthy outputs. • Recycling and reuse of materials in production. • Safety, hygiene, and maintenance of local production machines and premises, generating the minimum waste. • Design of ecological processes.	(Guan and Ma, 2003), (Yam et al., 2004), (Robledo-Velásquez et al., 2011), (Serrano-García and Robledo-Velásquez, 2013a), (Hart, 1995), (Ulrich and Eppinger, 2012), (Block and Marash, 2002), and (Dangelico and Pujari, 2010).
GOLRC: Green organizational learning and relationship capability	*Firms' abilities to learn about environmental sustainability with a focus on cleaner design, production, and packaging; remanufacturing; and recycling, among other aspects, through the collaboration of and continuous relationship with their stakeholders to improve their organizational actions and favor GPI development.*	• Participation of suppliers, customers, and the community in GPI development. • Brainstorming and exchange of information, techniques, and experiences with governments and/or nongovernmental organizations (NGOs) to learn about environmental solutions. • Organizational learning programs for compliance with environmental regulations.	(Yam et al., 2004), (Guan and Ma, 2003), (Yang, 2019), (Shevchenko et al., 2016), (Hart, 1995), (Nonaka, 1994), (Van Hoof, 2014), (Vickers and Cordey-Hayes, 1999), (Block and Marash, 2002), and (Albort-Morant et al., 2016).
GRMC: Green resource management capability	*Firms' abilities aimed at appropriately managing, obtaining, and allocating resources to implement R&D activities, thus favoring the invention of green products, the search and classification of ecological suppliers, the hiring of expert staff, the creation of learning and motivation programs concerning top environmental IC. Equally, the purchase of clean technologies and different inputs for production, the use of eco-friendly packaging, the identification of distribution channels, and recycling and potential remanufacturing, which, in turn, boosts the development and consolidation of GPI.*	• Strategic alliances between companies in the same sector for purchasing environmentally harmless inputs. • Negotiation agreements with suppliers certified in sustainability for the supply of raw materials. • Resource management for learning about and complying with environmental regulations. • Resource management for creating programs that foster the remanufacturing, recycling, and/or composting of products.	(Guan and Ma, 2003), (Yam et al., 2004), (Vickers and Cordey-Hayes, 1999), (Hart, 1995), (Serrano-García and Robledo-Velásquez, 2013a), (Block and Marash, 2002), (Chung and Wee, 2010), (Ludevid, 2000), (Chkanikova, 2016), and (Lee and Kim, 2011).
GMC: Green marketing capability	*Firms' abilities to redesign, publicize, and deliver products with a value offer based on environmental sustainability through using packaging, containers, and distribution channels that reduce and/or replace the use of nonrenewable resources (toxic resources) with light and/or recycled materials and components that can be reused and/or composted, thus facilitating the delivery of GPI to customers and consumers.*	• Availability of products with higher quality and preservation properties. • Offerings of products and packaging with reduced and/or zero harmful effects. • Product packaging that can be reused and recycled. • Final products' compliance with the ecological standards demanded by customers and consumers.	(Yam et al., 2004), (Guan and Ma, 2003), (OECD/Eurostat, 2005), (Prakash, 2000), (Vickers and Cordey-Hayes, 1999), (Ludevid, 2000), (Tsai, 2012), (Lin and Huang, 2012), and (Spack et al., 2012).

Source: Authors' elaboration.

innovation, and organizational systemic techniques under the green philosophy, improved products could be developed to satisfy the current needs of society and the environment (Jabbour et al., 2015).

4.3.4. Corporate environmental responsibility (CER)

This approach is built upon social responsibility, which refers to the actions taken by firms for the benefit of their stakeholders, represented in their economic, legal, ethical, and philanthropic commitments (Archie and Carroll, 1991). This approach also currently encompasses environmental social responsibility (Siegel, 2009), which is carried out under socially responsible strategies that seek to adequately satisfy the pressures of protecting the environment (López-Cabarcos et al., 2019). and lead to the development of green products, among other actions. Organizations must have the required capabilities to evaluate this behavior (Siegel, 2009) based on an articulated system that provides them with adequate support.

4.3.5. Environmental regulation (ER)

Compliance with environmental regulations—which have been of paramount importance for decades—is a dynamic aspect needed for GPI development. To this effect, regulations force companies to implement ecological measures that favor the creation of GPI, thereby avoiding sanctions for non-compliance (Foo et al., 2019). Therefore, the environmental rules serve to make organizations realise and be aware of the environmental harm they are causing (Pérez-Pérez et al., 2021). As visionaries, Porter and Van der Linde (1995) presented their hypothesis on how firms can respond to market needs in an eco-friendly way and how complying with environmental standards can become an extraordinary competitive advantage for them.

According to Majumdar and Marcus (2001), such regulations are classified as flexible and inflexible. Flexible regulations are willingly adopted by firms, based on their motivation and level of commitment to care for the environment, resulting in product innovation and compliance with environmental obligations. Inflexible regulations, on the other hand, include manuals and exact provisions that stifle innovation but fight against pollution. According to the results of Ramanathan et al. (2017), flexible regulations favor imagination, creation, and innovation within organizations, and are also essential as they can increase competitiveness at the industry level (Porter and Van der Linde, 1995). Hence, depending on the firms' appropriation of IC, they may be able to assimilate and respond to environmental regulations by developing transformative solutions such as, in this case, GPI development, thus impacting on their economic profit (Saenz and Atoche-Kong, 2014).

4.4. Definition of GPI based on GIC, OD, and its determinants

Developing GPI is an opportunity for manufacturing firms to protect the environment due to their reduced environmental impacts. This alternative also favors firms' market share and comparative and competitive advantage (Lee and Kim, 2011; Tsai, 2012). Based on these assertions, Table 3 contains a sample of definitions of a green product (GP) and GPI.

This table clearly shows that there are different definitions of GPI and there is no consensus on a globally accepted one for the general concept of green products (Sdrolia and Zarotiadis, 2019). "Being an entirely new industry, the designations 'green product 'or 'environmentally conscious product' cover a wide variety of different products with their own distinct characteristics"(Tsai, 2012) (p. 117). However, all the definitions seem to have the same purpose: to reduce and/or eliminate the environmental impacts generated by products that supposedly improve quality of life.

According to the systematic review of the literature in Sdrolia and Zarotiadis (2019), GPI is given different names such as "environmentally conscious product", "environmental product", "ecological product", "environmentally correct" or "environmentally sustainable product", "eco-product", "green product", or "sustainable product."

Table 3
GP and GPI definitions.

Authors	GP and GPI definitions
Albino et al. (2009)	A 'green product' is referred to as a product designed to minimize its environmental impacts during its whole life cycle.
Huang and Wu (2010)	Green new product success as the ability of a green new product or innovation to compete in the marketplace.
Dangelico and Pujari (2010)	Green product innovation is a multi-faceted process wherein three key types of environmental focus – material, energy, and pollution – are highlighted based on their major impact on the environment at different stages of the product's physical life cycle – manufacturing process, product use, and disposal. It is important to note that not all products have a significant environmental footprint at each stage of the physical product life cycle, and nor does the footprint stem from all aspects (material, energy, and pollution). However, almost all products have a significant environmental impact in at least one of the stages.
Lee and Kim (2011)	Green product innovation as a multi-faceted process aimed at minimizing environmental impacts while striving to protect and enhance the natural environment by conserving energy and resources.
Tsai (2012)	Green products are classified into the following seven categories based on the discussion of Grave (1992), Peattie (1992), Makower et al. (1993), Simon (1971), and Chen (2001): 1. It must be Environmental Protection Certified by the government. 2. It must use fewer raw materials or be readily recyclable. 3. It must be harmless to animal and plant life or produce less pollution. 4. It must be capable of being repeatedly used, replenished or sustainable. 5. Its operation must consume less energy. 6. It must possess a function to reduce pollution. 7. Its manufacturing process must produce less pollution.
Zhang and Li (2019)	Green products are the kind of products that are designed in such a way as to have the least environmental impact during their production and consumption.
Sdrolia and Zarotiadis (2019)	Green is a product (tangible or intangible) that minimizes its environmental impact (direct and indirect) during its whole life cycle, subject to the present technological and scientific status.
Long and Liao (2021)	Eco-product innovation exerts the most significant influence on sustainability because it aims to reduce resource use and pollution throughout the entire product life cycle, from product design to disposal.

Source: Authors' elaboration.

Based on these definitions of GPI and the sets of identified determinants, the GIC descriptions, and the OD arguments, and for the purpose of the present paper, what follows is the proposal regarding the understanding, description, and development of a GPI:

It is understood that the scope of green product innovation could represent a corporate commitment where a product is designed, created, produced, and traded with reduced or zero pollution or using nonrenewable materials and light packaging. In addition, this commitment would encourage consumers and firms to recycle and reuse it. Development could require new innovation performance directed towards reconfiguring and strengthening the seven GIC and the five OD for GPI. In addition, it requires a systemic approach that enables the orchestration of the corporate ecosystem and contributes to the generation of value, corporate profits, community satisfaction, and the environment.

4.5. Framework: taxonomy and matrix

What follows is the framework, which is made up of two elements. The taxonomy, which is where the determinants of GPI in GIC and OD are located, and the matrix, which operationalizes the taxonomy.

Table 4
Taxonomy of determinants in GIC and OD.

#	Authors	Brief description	Determinant	Green Innovation Capabilities (GIC)							Organizational Dimensions (OD)				
				GSPC	*GOIC*	*GR&DC*	*GPC*	*GOLRC*	*GRC*	*GMC*	*HR*	*OB*	*T*	*CER*	*ER*
A	(Albino et al., 2009), (Janine Fleth De Medeiros et al., 2018), (Leonidou et al., 2013), (Alharthey, 2019), (Dangelico, 2017), (Dangelico, 2016), (Lin and Huang, 2012), (Huang et al., 2016), (Jasti et al., 2015), (Ilg, 2019), (Dangelico and Pujari, 2010), and (Melander, 2017).	Formulation and implementation of short-, medium- and long-term policies, mission, programmes, strategies, and organizational objectives, aims and goals in procuring GPI.	Planning oriented at GPI	***GSPC***							***HR***			***CER***	
B.	(Huang and Wu, 2010), (Wee and Quazi, 2005), (El-Kassar and Singh, 2019), (Dangelico, 2017), (Melander, 2017), and (Tariq et al., 2017).	Philosophies, organizational commitment, identity, culture, and corporate environmental ethic leading to environmental management practices.	Corporate green commitment	***GSPC***	***GOIC***						***HR***	***OB***		***CER***	
C.	(Albino et al., 2009), (Jasti et al., 2015), (Lee and Kim, 2011), and (Tsai, 2012).	Planning, design, development, and control of green processes and products.	Design of green processes and products	***GSPC***		***GR&DC***	***GPC***		***GRC***				***T***	***CER***	***ER***
D.	(Dangelico and Pujari, 2010), (Chung and Wee, 2010), (Lee and Kim, 2011), (Tsai, 2012), (Wee and Quazi, 2005), (Chan et al., 2013), (Jasti et al., 2015), (Dangelico, 2017), and (Oliveira et al., 2018)	Organizational management in the supply chain, administrative and structural support in procuring the generation and adoption of green innovation, facilitating compliance with environmental regulations and social responsibility.	Organizational management directed at green innovation		***GOIC***		***GPC***	***GOLRC***		***GMC***		***OB***		***CER***	*ER*
E.	(Huang et al., 2016), (Jasti et al., 2015), and (Tariq et al., 2017).	Development and implementation of a certified environmental management system.	Environmental management system	***GSPC***	***GOIC***		GPC		GRC				T	***CER***	***ER***
F.	(Albino et al., 2009), (Dangelico and Pujari, 2010), (Chung and Wee, 2010), (Tsai, 2012), (Tariq et al., 2019), (Zhang and Li, 2019), (Jabbour et al., 2015), and (Berchicci and Bodewes, 2005), (Tsai, 2012), (Tariq et al., 2019), (Song et al., 2018), (Chen and Chang, 2013), and (Jabbour et al., 2015).	Manufacturing under the incorporation of practices for improving production and optimising processes, and for incorporating environmental attributes such as recyclable material, the use of eco efficient and less toxic material, the reuse and remanufacture of raw materials, using less quantity of resources, and/or eliminating contamination in procuring GPI.	Manufacturing under the incorporation of environmental practices and attributes			***GR&DC***	***GPC***		***GRC***				***T***	***CER***	***ER***
G.	(Tsai, 2012), (Leonidou et al., 2013), (Dost et al., 2019), (Tariq et al., 2019), (Janine Fleth	Development and use of green techniques and technologies that prevent pollution for the creation,	Development of environmental technologies		***GOIC***	***GR&DC***	***GPC***						***T***	***CER***	*ER*

(*continued on next page*)

Table 4 (*continued*)

#	Authors	Brief description	Determinant	Green Innovation Capabilities (GIC)							Organizational Dimensions (OD)				
				GSPC	*GOIC*	*GR&DC*	*GPC*	*GOLRC*	*GRC*	*GMC*	*HR*	*OB*	*T*	*CER*	*ER*
	De Medeiros et al., 2018), (Janine Fleith De Medeiros et al., 2018), (Dangelico, 2017), (Berchicci and Bodewes, 2005), (Tariq et al., 2017), and (Chen and Chang, 2013).	manufacturing, distribution, and end-of-life of green new products.													
H.	(Dangelico and Pujari, 2010), (Cheung and To, 2019), (Alharthey, 2019), (ShabbirHusain and Varshney, 2019), (Spack et al., 2012), and (Tan et al., 2019).	Credible advertising on communication platforms, showing the characteristic and environmental benefits of the green products offered by the firm.	Evidential advertising of GPI		***GOIC***			***GOLRC***		***GMC***			***T***		
I.	(Spack et al., 2012), (Leonidou et al., 2013), (Tan et al., 2019), (Chan et al., 2013), (Tariq et al., 2019), (Zhang and Li, 2019), and (Alharthey, 2019).	Lighter, cleaner, and more environmentally friendly product packaging that can be recycled or reused and/or can easily decompose.	Packing, packaging, and green labelling			***GR&DC***	***GPC***		***GRC***	***GMC***			***T***	***CER***	***ER***
J.	(Lin and Huang, 2012), (Tsai, 2012), (Leonidou et al., 2013), (Tan et al., 2019), (Yogananda and Nair, 2019), (Melander, 2017), (Alharthey, 2019), (Melander, 2018), (De Medeiros et al., 2014), (Janine Fleth De Medeiros et al., 2018), (De Medeiros et al., 2014), (Tariq et al., 2017), and (Cheung and To, 2019).	The demands and preferences of clients and consumers in terms of protecting the environment must be present and be complied with throughout the design, manufacturing, and distribution stages.	Customer demand	***GSPC***		***GR&DC***	***GPC***	***GOLRC***		***GMC***				***CER***	ER
K.	(Janine Fleth De Medeiros et al., 2018)	Market monitoring after product launch to assess consumers' satisfaction.	Monitoring the market							***GMC***	***HR***		***T***		
L.	(Huang and Wu, 2010), (Tsai, 2012), (Chen and Chang, 2013), and (Janine Fleith De Medeiros et al., 2018), (Tariq et al., 2017), (Berchicci and Bodewes, 2005), (Dangelico, 2016), (Dost et al., 2019), (Wee and Quazi, 2005), (Chan et al., 2013), and (Dangelico and Pujari, 2010).	R&D directed at green product innovation under the generation and implementation of original, novel, useful ideas in the whole of the product lifestyle.	R&D directed at GPI		***GOIC***	***GR&DC***	***GPC***	***GOLRC***				***OB***	***T***		***ER***
M.	(Albino et al., 2009), (Dangelico and Pujari, 2010), (Chung and Wee, 2010), (Chan et al., 2013), (Tariq et al., 2019), and (Zhang and Li, 2019).	Intelligent use of resources represented in the implementation of eco efficient materials, reuse, remanufacturing, and the recycling of raw materials and	Intelligent use of resources	***GSPC***			***GPC***		***GRC***		***HR***	***OB***	***T***	***CER***	***ER***

(*continued on next page*)

Table 4 (*continued*)

#	Authors	Brief description	Determinant	Green Innovation Capabilities (GIC)							Organizational Dimensions (OD)				
				GSPC	*GOIC*	*GR&DC*	*GPC*	*GOLRC*	*GRC*	*GMC*	*HR*	*OB*	*T*	*CER*	*ER*
		consumables, impacting on the reduction of costs and facilitating the creation of GPI.													
N.	(Wee and Quazi, 2005), (Chan et al., 2013), (Janine Fleth De Medeiros et al., 2018), (Janine Fleith De Medeiros et al., 2018), (Song et al., 2018), (Huang et al., 2016), (Chen and Chang, 2013), (Melander, 2017), and (Berchicci and Bodewes, 2005).	Investment of resources to comply with social responsibility and environmental regulations. Investment in laboratories, in R&D, in cleaner technologies, in ecological modernization, in improvements in production systems, in infrastructure, in qualified human resources, in knowledge, in relationships, and in collective learning, aimed at supporting GPI.	Investment in resources directed at green product development	***GSPC***					***GRC***					***CER***	***ER***
O.	(Lee and Kim, 2011), (Chkanikova, 2016), (Ilg, 2019), (Melander, 2018), (Dangelico, 2016), (Melander, 2017), (Dangelico, 2017), (De Medeiros et al., 2014), and (Tariq et al., 2017).	Collaborative and communication relationships with suppliers, customers, consumers, environmental groups, universities, research institutions, and firms, among others, for the supply and use of environmentally friendly materials and the design of initiatives and developments in terms of research, innovation, technology transfer, and cleaner products and processes.	Institutional relations		***GOIC***	***GR&DC***		***GOLRC***			***HR***	***OB***	***T***		
P.	(El-Kassar and Singh, 2019), (Ilg, 2019), (ShabbirHusain and Varshney, 2019), (Oliveira et al., 2018), (Melander, 2018), (Janine Fleith De Medeiros et al., 2018), (Dangelico, 2017), (Dangelico, 2016), (Huang et al., 2016), (Melander, 2017), (De Medeiros et al., 2014), (Tariq et al., 2017), (Lee and Kim, 2011), and (Wee and Quazi, 2005).	Response capacity and knowledge acquisition, dissemination, and exchange between employees and stakeholders, reflected in the elimination of cultural barriers, quality, best environmental practices, and new materials, technologies, and resources to favor GPI.	Acquiring knowledge		***GOIC***	***GR&DC***		***GOLRC***			***HR***	***OB***	***T***		
Q.	(Janine Fleth De Medeiros et al., 2018), (Janine Fleith De Medeiros et al., 2018), (Dangelico, 2017), (	Green-oriented leadership and transformative behavior translated into corporate ethic, monitoring and	Ecological organizational leadership		***GOIC***			***GOLRC***			***HR***	***OB***			

(*continued on next page*)

Table 4 (*continued*)

#	Authors	Brief description	Determinant	Green Innovation Capabilities (GIC)							Organizational Dimensions (OD)				
				GSPC	*GOIC*	*GR&DC*	*GPC*	*GOLRC*	*GRC*	*GMC*	*HR*	*OB*	*T*	*CER*	*ER*
	Huang et al., 2016), (Chen and Chang, 2013), (De Medeiros et al., 2014), and (Tariq et al., 2017).	identification of new opportunities, cross-functional collaboration, and motivation and incentives for the development of green product offerings.													
R.	(Wee and Quazi, 2005), (El-Kassar and Singh, 2019), (Janine Fleth De Medeiros et al., 2018), (De Medeiros et al., 2014), (Tariq et al., 2017), (Chen and Chang, 2013), (Melander, 2017), (Chang, 2016), (Song et al., 2018), (Melander, 2018), and (Huang et al., 2016).	Human resources with extensive knowledge on environmental sustainability to promote the creation and alignment of teams and cross-functional procedures and their communication for GPI development.	Human talent with competences towards GPI		***GOIC***			***GOLRC***			***HR***	***OB***			
S.	(Albino et al., 2009), (Huang and Wu, 2010), (Dangelico and Pujari, 2010), (El-Kassar and Singh, 2019), (Song et al., 2018), (ShabbirHusain and Varshney, 2019), (Chen and Chang, 2013), (Jasti et al., 2015), (Tariq et al., 2017), (Chang, 2016), and (Chung and Wee, 2010).	Corporate social responsibility as a philosophy, an ethical act, and an environmental commitment that provides a sense of identity and allows firms to adapt to achieve their green objectives.	Environmental responsibility	***GSPC***	***GOIC***							***OB***		***CER***	
T.	(Huang and Wu, 2010), (Dangelico and Pujari, 2010), (Tsai, 2012), (Chan et al., 2013), (Melander, 2018), and (Huang et al., 2016).	Assessment practices, such as emission measurement, auditing, and environmental offset incentives at each stage of the product's life cycle.	Environmental auditing		***GOIC***		***GPC***						***T***	***CER***	***ER***
U.	(Dangelico and Pujari, 2010), (Chung and Wee, 2010), (Zhang and Li, 2019), (Berchicci and Bodewes, 2005), and (Leonidou et al., 2013).	Organizational responsibility from the product's design until the end of its life cycle, through the incorporation of environmental attributes for GPI development.	Responsibility throughout the life cycle of the product		***GOIC***	***GR&DC***	***GPC***			***GMC***		***OB***		***CER***	
V.	(Dangelico and Pujari, 2010), (Lee and Kim, 2011), (Tsai, 2012), (Chan et al., 2013), (Song et al., 2018), (Janine Fleith De Medeiros et al., 2018), (Dangelico, 2017), (Dangelico, 2016), (Melander, 2017), (Tariq et al., 2017), and (De Medeiros et al., 2014).	Awareness, identification, and compliance with environmental policies, laws, and regulations to favor the creation of green products.	Compliance with environmental regulations		***GOIC***			***GOLRC***				***OB***			***ER***

Source: Authors' elaboration.

