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Efectos de la agilidad organizativa sobre la eco-innovación bajo el enfoque de las Capacidades Dinámicas

D. José Rabal Conesa

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Autor: D. José Rabal Conesa

Directores: Dr. D. Daniel Jiménez Jiménez y

Dra. Dª. Micaela Martínez Costa

UNIVERSIDAD DE MURCIA

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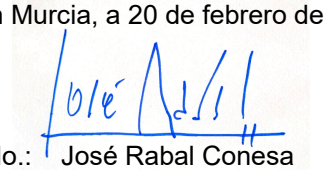

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A mi familia extensa, familiares y amigos, con un recuerdo especial a quienes ya no se encuentran entre nosotros. Estareis siempre en mi corazón.

A mis hermanos, por vuestro amor y también por vuestro aguante durante estos años.

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I. INTRODUCCIÓN

I.1. INTRODUCCIÓN A LA TEMÁTICA DE LA TESIS DOCTORAL

En el hiperconectado mundo actual, las fronteras físicas y tecnológicas se diluyen. Pandemias, crisis económicas, bloqueos logísticos como el del Canal de Suez, conflictos bélicos, o el cambio climático, tienen una incidencia global. En este contexto, la inestabilidad de los distintos mercados exige a las organizaciones modificar sus estructuras, procesos internos, y estrategias además de promover una cultura interna que les permita responder de forma ágil y proactiva a los cambios externos. La incorporación de tecnologías y conocimiento del exterior, la gestión de los recursos de forma eficiente, así como la implicación y el compromiso de las personas que las integran, contribuyen decisivamente minimizando el impacto de su actividad en el medio ambiente. Algunas de las lecciones aprendidas de las crisis recientes han puesto de manifiesto la necesidad de focalizarse en procesos de generación del conocimiento que ayuden a las organizaciones a responder de forma resiliente a los cambios del entorno y a ser ágiles en la gestión de sus procesos productivos y en la toma de decisiones, siendo al mismo tiempo capaces de obtener innovaciones respetuosas con el medio ambiente en el menor tiempo posible.

En esta línea, las capacidades dinámicas se consideran elementos estratégicos para el rendimiento empresarial en un entorno inestable como el actual, caracterizado por altas turbulencias y disrupciones (Hendry et al., 2019; Wamba et al., 2020). Fueron definidas inicialmente como la capacidad organizativa para gestionar, incorporar y reconfigurar las competencias internas y externas, de modo que permitan los cambios en el entorno empresarial (Teece et al., 1997). Eisenhardt y Martin (2000) amplían el alcance del concepto de capacidades dinámicas a los procesos estratégicos y organizativos reconocidos, como las colaboraciones o el desarrollo de productos. Su interés estratégico radica en su habilidad para aprovechar los recursos disponibles en la formulación de estrategias para la creación de valor. Estos autores defienden que las organizaciones necesitan llevar a cabo procesos continuos de reconfiguración, creación e integración de habilidades con el fin de obtener una ventaja competitiva a largo plazo mientras se adaptan a la evolución de sus entornos (Eisenhardt y Martin, 2000; Teece, 2007). Por consiguiente, la presencia de capacidades dinámicas en las organizaciones es

esencial para el éxito sostenido en la economía global actual, caracterizada por el creciente avance tecnológico y la globalización empresarial (Luo, 2000).

Asimismo, la capacidad de adaptación en individuos, equipos y organizaciones es reconocida ampliamente como la herramienta más eficaz para la gestión en entornos VUCA (acrónimo en inglés de Volatility, Uncertainty, Complexity y Ambiguity) (Baran y Woznyj, 2021). No es sorprendente, por tanto, que la agilidad sea considerada como una de las capacidades dinámicas más relevantes en la actualidad (Teece et al., 2016). La agilidad organizativa implica tener la capacidad de responder de manera rápida y efectiva a las demandas actuales del mercado, al mismo tiempo que se muestra proactiva en la exploración de nuevos mercados en comparación con los competidores clave (Bessant et al., 2001) o incluso mejorar sus capacidades de eco-innovación (Hart y Dowell, 2011). En definitiva, la agilidad es ampliamente considerada como una respuesta rápida a las demandas del mercado y de las partes interesadas y un factor crucial para el éxito organizativo (Overby et al., 2006; Denning, 2019).

Por otro lado, la capacidad de adaptación ha sido una cualidad reconocida a lo largo de la evolución humana. Las organizaciones, al ser entidades esencialmente humanas, encuentran en el concepto de adaptabilidad una perspectiva valiosa para abordar las complejidades del cambio organizativo. En esta línea, el término resiliencia se ha venido utilizando en varias esferas de la actividad humana (Ponomarov y Holcomb, 2009; Bhamra et al., 2011; Kamalahmadi y Parast, 2016). En términos generales, la resiliencia representa una habilidad fundamental que permite, tanto a las personas como a las organizaciones, superar retos y adecuarse a los cambios de su entorno. Ambulkar et al. (2015) definen la resiliencia organizativa desde una perspectiva dinámica, como la cualidad de la empresa para reconocer, adaptarse y reaccionar eficazmente ante las alteraciones causadas por una interrupción en la cadena de suministro. En este sentido, una cadena de suministro que sea resiliente no solo permite anticiparse a eventos imprevistos, sino que también garantiza la continuidad en su operativa, la rápida recuperación de las interrupciones y la mejora de su ventaja competitiva (Namdar et al., 2017). Además, ciertos autores han observado que las empresas comprometidas con la gestión de la cadena ecológica de suministro se recuperan más rápidamente de los desabastecimientos (Fasan et al., 2021), reducen el tiempo para recuperarse de los

efectos económicos y financieros de crisis como la COVID-19, y mejoran su resiliencia organizativa financiera (Irfan et al., 2022).

De este modo, el paradigma tradicional de gestión de riesgos que han venido utilizando las empresas para protegerse de riesgos predecibles como incendios o cortes de energía resulta inadecuado en el complejo y turbulento contexto económico y ambiental global actual. Ante la complejidad y las turbulencias, cuando las interrupciones son a menudo impredecibles, la evaluación de riesgos se vuelve inmanejable y las prácticas tradicionales de gestión de riesgos dejan de ser adecuadas, siendo necesario complementarlas con una perspectiva de gestión de la resiliencia (Fiksel, 2015). Acorde con esta idea, la adaptabilidad, la flexibilidad y la agilidad son conceptos incluidos implícitamente en todas las estrategias de resiliencia (Kamalahmadi y Parast, 2016).

La perspectiva de la resiliencia tiene implicaciones significativas para las empresas que buscan mejorar su sostenibilidad (Wu y Tham, 2023). Concretamente, debe conducir a cambios graduales que hagan compatible el beneficio económico con el medioambiente y los objetivos sociales (Fiksel, 2003). Para ello, la inclusión en la estrategia organizativa de enfoques que consideren la agilidad y la resiliencia como complementarias y compatibles en su aplicación simultánea en la cadena de suministro puede contribuir a asegurar una ventaja competitiva de la organización en un entorno empresarial dinámico e incierto (Carvalho et al., 2012; Altay et al., 2018; Dubey et al., 2018; Aldoghan, 2023).

Como reacción al cambio climático existe una creciente conciencia global que empuja a las empresas y a la sociedad a desarrollar procesos y productos más respetuosos con el medio ambiente, profundizando en la disminución de recursos, la reutilización y el reciclaje de materiales, y la sostenibilidad global de la actividad humana. La innovación desempeña un papel crucial en el avance de la industria hacia una producción sostenible, que se ha visto facilitada por la eco-innovación. Por lo que respecta al desarrollo de nuevos productos ecológicos, varios autores han destacado la relevancia de fomentar ciertas capacidades dinámicas, como el aprendizaje organizativo (Jerez-Gómez et al., 2007; Giniuniene y Jurksiene, 2015; Albort-Morant et al., 2016), la capacidad de absorción (Lane y Lubatkin, 1998; Hashim et al., 2015; Albort-Morant et al., 2018) o la agilidad organizativa (Hamad y Yozgat, 2017). De este modo, desarrollar capacidades

dinámicas verdes e integrarlas en los procesos productivos es uno de los objetivos de la innovación eco-ambiental. La idea subyacente es que las empresas deben impulsar sus capacidades dinámicas ecológicas para aumentar el rendimiento de su desarrollo de productos ecológicos (Chen y Chang, 2013). Varios autores señalan que la implementación de enfoques estratégicos, así como el desarrollo de productos y procesos eco-innovadores en las empresas les permiten obtener ventajas competitivas, reducir costos y mejorar las condiciones ambientales, pero también, lograr un mejor desempeño comercial (Porter y Van der Linde, 1995; Pujari et al., 2003; Chiou et al., 2011; Lin y Chen, 2017; Sellitto et al., 2020). La eco-innovación va más allá de los límites organizativos, para influir en el contexto social a través de cambios normativos, valores y comportamientos culturales, así como de las propias estructuras organizativas (Pilat, 2009).