Table 5
Matrix of the determinants driving GPI development.

Matrix of the determinants driving GPI development		Organizational dimensions for GPI				
		Human Resources (HR)	Organizational Behavior (OB)	Technology (T)	Corporate Environmental Responsibility (CER)	Environmental Regulation (ER)
Green Innovation Capabilities (GIC)	Green Strategic Planning Capability (GSPC)	[A, B, M]	[B, S]	[C, E, M]	[A, B, C, E, J, M, N, S]	[E, J, M, N]
	Green Organizational Innovation Capability (GOIC)	[B, O, P, Q, R]	[B, D, L, O, P, Q, R, U, S, U, V]	[E, G, H, L, O, P, T]	[B, D, E, G, S, T, U]	[C, D, E, G, L, T, V]
	Green R&D Capacity (GR&DC)	[O, P]	[L, O, P, U]	[C, F, G, I, L, O, P]	[C, F, G, I, J, U]	[C, F, G, I, J, L]
	Green Production Capability (GPC)	[M]	[D, L, U]	[C, E, F, G, I, L, M, T]	[C, D, E, F, G, I, J, M, T, U]	[C, D, E, F, G, I, J, L, M, T]
	Green Organizational learning and relationship capability (GOLRC)	[O, P, Q, R]	[D, L, O, P, Q, R]	[H, L, O, P]	[D]	[D, L]
	Green Resources Capability (GRC)	[M]	[M]	[C, E, F, I, M]	[C, E, F, I, M, N]	[C, E, F, I, M, N]
	Green Marketing Capability (GMC)	[K]	[D]	[H, I, K]	[D, I, J]	[D,I, J]

Source: Authors' elaboration.

4.5.1. Taxonomy of determinants in GIC and OD

The classification of determinants in GIC and OD may mean higher organizational and managerial understanding and may help to distinguish organizational factors where the determinant intervenes and should be available to channel and achieve GPI.

Continuing with the elements showed in Table 4, first there is a list of the seven GPI and five OD, and second there is a set of twenty-two associations with the respective capabilities and dimensions, given their organizational strategic extensions aimed at establishing GPI.

For instance, determinant *A, organizational policies, mission, plans, and objectives that favor GPI development,* shown in Table 4, falls within the *green strategic planning capability* because it represents a firm's ability to formulate and define organizational environmental strategies at the strategic, tactical, and operational levels. This determinant also impacts two organizational dimensions: *human resources,* since it is the staff themselves who carry out the planning activities and implement the strategies aimed at GPI development; and *environmental corporate responsibility,* because with this factor firms' efforts are directed towards reducing and/or eliminating their negative impacts on the environment which, in turn, yields benefits for their stakeholders.

Determinant *Q, green-oriented leadership and transformative behavior translated into corporate ethic, monitoring and identification of new opportunities, cross-functional collaboration, and motivation and incentives for the development of green product offerings,* shown in Table 4, impacts two capabilities: *green organizational innovation*, which concerns the ability established in a firm's design, management, and structure to face new environmental opportunities and bring them to the organization for their transformation; and *green organizational learning and relationship*, which refers to a firm's ability to learn about environmental sustainability, thus favoring the monitoring and identification of new opportunities and the improvement of its environmental actions.

For its part, determinant *V* falls within two organizational dimensions: *organizational behavior and human resources.* The first is related to the members of the firm's commitment, culture, and behavioral and motivational efforts oriented towards GPI development. And the second is the beings endowed with faculties and intelligence that can execute and materialize tangible actions through cross-functional collaboration, motivation, and incentives.

With the aim of testing the suitability of the taxonomy presented in Table 4, and by means of example, some of the theoretical referents used by the authors for the association of the sets of determinants within GIC and OD are presented. The less common name of the drivers in italics belong to this paper, and those in inverted commas are their similes identified in the theoretical references.

To this effect, what follows are the drivers that associated with GMC: *advertising evidence of GPI* is related to the factor "clear communication of green products and brand characteristics to reduce information asymmetry"(Dangelico and Vocalelli, 2017); *monitoring the market* is associated with "conducting environmental benchmarketing" (Dangelico, 2016); *client demand* coincides with "purchase intention" and "consumer buying decision" (Alharthey, 2019); *packing, packaging and green labelling* is related to "ecolabels and packaging as key identifiers of green products" (Dangelico and Vocalelli, 2017) and "environmentally friendly packaging and labeling green packaging" (Jasti et al., 2015).

Similarly, the determinants associated with *GOLRC* compare with the key factors found in papers that develop the topic of learning and green collaboration. To this effect, *human talent with green oriented competencies* relates to "development of a set of green competences" (De Medeiros et al., 2014); *institutional relations* is associated with "relationship management" and "partner selection" (Melander, 2017); *client demand* relates to "customer demand" (Melander, 2017); *complying with environmental regulations* is related with "regulations" (Melander, 2017); and *acquiring knowledge* is related to "knowledge access" (Melander, 2017).

The determinants associated with the *HR* dimension in the classification of the present paper are related to the key factors stated in papers that develop themes associated with human resources. To this effect, *human talent with green oriented competences* is associated with the determinant "employees' competence in environmental protection" (Chang, 2016); *ecological organizational leadership* with the driver "managers in the company can fully support their employees to achieve the goals of environmental protection" (Chang, 2016); and, *corporative green commitment* with "green values" (referring to individual and organizational values oriented to managing environmental sustainability) (Chams and García-Blandón, 2019). The link between the determinants *planning strategy oriented to GPI* and *the acquisition of knowledge* and *HR* is reinforced by the affirmations "human resources play a significant role in the strategic management of the organization" (Garavan et al., 2002, p. 1) and "HRM systems supporting knowledge-intensive teamwork are associated with greater team knowledge acquisition and team knowledge sharing" (Chuang et al., 2013) and (Jackson et al., 2014), respectively.

Consequently, below is a description of how each determinant impacts organizational capabilities and dimensions and how they are related and interconnected. The analysis was carried out with each identified determinant because each of them impacts, involves, and is linked to the organization and its functions at the environmental level. Hence, the importance of their taxonomy and grouping, allowing them to be reconfigured and properly distributed to identify specific actions aimed at GPI development. Table 4 shows the results of the taxonomy of determinants in GPI and OD.

4.5.2. Operationalisation matrix of the CIV, OD and determinants

Taking as a reference the previous works of Robledo-Velásquez (2020), Robledo-Velásquez et al. (2011), and Serrano-García and Robledo-Velásquez, 2013a, and summarizing the results of the taxonomy of determinants in GIC and OD postulated in Table 4, a matrix was then proposed through which the taxonomy was operationalized, illustrating the interrelation between GIC, OD and the sets of the determinants presented in Table 5. The rows and columns represent GIC and OD, respectively, and show the location of each determinant within the intersection of GIC and OD, including the one it is related to, thus facilitating an eventual organizational performance that contributes to the determinants and fosters GPI development.

This matrix shows how the determinants involve a capability, a dimension, or different combinations of these within the organization. It evinces that the whole organization must work together in permanent interrelationship between its parts and using different abilities to achieve an adequate application of the determinants leading to GPI. Accordingly, this matrix would favor the assessment of GPI development via a coherent definition of the variables representing the determinants which, in turn, would fulfill both GIC and OD.

In theory, firms should achieve all the determinants of GPI. However, making progress in each of them would allow them to gradually ascend the different levels and, at some point, fully develop GPI. Based on the proposed classification and grouping, it could be said that what is needed to comply with the determinants is a GIC strategic approach, together with green-oriented OD, since this provides the organization with support. This could lead to the commercial transformation and exploitation of firms by capturing and delivering value through GPI development. This, in turn, would encourage a context in which the organization is examined as an integral system that favors reciprocal connection and complementarity between the organization, the capabilities, the dimensions, and the determinants, thus boosting GPI development to have a positive impact on its economic, social, and environmental performance.

5. Discussion

The objective of this study was to identify the determinants and their configuration within GIC and OD for GPI development. Therefore, it moves towards the unification of the constituent elements of GPI, providing 22 sets of determinants and evincing a series of characteristics that specifically show the environmental factor being fostered by turning it into an organizational challenge. This is important because it enables the identification of which situation-capability-area each set of determinants is affecting at the organizational level to favor its interpretation and the performance/behavior placement being considered within the organization. Similarly, useful basic data are provided for future research to move forward in pursuit of improving the determinants needed in GPI configuration. Additionally, this study may serve as a starting point for the implementation of other frameworks in fields such as administration, innovation, and technology management under a green approach.

Furthermore, manufacturing companies currently need to update their capacities to promote the achievement of GPI to continue acquiring competitiveness in the market (Salim et al., 2020). At the same time, DC are necessary to favor innovation and allow companies to constantly evolve, facilitating their adaptation to environmental demands. To this effect, DC play a moderating role, intervening to create facilitate the creation of ecological product innovation (Long and Liao, 2021). Therefore, the present work considers the structure of DC, which relate properties that generate innovation such as the dynamism and evolution accomplished by means if IC.

The above explains the fact that the concepts and generalities of the seven IC are widely used nowadays to develop and define specific characteristics in each of these capabilities to provide a solution to CPI. Nonetheless, the descriptors of these seven IC in relation to the concept of GPI are unknown. Thus, one of the contributions of this paper is that it finds and connects these specific and unique elements, defining each of these already established capabilities but relocated to the green context which, to the best of the authors' knowledge and belief, has not been postulated and unified by any other author. More specifically, this study shows how the seven proposed GIC agree with key organizational abilities, which could jointly favor innovation management to respond to the green challenge. Furthermore, the form and scope of each GIC at the administrative and green technical levels are clearly described for easy understanding and application within the organization.

Moreover, this research proposes five OD that are part of an extension towards the green approach. Following Nadler et al. (2011) and Gouel (2005), the *formal organization* dimension is represented, in this study, in the *corporate environmental responsibility and environmental regulation* dimension, given that these two latter aspects correspond to organizational agreements subject to coordination and control to ensure they are complied with. The *informal organization* dimension is represented in the *organizational behavior* dimension since it appears spontaneously but affects the behavior and results of the firm in terms of sustainability. The *human talent* dimension comprises the individuals performing work activities, whose knowledge, abilities, expectations, and motivations regarding the environment must be considered. Last, the *technology* dimension is represented in the pooling of knowledge facilitating the creation of green products.

Regarding the understanding, definition and development of a GPI, we identified that to be classified as a green product it must have certain ecological technical and organizational characteristics that make it different from a conventional innovative product. However, considering the findings of this paper, what is required to achieve GPI is a systemic orientation of the organization as the facilitating entity, supported by administrative pillars such as GIC and OD which, according to the set of determinants, could favor GPI configuration.

It is clear how the sets of determinants relate to the proposed GIC and OD, with their groupings and interconnections in terms of how each of them affects, involves, and relates to the organization and its role in the environmental field illustrated, thus facilitating the integrity and consistency of the determinants. Hence, the importance of their classification and grouping within GIC and OD, as this implies a better understanding for the organization and managers. The taxonomy proposed has practical value in terms of the identification of the existing relations between the GIC, OD and the determinants, to produce a global vision of the factors required for organizational reconfiguration towards GPI development.

Having shaped the taxonomy, the matrix that operationalized GIC, OD and the determinants was created, seeking to make the interrelations and interdependencies more evident and easily understandable. This will allow the corresponding variables to be selected and controlled in the future to measure and assess the aforementioned association in terms of innovation management oriented towards GPI development.

Therefore, the matrix was developed as a systemic tool, given that it illustrates the interrelation between GIC, OD and the determinants within the organization. It is also dynamic because it can be adapted to the different variants and environments in which the company may find itself and it allows the variables to be updated and modified to reach a diagnosis that enables the strategy and the actions needed to procure achieving GPI to be defined. The matrix has been proposed from a general perspective of the organization and based on the determinants identified. However, faced with specific conditions, the matrix can evolve to adapt to each problem and organizational dynamic. Consequently, the development and updating of the matrix will allow firms to move up through the different organizational levels, leading them at some point to the full configuration of GPI.

A series of frameworks based on determinants for facing GPI at the organizational level have been proposed in several research articles. Dangelico (2016) suggests a success factor framework for GPI development that includes four capabilities: external integrative, technological, internal integrative, and marketing. For his part, Melander (2018) combines the frameworks proposed by Dangelico (2016) and Melander

(2017) under internal and external capabilities and focuses on firm collaboration in the lengthening of the supply chain with suppliers and clients for GPI development. Although there are groupings of determinants based on capabilities in these proposals, there was still need for a specific, holistic, and strategic approach capable of containing most of the determinants of GPI leading to organizational functions.

Tariq et al. (2017) propose a framework based on the identification of drivers (factors) and consequences (performance) for ecological processes and products. This interrelation is carried out from the identification of measuring and moderating variables, within which the framework resorts to linking certain capabilities and thematic organizational approaches. However, these authors call for the structuring of organizational factors using DC to advance in responding to the environmental challenges.

Berchicci and Bodewes (2005) present a framework that includes three organizational aspects: design specifications, coordination and alignment within teams, and project management support. This framework considers the lack of specificity, for instance the required research and development approach to contribute to determinants such as clean processes and technologies, and organizational learning, evidencing the need for knowledge regarding environmental sustainability and strategic planning linked to greening at the organizational level, among other necessary factors for the determinants of GPI.

Jasti et al. (2015) identify principles, tools, and techniques to develop green products. Their study includes up to 80 similar elements that are then grouped in eleven strategic organizational factors. However, no GIC and OD are considered which, according to our grouping and taxonomy, must be considered to support the determinants of GPI. Moreover, capabilities such as research and development, resource management, and organizational learning are not considered, and neither are dimensions such as human talent management, organizational behavior, social responsibility, and environmental regulation.

The main focus of the study conducted by Janine Fleth De Medeiros et al. (2018a,b) is the planning, operation, and marketing of green product development. Nevertheless, aspects such as human talent management, organizational behavior, social responsibility, research and development, and organizational learning and relationships aimed at GPI are not considered in their proposal.

Ilg (2019) proposes an analytical framework in the form of a virtuous circle for the development of ecological materials and products in the construction industry, thus fostering ecological innovation by considering suitable organizational approaches. However, neither the GIC concept nor research and development capability, which contributes to research on new technologies in the construction field, are considered in these frameworks.

Considering the above, there is no conceptual scenario shown that displays how the determinants are organized under an integral approach, supported by the seven proposed GIC and the structuring of the five identified OD, to respond to the transformation of processes that favor innovation management oriented towards the green approach. To the best of the authors' knowledge and belief, this is the first research that postulates the articulation of GIC and OD to favor innovation management and its corresponding extension to GPI. Additionally, the authors would like to highlight that despite the number of proposed and related GIC and OD, they were brought about under the scrutiny of the identification, grouping, and taxonomy classification of the required determinants in pursuit of GPI.

The proposed framework, made up of the taxonomy and the matrix, considers the organization to be an interrelated system in which the proposed foundations adjust, mutually support, and continuously coordinate to achieve the innovation management objectives, according to the planned strategies (Nadler and Tushman, 1998). This framework provides a structural relation of the organizational elements, allowing the strategies, functions, and actions to be redirected to strengthen technological innovation management in pursuit of GPI creation and development. Therefore, the proposal to organizations to be able to reconfigure themselves to achieve GPI presented in this paper is the association of the determinants of GPI with GIC and OD, structured in the taxonomy and operationalized in the matrix, based on innovation management.

By way of analogy, and to visualize the proposal presented in this paper in a holistic and general way, the authors envisage the framework located in the organization as a tree, under which the structural relationship to achieve GPI is interpreted. The roots represent GIC, whose function is to absorb the nutrients to ensure its growth. Meanwhile, these roots connect to the trunk and the branches representing the five OD as a fundamental component, which themselves project out in a way that maximises the absorption of energy through the leaves, symbolising the determinants and, at the same time, satisfying the needs of the fruit, which represents the creation of GPI. In this analogy, the fruit depends on the leaves and the branches, and the branches strongly depend on the health of the tree trunk and the solid structural base provided by the roots. Similarly, given that the seven proposed GIC and five OD that make up the organizational reconfiguration make it easier for firms to adapt, the consistency and integrity of the determinants leading to GPI development are also facilitated.

6. Conclusions

Nowadays, firms have a tremendous opportunity to be competitive if they become involved in GPI. However, to do so, they need to change and reconfigure themselves based on certain organizational skills and dimensions that would then serve as the foundations for the determinants required for GPI development.

This paper proposes the extension and adjustment of seven GIC to create and develop green products based on the new demands of the environment. These GIC were carefully selected and arranged to guide firms to reconfigure themselves and optimize their environmental actions. Moreover, the proposed OD are regarded as constitutive and support elements associated with organizational changes, adaptation, and revitalization from an environmental perspective. Hence, GIC and OD together are factors that could shape a set of organizational adjustments required for firms to address their current responsibility in terms of developing green products.

Furthermore, after gathering and analyzing previous studies in the field, strategic determinants that influence the development and implementation of GPI were identified and thoroughly classified. These determinants refer to the attributes that firms should consider when they decide to address the challenge of GPI. In addition, they are factors that require a solid base at the organizational level, leading us to identify their required connection and association with the proposed GIC and OD.

Therefore, another outcome of this research is the classification and strategic association of the determinants of GPI within the different GIC and OD, showing how they relate to each other and facilitating the identification of actions inherent to innovation management to help organizations to face and address their needs in terms of GPI. Likewise, a matrix is established, which allows organizations to assess and monitor their progress in GPI management.

The proposed framework combines typical and necessary organizational factors. It could be seen as a roadmap for firms to understand their organizational redesign when they are adapting and being revitalized based on the scenarios, interdisciplinarity, and eventualities of the current context in terms of environmental sustainability. This framework fosters links in the evolution of the organization, supported by GIC and OD, which are represented in the innovative and technological transforming processes and abilities to meet the requirements of the determinants and to finally deliver a GPI.

In general, this framework regards organizations as open systems of interconnected parts that facilitate their constant adaptation to boost GPI development. Therefore, the proposed framework could become a tool for the transition and/or transformation of firms towards the development of environmentally friendly products from the innovative perspective of their new organizational commitment.

This study aims to contribute to the advancement in the organizational and technological innovation management theories towards GPI consolidation, as well as to the research on the structuring of environmental sustainability at the organizational level. It is especially intended for researchers, managers in the manufacturing sector, and government bodies interested in environmental sustainability, proposing a holistic and systematic approach that redefines the boundaries of opportunities for new competence and performance. Various studies have found all these aspects to be missing and necessary (Dangelico et al., 2016; Engert et al., 2016; Leih et al., 2015; Shevchenko et al., 2016; Teece, 2018a).

6.1. Limitations and future work

A series of limitations that can also be opportunities for further research were identified, the purpose of which is to encourage creativity in the debate and discussion generated by our work. The first is that we did not consider other organizational and technology management lines of theory that could also favor the strengthening and development of GPI. Second, future research should study each GIC separately in combination with each OD to favor GPI development, as well as design a conceptual framework from other perspectives and under different grouping and correlation criteria. Third, given that this work mainly focused on theoretical and conceptual aspects, it is recommended that further research converts the sets of determinants into variables that can be implemented and controlled by firms. Fourth, the framework developed could be applied in studies whose aim is to study the environments and the varied conditions in which the company can find itself, to ensure the advance towards the constitution of GIP. Fifth, one aspect to consider from the basis created is the development of future empirical research to analyze its validity and reliability in real settings, and to identify possible configurations and impacts on organizational performance.

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CRediT authorship contribution statement

Jakeline Serrano-García: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Writing – original draft, Project administration, Funding acquisition. **Andrea Bikfalvi:** Conceptualization, Methodology, Formal analysis, Investigation, Resources, Writing – review & editing, Supervision, Project administration, Funding acquisition. **Josep Llach:** Conceptualization, Methodology, Formal analysis, Investigation, Resources, Writing – review & editing, Supervision, Project administration, Funding acquisition. **Juan José Arbeláez-Toro:** Conceptualization, Methodology, Formal analysis, Writing – review & editing, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

Renard, L., St-amant, G.E., 2003. Capacité, capacité organisationnelle et capacité dynamique : une proposition de définitions. Les Cah. du Manag. Technol. 13, 43–56.
Adler, P., Sbenbar, A., 1990. Adapting your technological base: the organizational challenge. Sloan Manag. Rev. 32, 25–37.
Albino, V., Balice, A., Dangelico, R.M., 2009. Environmental strategies and green product development: an overview on sustainability-driven companies. Bus. Strat. Environ. 18, 83–96. https://doi.org/10.1002/bse.638.
Albort-Morant, G., Leal-Millán, A., Cepeda-Carrión, G., 2016. The antecedents of green innovation performance: a model of learning and capabilities. J. Bus. Res. 69, 4912–4917. https://doi.org/10.1016/j.jbusres.2016.04.052.
Alharthey, B.K., 2019. Impact of green marketing practices on consumer purchase intention and buying decision with demographic characteristics as moderator. Int. J. Adv. Appl. Sci. 6, 62–71. https://doi.org/10.21833/ijaas.2019.03.010.
Amores-Salvadó, J., Martin-de Castro, G., Navas-López, J.E., 2015. The importance of the complementarity between environmental management systems and environmental innovation capabilities: a firm level approach to environmental and business performance benefits. Technol. Forecast. Soc. Change 96, 288–297. https://doi.org/10.1016/j.techfore.2015.04.004.
Archie, C.B., Carroll, A.B., 1991. The pyramid of corporate social responsibility: toward the moral management of organizational stakeholders. Bus. Horiz. 34, 39–48. https://doi.org/10.1016/0007-6813(91)90005-g.
Ardyan, E., Rahmawan, G., Tinggi, S., Ekonomi, I., 2017. Green innovation capability as driver of sustainable competitive advantages and smes marketing performance. Int. J. Civ. Eng. Technol. 8, 1114–1122.
Armbruster, H., Bikfalvi, A., Kinkel, S., Lay, G., 2008. Organizational innovation: the challenge of measuring non-technical innovation in large-scale surveys. Technovation 28, 644–657. https://doi.org/10.1016/j.technovation.2008.03.003.
Berchicci, L., Bodewes, W., 2005. Bridging environmental issues with new product development. Bus. Strat. Environ. 14, 272–285. https://doi.org/10.1002/bse.488.
Berry, M.A., Randinelli, D.A., 1998. Proactive corporate Environmental Management: a new industrial revolution. Acad. Manag. Exec. 2, 39–50.
Bhaskar, A.U., Mishra, B., 2017. Exploring relationship between learning organizations dimensions and organizational performance. Int. J. Emerg. Mark. 12, 593–609. https://doi.org/10.1108/IJoEM-01-2016-0026.
Block, M.R., Marash, R., 2002. Integración de la ISO 14000 en un sistema de gestión de la calidad, 3a. ed. Madrid - España.
Bocken, N.M.P., de Pauw, I., Bakker, C., van der Grinten, B., 2016. Product design and business model strategies for a circular economy. J. Ind. Prod. Eng. 33, 308–320. https://doi.org/10.1080/21681015.2016.1172124.
Bolden, R., Waterson, P., Warr, P., Clegg, C., Wall, T., 1997. A new taxonomy of modern manufacturing practices. Int. J. Oper. Prod. Manag. 17, 1112–1130. https://doi.org/10.1108/01443579710177879.
Bowen, F.E., Cousins, P.D., Lamming, R.C., Faruk, A.C., 2001. The role of supply management capabilities in green supply. Prod. Oper. Manag. 10, 174–189. https://doi.org/10.1111/j.1937-5956.2001.tb00077.x.
Burgelman, R., Maidique, M., Wheelwright, S., 2004. Strategic Management of Technology and Innovation. McGraw-Hill.
Chams, N., García-Blandón, J., 2019. On the importance of sustainable human resource management for the adoption of sustainable development goals. Resour. Conserv. Recycl. 141, 109–122. https://doi.org/10.1016/j.resconrec.2018.10.006.
Chan, H.K., Wang, X., White, G.R.T., Yip, N., 2013. An extended fuzzy-AHP approach for the evaluation of green product designs. IEEE Trans. Eng. Manag. 60, 327–339. https://doi.org/10.1109/TEM.2012.2196704.
Chang, C.H., 2016. The determinants of green product innovation performance. Corp. Soc. Responsib. Environ. Manag. 23, 65–76. https://doi.org/10.1002/csr.1361.
Chang, C.H., 2017. How to enhance green service and green product innovation performance? The roles of inward and outward capabilities. Corp. Soc. Responsib. Environ. Manag. 425, 411–425. https://doi.org/10.1002/csr.1469.
Chen, C., 2001. Design for the environment: a quality-based model for green product development. Manag. Sci. 47 (2), 250–263. https://doi.org/10.1287/mnsc.47.2.250.9841.
Chen, Y.S., Chang, C.H., 2013. The determinants of green product development performance: green dynamic capabilities, green transformational leadership, and green creativity. J. Bus. Ethics 116, 107–119. https://doi.org/10.1007/s10551-012-1452-x.
Chen, Y., Lin, S., Wen, C., 2006. The influence of green innovation performance on corporate advantage in Taiwan. J. Bus. Ethics 67, 331–339. https://doi.org/10.1007/s10551-006-9025-5.
Cheung, M.F.Y., To, W.M., 2019. An extended model of value-attitude-behavior to explain Chinese consumers' green purchase behavior. J. Retailing Consum. Serv. 50, 145–153. https://doi.org/10.1016/j.jretconser.2019.04.006.
Chiavenato, I., 2006. Introducción a la teoría general de la administración, Séptima ed. McGraw-Hill Interamericana, México.
Chiavenato, I., 2009. Administración de recursos humanos. El capital humano de las organizaciones, Octava. McGraw-Hill Interamericana, México.

Chkanikova, O., 2016. Sustainable purchasing in food retailing: interorganizational relationship management to green product supply. Bus. Strat. Environ. 25, 478–494. https://doi.org/10.1002/bse.1877.

Chuang, C.H., Jackson, S.E., Jiang, Y., 2013. Can knowledge-intensive teamwork Be managed? Examining the roles of HRM systems, leadership, and tacit knowledge. J. Manag. https://doi.org/10.1177/0149206313478189.

Chung, C.J., Wee, H.M., 2010. Green-product-design value and information-technology investment on replenishment model with remanufacturing. Int. J. Comput. Integrated Manuf. 23, 466–485. https://doi.org/10.1080/09511921003667714.

Daft, R.L., 2011. Teoría Y Diseño Organizacional, Décima. Cengage Learning Editores.

Dangelico, R.M., 2016. Green Product Innovation: where we are and where we are Going. Bus. Strat. Environ. 25, 560–576. https://doi.org/10.1002/bse.1886.

Dangelico, R.M., 2017. What drives green product development and how do different antecedents affect market performance? A survey of Italian companies with eco-labels. Bus. Strat. Environ. 26, 1144–1161. https://doi.org/10.1002/bse.1975.

Dangelico, R.M., Pujari, D., 2010. Mainstreaming green product innovation: why and how companies integrate environmental sustainability. J. Bus. Ethics 95, 471–486. https://doi.org/10.1007/s10551-010-0434-0.

Dangelico, R.M., Vocalelli, D., 2017. "Green Marketing": an analysis of definitions, strategy steps, and tools through a systematic review of the literature. J. Clean. Prod. 165, 1263–1279. https://doi.org/10.1016/j.jclepro.2017.07.184.

Dangelico, R.M., Pujari, D., Pontrandolfo, P., 2016. Green product innovation in manufacturing firms: a sustainability-oriented dynamic capability perspective. Bus. Strat. Environ. 26, 490–506. https://doi.org/10.1002/bse.1932.

De Medeiros, J.F., Ribeiro, J.L.D., Cortimiglia, M.N., 2014. Success factors for environmentally sustainable product innovation: a systematic literature review. J. Clean. Prod. 65, 76–86. https://doi.org/10.1016/j.jclepro.2013.08.035.

De Medeiros, Fleth, Janine, Lago, N.C., Colling, C., Ribeiro, J.L.D., Marcon, A., Duarte Ribeiro, J.L., Marcon, A., 2018a. Proposal of a novel reference system for the green product development process (GPDP). J. Clean. Prod. 187, 984–995. https://doi.org/10.1016/j.jclepro.2018.03.237.

De Medeiros, Fleith, Janine, Vidor, G., Ribeiro, J.L.D., 2018b. Driving factors for the success of the green innovation market: a relationship system proposal. J. Bus. Ethics 147, 327–341. https://doi.org/10.1007/s10551-015-2927-3.

Dost, M., Pahi, M.H., Magsi, H.B., Umrani, W.A., 2019. Influence of the best practices of environmental management on green product development. J. Environ. Manag. 241, 219–225. https://doi.org/10.1016/j.jenvman.2019.04.006.

Edison, H., Bin Ali, N., Torkar, R., 2013. Towards innovation measurement in the software industry. J. Syst. Software 86, 1390–1407. https://doi.org/10.1016/j.jss.2013.01.013.

El-Kassar, A.N., Singh, S.K., 2019. Green innovation and organizational performance: the influence of big data and the moderating role of management commitment and HR practices. Technol. Forecast. Soc. Change 144, 483–498. https://doi.org/10.1016/j.techfore.2017.12.016.

Engert, S., Rauter, R., Baumgartner, R.J., 2016. Exploring the integration of corporate sustainability into strategic management: a literature review. J. Clean. Prod. 112, 2833–2850. https://doi.org/10.1016/j.jclepro.2015.08.031.

Fan, X., Liu, W., Zhu, G., 2017. Scientific linkage and technological innovation capabilities: international comparisons of patenting in the solar energy industry. Scientometrics 111, 117–138. https://doi.org/10.1007/s11192-017-2274-5.

Fernando, Y., Chiappetta Jabbour, C.J., Wah, W.X., 2019. Pursuing green growth in technology firms through the connections between environmental innovation and sustainable business performance: does service capability matter? Resour. Conserv. Recycl. 141, 8–20. https://doi.org/10.1016/j.resconrec.2018.09.031.

Fjeldstad, Ø.D., Snow, C.C., 2018. Business models and organization design. Long. Range Plan. 51, 32–39. https://doi.org/10.1016/j.lrp.2017.07.008.

Foo, M.Y., Kanapathy, K., Zailani, S., Shaharudin, M.R., 2019. Green purchasing capabilities, practices and institutional pressure. Manag. Environ. Qual. Int. J. 30, 1171–1189. https://doi.org/10.1108/MEQ-07-2018-0133.

Foss, N.J., Saebi, T., 2015. Business models and business model innovation bringing organization into the discussion. Business Model Innovation: the Organizational Dimension. Oxford University Press, Oxford, pp. 1–26. https://doi.org/10.1093/acprof:oso/9780198701873.001.0001.

Galbraith, J.R., 1982. Designing the innovating organization. Organ. Dynam. 5–25.

Gao, X., Zhang, W., 2013. Foreign investment, innovation capacity and environmental efficiency in China. Math. Comput. Model. 58, 1040–1046. https://doi.org/10.1016/j.mcm.2012.08.012.

Garavan, T.N., Morley, M., Gunnigle, P., Mcguire, D., 2002. Human resource development and workplace learning: emerging theoretical perspectives and organisational practices. J. Eur. Ind. Train. 26, 60–71. https://doi.org/10.1108/03090590210428133.

Geiger, N., Swim, J.K., Glenna, L., 2019. Spread the green word: a social community perspective into environmentally sustainable behavior. Environ. Behav. 51, 561–589. https://doi.org/10.1177/0013916518812925.

Gouel, P., 2005. Theories of Organization. Industrial and Operations Engineering, Course IOE 421 Work Organizations. Michigan, USA. Michigan, USA.

Grave, M., 1992. The green of business document: an environmental strategy for micrographics. IMC J. 4, 117–186.

Guan, J., Ma, N., 2003. Innovative capability and export performance of Chinese firms. Technovation—The Int. J. Technol. Innov. Entrep. 23, 737–747.

Guan, J.C., Yam, R.C.M., Mok, C.K., Ma, N., Kam, C., Ma, N., 2006. A study of the relationship between competitiveness and technological innovation capability based on DEA models. Eur. J. Oper. Res. 170, 971–986. https://doi.org/10.1016/j.ejor.2004.07.054.

Hart, S.L., 1995. A natural-resource-based view of the firm. Acad. Manag. Rev. 20 https://doi.org/10.5465/AMR.1995.9512280033.

Hart, S.L., Dowell, G., 2011. A natural-resource-based view of the firm: fifteen years after. J. Manag. 37, 1464–1479. https://doi.org/10.1177/0149206310390219.

Herrera-Baltazar, M.E., 2015. Creating competitive advantage by institutionalizing corporate social innovation. J. Bus. Res. 68, 1468–1474. https://doi.org/10.1016/j.jbusres.2015.01.036.

Huang, Y.C., Wu, Y.C.J., 2010. The effects of organizational factors on green new product success: evidence from high-tech industries in Taiwan. Manag. Decis. 48, 1539–1567. https://doi.org/10.1108/00251741011090324.

Huang, Y.C., Yang, M.L., Wong, Y.J., 2016. The effect of internal factors and family influence on firms' adoption of green product innovation. Manag. Res. Rev. 39, 1167–1198. https://doi.org/10.1108/MRR-02-2015-0031.

Huijben, J.C.C.M., Verbong, G.P.J., Podoynitsyna, K.S., 2016. Mainstreaming solar: stretching the regulatory regime through business model innovation. Environ. Innov. Soc. Trans. 20, 1–15. https://doi.org/10.1016/j.eist.2015.12.002.

Hukkinen, J., 1995. Green virus: exploring the environmental product concept. Bus. Strateg. Environ. 4, 135–144.

Ilg, P., 2019. How to foster green product innovation in an inert sector. J. Innov. Knowl. 4, 129–138. https://doi.org/10.1016/j.jik.2017.12.009.

Jabbour, C.J.C., Jugend, D., De Sousa Jabbour, A.B.L., Gunasekaran, A., Latan, H., 2015. Green product development and performance of Brazilian firms: measuring the role of human and technical aspects. J. Clean. Prod. 87, 442–451. https://doi.org/10.1016/j.jclepro.2014.09.036.

Jackson, S.E., Schuler, R.S., Jiang, K., 2014. An aspirational framework for strategic human resource management. Acad. Manag. Ann. 8, 1–56. https://doi.org/10.1080/19416520.2014.872335.

Jakhar, S.K., Mangla, S.K., Luthra, S., Kusi-Sarpong, S., 2019. When stakeholder pressure drives the circular economy: measuring the mediating role of innovation capabilities. Manag. Decis. 57, 904–920. https://doi.org/10.1108/MD-09-2018-0990.

Jaspers, F., Prencipe, A., Van Den Ende, J., 2012. Organizing interindustry architectural innovations: evidence from mobile communication applications. J. Prod. Innovat. Manag. 29, 419–431. https://doi.org/10.1111/j.1540-5885.2012.00915.x.

Jasti, N.V.K., Sharma, A., Karinka, S., 2015. Development of a framework for green product development. Benchmark Int. J. 22, 426–445. https://doi.org/10.1108/BIJ-06-2014-0060.

Joo, H.Y., Seo, Y.W., Min, H., 2018. Examining the effects of government intervention on the firm's environmental and technological innovation capabilities and export performance. Int. J. Prod. Res. 56, 6090–6111. https://doi.org/10.1080/00207543.2018.1430902.

Khan, S.A.R., Yu, Z., Golpira, H., Sharif, A., Mardani, A., 2021. A state-of-the-art review and meta-analysis on sustainable supply chain management: future research directions. J. Clean. Prod. 278, 123357. https://doi.org/10.1016/j.jclepro.2020.123357.

Kim, M.K., Sheu, C., Yoon, J., 2018. Environmental sustainability as a source of product innovation: the role of governance mechanisms in manufacturing firms. Sustain. Times 10. https://doi.org/10.3390/su10072238.

Kong, T., Feng, T., Ye, C., 2016. Advanced manufacturing technologies and green innovation: the role of internal environmental collaboration. Sustain. Times 8, 9–11. https://doi.org/10.3390/su8101056.

Kramar, R., 2014. Beyond strategic human resource management: is sustainable human resource management the next approach? Int. J. Hum. Resour. Manag. 25, 1069–1089. https://doi.org/10.1080/09585192.2013.816863.

Lahovnik, M., Breznik, L., 2014. Technological innovation capabilities as a source of competitive advantage: a case study from the home appliance industry. Transform. Bus. Econ. 13, 144–160.

Lee, K.H., Kim, J.W., 2011. Integrating suppliers into green product innovation development: an empirical case study in the semiconductor industry. Bus. Strat. Environ. 20, 527–538. https://doi.org/10.1002/bse.714.

Leih, S., Linden, G., Teece, D.J.T., 2015. Business model innovation and organizational design. A dynamic capabilities perspective. In: Business Model Innovation: the Organizational Dimension. Oxford, pp. 1–23. https://doi.org/10.1093/acprof.

Leonidou, C.N., Katsikeas, C.S., Morgan, N.A., 2013. "Greening" the marketing mix: do firms do it and does it pay off? J. Acad. Market. Sci. 41, 151–170. https://doi.org/10.1007/s11747-012-0317-2.

Liao, Y.C., Tsai, K.H., 2019. Innovation intensity, creativity enhancement, and eco-innovation strategy: the roles of customer demand and environmental regulation. Bus. Strat. Environ. 28, 316–326. https://doi.org/10.1002/bse.2232.

Lin, P.C., Huang, Y.H., 2012. The influence factors on choice behavior regarding green products based on the theory of consumption values. J. Clean. Prod. 22, 11–18. https://doi.org/10.1016/j.jclepro.2011.10.002.

Lin, Y., Tseng, M.L., Chen, C.C., Chiu, A.S.F., 2011. Positioning strategic competitiveness of green business innovation capabilities using hybrid method. Expert Syst. Appl. 38, 1839–1849. https://doi.org/10.1016/j.eswa.2010.07.113.

Lisi, W., Zhu, R., Yuan, C., 2019. Embracing green innovation via green supply chain learning: the moderating role of green technology turbulence. Sustain. Dev. 1–14 https://doi.org/10.1002/sd.1979.

Liu, Z., Gong, Y., 2018. The threshold effect of environmental regulation on green technology innovation capability: an empirical test of Chinese manufacturing industries. Ekoloji 27, 503–516.

Long, S., Liao, Z., 2021. Are fiscal policy incentives effective in stimulating firms' eco-product innovation? The moderating role of dynamic capabilities. Bus. Strat. Environ. 1–10. https://doi.org/10.1002/bse.2791.

López-Cabarcos, M.Á., Pérez-Pico, A.M., López-Pérez, M.L., 2019. Does social network sentiment influence S & P 500 environmental & socially responsible index? Sustain. Times 11. https://doi.org/10.3390/su11020320.

Ludevid, M., 2000. La gestión ambiental de la empresa. In: Ariel Economía, Primera ed.