Al igual que en otros tipos de innovación, el desarrollo de nuevos productos ecológicos requiere de una cultura abierta y de nuevos conocimientos (Cegarra-Navarro et al., 2019), en este caso de carácter medioambiental. Para ello, la generación de nuevo conocimiento y la gestión de este es fundamental para las empresas (Civelek et al., 2015; Khosravi et al., 2018; Abbas y Sağsan, 2019; Moaniba et al., 2020). Así, la incorporación de nuevos conocimientos incita a las empresas a explorar nuevas formas de hacer las cosas y a explotar las capacidades existentes de manera más efectiva para obtener ventajas competitivas a través de innovaciones (Andreeva y Kianto, 2011; Yaghoubi et al., 2011; Liao, 2016). De este modo, las empresas deben encontrar los mecanismos necesarios para adquirir nuevos conocimientos e integrarlos con los conocimientos existentes para fortalecer las habilidades organizativas y ser más competitivas (Grant, 1996; Chen y Vanhaverbeke, 2011; Tsai y Hsu, 2014; Chen et al., 2016). Así, contar con un sistema de gestión del conocimiento apropiado es esencial para alcanzar ese objetivo.

Esto es aún más relevante para las empresas innovadoras. La constante necesidad de desarrollar nuevos productos presiona a las empresas para que aumenten y reacondicionen sus conocimientos, tecnologías y habilidades para ofrecer productos con nuevas especificaciones que renueven la confianza de los consumidores existentes o permitan a las empresas incorporarse a otros segmentos o mercados. En este escenario, es esencial mantener un equilibrio adecuado entre ambos tipos de conocimiento

mediante una capacidad precisa de gestión, que esté alineada con las características organizativas y la estrategia empresarial. Asimismo, las empresas más innovadoras y concienciadas con el medio ambiente son conscientes de que, además de satisfacer las exigencias que conllevan los procesos de innovación en entornos turbulentos, deben introducir también tecnologías que les permita ser más respetuosas con el medio ambiente. El uso de las tecnologías de la información y la mejora de las capacidades digitales organizativas es clave para optimizar la cadena de suministro (Aldoghan, 2023).

Finalmente, las regulaciones ambientales y el apoyo gubernamental fomentan el negocio ecológico y los productos eco-innovadores, con una influencia notablemente positiva en los consumidores, la competencia, la gestión y la mejora de los procesos ecológicos (Achmad et al., 2023). Los clientes pueden contribuir a la creación de valor en los procesos internos y externos y a desarrollar nuevos productos y servicios desempeñando un papel activo (Du y Chen, 2018; Denning, 2019). El compromiso del cliente parece tener un impacto positivo en la calidad técnica y en la velocidad de innovación (Carbonell et al., 2009). La mayor efectividad de la participación del cliente en el desarrollo del nuevo producto parece encontrarse en las fases de ideación y lanzamiento, influyendo directamente en el rendimiento financiero del nuevo producto y reduciendo indirectamente el tiempo de comercialización (Chang y Taylor, 2016). Además, la agilidad del cliente permite a las empresas actuar rápidamente en entornos cambiantes (Roberts y Grover, 2012). De este modo, los beneficios de la participación del cliente en el desarrollo de nuevos productos aparecen estrechamente ligados a la capacidad de la organización para incorporar el feedback del cliente, procesarlo, analizarlo y convertirlo en objetivos de negocio (Morgan et al., 2018).

Las ideas expuestas hasta ahora nos ayudan a establecer los objetivos generales de esta tesis doctoral.

I.2. OBJETIVOS DE LA INVESTIGACIÓN

Basándose en el marco teórico de las Capacidades Dinámicas, este trabajo doctoral tiene como objetivo global examinar la relación entre el binomio agilidad organizativa y eco-innovación, enunciándose como sigue:

¿Cómo la agilidad organizativa puede facilitar una respuesta rápida y eficaz de la empresa a los cambios repentinos que se producen en mercados y clientes, innovando en procesos y productos medioambientalmente más sostenibles, y promoviendo así la generación de ventajas competitivas?