Ma, Y., Yin, Q., Pan, Y., Cui, W., Xin, B., Rao, Z., 2018. Green product innovation and firm performance: assessing the moderating effect of novelty-centered and efficiency-centered business model design. Sustain. Times 10. https://doi.org/10.3390/su10061843.
Majumdar, S.K., Marcus, A. a, 2001. Rules versus discretion: the productivity consequences of flexible regulation. Acad. Manag. J. 44, 170–179. https://doi.org/10.2307/3069344.
Makower, J., Elkington, J., Hailes, J., 1993. The Green Consumer. Penguin, New York, NY, USA.
Melander, L., 2017. Achieving sustainable development by collaborating in green product innovation. Bus. Strat. Environ. 26, 1095–1109. https://doi.org/10.1002/bse.1970.
Melander, L., 2018. Customer and supplier collaboration in green product innovation: external and internal capabilities. Bus. Strat. Environ. 27, 677–693. https://doi.org/10.1002/bse.2024.
Mellett, S., Kelliher, F., Harrington, D., 2018. Network-facilitated green innovation capability development in micro-firms. J. Small Bus. Enterprise Dev. 25, 1004–1024. https://doi.org/10.1108/JSBED-11-2017-0363.
Mousavi, S., Bossink, B.A.G., 2018. Firms' capabilities for sustainable innovation: the case of biofuel for aviation. J. Clean. Prod. 167, 1263–1275. https://doi.org/10.1016/j.jclepro.2017.07.146.
Nadler, D., Tushman, M., 1980. A model for diagnosing organizational behavior. Organ. Dynam. 9, 35–51. https://doi.org/10.1016/0090-2616(80)90039-X.
Nadler, D.A., Tushman, M.L., 1997. Competing by design: the power of organizational architecture, competing by design. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195099171.001.0001.
Nadler, D., Tushman, M., 1998. A model for diagnosing organizational behavior. Organ. Dynam.
Nadler, D., Tushman, M., Nadler, M., 2011. Chapter 3: mapping the organizational terrain university. Competing by Design: the Power of Organizational. Oxford Scholarship Online, Oxford Scholarship, pp. 603–610. https://doi.org/10.1093/acprof:oso/9780195099171.001.0001.
Niedermeier, A., Emberger-Klein, A., Menrad, K., 2021. Drivers and barriers for purchasing green Fast-Moving Consumer Goods: a study of consumer preferences of glue sticks in Germany. J. Clean. Prod. 284, 124804. https://doi.org/10.1016/j.jclepro.2020.124804.
Nonaka, I., 1994. A dynamic theory of organizational knowledge creation. Organ. Sci. 5, 14–37. https://doi.org/10.1287/orsc.5.1.14.
Ocde, 2015. Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development, the Measurement of Scientific, Technological and Innovation Activities, the Measurement of Scientific, Technological and Innovation Activities. París. https://doi.org/10.1787/9789264239012-en.
OECD/Eurostat, 2005. Manual de Oslo, Guía para la recogida e interpretación de datos sobre innovación. Luxembourg, Tercera. https://doi.org/10.1787/9789264065659-es.
OECD/Eurostat, 2018. Oslo Manual: Guidelines for Collecting, Reporting and Using Data on Innovation, fourth ed. Paris/Eurostat, Luxembourg. https://doi.org/10.1787/9789264304604-en.
Oliveira, G.A., Tan, K.H., Guedes, B.T., 2018. Lean and green approach: an evaluation tool for new product development focused on small and medium enterprises. Int. J. Prod. Econ. 205, 62–73. https://doi.org/10.1016/j.ijpe.2018.08.026.
Patrucco, A.S., Walker, H., Luzzini, D., Ronchi, S., 2019. Which shape fits best? Designing the organizational form of local government procurement. J. Purch. Supply Manag. 25, 100504. https://doi.org/10.1016/j.pursup.2018.06.003.
Peattie, K., 1992. Green Marketing. Pitman Publishing, London, UK.
Pellegrini, C., Rizzi, F., Frey, M., 2018. The role of sustainable human resource practices in influencing employee behavior for corporate sustainability. Bus. Strat. Environ. 27, 1221–1232. https://doi.org/10.1002/bse.2064.
Pérez-Pérez, J.F., Parra, J.F., Serrano-García, J., 2021. A system dynamics model : transition to sustainable processes. Technol. Soc. 65, 1–16. https://doi.org/10.1016/j.techsoc.2021.101579.
Pons, M., Bikfalvi, A., Llach, J., 2018. Clustering product innovators: a comparison between conventional and green product innovators. Int. J. Prod. Manag. Eng. 6, 37. https://doi.org/10.4995/ijpme.2018.8762.
Porter, M.E., Van der Linde, C., 1995. Toward a new conception of the environment-competitiveness relationship. J. Econ. Perspect. 9, 97–118. https://doi.org/10.1257/jep.9.4.97.
Prakash, A., 2000. Greening the Firm: the Politics of Corporate Environmentalism. Cambridge University Press, Cambridge.
Ramanathan, R., He, Q., Black, A., Ghobadian, A., Gallear, D., 2017. Environmental regulations, innovation and firm performance: a revisit of the Porter hypothesis. J. Clean. Prod. 155, 79–92. https://doi.org/10.1016/j.jclepro.2016.08.116.
Ramanathan, R., Ramanathan, U., Bentley, Y., 2018. The debate on flexibility of environmental regulations, innovation capabilities and financial performance – a novel use of DEA. Omega (United Kingdom) 75, 131–138. https://doi.org/10.1016/j.omega.2017.02.006.
Rehman Khan, S.A., Zhang, Y., Anees, M., Golpîra, H., Lahmar, A., Qianli, D., 2018. Green supply chain management, economic growth and environment: a GMM based evidence. J. Clean. Prod. 185, 588–599. https://doi.org/10.1016/j.jclepro.2018.02.226.
Robbins, S.P., Coulter, M., 2014. Administración, Décimosegunda. Pearson Educación, España.
Robbins, S.P., Judge, T.A., 2009. Comportamiento Organizacional. Decimotercera Pearson Educación, México.
Robledo Velásquez, J., 2019. Introducción a la Gestión de la Tecnología y la Innovación Empresarial. Universidad Nacional de Colombia - Sede Medellín.
Robledo Velásquez, J., 2020. Introducción a la gestión de la tecnología y la innovación empresarial, Primera. Universidad Nacional de Colombia. Facultad de Minas, Medellín.
Robledo-Velásquez, J., Aguilar-Zambrano, J., Pérez-Vélez, J., 2011. Methodological tool for measurement and assessment of technological innovation capabilities. Technol. Manag. Energy Smart. World 1–8.
Rodriguez, J.A., Wiengarten, F., 2017. The role of process innovativeness in the development of environmental innovativeness capability. J. Clean. Prod. 142, 2423–2434. https://doi.org/10.1016/j.jclepro.2016.11.033.
Saenz, S., Atoche-Kong, C., 2014. Profiting from environmental economic regulations: the mediating role of innovation capabilities. Manag. Eng. Technol. (PICMET), 2014 Portl. Int. Conf. 1626–1632.
Salim, N., Rahman, M.N.A., Wahab, D.A., Muhamed, A.A., 2020. Influence of social media usage on the green product innovation of manufacturing firms through environmental collaboration. Sustain. Times 12, 1–17. https://doi.org/10.3390/su12208685.
Sana, S.S., 2020. Price competition between green and non green products under corporate social responsible firm. J. Retailing Consum. Serv. 55, 102118. https://doi.org/10.1016/j.jretconser.2020.102118.
Sdrolia, E., Zarotiadis, G., 2019. A comprehensive review for green product term : from definition to evaluation. J. Econ. Surv. 33, 150–178. https://doi.org/10.1111/joes.12268.
Serrano-García, J., Robledo-Velásquez, J., 2013a. Methodology for evaluating Innovation Capabilities at university institutions using a fuzzy system. J. Technol. Manag. Innovat. 8, 246–259. https://doi.org/10.4067/s0718-27242013000300051.
Serrano-García, J., Robledo Velásquez, J., 2013b. Variables para la medicion de las capacidades de innovación tecnológica en instituciones universitarias. Ciencias Estratégicas 22, 267–284.
Serrano-García, J., Acevedo-Álvarez, C.A., Castelblanco-Gómez, J.M., Arbeláez-Toro, J. J., 2017. Measuring organizational capabilities for technological innovation through a fuzzy inference system. Technol. Soc. 50, 93–109. https://doi.org/10.1016/j.techsoc.2017.05.005.
ShabbirHusain, R.V., Varshney, S., 2019. Is current way of promoting sustainability, sustainable? J. Nonprofit & Public Sect. Mark. 31, 84–113. https://doi.org/10.1080/10495142.2018.1526735.
Shevchenko, A., Lévesque, M., Pagell, M., 2016. Why firms delay reaching true sustainability. J. Manag. Stud. 53, 911–935. https://doi.org/10.1111/joms.12199.
Siegel, D.S., 2009. Green management matters only if it yields more: an economic/strategic perspective. Acad. Manag. Perspect. 23, 5–17.
Simon, J.L., 1971. The Management of Advertising. Prentice-Hall, Englewood Cliffs, NJ, USA.
Song, W., Ren, S., Yu, J., 2018. Bridging the gap between corporate social responsibility and new green product success: the role of green organizational identity. Bus. Strat. Environ. 28, 88–97. https://doi.org/10.1002/bse.2205.
Spack, J.A., Board, V.E., Crighton, L.M., Kostka, P.M., Ivory, J.D., 2012. It's easy being green: the effects of argument and imagery on consumer responses to green product packaging. Environ. Commun. 6, 441–458. https://doi.org/10.1080/17524032.2012.706231.
Stucki, T., 2019. What hampers green product innovation: the effect of experience. Ind. Innovat. 26, 1242–1270. https://doi.org/10.1080/13662716.2019.1611417.
Su, J.C.P., Wang, L., Ho, J.C., 2017. The timing of green product introduction in relation to technological evolution. J. Ind. Prod. Eng. 34, 159–169. https://doi.org/10.1080/21681015.2016.1233911.
Tan, C.N.L., Ojo, A.O., Thurasamy, R., 2019. Determinants of green product buying decision among young consumers in Malaysia. Young Consum. 20, 121–137. https://doi.org/10.1108/YC-12-2018-0898.
Tariq, A., Badir, Y.F., Tariq, W., Bhutta, U.S., 2017. Drivers and consequences of green product and process innovation: a systematic review, conceptual framework, and future outlook. Technol. Soc. 51, 8–23. https://doi.org/10.1016/j.techsoc.2017.06.002.
Tariq, A., Badir, Y., Chonglerttham, S., 2019. Green innovation and performance: moderation analyses from Thailand. Eur. J. Innovat. Manag. 22, 446–467. https://doi.org/10.1108/EJIM-07-2018-0148.
Teece, D.J., 2007. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. Strat. Manag. J. 28, 1319–1350. https://doi.org/10.1002/smj.640.
Teece, D.J., 2018a. Business models and dynamic capabilities. Long. Range Plan. 51, 40–49. https://doi.org/10.1016/j.lrp.2017.06.007.
Teece, D.J., 2018b. Dynamic capabilities as (workable) management systems theory. J. Manag. Organ. 24, 359–368. https://doi.org/10.1017/jmo.2017.75.
Teece, D.J., Pisano, G., Shuen, A., 1997. Strategic management. Strateg. Manag. 18, 77–115. https://doi.org/10.1007/978-1-137-03545-5.
Tsai, C.C., 2012. A research on selecting criteria for new green product development project: taking Taiwan consumer electronics products as an example. J. Clean. Prod. 25, 106–115. https://doi.org/10.1016/j.jclepro.2011.12.002.
Tseng, C.H., Chang, K.H., Chen, H.W., 2019. Strategic orientation, environmental innovation capability, and environmental sustainability performance: the case of Taiwanese suppliers. Sustain. Times 11. https://doi.org/10.3390/su11041127.
Ulrich, K.T., Eppinger, S.D., 2012. Diseño y desarrollo de productos, Quinta edi. McGraw Hill Education, México.
Van Hoof, B., 2014. Organizational learning in cleaner production among Mexican supply networks. J. Clean. Prod. 64, 115–124. https://doi.org/10.1016/j.jclepro.2013.07.041.

Vickers, I., Cordey-Hayes, M., 1999. Cleaner production and organizational learning. Technol. Anal. Strat. Manag. 11, 75–94. https://doi.org/10.1080/095373299107591.

Volberda, H.W., 1999. Chapter 6: the organization design task: reducing organizational barriers. In: Online, O.S. (Ed.), Building the Flexible Firm: How to Remain Competitive, pp. 1–68. https://doi.org/10.1093/acprof.

Wang, W., Zhang, C., 2018. Evaluation of relative technological innovation capability: model and case study for China's coal mine. Resour. Pol. 58, 144–149. https://doi.org/10.1016/j.resourpol.2018.04.008.

Wang, C.H., Lu, I.Y., Chen, C.B., 2008. Evaluating firm technological innovation capability under uncertainty. Technovation 28, 349–363. https://doi.org/10.1016/j.technovation.2007.10.007.

Wang, J., Wan, Q., Yu, M., 2020. Green supply chain network design considering chain-to-chain competition on price and carbon emission. Comput. Ind. Eng. 145, 106503. https://doi.org/10.1016/j.cie.2020.106503.

Wee, Y.S., Quazi, H.A., 2005. Development and validation of critical factors of environmental management. Ind. Manag. Data Syst. 105, 96–114. https://doi.org/10.1108/02635570510575216.

Weerts, K., Vermeulen, W., Witjes, S., 2018. On corporate sustainability integration research: analysing corporate leaders' experiences and academic learnings from an organisational culture perspective. J. Clean. Prod. 203, 1201–1215. https://doi.org/10.1016/j.jclepro.2018.07.173.

Wu, C.Y., 2014. Comparisons of technological innovation capabilities in the solar photovoltaic industries of Taiwan, China, and Korea. Scientometrics 98, 429–446. https://doi.org/10.1007/s11192-013-1120-7.

Wu, C.Y., Hu, M.C., 2015. The development trajectory and technological innovation capabilities in the global renewable energy industry. Portl. Int. Conf. Manag. Eng. Technol. 2015-Septe 2574–2580. https://doi.org/10.1109/PICMET.2015.7273069.

Xu, J.Z., Wang, M.M., 2018. Empirical research on green innovation capability evaluation of China's manufacturing enterprises based on principal component and cluster analysis. Int. Conf. Manag. Sci. Eng. - Annu. Conf. Proc. 2017-Augus 304–312. https://doi.org/10.1109/ICMSE.2017.8574432.

Yam, R., Guan, J.C., Pun, K.F., Tang, E.P.Y., 2004. An audit of technological innovation capabilities in Chinese firms: some empirical findings in Beijing, China. Res. Pol. 33, 1123–1140. https://doi.org/10.1016/j.respol.2004.05.004.

Yang, D., 2019. What should SMEs consider to introduce environmentally innovative products to market? Sustain. Times 11. https://doi.org/10.3390/su11041117.

Yogananda, A.P.Y., Nair, P.B., 2019. Green food product purchase intention: factors influencing Malaysian consumers. Pertanika J. Soc. Sci. Humanit. 27, 1131–1144.

Yong, J.Y., Yusliza, M.Y., Ramayah, T., Fawehinmi, O., 2019. Nexus between green intellectual capital and green human resource management. J. Clean. Prod. 215, 364–374. https://doi.org/10.1016/j.jclepro.2018.12.306.

Zhang, B.Y., Li, J., 2019. Design for environmental protection: measuring the appeal factors of green product for consumers. Ekoloji 28, 1699–1707.

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RESEARCH ARTICLE

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Capabilities and organisational dimensions conducive to green product innovation: Evidence from Croatian and Spanish manufacturing firms

Jakeline Serrano-García[1,2] | Andrea Bikfalvi[3] | Josep Llach[3,4] | Juan José Arbeláez-Toro[5,6]

[1]Universitat Politècnica de València, Valencia, Spain

[2]Faculty of Economic and Administrative Sciences, Instituto Tecnológico Metropolitano, Medellín, Colombia

[3]Department of Business Administration and Product Design, Universitat de Girona, Girona, Spain

[4]UPF Barcelona, School of Management, Universitat Pompeu Fabra, Barcelona, Spain

[5]AMADE, Polytechnic School, Universitat de Girona, Girona, Spain

[6]Faculty of Engineering, Instituto Tecnológico Metropolitano, Medellín, Colombia

Correspondence
Jakeline Serrano-García, Faculty of Economic and Administrative Sciences, Instituto Tecnológico Metropolitano, Cl. 54a #30-01, Medellín, Colombia; Department of Business Administration and Product Design, Universitat de Girona, Montilivi campus s/n, Girona 17073, Spain.
Email: jakelineserrano@itm.edu.co; jserrano2005@gmail.com

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Abstract

This paper aims to determine which configuration of green innovation capabilities (GICs) and organisational dimensions (ODs) leads to achieving green product innovation (GPI). We used data collected through the European Manufacturing Survey (EMS) from manufacturing firms in Spain and Croatia considered to be innovators. After conducting a cluster analysis, we identified a group of firms that still develop conventional product innovations (CPIs) and three groups of firms at different stages of GPI development. The four clusters were characterised using different variables, or determinants of GPI, associated with seven GICs and five ODs that favour GPI. According to the findings, all the GICs and ODs under analysis have a positive impact on GPI development, which results in the consolidation of a framework that organisations could use to manage green innovation. By empirically showing the relevance of applying these constructs, this study makes contributions to the Resource-Based Theory (RBT), along with its extension to GICs, and points to the need to associate them with the ODs to achieve GPI towards the challenge of sustainable development.

KEYWORDS
determinants, green innovation capabilities, green product innovation, manufacturing firms, organisational dimensions, sustainable development

Abbreviations: AMT-PROD, additive manufacturing technologies for mass production; AUTOMAT, control-automation systems for an energy efficient production; CER, Corporate Environmental Responsibility; CERT-ENER, certified energy management system (EN ISO 50001, previously EN 16001); CPIs, conventional products innovation; DCs, dynamic capabilities; EMS, European Manufacturing Survey; ER, Environmental Regulations; GICs, Green Innovation Capabilities; GMC, Green Marketing Capability; GOIC, Green Organisational Innovation Capability; GOLRC, Green Organisational Learning and Relationship Capability; GPC, Green Production Capability; GPIs, Green Product Innovations; GR&DC, Green Research and Development Capability; GRMC, Green Resource Management Capability; GSPC, Green Strategic Planning Capability; HR, Human Resources; IMP S-E, impact and performance measurements of social and environmental corporate activities; INFORMAT, use information gathered to develop or adapt current products, services or processes; INS-LIFECY, instruments of life-cycle assessment (e.g., EU Ecolabel, C2C, ISO 14020); IT-TRAINING, IT-based self-study programs (e-learning) for continuous training and evaluation of production employees; LINES, customer- or product-oriented lines/cells in the factory; LOGISTIC, practices to improve internal logistics (e.g., method of value stream mapping/design, changes in the spatial arrangement of the production chain); MACHINE, upgrading existing machinery or equipment (e.g., premium efficient motors [IE3], attach insulation, recuperators); NRBV, Natural Resource-Based View; OB, Organisational Behaviour; ODs, Organisational Dimensions; PLAN, software for production planning and scheduling (e.g., ERP system); PLM, product lifecycle management system (PLM) or product/process data management; R&D-COOP, R&D cooperation with customers or suppliers; RBT, Resource-Based Theory; SENSORS, sensors or control elements for machines or components to allow delivery of remote services; SKILLS-PROG, specific programs of competence development; TASK, integration of tasks (planning, operating or controlling functions with the machine operator); VISUAL, visual management (display board in production for work processes and work status); WORK, Method of 5S ("workplace appearance and cleanliness").

[Correction added on 28 March 2022, after first online publication: UPF Barcelona has been added in the fourth affiliation.]

1 | INTRODUCTION

The current environmental issues, which call for greater environmental awareness, have become one of the most pressing challenges faced by governments, institutions and individuals. Firms, in particular, have had to re-evaluate their organisational strategies to lessen their negative environmental impact. A possible solution to this problem for manufacturing firms could be the development of green product innovations (GPIs) (Salim et al., 2021; Shahzad et al., 2021). These products seem to be key to achieve comparative and competitive advantages because they not only provide economic benefits but they also help to preserve natural resources for future generations (Pérez-Pérez et al., 2020; Salim et al., 2021). In addition, GPIs could please socially conscious consumers (Sana, 2020) while also serving as a stimulus for businesses, which could receive incentives such as direct subsidies and tax credits for their development (Long & Liao, 2021).

Many organisations, however, have not yet decided to develop GPI for several reasons: (i) Ecological innovation is only considered after core business problems are addressed (Yin et al., 2020); (ii) firms feel overwhelmed by the imposed environmental regulations, which limits their willingness to voluntarily participate in ecological activities (Collins et al., 2007); (iii) small businesses believe that their contribution to the green economy is insignificant (Mellett et al., 2018); (iv) there is insufficient knowledge about why and how firms could foster corporate environmental sustainability to pursue GPI (Dangelico & Pujari, 2010) and (v) green innovation demands corporate commitment and the implementation of environmental policies and strategic guidelines to materialise ideas for green products (Dangelico & Pujari, 2010).

GPIs require certain determinants for their design, materialisation, production, distribution and disposal, making them different from conventional product innovations (CPIs) (Chkanikova, 2016; de Medeiros et al., 2018; Jasti et al., 2015). Despite the substantial progress made in defining the determinants of GPI, their configuration at the organisational level is considered difficult (Jasti et al., 2015; Tariq et al., 2017) because they affect several organisational functions. Therefore, these determinants must be backed by organisational elements that enable innovation to be managed in a way that results in GPI (Serrano-García et al., 2021).

Various authors have studied how the determinants of GPI can be configured at the organisational level from a variety of research topics such as corporate environmental management (Wee & Quazi, 2005); environmental strategies and green product development (Albino et al., 2009); firms' motivations, environmental policies, goals and challenges in developing and marketing GPI (Dangelico & Pujari, 2010); management of interorganisational relationships aimed at supplying materials for green products (Cheung & To, 2019) and reference models to develop green products at the corporate level (Berchicci & Bodewes, 2005; Ilg, 2019; Jasti et al., 2015; Tariq et al., 2017). Likewise, several theories have been used for this configuration, including organisational identity (Song et al., 2018), consumption values (Lin & Huang, 2012), the institutional theory (Zhang et al., 2020), stakeholder involvement (Zhao et al., 2018), the contingency theory (Saengchai et al., 2019) and the resource-based theory (RBT) using green capabilities (Aboelmaged & Hashem, 2019; Albort-Morant et al., 2016; Chen & Chang, 2013; Salim et al., 2019). The RBT is well known for its potential to support firms in developing green products (Tariq et al., 2017). However, there are still few theoretical and empirical studies on resource management and the use of capabilities oriented toward green innovation (Aboelmaged & Hashem, 2019; Qiu et al., 2020; Salim et al., 2019; Sirmon et al., 2011; Tariq et al., 2017; Teece, 2018).

Moreover, further research is needed on how organisations must restructure themselves to meet the challenge of sustainability and how the necessary adjustments can be made (Millar et al., 2012). In addition, more studies need to be developed to determine how firms' capabilities and the orchestration of organisational assets are the basis for efficiently managing various environmental challenges and implementing environmental sustainability plans at the corporate level (Annunziata et al., 2018; Dangelico et al., 2016; Serrano-García et al., 2021; Sirmon et al., 2011). From the perspective of organisational management, much uncertainty still exists about how environmental protection or going green might become a core competence (Yusr et al., 2020). Furthermore, most analyses based on the Natural Resource-Based View (NRBV) theory have found gaps in empirical studies focused on product stewardship (Hart & Dowell, 2011), which refers to 'practices that reduce environmental risks or problems resulting from the design, manufacturing, distribution, use, or disposal of products' (Berry & Rondinelli, 1998, p. 44).

Therefore, GPI, which causes changes at the organisational level (Berchicci & Bodewes, 2005; Dugoua & Dumas, 2021), could be supported by the incorporation of differential green innovation capabilities (GICs) (Serrano-García et al., 2021), which are based on the RBT (Barney, 1991; Barney et al., 2011), the NRBV (Hart, 1995), the dynamic capabilities (DCs) (Leih et al., 2015; Teece, 2007; Teece et al., 1997) and the innovation capabilities (ICs[1]) (Tariq et al., 2020). Nevertheless, having GICs is not enough for firms to achieve a competitive advantage; they also need a variety of assets—or organisational dimensions (ODs)—(e.g., people and their knowledge, processes and procedures, strategies, environmental regulations, corporate environmental responsibility, a structure and an organisational behaviour) to develop and deploy their technological capabilities (Adler & Sbenbar, 1990; Nadler et al., 2011; Serrano-García et al., 2021; Sirmon et al., 2011; Teece, 2018). Furthermore, within the ODs favouring innovation, the relevance of resources and capabilities must be acknowledged (Bogers et al., 2015). A firm's environmental strategy and competitive advantage would therefore depend on how GPI is handled at the organisational level through the innovative management of its determinants, as well as on how the organisational capabilities and dimensions are intertwined to construct and achieve the organisation's strategic goals (Adler & Sbenbar, 1990; Leih et al., 2015; Serrano-García et al., 2021; Teece, 2018; Tushman & Nadler, 1986).

All the above points to the need for more research and empirical validation on how to configure the GICs and the ODs so that they are integrated at the organisational level and recognised for their potential to support the determinants conducive to GPI. In the study by Serrano-García et al. (2021), this aspect is also outlined as future work. Based on the identified descriptions and difficulties, the purpose of this study is to analyse which GICs-ODs configuration leads to achieving GPI. The contribution of this research, therefore, is the practical and experimental orchestration of a complex structural relation between GICs, ODs and GPI to serve as a framework of reference for the management of green innovation in achieving sustainable development.

The rest of this paper is structured as follows. Section 2 provides a theoretical background on the matter. Section 3 describes the methodology we implemented. Section 4 presents the results. Section 5 discusses the findings. Last, Section 6 draws the conclusions and outlines the limitations and future lines of research.

2 | THEORETICAL BACKGROUND AND LITERATURE REVIEW

2.1 | Literature review

Table 1 below is a review of the quantitative studies on managerial concepts towards an understanding of GPI.

These studies are examples of some relevant work done in the field of GPI. Previous studies, mainly using the theoretical lenses of RBV, identify some key elements such as green human resource management, research and development, stakeholders, formal and informal structure, market orientation, together with efforts framed within learning, environmental regulations, strengthening of capabilities and understanding green innovation, in a context of technological turbulence, and with associated performance aims. The cited studies are illustrative of a clear interest and the significant advance made towards understanding the phenomenon of GPI at the organisational level. However, in line with the studies previously conducted, and according to our knowledge, there is a lack of research crossing the boundaries of the structural relation in this case of seven GICs associated with five ODs, such as the ones included in this research, which enables obstacles to be overcome and the promotion of a paradigm shift to pursue environmental strategies in the organisation of meeting the challenge of GPI.

2.2 | Conventional product innovation vs. green product innovation

Innovation is defined as 'a new or improved good or service that differs significantly from the firm's previous goods or services and that has been introduced on the market' (OECD/Eurostat, 2018, p. 21). When developing CPIs, several characteristics must be considered, including production capacity, product conceptualisation, organisational aptitude and competition (Tsai, 2012). CPI, once conceived, could contribute to the creation of green products (Berchicci & Bodewes, 2005; Pérez-Pérez et al., 2021) because innovation leads to refining technical requirements or aligning them with consumer demands and preferences (such as overcoming current environmental issues) (Dangelico et al., 2021; Niedermeier et al., 2021).

Conversely, GPI is a product with a lesser environmental impact during both its production and its consumption. This product is designed to consume less energy, generate less emissions and be produced with renewable and environmentally friendly raw materials (Melander, 2018). It is currently widely recognised as key in business expansion and competitiveness: society, customers, consumers and governments perceive it as an effective alternative to improve environmental outcomes and, consequently, individuals' quality of life (Tariq et al., 2017). It results from the interaction and coordination between innovation and sustainability (Dangelico & Pontrandolfo, 2010).

GPI represents a business opportunity for today's firms because it has evolved into a strategy for competitiveness and added-value incorporation and growth. Likewise, it allows organisations from the member states of the United Nations to contribute to the 2030 Agenda by directly tackling Sustainable Development Goal 9, which encourages sustainable industrialisation and fosters innovation (United Nations, 2018).

2.3 | Determinants of green product innovation

When it comes to the need to protect the environment, firms must consider a number of determinants that enable them to eliminate barriers and paradigms and thus develop green products while also improving their environmental, economic and social performance (Chen & Chang, 2013; Jasti et al., 2015; Tan et al., 2019). Serrano-García et al. (2021) made headway toward unifying the determinants that characterise and distinguish GPI and that are needed for its development and marketing. They proposed 22 sets of determinants that describe environmental characteristics in relation to organisational challenges. These determinants help firms to restructure themselves to meet current requirements in terms of GPI because the creation, production and commercialization of GPIs can facilitate the generation of businesses with the green focus that consider the strong relation with the preservation of the environment. While these previously analysed determinants will be further explored later in this study, they will be represented here as variables to assess their possible effect on firms' restructuring aimed at GPI development by means of an empirical analysis.

These determinants, however, are not enough to drive GPI; they require the support of certain organisational skills and components for their management (Serrano-García et al., 2021). This is where businesses could assess whether they need to restructure themselves to respond to the various determinants of GPI (Qiu et al., 2020). GICs and ODs become important here because they could help firms to adapt and update to promote a direct relationship with and respond to the determinants of GPI (Serrano-García et al., 2021).

TABLE 1 Review of quantitative studies on the topic of GPI

	Authors	Objective/questions	Theoretical perspectives	Methodology	Key findings
a.	Bhatia and Jakhar (2021)	Do environment regulations affect top management commitment towards GPI?Does organisational learning mediate between top management commitment and GPI practices?Do GPI practices enhance performance?	Dynamic capabilities view and upper echelons theory	96 Indian car manufacturing firms, cross-sectional survey research with partial least squares.	Findings evidence how top management commitment and organisational learning are important when implementing GPI in response to regulations, seeking to achieve better environmental and economic performance. Findings also include how organisational learning is a mediator between top management commitment and GPI.
b.	Awan et al. (2020)	How do buyer-driven knowledge transfer activities affect a firm's green product innovation via knowledge management capabilities? What is the impact of buyer-driven knowledge transfer activities on social performance improvement through knowledge management capabilities?	Absorptive capacity as a theoretical lens	Use of survey data collected from 239 Pakistani export-manufacturing companies, application of structural equation models.	Evidences how buyer-driven knowledge transfer activities contribute significantly to strengthening knowledge management capabilities in combination with resource acquisition capability to achieve GPI.
c.	Zhao et al. (2018)	Investigate the impact of external involvement on green product innovation.	Contingency theory and organisational information processing theory	Employment of survey data collected from 198 Chinese manufacturing firms and use of hierarchical moderated regression analyses	Findings support the importance of client and supplier participation to achieve GPI. Results also show how technological uncertainty and demand positively affect GPI.
d.	Andersén (2021)	To contribute to the development of a relational NRBV (RNRBV) on product innovation by examining the relationships between GPI, green suppliers, and differentiation advantage.	To consider the extensions of the RBV in product innovation, the article applies a relational NRBV (RNRBV) on product innovation.	Employment of survey data collected from 305 small Swedish manufacturing firms.	Among the findings is a direct relationship between GPI and the performance of the organisation, suggesting examining the influence of GPI through the creation of organisational strategies. The author also identifies how suppliers that focus on green provisions contribute with complementary resources that facilitate achieving GPI in the organisation, making the relation between the organization and the green suppliers essential, thereby confirming the importance of the relation between NRBV and product innovation.

TABLE 1 (Continued)

	Authors	Objective/questions	Theoretical perspectives	Methodology	Key findings
e.	Zhang et al. (2021)	'How does the inter-organisational control mechanism contribute to the development of GPI?' 'How does the adoption of GPI impact on organizational performance?'	Inter-organisational control in the green context: Formal structure and informal structure	Based on a sample of 239 senior managers and directors in the Chinese manufacturing industry, testing of the hypotheses using structural equation modelling.	The results show how the interaction between formal control and social control is positive and significant, making it essential to consider this interaction and to follow the philosophies to achieve a better GPI result. They also find how the effect of GPI on financial performance is mediated by environmental and social performance.
f.	Chen and Liu (2020)	To explore the coopting and enabling roles of customer participation in green product innovation in SMEs, and to uncover the indirect impact of customer participation through its influence on opportunity recognition and exploitation	Stakeholder engagement literature	Analysis of a sample of 195 SMEs in China using regression analysis	The findings indicate how participation of the interested parties, including clients, is necessary to group and orchestrate resources that can improve green product innovation. Furthermore, they find that the client participation can facilitate the exploitation of opportunities, and improve creativity and the capacity of the company towards producing green products.
g.	Akhtar et al. (2021)	To answer the question of "how market orientation affects green product innovation with the mediating role of green self-efficacy and the moderating role of resource."	Market orientation	477 SMEs managing green production using structural equation modelling	The results show that the market orientation represented in the environmental practices affects green self-efficacy and GPI. Furthermore, their results indicate how green self-efficacy has a mediating role between the market orientation and GPIs.
h.	Ogbeibu et al. (2020)	Investigation of the predictive powers of green human resource management (GHRM) bundles and green team creativity on green product innovation. Examine the roles of technological turbulence and environmental dynamic capability.	Green human resource management (GHRM)	A cross-sectional survey design with 229 leaders and subordinates in teams from the HRM and R&D departments of 31 manufacturing organisations in Malaysia. Employment of partial least square path modelling for data analysis.	The results indicate that green training, involvement and development is a more significant predictor of green team creativity than green recruitment and selection and technological turbulence. The study also shows how Green Team Creativity positively predicts GPI. However, environmental dynamic capability is identified as a negative predictor.

(Continues)

TABLE 1 (Continued)

	Authors	Objective/questions	Theoretical perspectives	Methodology	Key findings
i.	Agustia et al. (2020)	Determine the effect of research and development intensity (RNDI) on firm performance (FP) with green product innovation (GPI) as an intervening variable.	Research and development	Uses 170 companies listed on the Indonesian Stock Exchange in the period 2013–2017, with regression analysis	The results show that the intensity of research and development and GPI present a significant effect on company performance. Likewise, the intensity of research and development presents a significant effect on GPI.
j.	Zhang and Zhu (2019)	Explore whether environmental pressures from different stakeholders influence green innovation differently and how this is further mediated by organisational learning.	Stakeholder theory and organisational learning theory	259 Chinese manufacturing firms, with confirmatory factor and regression analyses	The results of this work indicate how consumer pressure presents a major effect on GPI, while regulatory pressure is more linked to GPI. Furthermore, they show how organisational learning-exploration and exploitation approaches are necessary and are mediators between the pressures of the interested parties and green innovation.

2.4 | The resource-based theory and the dynamic capability approach

The RBT is well known for its exceptional and powerful ability to predict and explain organisational relationships (Barney et al., 2011). It mainly focuses on making an organisation's internal and coordinated factors valuable, rare, inimitable and non-substitutable (Barney, 1991). This theory links the organisation's resources, capacities and competitive advantage (Hart, 1995). Having said that, Renard and St-amant (2003) identify how capacity is related to organisational aptitude to carry out processes of value creation in combination with resources (Renard & St-amant, 2003) which, at the same time, facilitates organisational reconfiguration favouring competitive advantage.

With the support of organisational components, this theory favours the implementation of strategies focused on corporate environmental actions (Dangelico & Pujari, 2010; Teece, 2010) to achieve long-term advantages (Barney, 1991). Consequently, a current challenge to consider within the organisational context that could be addressed from RBT in association with organisational components with a green focus is the reduction of the negative environmental impact. Therefore, a particularly important pillar for the theoretical grounding of the present work is based on NRBV. According to Hart (1995), competitive strategy and competitive advantage based on the firm's capabilities and the natural environment would be key in promoting environmentally sustainable economic activities. The NRBV therefore extends the RBT to the field of environmental sustainability.

DCs derive from the RBT (Teece, 2018; Teece et al., 1997) and refer to the transformations causing changes in products (Albort-Morant et al., 2016). Creating a synergy for a more successful innovation performance, DCs favour knowledge transformation, particularly in the manufacture of green products (Salim et al., 2019). Hence, firms must build and strengthen the DCs associated with green innovation to make progress in addressing environmental concerns (Huang & Li, 2017), generating new and improved products and respecting the environment from their conception to the way they are eliminated.

2.5 | Green innovation capabilities

The notion of IC derives from DC (Lahovnik & Breznik, 2014), a driver of innovation that enables organisations to adapt to the market (Teece et al., 1997). ICs refers to the capabilities linked to the organisation and its management that are coordinated to start, develop and execute innovation (OECD/Eurostat, 2018) under a systemic corporate approach resulting from a strategic and operational management (Serrano-García et al., 2017; Serrano-García & Robledo-Velásquez, 2013). ICs are considered a special organisational asset that allows firms to create and sustain a competitive advantage (Guan & Ma, 2003; Yam et al., 2004).

To tackle climate change especially through the creation of GPI, organisations must use certain capabilities that support them. Hence, the importance of the green-oriented ICs (GICs) because they could be considered as contributors when facilitating ecological innovation (Wang et al., 2019). These capabilities enable businesses to transform their processes, thus allowing them to develop GPI (Tariq et al., 2020) and to comply with environmental obligations and engage in the emerging green economy (Mellett et al., 2018). In addition, they refer to a firm's ability to pursue an ecological and sustainable development (Tseng et al., 2019) in a challenging environment like the current one.

GICs focus on the integration, construction and reconfiguration of a firms' resources related to environmental protection (Qiu et al., 2020). These capabilities, therefore, must be identified and integrated into each organisational function for organisations to respond to the demands and adjustments necessary to achieve GPI (Serrano-García et al., 2021). Progress in the adoption of GICs helps firms to clarify their processes, techniques and products to reduce environmental damage (Tseng et al., 2019), as these capabilities allow them to better understand the specific aspects that must be adapted. In this case, these capabilities favour the incorporation of skills that lead to an organisational restructuring and that are centred on enabling compliance with the determinants of GPI.

In this research, we consider the seven GICs proposed (Serrano-García et al., 2021), which are (a) *Green Strategic Planning Capability* (GSPC), (b) *Green Organisational Innovation Capability* (GOIC), (c) *Green Research and Development Capability* (GR&DC), (d) *Green Production Capability* (GPC), (e) *Green Organisational Learning and Relationship Capability* (GOLRC), (f) *Green Resource Management Capability* (GRMC) and (g) *Green Marketing Capability* (GMC). These capabilities are regarded as an alternative for organisations to respond to the determinants of GPI and to design, develop, produce and market sustainable products. Their contribution to the development of GPI, however, must be empirically validated. Furthermore, GICs must be further explored with the help of organisational and managerial dimensions that allow firms to adapt to the requirements of environmental businesses (Salim et al., 2019; Teece, 2007), thus leading them to create GPI and achieve a sustainable competitive advantage.

2.6 | Organisational dimensions

Innovation favours change within organisations (Damanpour, 1991). According to Nadler and Tushman (1999) and Nadler et al. (2011), firms need sufficient diversity and changes in their strategies, structures, people, processes and organisational values to achieve different sorts of innovation. Consequently, developing GPI is a type of innovation that involves creating and taking organisational actions aimed at preventing, minimising, mitigating or eliminating a firm's negative impact on the environment.

The challenge is, therefore, to create congruent organisational components that allow for the achievement of strategic objectives that drive innovation (Nadler et al., 2011; Nadler & Tushman, 1980). Based on this, firms are structured in such a way as to seek coherence between goals and innovation—a coherence that is supported by the ODs (Galbraith, 1982). These dimensions, which involve the entire organisation, represent the establishment of provisions concerning organisational characteristics of structure, processes, hierarchy, people, functions and interdepartmental relationships (Daft, 2011). Likewise, they are shaped by aspects such as values, culture, the surroundings and organisational behaviours (Herrera-Baltazar, 2015). Firms, therefore, should reconsider what types of ODs would allow them to efficiently manage their work to meet their strategic goals (Nadler & Tushman, 1999) aimed at GPI development. By evaluating the ODs, managers can identify the means and possible pitfalls that could be avoided to implement the environmental strategy (Rothenberg et al., 1992).