El análisis de la literatura existente revela varias estrategias que pueden contribuir a alcanzar el objetivo general planteado. Agilidad organizativa y eco-innovación están presentes en los tres estudios empíricos realizados, que se abordarán a lo largo de esta tesis doctoral. Derivados de los tres modelos de investigación, que a su vez han sido extraídos del modelo global, se incorporarán otros constructos o variables que ayudan a entender la problemática planteada. Se abordan preguntas específicas que ofrecen respuestas a diversos aspectos relacionados con el objetivo principal de esta tesis, afrontando también algunas de las lagunas identificadas en la literatura.

En primer lugar, hemos de considerar que, aunque estudios previos han explorado la influencia de la agilidad en la innovación o en la competitividad de las empresas (Burchardt y Maisch, 2019), no se ha estudiado suficientemente sus efectos sobre la eco-innovación, pese a la necesidad manifestada de entender esta relación. Para tratar de suplir este vacío identificado en la literatura, profundizaremos en esta capacidad, analizando los efectos de la agilidad organizativa en la creación de conocimiento ambiental tanto interno como externo. Pretendemos de este modo subrayar las tensiones que se producen entre el conocimiento interno y externo para la generación de eco-innovaciones exitosas, y profundizar en la importancia de ambos tipos de conocimiento para el desarrollo de nuevos productos ecológicos. Por tanto, los primeros interrogantes específicos que abordamos al hilo del objetivo general planteado son:

a. *¿Puede la agilidad organizativa favorecer la eco-innovación exitosa en producto?*
b. *¿Qué conocimiento es más relevante para estas eco-innovaciones, el conocimiento interno o el externo?*
c. *¿Puede el conocimiento interno influir en la interacción entre agilidad organizativa y eco-innovación exitosa de producto?*

En segundo lugar, Oduro et al. (2022), en una revisión reciente de la investigación sobre eco-innovación identificaron algunas lagunas en la literatura, incluyendo la falta de variables moderadoras entre la eco-innovación y el rendimiento empresarial, así como la necesidad de introducir otras teorías (diferentes a la de Porter, Recursos y Capacidades o Institucional, entre otras), como la de las Capacidades Dinámicas, para explorar contextos dinámicos como los entornos ecológicos. En este sentido, esta investigación cubre la falta de literatura sobre la dependencia entre la agilidad en las organizaciones y el desarrollo de la eco-innovación, de procesos y productos, considerando que no se ha estudiado con la necesaria profundidad (Franco et al., 2022) y que la agilidad actúa como una capacidad dinámica esencial en este proceso. Además, el modelo analiza el rol desempeñado por la participación de los clientes en estas eco-innovaciones y los efectos de estas en los resultados de negocio asegurando el éxito de las innovaciones. Esto se justifica en la necesidad de incorporar conocimiento externo en el proceso de desarrollo de nuevos productos, contribuyendo así a ampliar el cuerpo de investigación que analiza esta relación y poniendo la atención sobre una orientación empresarial más *verde*, que facilite alcanzar objetivos empresariales, pero que contribuya a defender la sostenibilidad del planeta. De este modo, el segundo bloque de cuestiones específicas que consideraremos son las siguientes:

d. ¿Contribuye la eco-innovación de procesos y productos a la obtención de mejores resultados empresariales?

e. ¿Qué papel juega la implicación o la participación de los clientes en la conexión entre agilidad y eco-innovación en procesos y productos?

f. ¿La participación de los clientes en la eco-innovación puede contribuir a mejorar los resultados empresariales?

Finalmente, estudiaremos la aplicación simultánea de estrategias IKARG (acrónimo en inglés de Information, Knowledge Management, Agility, Resilience y Green Innovation) en una misma organización, hasta donde llega nuestro conocimiento, no aplicada con anterioridad. Siendo ésta una variante de las estrategias LARG (acrónimo en inglés de Leanness, Agility, Resilience and Greenness) en las cadenas de suministro, referenciadas por varios autores en la literatura (Carvalho et al., 2011; Duarte y Cruz-Machado, 2013; Sharma et al., 2020; Anvari, 2021; Sonar et al., 2022). La aplicación de metodologías

ágiles (Fowler y Highsmith, 2001) a la gestión de las empresas marca un camino para las que quieren desarrollar nuevos productos exitosos a través de la agilidad organizativa. Así, el tercer bloque de cuestiones a las que responderemos está conformado por las siguientes preguntas:

g. *¿Puede contribuir la resiliencia organizativa a la eco-innovación exitosa de producto?*
h. *¿La gestión del conocimiento, considerada como capacidad dinámica, puede influir en las relaciones entre resiliencia y agilidad organizativas y eco-innovación exitosa de producto?*
i. *¿Qué influencia puede tener la capacidad de información en las relaciones entre la gestión dinámica del conocimiento, la resiliencia y la agilidad organizativas?*

En resumen, esta tesis intenta ir más allá de su aportación teórica desarrollando modelos de relaciones que se puedan materializar fácilmente en herramientas y soluciones prácticas de aplicación en el ámbito profesional. Estimamos que estas contribuciones son cruciales para la adaptación de las organizaciones a entornos empresariales y económicos caracterizados por la inestabilidad y la incertidumbre. Aunque las claves del éxito empresarial no son únicas, la implementación de enfoques organizativos y estratégicos adecuados puede aumentar las posibilidades de captar las oportunidades de negocio en los mercados actuales, colocando a las empresas en una posición ventajosa frente a sus competidores.

I.3. METODOLOGÍA EMPLEADA

Para abordar los objetivos expuestos con anterioridad se ha realizado una revisión exhaustiva de la literatura, explorando diversos enfoques teóricos que respaldan la tesis. Se ha propuesto también un modelo teórico integral, el cual conduce a un posterior estudio empírico donde se establecen relaciones entre las variables analizadas.

Concretamente, esta tesis incluye tres investigaciones empíricas que tratan de responder a diversos aspectos relacionadas con los cuatro pilares principales que sustentan el modelo global de relaciones presentes en este trabajo: agilidad organizativa, gestión del conocimiento, eco-innovación y resiliencia.

Por otro lado, es necesario señalar que este proyecto forma parte de un estudio más amplio - ECO2017-88987-R (MINECO/FEDER; UE) - financiado por el Ministerio de Economía, Industria y Competitividad de España y la Unión Europea a través del Fondo Europeo de Desarrollo Regional (FEDER).

Con la intención de evitar repeticiones y teniendo en cuenta que esta metodología será común en los diferentes estudios que conforman esta tesis, se recogen a continuación los aspectos más relevantes de la misma.

Para la recolección de datos de los tres estudios empíricos se realizó una encuesta, a través de un cuestionario estructurado, previamente probado y alojado en la web corporativa de la Universidad de Murcia. Se realizó también un seguimiento telefónico por una empresa externa de investigación de mercados, colaboradora habitual de la universidad, que facilitó la recogida de estos datos. Tras la familiarización con el cuestionario y las pruebas previas con las empresas asociadas, se inició la recopilación de datos. En el anexo final se incluye el cuestionario utilizado.

El estudio empleó escalas Likert de siete puntos como principal herramienta de medición para evaluar los diversos componentes dentro del marco de la investigación. Estas escalas Likert sirvieron como instrumentos de medición de los constructos constituyentes del modelo de investigación, permitiendo también una evaluación integral del modelo y de las relaciones entre sus variables. El uso de una escala de siete puntos proporcionó una perspectiva matizada y detallada, lo que facilitó una comprensión más profunda de los constructos de la investigación y sus asociaciones.

El procedimiento de recogida de información consistió en el envío de cartas de presentación a las empresas, proporcionando información detallada sobre el proyecto y su conexión con el equipo de investigación. Asimismo, se incluyó una invitación a participar en el estudio y un enlace al cuestionario en línea. Aquellas empresas que no respondieron inicialmente recibieron recordatorios, y se corrigieron los errores en las direcciones de contacto. También se brindó la opción de participar en la encuesta mediante entrevista telefónica. Las empresas fueron seleccionadas de forma aleatoria de la base de datos poblacional señalada, y en el caso de no lograr el contacto objetivo

de estudio o declinar la participación, se procedió a contactar con la siguiente empresa de la lista.