Serrano-García et al. (2021) point out the need for organisations to have the following five ODs, which focus on the innovation requirements necessary to manage the determinants of GPI: (a) *Human Resources* (HR), (b) *Organisational Behaviour* (OB), (c) *Technology* (T), (d) *Corporate Environmental Responsibility* (CER) and e) *Environmental Regulations* (ER). The authors also emphasise the importance of relating the various ODs with the GICs as a fundamental support and complement for firms to achieve innovation, in this case to achieve GPI.

Therefore, by means of an empirical analysis, we examine the contributions of the different ODs and GICs to the management of the determinants of GPI as a system that would facilitate the achievement of GPI. In formulating the environmental strategies, it is necessary to be consistent with the organisational characteristics, capacities and operational context of the company (Rothenberg et al., 1992).

3 | RESEARCH METHODOLOGY

To fulfil the objective set out in this paper, we use a combination of the approaches proposed in Serrano-García et al. (2021), who created a matrix associating GICs-ODs to identify and select the variables representing the determinants. Bikfalvi et al. (2013) used data collected by means of the same instrument and method and conducted a similar analysis—but with a different purpose—classifying companies according to certain characteristics by means of forming clusters. From the EMS, each of the variables corresponding to the intersection between each capacity and dimension were then extracted. The items employed and the procedures followed are described below.

3.1 | Data collection

We used data from the 2015 European Manufacturing Survey (EMS) to conduct the empirical and descriptive analysis. This survey is structured by thematic areas to measure characteristics and effects of organisational and environmental concepts in manufacturing firms. The purpose of the EMS is to collect up-to-date information from European firms to contribute to improving production processes. The survey's questions are developed by the members of a consortium made up of European research centres and universities and managed by the Fraunhofer Institute for Systems and Innovation Research (ISI) (Fraunhofer Institute for Systems and Innovation Research ISI, 2021).

The data provided by the EMS have been employed to analyse and execute projects under environmental approaches. This is the case of the study carried out by Pons et al. (2018), who characterised patterns between GPI and CPI in manufacturing firms. Likewise, Sartal et al. (2017) demonstrated that the role of environmental and information technologies in the lean manufacturing capability can lead to a better industrial performance. For their part, Palčič and Prester (2020) showed that advanced manufacturing technologies can contribute to both firm performance and ecological innovation. Pons et al. (2013) also mapped the adoption of technologies that help to reduce energy and resource consumption, verifying the relationship between their implementation and the performance of manufacturing firms.

3.2 | Sample

The data used in this study come from 101 and 105 firms in Spain and Croatia, respectively, representing the business population of the two nations. The samples were addressed under the same approach for three main reasons: (a) The EMS questions were equally applied in both countries, and the same criteria were considered to select the samples; (b) in 2015, Spain and Croatia were classified as *moderate innovators* by the European Innovation Scoreboard, which assesses research and innovation performance across the member states of the European Union (EU) (Hollanders et al., 2015) and (c) in 2014, Spain and Croatia fell into the *Average Eco-I performers group*, with scores of 111 and 91, respectively (close to the average EU score of 100), according to the results of the Eco-Innovation Index, which evaluates eco-innovation performance in the EU member states and promotes a holistic view of economic, environmental and social performance (European Commission, 2021).

The set of firms analysed here carries out the industrial manufacturing activities listed in NACE Rev. 2 (codes 10 to 32) and have at least 20 employees; see Table 2.

TABLE 2 Geographical, sectoral and firm size distribution of the sample

	Frequency	Percentage
Country		
Spain	101	49.0
Croatia	105	51.0
Total	206	
Manufacturing industry		
Food products and beverages	39	18.9
Textiles, wearing apparel, leather and related products	22	10.7
Furniture, products of wood, and articles of straw and plaiting materials	14	6.8
Paper and paper products; printing and reproduction of recorded media	15	7.3
Chemicals, rubber and plastic products and other non-metallic mineral products	36	17.5
Basic pharmaceutical products and pharmaceutical preparations	2	1.0
Basic metals and fabricated metal products	37	18.0
Manufacture of computer, electronic, electrical and optical equipment	10	4.9
Machinery and equipment n.e.c.	23	11.2
Motor vehicles, trailers and semi-trailers and other transport equipment	7	3.4
Other manufacturing industries	1	0.5
Total	206	100.0
Number of employees		
Up to 49	77	37.4
From 50 to 249	84	40.8
250 and more	45	21.8
Total	206	100.0

3.3 | GIC-OD matrix and selection of variables representing the determinants of GPI

Given the several relationships between the various definitions of GICs and ODs, they must be structured using a graphical and descriptive approach. For this reason, we constructed a matrix that established the relationship between each GIC (in rows) and OD (in columns), extracting 63 dichotomous measurable variables from the EMS and analytically placing them at the intersections between each GIC and OD. These variables represent the determinants necessary for an organisational restructuring aimed at developing GPI, as proposed by Serrano-García et al. (2021). For a more thorough understanding of the process of creating the matrix, Appendix A shows the classification of variables (in representation of the determinants) within a specific GIC and related to each of the five proposed ODs, where the typology of each variable is binary (Yes/No).

3.4 | GPI-specific attributes

To evaluate GPI development, we only considered the firms that claim to have introduced completely new products or significant technological improvements in existing products, resulting in a drop from 206 to 140 firms. We analysed whether the new or improved products cause a lesser environmental impact when used or discarded, as well as the environmental improvements they deliver in relation to six attributes: (a) reduction of health risks for users; (b) reduction of energy consumption when in use; (c) easier to maintain or to retrofit; (d) extended product lifetime; (e) reduction of environmental pollution when in use and (f) improved recycling, redemption or disposal properties.

Firms were given a score ranging from 0 to 100 based on how many environmental improvements they achieved. A score of 100 indicated that they had achieved all the improvements, while a score of 0 meant they had achieved none. The *GPI achievement* variable was thereby created, which assigns each firm a score depending on the number of environmental improvements it achieves in its GPI. The purpose of these attributes is to identify which firms already create products with GPI-specific characteristics.

3.5 | Statistical method

The next step was to perform a cluster analysis, which is a multivariate statistical technique that organises input data by categorising cases (individuals) into homogeneous groups and delivers results from the cases that share similar content characteristics and are classified into the four clusters (Pérez-López, 2008). As a result, it is possible to obtain as many clusters as similarities are contained and identified in the analysed data (Pérez-López, 2008).

The six attributes of *GPI achievement* were studied using multiple correspondence analysis (MCA), given that by their very nature the data are qualitative. The MCA results sought to study the association between the companies, or which of them had similar responses in the six attributes. The results of the associations between companies were used to form the clusters. The possibility of creating six groups of companies was considered, but it was decided to stay with four groups because of the homogeneity they presented. The clusters are shown in the dendrogram. The data were processed using the statistics software *R-Project*. Subsequently, the 61 variables identified in the matrix and representing the determinants necessary for an organisational restructuring aimed at developing GPI were integrated into each cluster. The aim was to identify which variables were more closely related to GPI development and to determine the relevance or involvement of each GIC and OD. Additionally, we identified the main differences between the clusters and intra-clusters, in addition to the influence of the industrial sector in the clusters to further characterise them.

4 | RESULTS

The results are organised below in five stages. First, the dendrogram is presented, followed by the content of the four resulting clusters and of the determinants of GPI with GICs and ODs. Next, each of the groups and the influence of the industrial sector in the clusters are characterised.

Following the result of the statistical process, Figure 1 is the dendrogram resulting from the hierarchical analytical analysis of the six attributes of *GPI achievement*.

From the statistical analysis, four clusters were formed based on the number of average environmental improvements (AEI) that the firms had implemented. *Cluster 1* includes firms that had not achieved environmental improvements in their new or improved products and that were considered to develop CPI. Although classified as innovative, CPIs do not favourably contribute to the environment. For their part, *Clusters 2–4* comprise firms that had achieved some type of environmental improvement in their new or improved products and that are considered to be developing GPI. The AEI of *Clusters 1–4* were 0 (0 improvements), 1.6 (between 1 and 2), 3.0 (all with three improvements) and 4.4 (between 4 and 5), respectively.

Afterwards, the 61 matrix variables related to the GICs, the ODs and the determinants of GPI were incorporated into the clusters. From Table 3, in 18 of the 61 variables, we observed a tendency in which the percentage of firms that use the resource described by the variable increases as the AEI value increases.

Figure 2 shows the overall percentage of firms (from the sample addressed in this study) that implemented and did not implement each variable. As can be observed, visual management (display board in production for work processes and work status) and integration of tasks (planning, operating or controlling functions with the machine operator) were the most implemented practice or resource, while certified energy management systems (ISO 50001) was the least implemented one.

Table 4 presents the configuration matrix that relates the determinants of GPI to each GIC and OD. In this matrix, each of the identified 18 variables representing the determinants is placed at the intersections between each GIC and OD, thus showing the existing interrelationships between the components.

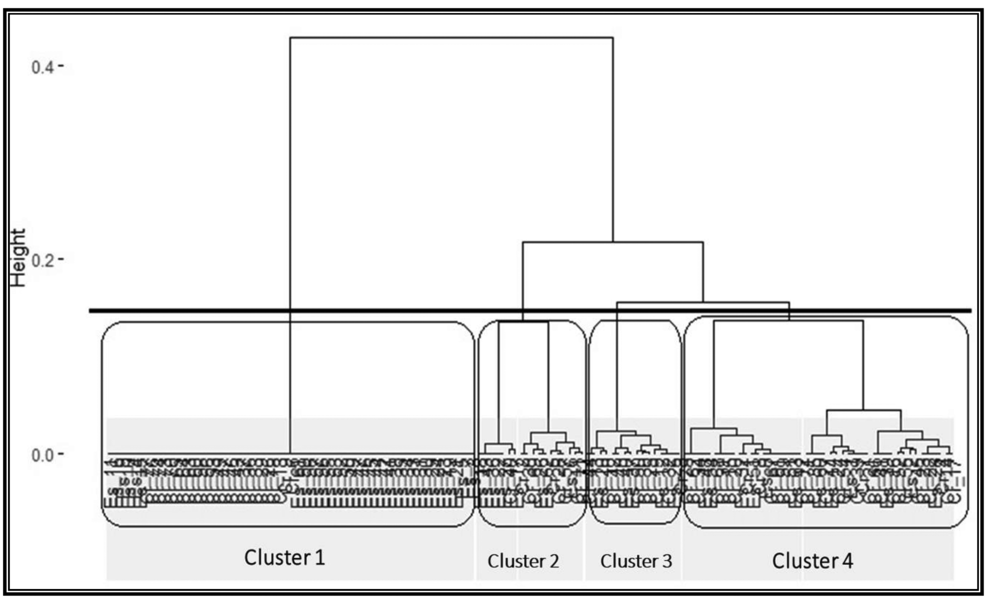

FIGURE 1 Dendrogram of clusters, in accordance with GPI achievement

TABLE 3 Cluster analysis results

Variable	Dimension-Capability	CPI Cluster 1 (AEI=0)	GPI Cluster 2 (AEI=1.6)	GPI Cluster 3 (AEI=3.0)	GPI Cluster 4 (AEI=4.4)
VISUAL: Visual management (display board in production for work processes and work status)	OB/GPC	80%	80%	88%	94%
TASK: Integration of tasks (planning, operating or controlling functions with the machine operator)	HR/GSPC	53%	79%	75%	83%
R&D-COOP: R&D cooperation with customers or suppliers	OB/GR&DC	60%	64%	75%	94%
WORK: Method of 5S ("workplace appearance and cleanliness")	HR/GOIC	57%	66%	88%	83%
INFORMAT: Use information gathered to develop or adapt current products, services or processes	CER/GOLRC	50%	72%	93%	82%
SKILLS-PROG: Specific programs of competence development	HR/GOLRC	53%	68%	73%	72%
LOGISTIC: Practices to improve internal logistics (e.g. method of value stream mapping / design, changes in the spatial	OB/GSPC	50%	59%	75%	83%
PLAN: Software for production planning and scheduling (e.g. ERP system)	T/GSPC	58%	51%	75%	72%
LINES: Customer- or product-oriented lines/cells in the factory	CER/GMC	47%	50%	69%	83%
IMP S-E: Impact and performance measurements of social and environmental corporate activities	CER/GSPC	30%	53%	67%	67%
MACHINE: Upgrading existing machinery or equipment (e.g. premium efficient motors (IE3), attach insulation, recuperators)	T/GRC	45%	44%	50%	53%
IT-TRAINING: IT-based self-study programs (e-learning) for continuous training and evaluation of production employees	HR/GMC	37%	50%	56%	56%
AUTOMAT: Control-automation systems for an energy efficient production	ER/GRC	18%	30%	38%	44%
AMT-PROD: Additive manufacturing technologies for mass production	T/GPC	10%	9%	25%	50%
PLM: Product lifecycle management system (PLM) or product/process data management	ER/GSPC	12%	16%	19%	28%
INS-LIFECY: Instruments of life-cycle assessment (e.g. EU Ecolabel, C2C, ISO 14020)	ER/GPC	9%	12%	13%	28%
SENSORS: Sensors or control elements for machines or components to allow delivery of remote services	T/GMC	9%	11%	20%	24%
CERT-ENER: Certified energy management system (EN ISO 50001, previously EN 16001)	ER/GOIC	4%	14%	20%	22%
N		61	45	16	18
%		44%	32%	11%	13%

Table 5 shows the practices or resources (variables) involved in each of the clusters, ordered from the highest to the lowest percentage of companies that use or implement them, identifying the most outstanding in each group.

Each cluster was named according to the average number of variables (which include resources or and practices) implemented by firms and the percentage of firms that use each variable. *Cluster 1*, which comprises firms that develop CPI, was called *Low implementation of practices or resources* because firms in this cluster used an average of 6.10 of the 18 resources or practices under analysis. Additionally, in this cluster, only the *visual management (display board in production for work processes and work status)* variable is in the fourth quartile of the data (75–100%), while the other variables have less percentages of firms that implement the resource or practice.

The other three clusters, which include firms geared towards GPI development, were characterised in an equivalent manner. *Cluster 2* was named *Limited implementation of practices or resources* because the average number of resources or practices used by firms in this cluster was 7.31. Only the *visual management (display board in production for work processes and work status)* and *integration of tasks*

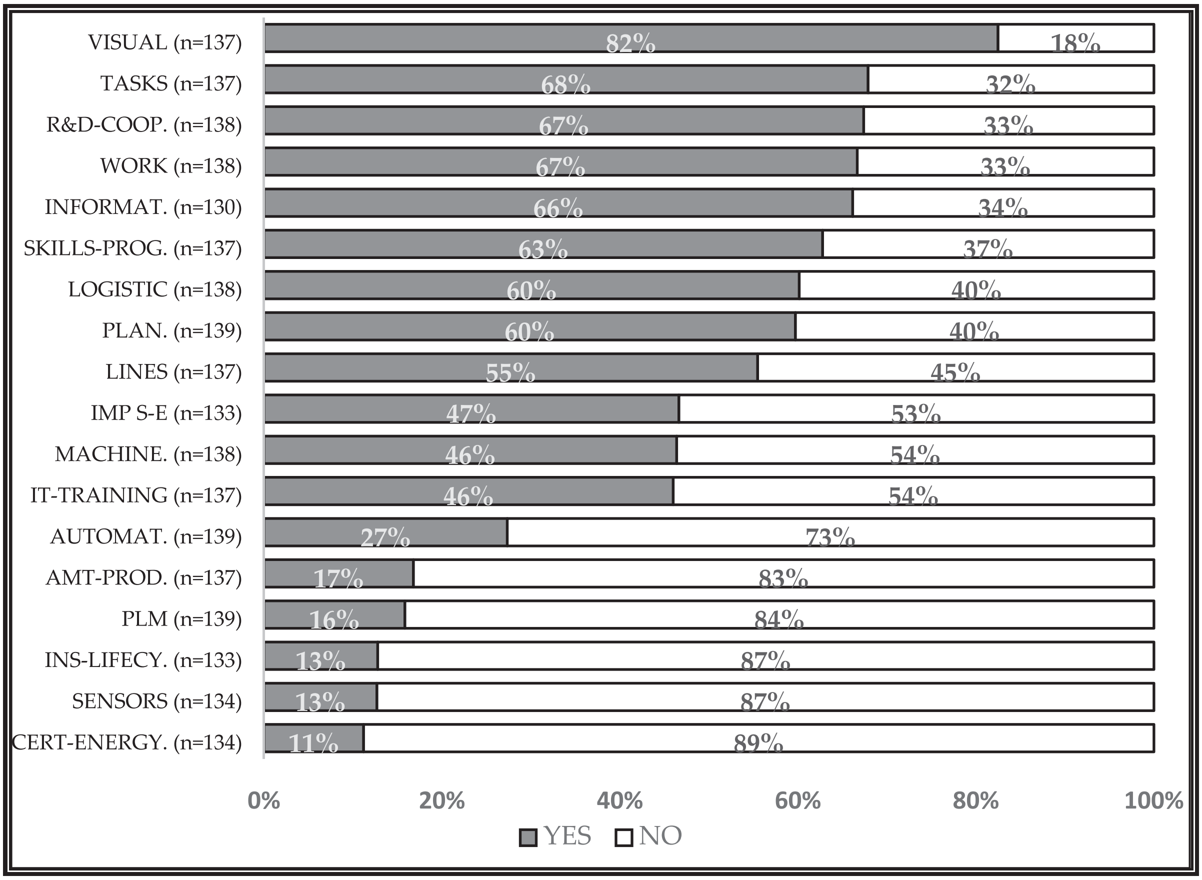

FIGURE 2 Concepts contributing to GPI development

TABLE 4 Configuration matrix between the determinants of GPI, the GICs, and the ODs

		Organisational Dimensions (ODs)					
		HR	OB	T	CER	ER	No. of variables - GICs
Green Innovation Capabilities (GICs)	GSPC	TASKS.	LOGISTICS.	PLAN.	IMP S-E.	PLM	5
	GOIC	WORK.				CERT-ENER.	2
	GR&DC		R&D-COOP.				1
	GPC		VISUAL.	AMT-PRODU.		INS-LIFECY.	3
	GOLRC	SKILLS-PROG.			INFORMAT.		2
	GRMC			MACHINE.		AUTOMAT.	2
	GMC	IT-TRAINING.		SENSORS.	LINES.		3
	No. of variables - ODs	4	3	4	3	4	

(planning, operating or controlling functions with the machine operator) variables were found to have an implementation above 75% in this cluster. *Cluster 3* was called *Moderate implementation of practices or resources*, with firms in this cluster using an average of 9.19 resources or practices and with the *integration of tasks (planning, operating or controlling functions with the machine operator), practices to improve internal logistics (e.g., method of value stream mapping/design, changes in the spatial arrangement of the production chain), software for production planning and scheduling (e.g., ERP system), method of 5S (workplace appearance and cleanliness), R&D cooperation with customers or suppliers, visual management (display board in production for work processes and work status and use information gathered to develop or adapt current products, services or processes* variables having an implementation above 75%. Last, *Cluster 4* was named *High implementation of practices or resources*, with firms in this cluster using an average of 10.28 resources or practices and with the *integration of tasks (planning, operating or controlling functions with the machine operator, practices to improve internal logistics (e.g., method of value stream mapping/design,*

TABLE 5 Characterisation of each cluster

CPI				GPI			
Cluster 1 (AEI=*0.0*)		Cluster 2 (AEI=*1.6*)		Cluster 3 (AEI=*3.0*)		Cluster 4 (AEI=*4.4*)	
%	*Low implementation of practices or resources*	%	*Limited implementation of practices or resources*	%	*Moderated implementation of practices or resources*	%	*High implementation of practices or resources*
	VISUAL		VISUAL		INFORMAT.		R&D-COOP.
	R&D-COOP.		TASKS		WORK		VISUAL
	PLAN.		INFORMAT.		VISUAL		TASKS
	WORK		SKILLS-PROG.		TASKS		LOGISTIC
	TASKS		WORK		LOGISTIC		WORK
	SKILLS-PROG.		R&D-COOP.		PLAN.		LINES
	LOGISTIC		LOGISTIC		R&D-COOP.		INFORMAT.
	INFORMAT.		IMP S-E		SKILLS-PROG.		PLAN.
	LINES		PLAN.		LINES		SKILLS-PROG.
	MACHINE.		IT-TRAINING		IMP S-E		IMP S-E
	IT-TRAINING		LINES		IT-TRAINING		IT-TRAINING
	IMP S-E		MACHINE.		MACHINE.		MACHINE.
	AUTOMAT.		AUTOMAT.		AUTOMAT.		AMT-PRODU.
	PLM		PLM		AMT-PRODU.		AUTOMAT.
	AMT-PRODU.		CERT-ENER.		CERT-ENER.		PLM
	INS-LIFECY.		INS-LIFECY.		SENSORS		INS-LIFECY.
	SENSORS		SENSORS		PLM		SENSORS
	CERT-ENER.		AMT-PRODU.		INS-LIFECY.		CERT-ENER.

changes in the spatial arrangement of the production chain), method of 5S (workplace appearance and cleanliness), R&D cooperation with customers or suppliers, visual management (display board in production for work processes and work status), use information gathered to develop or adapt current products, services or processes and customer- or product-oriented lines/cells in the factory variables having an implementation above 75% of all the firms under analysis.

Table 5 also shows three behaviours referring to the implementation of these concepts at the inter-cluster level. To this effect, the variables *visual management (display board in production for work processes and work status), R&D cooperation with customers or suppliers, method of 5S (workplace appearance and cleanliness), integration of tasks (planning, operating or controlling functions with the machine operator), practices to improve internal logistics (e.g., method of value stream mapping/design, changes in the spatial arrangement of the production chain), specific programs of competence development, software for production planning and scheduling (e.g., ERP system) and use information gathered to develop or adapt current products, services or processes* present an implementation of practices or improvements in greater percentages in all four clusters, with the greatest proportion generally in clusters three and four. At an intermediate level of implementation, *customer- or product-oriented lines/cells in the factory, upgrading existing machinery or equipment (e.g., premium efficient motors [IE3], attach insulation, recuperators), IT-based self-study programs (e-learning) for continuous training and evaluation of production employees, impact and performance measurements of social and environmental corporate activities* stand out, while the variables *control-automation systems for an energy efficient production, product lifecycle management system (PLM) or product/process data management, additive manufacturing technologies for mass production, instruments of life-cycle assessment (e.g., EU Ecolabel, C2C, ISO 14020), sensors or control elements for machines or components to allow delivery of remote services and certified energy management system (ISO 50001)* present an implementation in lower proportions in all the clusters, and especially in clusters 1 and 2.

In accordance with the hierarchical clustering of the companies in the four groups, and illustrated in Tables 3 and 5, differences are presented regarding the implementation of practices and resources at the level of industrial sectors. The companies in the sectors *basic pharmaceutical products and pharmaceutical preparations* are all in cluster 1, or in other words, they have a low implementation of practices and resources. Around 90% of the companies in the sectors *food products and beverages* have low and limited levels (clusters 1 and 2) and 10% moderate and high levels (clusters 3 and 4). Regarding companies in the sectors, *textiles, wearing apparel, leather, and related products, furniture, products of wood, and articles of straw and plaiting materials, paper and paper products, printing, and reproduction of recorded media, chemicals, rubber and plastic products and other non-metallic mineral products, machinery and equipment n.e.c.*, some 80% have a low or limited implementation and 20% moderate or high levels. Around 65% of the companies in the sectors *basic metals and fabricated metal products* have low and moderate levels, and 35% have high levels. Half (50%) of the companies in the sectors *motor vehicles, trailers and semi-trailers and other transport equipment* have low levels and the other half have moderate levels. Some 30% of the companies in the sectors *manufacture of computer, electronic, electrical and optical equipment* have low and limited levels, while 80% have moderate and high levels.

5 | DISCUSSION

In this paper, we aim to analyse which GIC-OD configuration leads to a better GPI development. Because each determinant of GPI, depending on its nature, is associated with each GIC and OD, and based on the result given by the statistical process, we identify 18 key determinants. In addition, we show which GICs and ODs are the most closely related to GPI development.

According to the results obtained in this study, the *Environmental Regulations* dimension is strongly associated with GPI development. In particular, the group of firms that are in the most advanced stage of GPI are found to highly implement practices or resources such as *product lifecycle management (PLM) systems or product/process data management*, *instruments of lifecycle assessment (ISO 14020 or Ecolabel)*, *certified energy management systems (ISO 50001)* and *control-automation systems for an energy efficient production*, while these resources are less implemented in firms in the CPI group. This is in line with the findings of Comoglio and Botta (2012), who find that flexible environmental regulations, such as *environmental management systems*, have a positive effect on firms' environmental performance because they increase firms' commitment to environmental improvement.

The *Human Resources* dimension also proves to be key in organisations seeking to restructure themselves to achieve GPI. In fact, several firms in the group with the greatest advance in GPI follow practices like *integration of tasks (planning, operating or controlling functions with the machine operator)* and implement resources such as the *method of 5S (workplace appearance and cleanliness)*, *specific programs of competence development* and *IT-based self-study programs (e-learning) for continuous training and evaluation of production employees* more than those in the CPI group. This finding is consistent with that of del Giudice and Della Peruta (2016), who report that green human resource management (GHRM) influences firms' environmental progress. Additionally, this result corroborates the ideas of Úbeda-García et al. (2021) and Zhang et al. (2019), who state that GHRM has a positive impact on environmental management. In light of the above, firms' personnel must be qualified in green matters and organisational practices geared towards environmental innovation management so that organisations can strengthen skills and take on environmental management as a responsibility.

Furthermore, the *Technology* dimension, which includes practices like *upgrading existing machinery or equipment*, as well as resources such as *software for production planning and scheduling (e.g., ERP system)*, *additive manufacturing technologies for mass production* and *sensors or control elements for machines or components to allow delivery of remote services*, is shown to have a higher implementation in firms with the greatest progress in GPI. According to Palčič and Prester (2020), some of these technologies, which are considered to be advanced manufacturing technologies, are positively related to the development of green products. This is in agreement with the findings of Jabbour et al. (2015), who find that the various technological advances favourably influence GPI.

The *Corporate Environmental Responsibility* dimension is also found to be necessary for GPI. It is supported by practices such as *impact and performance measurements of social and environmental corporate activities*, *use information gathered to develop or adapt current products, services or processes* and *customer- or product-oriented lines/cells in the factory*. This result is in line with that of Awan et al. (2017), who demonstrate that social development programs and practices such as assessing the impact of processes and management actions on the environment lead to a higher market share and an improved environmental performance. Likewise, this corroborates the ideas of Shahzad et al. (2020), who conclude that, by efficiently managing information or knowledge, firms can achieve greater corporate sustainability. Additionally, as stated by Abbas (2020), corporate social responsibility integrates social and environmental concerns and is crucial to achieve a better environmental performance.

Last, the *Organisational Behaviour* dimension also proves to be an important organisational aspect in boosting environmental innovation. Resources such as *practices to improve internal logistics (e.g., method of value stream mapping/design, changes in the spatial arrangement of the production chain)*, *R&D cooperation with customers or suppliers*, and *visual management (display board in production for work processes and work status)* stand out in this dimension. This finding is in agreement with that of Isensee et al. (2020), who state that there is a high interdependence between organisational behaviour and firms' level of environmental sustainability, hence the need for an organisational approach towards environmental protection. This is also supported by the study of Hallstedt et al. (2010), who confirm that creating an environmentally sustainable culture within organisations is key to making progress in developing green products.

Regarding GICs, the *Green Strategic Planning Capability* is shown to be the most closely related to GPI development. This points to the need to define aspects such as goals, programs, projects, activities, tasks and deadlines that lead firms to an organisational restructuring focused on sustainability. According to Landrum (2018), since business-oriented corporate sustainability is not enough to address the environmental crisis, environmental science and ecology must be integrated into firms' strategic planning to achieve progress in managing corporate sustainability.

The *Green Production Capability* is found to be the second most related aspect to GPI development. This suggests that organisations should maintain or increase their productivity levels while using biodegradable raw materials and generating less waste and pollution (Bogue, 2014). Moreover, based on our results, the *Green Marketing Capability* also influences the development of green products. This is confirmed by the study of Guoyou et al. (2013), who demonstrate that marketing pressures drive corporate sustainability.

Likewise, the *Green Organisational Innovation Capability*, which is concerned with a firm's operations, is found to help to respond to environmental concerns by incorporating and implementing GPI. This finding is in line with that of Qiu et al. (2020), who state that GPI can be consolidated at the organisational level through its institutionalisation, thus encouraging and leading to an organisational restructuring.

Furthermore, the *Green Organisational Learning and Relationship Capability* shows a positive effect on GPI development, which concurs with the results of Karman and Savanevičienė (2020), who report that gaining knowledge and skills in environmental matters, cooperating with partners and developing employee best practices influence firms' environmental performance. Since creating GPI is often new to most organisations, the role of organisational learning in achieving this type of innovation should be given considerable attention (Qiu et al., 2020).

The *Green Resource Management Capability* also proves to influence the development of green products because investing, for instance, in resources to strengthen ecological skills, laboratories, equipment, qualified personnel and the research and development of cleaner technologies could favour the creation of GPI (Chen & Chang, 2013; de Medeiros et al., 2014).

Last, the *Green Research and Development Capability* is also found to have a favourable impact on the development of green products. This is consistent with the findings of Liao (2017), who state that green-oriented R&D positively influences firms' environmental development. R&D plays a key role in helping firms to exploit their existing invention skills and explore new technological creations (Tushman, 2017) that could lead to GPI.

Although some of the proposed capabilities and dimensions stand out more than the others, it does not mean that some are more important than the others. In other words, this paper does not try to analyse the contribution of each OD and GIC but rather their overall configuration as a systemic approach aimed at achieving GPI.

In light of the above, all the ODs (i.e., *ER*, *HR*, *T*, *OB* and *CER*) and GICs (i.e., *GSPC*, *GOIC*, *GPC*, *GOLRC*, *GRC*, *GMC* and *GR&DC*) proposed by (Serrano-García et al., 2021) play a part, from their own perspective and technical nature, in the management of the determinants leading to GPI. This results in a system of interrelated elements, each of which contributes to the organisational restructuring necessary to transform processes and direct them towards an innovation management conducive to GPI.

During the characterisation of the clusters, firms that already implement environmental improvements in their products are shown to better manage their work compared to those that have not yet implemented environmental improvements. In fact, the former extensively employ strategies such as planning, logistics and order at work; R&D cooperation; development of specific new production lines and learning from accumulated experience and errors. However, we also find that even firms with better environmental management still need to strengthen those green-oriented determinants–variables that could lead them to better respond to GPI. Regarding the influence of the industrial sector, differences were found in the sense that within and between sectors the companies presented low, limited, moderate and high levels of environmental practices and improvements. More specifically, no sector stands out in any of these levels.

6 | CONCLUSIONS

In this paper, we analyse how the GIC-OD configuration proposed by (Serrano-García et al., 2021) serves as a reference framework for managing innovation, in an attempt to respond to the green-oriented determinants and thereby encourage an organisational restructuring focused towards GPI development. By means of a matrix, we establish a connection between the different GIC and OD to build a structural relationship associated with the determinants of GPI in a practical and experimental way.

Our findings empirically confirm the positive impact of each GIC and OD on GPI development. Hence, the framework proposed in Serrano-García et al. (2021) is found to influence the environmental management of the firms under analysis. For an innovation management focused on GPI development, organisations should be considered under a systemic approach that encompasses each of the aforementioned capabilities and dimensions and directs them towards the green purpose.

6.1 | Theoretical and management implications

These findings evidence a series of theoretical repercussions and managerial practices that could be useful for academics, government entities and professionals in different fields. From an academic perspective, this research makes contributions to the RBT, the NRBV and the DCs, along with their extension to the GICs, and supports the need to associate them with the ODs. Moreover, all the proposed GICs and ODs are found to be necessary and to contribute to the design of a governance mechanism focused on an innovation management aimed at achieving the determinants of GPI to favour environmental sustainability. This study also demonstrates that the configuration of the seven GICs and five ODs constitutes a means to achieve GPI. It therefore opens up new fields of research for academia to explore and further examine the relationship between GICs and ODs and green innovation management.

Last, from the perspective of managers of manufacturing firms and government organisations interested in environmental sustainability, we found how, as firms boost GPI development at the organisational level under the strategic support of the different GICs and ODs, they could reduce their negative impacts and help to solve the environmental problems they cause. This would, indeed, encourage a transition from CPI to GPI.

6.2 | Limitations and future work

Although this study proposes and empirically validates a GIC-OD configuration for GPI development, it has various limitations. The EMS provides representative empirical evidence and evaluates key variables in the field of environmental management. However, since the data collected come from a survey, the variables under analysis are not measured directly but are limited to the responses provided by respondents. Additionally, even though large-scale surveys can contribute to the validity and strength of the evidence in this strategic matter, it would be interesting to include data from other countries where the EMS has also been applied, as each country may have unique characteristics that could lead to differences in the results, to discover patterns of as yet unobserved behaviour in the companies and industrial sectors analysed in the present document.

Furthermore, we identify a number of possible future works that could significantly contribute to this line of research. On the basis of the link between GICs and ODs, future studies could use other variables that can be operated and controlled by organisations to represent the determinants of GPI. Moreover, further research might consider addressing GPI development under other conceptual perspectives (e.g., the stakeholder, contingency, value chain and business model theories) in combination with the GICs and the ODs. Likewise, it would be interesting to extend the association between the GICs and green-oriented ODs to other economic sectors, such as the construction, health, tourism and education sectors, which are also seeking to reduce their environmental impact. Last, it is recommended that future studies consider different variables or criteria to evaluate the characteristics of a constituted GPI to assess firms' environmental performance and their impact on financial performance.

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ORCID

Jakeline Serrano-García https://orcid.org/0000-0003-0609-6077
Andrea Bikfalvi https://orcid.org/0000-0003-4138-5229
Josep Llach https://orcid.org/0000-0001-8766-8756
Juan José Arbeláez-Toro https://orcid.org/0000-0002-9741-2225

ENDNOTE

[1] Although, in the literature, 'ICs' and 'TICs' are frequently employed to refer to a similar set of capabilities, we consider them equivalent terms here. However, 'ICs' will be mostly used to allude to innovation capabilities, in accordance with the terminology defined in the Oslo Manual 2018 (OECD/Eurostat, 2018).

REFERENCES

Abbas, J. (2020). Impact of total quality management on corporate green performance through the mediating role of corporate social responsibility. *Journal of Cleaner Production*, *242*, 118458. https://doi.org/10.1016/j.jclepro.2019.118458

Aboelmaged, M., & Hashem, G. (2019). Absorptive capacity and green innovation adoption in SMEs: The mediating effects of sustainable organisational capabilities. *Journal of Cleaner Production*, *220*, 853–863. https://doi.org/10.1016/j.jclepro.2019.02.150

Adler, P., & Sbenbar, A. (1990). Adapting your technological base: The organizational challenge. *Sloan Management Review*, *32*, 25–37.

Agustia, D., Permatasari, Y., Fauzi, H., & Sari, M. N. A. (2020). Research and development intensity, firm performance, and green product innovation. *Journal of Security and Sustainability Issues*, *9*, 1039–1049. https://doi.org/10.9770/jssi.2020.9.3(27)

Akhtar, S., Martins, J. M., Mata, P. N., Tian, H., Naz, S., Dâmaso, M., & Santos, R. S. (2021). Assessing the relationship between market orientation and green product innovation: The intervening role of green self-efficacy and moderating role of resource bricolage. *Sustainability*, *13*(20), 1–15. https://doi.org/10.3390/su132011494

Albino, V., Balice, A., & Dangelico, R. M. (2009). Environmental strategies and green product development: An overview on sustainability-driven companies. *Business Strategy and the Environment*, *18*(2), 83–96. https://doi.org/10.1002/bse.638

Albort-Morant, G., Leal-Millán, A., & Cepeda-Carrión, G. (2016). The antecedents of green innovation performance: A model of learning and capabilities. *Journal of Business Research*, *69*(11), 4912–4917. https://doi.org/10.1016/j.jbusres.2016.04.052

Andersén, J. (2021). A relational natural-resource-based view on product innovation: The influence of green product innovation and green suppliers on differentiation advantage in small manufacturing firms. *Technovation*, *104*, 102254. https://doi.org/10.1016/j.technovation.2021.102254

Annunziata, E., Pucci, T., Frey, M., & Zanni, L. (2018). The role of organizational capabilities in attaining corporate sustainability practices and economic performance: Evidence from Italian wine industry. *Journal of Cleaner Production*, *171*, 1300–1311. https://doi.org/10.1016/j.jclepro.2017.10.035

Awan, U., Kraslawski, A., & Huiskonen, J. (2017). Understanding the relationship between stakeholder pressure and sustainability performance in manufacturing firms in Pakistan. *Procedia Manufacturing*, *11*, 768–777. https://doi.org/10.1016/j.promfg.2017.07.178

Awan, U., Nauman, S., & Sroufe, R. (2020). Exploring the effect of buyer engagement on green product innovation: Empirical evidence from manufacturers. *Business Strategy and the Environment*, *30*(1), 1–15. https://doi.org/10.1002/bse.2631

Barney, J. B. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Barney, J. B., Ketchen, D. J., & Wright, M. (2011). The future of resource-based theory: Revitalization or decline? *Journal of Management*, *37*(5), 1299–1315. https://doi.org/10.1177/0149206310391805

Berchicci, L., & Bodewes, W. (2005). Bridging environmental issues with new product development. *Business Strategy and the Environment*, *14*(5), 272–285. https://doi.org/10.1002/bse.488

Berry, M. A., & Randinelli, D. A. (1998). Proactive corporate Environmental Management: A new industrial revolution. *Academy of Management Executive*, *2*, 39–50. https://doi.org/10.5465/ame.1998.650515

Bhatia, M. S., & Jakhar, S. K. (2021). The effect of environmental regulations, top management commitment, and organizational learning on green product innovation: Evidence from automobile industry. *Business Strategy and the Environment*, *30*(8), 3907–3918. https://doi.org/10.1002/bse.2848

Bikfalvi, A., Lay, G., Maloca, S., & Waser, B. R. (2013). Servitization and networking: Large-scale survey findings on product-related services. *Service Business*, *7*(1), 61–82. https://doi.org/10.1007/s11628-012-0145-y

Bogers, M., Sund, K. J., & Villarroel, J. A. (2015). The organizational dimension of business model exploration. In *Business model innovation: The organizational dimension* (pp. 603–610). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198701873.001.0001

Bogue, R. (2014). Sustainable manufacturing: A critical discipline for the twenty-first century. *Assembly Automation*, *34*(2), 117–122. https://doi.org/10.1108/AA-01-2014-012

Chen, J., & Liu, L. (2020). Customer participation, and green product innovation in SMEs: The mediating role of opportunity recognition and exploitation. *Journal of Business Research*, *119*, 151–162. https://doi.org/10.1016/j.jbusres.2019.05.033

Chen, Y. S., & Chang, C. H. (2013). The determinants of green product development performance: Green dynamic capabilities, green transformational leadership, and green creativity. *Journal of Business Ethics*, *116*(1), 107–119. https://doi.org/10.1007/s10551-012-1452-x

Cheung, M. F. Y., & To, W. M. (2019). An extended model of value-attitude-behavior to explain Chinese consumers' green purchase behavior. *Journal of Retailing and Consumer Services*, *50*, 145–153. https://doi.org/10.1016/j.jretconser.2019.04.006

Chkanikova, O. (2016). Sustainable purchasing in food retailing: Interorganizational relationship management to green product supply. *Business Strategy and the Environment*, *25*(7), 478–494. https://doi.org/10.1002/bse.1877

Collins, E., Lawrence, S., Pavlovich, K., & Ryan, C. (2007). Business networks and the uptake of sustainability practices: The case of New Zealand. *Journal of Cleaner Production*, *15*(8–9), 729–740. https://doi.org/10.1016/j.jclepro.2006.06.020

Comoglio, C., & Botta, S. (2012). The use of indicators and the role of environmental management systems for environmental performances improvement: A survey on ISO 14001 certified companies in the automotive sector. *Journal of Cleaner Production*, *20*(1), 92–102. https://doi.org/10.1016/j.jclepro.2011.08.022

Daft, R. L. (2011). *Teoría y diseño organizacional*. (S. A. de C. V. Cengage Learning Editores, Ed.) (Décima). Cengage Learning Editores.

Damanpour, F. (1991). Organizational innovation: A Meta-analysis of effects of determinants and moderators. *Academy of Management Journal*, *34*(3), 555–590. https://doi.org/10.5465/256406

Dangelico, R. M., Nonino, F., & Pompei, A. (2021). Which are the determinants of green purchase behaviour? A study of Italian consumers. *Business Strategy and the Environment*, *30*(5), 1–21. https://doi.org/10.1002/bse.2766

Dangelico, R. M., & Pontrandolfo, P. (2010). From green product definitions and classifications to the Green Option Matrix. *Journal of Cleaner Production*, *18*(16–17), 1608–1628. https://doi.org/10.1016/j.jclepro.2010.07.007

Dangelico, R. M., & Pujari, D. (2010). Mainstreaming green product innovation: Why and how companies integrate environmental sustainability. *Journal of Business Ethics*, *95*(3), 471–486. https://doi.org/10.1007/s10551-010-0434-0

Dangelico, R. M., Pujari, D., & Pontrandolfo, P. (2016). Green product innovation in manufacturing firms: A sustainability-oriented dynamic capability perspective. *Business Strategy and the Environment*, *26*(4), 490–506. https://doi.org/10.1002/bse.1932

de Medeiros, J. F., Ribeiro, J. L. D., & Cortimiglia, M. N. (2014). Success factors for environmentally sustainable product innovation: A systematic literature review. *Journal of Cleaner Production*, *65*, 76–86. https://doi.org/10.1016/j.jclepro.2013.08.035

de Medeiros, J. F., Vidor, G., & Ribeiro, J. L. D. (2018). Driving factors for the success of the green innovation market: A relationship system proposal. *Journal of Business Ethics*, *147*(2), 327–341. https://doi.org/10.1007/s10551-015-2927-3

del Giudice, M., & Della Peruta, M. R. (2016). The impact of IT-based knowledge management systems on internal venturing and innovation: A structural equation modeling approach to corporate performance. *Journal of Knowledge Management*, *20*(3), 484–498. https://doi.org/10.1108/JKM-07-2015-0257

Dugoua, E., & Dumas, M. (2021). Green product innovation in industrial networks: A theoretical model. *Journal of Environmental Economics and Management*, *107*, 102420. https://doi.org/10.1016/j.jeem.2021.102420

European Commission. (2021). The eco-innovation scoreboard and the eco-innovation index. Retrieved March 22, 2021, from https://ec.europa.eu/environment/ecoap/indicators/index_en

Fraunhofer Institute for Systems and Innovation Research ISI. (2021). European Manufacturing Survey (EMS) 2015. Retrieved from https://www.isi.fraunhofer.de/en/themen/industrielle-wettbewerbsfaehigkeit/fems.html

Galbraith, J. R. (1982). Designing the innovating organization. *Organizational Dynamics*, *10*, 5–25. https://doi.org/10.1016/0090-2616(82)90033-X

Guan, J., & Ma, N. (2003). Innovative capability and export performance of Chinese firms. *Technovation-–The International Journal of Technological Innovation and Entrepreneurship*, *23*, 737–747. https://doi.org/10.1016/S0166-4972(02)00013-5

Guoyou, Q., Saixing, Z., Chiming, T., Haitao, Y., & Hailiang, Z. (2013). Stakeholders' influences on corporate green innovation strategy: A case study of manufacturing firms in China. *Corporate Social Responsibility and Environmental Management*, *20*(1), 1–14. https://doi.org/10.1002/csr.283

Hallstedt, S., Ny, H., Robèrt, K. H., & Broman, G. (2010). An approach to assessing sustainability integration in strategic decision systems for product development. *Journal of Cleaner Production*, *18*(8), 703–712. https://doi.org/10.1016/j.jclepro.2009.12.017

Hart, S. L. (1995). A natural-resource-based view of the firm. *Academy of Management Review*, *20*, 986–1014. https://doi.org/10.5465/AMR.1995.9512280033

Hart, S. L., & Dowell, G. (2011). A natural-resource-based view of the firm: Fifteen years after. *Journal of Management*, *37*(5), 1464–1479. https://doi.org/10.1177/0149206310390219

Herrera-Baltazar, M. E. (2015). Creating competitive advantage by institutionalizing corporate social innovation. *Journal of Business Research*, *68*(7), 1468–1474. https://doi.org/10.1016/j.jbusres.2015.01.036

Hollanders, H., Es-Sadki, N., Kanerva, M., Garcia-Porras, B., Licciardello, A., & Nicklas, M. (2015). Innovation Union Scoreboard 2015. https://doi.org/10.2769/247779

Huang, J., & Li, Y. (2017). Green innovation and performance: The view of organizational capability and social reciprocity. *Journal of Business Ethics*, *145*(2), 309–324. https://doi.org/10.1007/s10551-015-2903-y

Ilg, P. (2019). How to foster green product innovation in an inert sector. *Journal of Innovation & Knowledge*, *4*(2), 129–138. https://doi.org/10.1016/j.jik.2017.12.009

Isensee, C., Teuteberg, F., Griese, K. M., & Topi, C. (2020). The relationship between organizational culture, sustainability, and digitalization in SMEs: A systematic review. *Journal of Cleaner Production*, *275*, 122944. https://doi.org/10.1016/j.jclepro.2020.122944

Jabbour, C. J. C., Jugend, D., de Sousa Jabbour, A. B. L., Gunasekaran, A., & Latan, H. (2015). Green product development and performance of Brazilian firms: Measuring the role of human and technical aspects. *Journal of Cleaner Production*, *87*(1), 442–451. https://doi.org/10.1016/j.jclepro.2014.09.036

Jasti, N. V. K., Sharma, A., & Karinka, S. (2015). Development of a framework for green product development. *Benchmarking: An International Journal*, *22*(3), 426–445. https://doi.org/10.1108/BIJ-06-2014-0060

Karman, A., & Savanevičienė, A. (2020). Enhancing dynamic capabilities to improve sustainable competitiveness: Insights from research on organisations of the Baltic region. *Baltic Journal of Management Emerald Publishing Limited.*, *16*, 318–341. https://doi.org/10.1108/BJM-08-2020-0287

Lahovnik, M., & Breznik, L. (2014). Technological innovation capabilities as a source of competitive advantage: A case study from the home appliance industry. *Transformations in Business and Economics*, *13*(2), 144–160.

Landrum, N. E. (2018). Stages of corporate sustainability: Integrating the strong sustainability worldview. *Organization and Environment*, *31*(4), 287–313. https://doi.org/10.1177/1086026617717456

Leih, S., Linden, G., & Teece, D. J. T. (2015). Business model innovation and organizational design. A dynamic capabilities perspective. In *Business model innovation: The organizational dimension* (pp. 1–23). OUP. https://doi.org/10.1093/acprof

Liao, W. W. (2017). A study on the correlations among environmental education, environment-friendly product development, and green innovation capability in an enterprise. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(8), 5435–5444. https://doi.org/10.12973/eurasia.2017.00841a

Lin, P. C., & Huang, Y. H. (2012). The influence factors on choice behavior regarding green products based on the theory of consumption values. *Journal of Cleaner Production*, *22*(1), 11–18. https://doi.org/10.1016/j.jclepro.2011.10.002

Long, S., & Liao, Z. (2021). Are fiscal policy incentives effective in stimulating firms' eco-product innovation? The moderating role of dynamic capabilities. *Business Strategy and the Environment*, *30*(7), 1–10. https://doi.org/10.1002/bse.2791

Melander, L. (2018). Customer and supplier collaboration in green product innovation: External and internal capabilities. *Business Strategy and the Environment*, *27*(6), 677–693. https://doi.org/10.1002/bse.2024

Mellett, S., Kelliher, F., & Harrington, D. (2018). Network-facilitated green innovation capability development in micro-firms. *Journal of Small Business and Enterprise Development*, *25*(6), 1004–1024. https://doi.org/10.1108/JSBED-11-2017-0363

Millar, C., Hind, P., Millar, C., Hind, P., Millar, C., & Magala, S. (2012). Sustainability and the need for change: Organisational change and transformational vision. *Journal of Organizational Change Management*, *25*(4), 489–500. https://doi.org/10.1108/09534811211239272

Nadler, D., & Tushman, M. (1980). A model for diagnosing organizational behavior. *Organizational Dynamics*, *9*(2), 35–51. https://doi.org/10.1016/0090-2616(80)90039-X

Nadler, D., & Tushman, M. (1999). The organization of the future: Strategic imperatives and Core competencies for the 21st century. *Organisational Dynamics*, *28*(1), 45–60. https://doi.org/10.1016/S0090-2616(00)80006-6

Nadler, D., Tushman, M., & Nadler, M. (2011). Chapter 3: Mapping the organizational Terrain University. In *Competing by design: The power of organizational architecture* (pp. 603–610). Oxford Scholarship Online. https://doi.org/10.1093/acprof:oso/9780195099171.001.0001

Niedermeier, A., Emberger-Klein, A., & Menrad, K. (2021). Drivers and barriers for purchasing green fast-moving consumer goods: A study of consumer preferences of glue sticks in Germany. *Journal of Cleaner Production*, *284*, 124804. https://doi.org/10.1016/j.jclepro.2020.124804

OECD/Eurostat. (2018). *Oslo manual: Guidelines for collecting, reporting and using data on innovation* (4th ed.). Paris/Eurostat. https://doi.org/10.1787/9789264304604-en

Ogbeibu, S., Emelifeonwu, J., Senadjki, A., Gaskin, J., & Kaivo-oja, J. (2020). Technological turbulence and greening of team creativity, product innovation, and human resource management: Implications for sustainability. *Journal of Cleaner Production*, *244*, 118703. https://doi.org/10.1016/j.jclepro.2019.118703

Palčič, I., & Prester, J. (2020). Impact of advanced manufacturing technologies on green innovation. *Sustainability (Switzerland)*, *12*(8), 3499. https://doi.org/10.3390/SU12083499

Pérez-López, C. (2008). Técnicas de análisis multivariante de datos. (P. Educación, Ed.). Madrid - España. Retrieved from http://bit.ly/1JzSD8y

Pérez-Pérez, J. F., Parra, J. F., & Serrano-García, J. (2021). A system dynamics model: Transition to sustainable processes. *Technology in Society*, *65*, 1–16. https://doi.org/10.1016/j.techsoc.2021.101579

Pérez-Pérez, J. F., Serrano-García, J., & Arbeláez-Toro, J. J. (2020). Methods to analyze eco-innovation implementation: A theoretical review. *Advances in Intelligent Systems and Computing*, *894*, 153–168. https://doi.org/10.1007/978-3-030-15413-4

Pons, M., Bikfalvi, A., & Llach, J. (2018). Clustering product innovators: A comparison between conventional and green product innovators. *International Journal of Production Management and Engineering*, *6*(1), 37. https://doi.org/10.4995/ijpme.2018.8762

Pons, M., Bikfalvi, A., Llach, J., & Palcic, I. (2013). Exploring the impact of energy efficiency technologies on manufacturing firm performance. *Journal of Cleaner Production*, *52*, 134–144. https://doi.org/10.1016/j.jclepro.2013.03.011

Qiu, L., Jie, X., Wang, Y., & Zhao, M. (2020). Green product innovation, green dynamic capability, and competitive advantage: Evidence from Chinese manufacturing enterprises. *Corporate Social Responsibility and Environmental Management*, *27*(1), 146–165. https://doi.org/10.1002/csr.1780

Renard, L., & St-amant, G. E. (2003). Capacité, capacité organisationnelle et capacité dynamique: Une proposition de définitions. *Les Cahiers Du Management Technologique*, *13*(1), 43–56.

Rothenberg, S., Maxwell, J., & Marcus, D. A. (1992). Issues in the implementation of proactive environmental strategies. *Business Strategy and the Environment*, *1*(4), 1–12. https://doi.org/10.1002/bse.3280010402

Saengchai, S., Rodboonsong, S., & Jermsittiparsert, K. (2019). Environmental regulation, green product innovation and performance: Do the environmental dynamics matter in thai sports industry? *Journal of Human Sport and Exercise*, *14*(Proc5), S2276–S2289. https://doi.org/10.14198/jhse.2019.14.Proc5.44

Salim, N., Ab Rahman, M. N., & Abd Wahab, D. (2019). A systematic literature review of internal capabilities for enhancing eco-innovation performance of manufacturing firms. *Journal of Cleaner Production*, *209*, 1445–1460. https://doi.org/10.1016/j.jclepro.2018.11.105

Salim, N., Ab Rahman, N. M., & Wahab, D. A. (2021). Enhancing green product competitiveness through proactive capabilities of manufacturing firms. *Jurnal Kejuruteraan*, *33*(1), 73–82. https://doi.org/10.17576/jkukm-2020-33(1)-08

Sana, S. S. (2020). Price competition between green and non green products under corporate social responsible firm. *Journal of Retailing and Consumer Services*, *55*, 102118. https://doi.org/10.1016/j.jretconser.2020.102118

Sartal, A., Llach, J., Vázquez, X. H., & de Castro, R. (2017). How much does lean manufacturing need environmental and information technologies? *Journal of Manufacturing Systems*, *45*, 260–272. https://doi.org/10.1016/j.jmsy.2017.10.005

Serrano-García, J., Acevedo-Álvarez, C. A., Castelblanco-Gómez, J. M., & Arbeláez-Toro, J. J. (2017). Measuring organizational capabilities for technological innovation through a fuzzy inference system. *Technology in Society*, *50*, 93–109. https://doi.org/10.1016/j.techsoc.2017.05.005

Serrano-García, J., Bikfalvi, A., Llach, J., & Arbeláez-Toro, J. J. (2021). Orchestrating capabilities, organizational dimensions and determinants in the pursuit of green product innovation. *Journal of Cleaner Production*, *313*, 2–18. https://doi.org/10.1016/j.jclepro.2021.127873

Serrano-García, J., & Robledo-Velásquez, J. (2013). Methodology for evaluating innovation capabilities at university institutions using a fuzzy system. *Journal of Technology Management and Innovation*, *8*(SPL.ISS.3), 246–259. https://doi.org/10.4067/s0718-27242013000300051

Shahzad, M., Qu, Y., Ur Rehman, S., Zafar, A. U., Ding, X., & Abbas, J. (2020). Impact of knowledge absorptive capacity on corporate sustainability with mediating role of CSR: Analysis from the Asian context. *Journal of Environmental Planning and Management*, *63*(2), 148–174. https://doi.org/10.1080/09640568.2019.1575799

Shahzad, M., Qu, Y., Zafar, A. U., & Appolloni, A. (2021). Does the interaction between the knowledge management process and sustainable development practices boost corporate green innovation? *Business Strategy and the Environment*, *30*(8), 1–17. https://doi.org/10.1002/bse.2865

Sirmon, D. G., Hitt, M. A., Ireland, R. D., & Gilbert, B. A. (2011). Resource orchestration to create competitive advantage: Breadth, depth, and life cycle effects. *Journal of Management*, *37*(5), 1390–1412. https://doi.org/10.1177/0149206310385695

Song, W., Ren, S., & Yu, J. (2018). Bridging the gap between corporate social responsibility and new green product success: The role of green organizational identity. *Business Strategy and the Environment*, *28*(1), 88–97. https://doi.org/10.1002/bse.2205

Tan, C. N. L., Ojo, A. O., & Thurasamy, R. (2019). Determinants of green product buying decision among young consumers in Malaysia. *Young Consumers*, *20*(2), 121–137. https://doi.org/10.1108/YC-12-2018-0898

Tariq, A., Badir, Y. F., Safdar, U., Tariq, W., & Badar, K. (2020). Linking firms' life cycle, capabilities, and green innovation. *Journal of Manufacturing Technology Management*, *31*(2), 284–305. https://doi.org/10.1108/JMTM-08-2018-0257

Tariq, A., Badir, Y. F., Tariq, W., & Bhutta, U. S. (2017). Drivers and consequences of green product and process innovation: A systematic review, conceptual framework, and future outlook. *Technology in Society*, *51*, 8–23. https://doi.org/10.1016/j.techsoc.2017.06.002

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*, 1319–1350. https://doi.org/10.1002/smj.640

Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, *43*(2–3), 172–194. https://doi.org/10.1016/j.lrp.2009.07.003

Teece, D. J. (2018). Business models and dynamic capabilities. *Long Range Planning*, *51*(1), 40–49. https://doi.org/10.1016/j.lrp.2017.06.007

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management*, *18*(7), 77–115. https://doi.org/10.1007/978-1-137-03545-5

Tsai, C. C. (2012). A research on selecting criteria for new green product development project: Taking Taiwan consumer electronics products as an example. *Journal of Cleaner Production*, *25*, 106–115. https://doi.org/10.1016/j.jclepro.2011.12.002

Tseng, C. H., Chang, K. H., & Chen, H. W. (2019). Strategic orientation, environmental innovation capability, and environmental sustainability performance: The case of Taiwanese suppliers. *Sustainability (Switzerland)*, *11*(4), 1127. https://doi.org/10.3390/su11041127

Tushman, M. (2017). Innovation streams and executive leadership: R&D leadership plays a central role in shaping a firm's ability to both exploit existing capabilities and explore new technological domains. *Research Technology Management*, *60*(6), 42–47. https://doi.org/10.1080/08956308.2017.1373050

Tushman, M., & Nadler, D. (1986). Organizing for innovation. *California Management Review*, *28*(3), 74–92. https://doi.org/10.2307/41165203

Úbeda-García, M., Claver-Cortés, E., Marco-Lajara, B., & Zaragoza-Sáez, P. (2021). Corporate social responsibility and firm performance in the hotel industry. The mediating role of green human resource management and environmental outcomes. *Journal of Business Research*, *123*, 57–69. https://doi.org/10.1016/j.jbusres.2020.09.055

United Nations. (2018). The 2030 agenda and the sustainable development goals an opportunity for Latin America and the Caribbean. Santiago de Chile. Retrieved from www.cepal.org/en/suscripciones

Wang, J., Xue, Y., & Yang, J. (2019). Boundary-spanning search and firms' green innovation: The moderating role of resource orchestration capability. *Business Strategy and the Environment*, *29*(2), 361–374. https://doi.org/10.1002/bse.2369

Wee, Y. S., & Quazi, H. A. (2005). Development and validation of critical factors of environmental management. *Industrial Management and Data Systems*, *105*(1), 96–114. https://doi.org/10.1108/02635570510575216

Yam, R., Guan, J. C., Pun, K. F., & Tang, E. P. Y. (2004). An audit of technological innovation capabilities in Chinese firms: Some empirical findings in Beijing, China. *Research Policy*, *33*(8), 1123–1140. https://doi.org/10.1016/j.respol.2004.05.004

Yin, S., Zhang, N., & Li, B. (2020). Enhancing the competitiveness of multi-agent cooperation for green manufacturing in China: An empirical study of the measure of green technology innovation capabilities and their influencing factors. *Sustainable Production and Consumption*, *23*, 63–76. https://doi.org/10.1016/j.spc.2020.05.003

Yusr, M. M., Salimon, M. G., Mokhtar, S. S. M., Abaid, W. M. A. W., Shaari, H., Perumal, S., & Saoula, O. (2020). Green innovation performance! How to be achieved? A study applied on Malaysian manufacturing sector. *Sustainable Futures*, *2*, 100040. https://doi.org/10.1016/j.sftr.2020.100040

Zhang, F., & Zhu, L. (2019). Enhancing corporate sustainable development: Stakeholder pressures, organizational learning, and green innovation. *Business Strategy and the Environment*, *28*(6), 1012–1026. https://doi.org/10.1002/bse.2298

Zhang, J., Liang, G., Feng, T., Yuan, C., & Jiang, W. (2020). Green innovation to respond to environmental regulation: How external knowledge adoption and green absorptive capacity matter? *Business Strategy and the Environment*, *29*(1), 39–53. https://doi.org/10.1002/bse.2349

Zhang, M., Zeng, W., Tse, Y. K., Wang, Y., & Smart, P. (2021). Examining the antecedents and consequences of green product innovation. *Industrial Marketing Management*, *93*, 413–427. https://doi.org/10.1016/j.indmarman.2020.03.028

Zhang, S., Wang, Z., & Zhao, X. (2019). Effects of proactive environmental strategy on environmental performance: Mediation and moderation analyses. *Journal of Cleaner Production*, *235*, 1438–1449. https://doi.org/10.1016/j.jclepro.2019.06.220

Zhao, Y., Feng, T., & Shi, H. (2018). External involvement and green product innovation: The moderating role of environmental uncertainty. *Business Strategy and the Environment*, *27*(8), 1167–1180. https://doi.org/10.1002/bse.2060

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