La encuesta fue dirigida a las personas responsables de la innovación o de forma alternativa a los directivos encargados de gestionar el conocimiento de la organización. Entendiendo que dichas personas disponían de una visión integral y relevante para responder a las cuestiones incluidas en la encuesta.

I.3.1. Población y muestra escogida

La población del estudio está formada por empresas industriales españolas con más de 100 empleados y un mínimo de 5 años de antigüedad. Se fijó este objetivo para asegurar que las empresas disponían de procesos de gestión del conocimiento e innovación desarrollados y consolidados, que permitiesen obtener conclusiones relevantes. Para ello, estas compañías fueron seleccionadas de la base de datos SABI (Bureau van Dijk), un repositorio exhaustivo de datos de análisis financiero de los últimos 25 años en firmas de España y Portugal. El objetivo era poder generalizar los resultados y conclusiones de forma ágil y poder aplicar las contribuciones resultantes a cualquier empresa industrial. La base de datos poblacional resultante constó de 2.318 empresas.

Utilizando la metodología previamente señalada, el grupo encuestado estuvo compuesto predominantemente por hombres (87%) con una antigüedad promedio de 9 años y 16 años de experiencia. La recopilación de datos duró tres meses, lo que dio como resultado información válida procedente de 260 empresas. Un análisis de potencia utilizando G*Power demostró resultados satisfactorios de potencia (0,8) y alfa (0,05), cumpliendo con el requisito de tamaño mínimo de muestra dado el tamaño medio del efecto (Faul et al., 2009).

Con tres excepciones, las empresas encuestadas se dedicaban a actividades internacionales de importación y/o exportación, con una antigüedad media superior a los 39 años. El resultado medio de explotación fue de 237.740.000 euros y el beneficio se situó en 14.004.000 euros. Los promedios de rentabilidad económica y financiera fueron de 7,95% y 18,44%, respectivamente, con un tamaño promedio de la empresa

que superó los 435 empleados. En la Tabla I.1. pueden consultarse más detalles acerca de la muestra.

Tabla I.1. Características de la muestra

Indicadores	*Media*	*Percentil 25*	*Percentil 50*	*Percentil 75*
Antigüedad de la empresa	39.41	25.00	36.00	51.00
Empleados/a	435.47	179.00	252.50	438.00
Resultado de explotación (mill €)	237.74	53.83	85.09	172.38
Beneficio ejercicio (mill €)	14.04	1.52	3.82	9.30
Activos totales (mill €)	187.16	44.37	70.83	144.46
Rentab. económica (%)	7.95	2.08	5.93	11.40
Rentab. financiera (%)	18.44	5.61	13.07	22.41
Sectores de la muestra	20.77% Industria de alimentos y bebidas; 9,62% Industria química; 8,85% Fabricación de maquinaria; 8,46 por ciento Fabricación de vehículos de motor; 8,46% Fabricación de productos de caucho y plástico; 8,08% Fabricación de hierro. productos siderúrgicos y de ferroaleaciones; 7,31% Fabricación de productos metálicos; 6,15 por ciento Fabricación de productos minerales no metálicos; 3,46% Fabricación de productos farmacéuticos; 3,08% Industria papelera y gráfica; 3,08% Fabricación de material y equipo eléctrico; 3.08% Manufactura de bebidas; 2,31% Industria de la madera y el corcho; 1.92% Fabricación de computadoras. productos electrónicos y ópticos; 1,54% Manufactura de construcción naval; 1,54% Industria de la madera y el corcho; 2.31% Descanso			
Total: 260 empresas				

I.3.2. Técnicas estadísticas utilizadas

Para examinar los tres modelos de investigación planteados se optó por utilizar la técnica estadística de regresión de mínimos cuadrados parciales (PLS o partial least squares regression en inglés). Este enfoque utiliza la Metodología de Ecuaciones Estructurales (SEM o structural equation models en inglés), que facilita la medición de variables latentes que no son directamente observables pero que se infieren de nuestras hipótesis subyacentes (Cepeda-Carrion et al., 2019). Estas variables latentes se evalúan mediante una serie de indicadores dentro de la muestra (Cepeda-Carrión et al., 2016).

Como sugieren Rigdon (2016) y Henseler (2017), PLS-SEM es un método adecuado cuando se trata de datos distribuidos de forma no normal, se realiza un estudio exploratorio de relaciones que carecen de un amplio apoyo bibliográfico, o cuando se emplean variables reflexivas para medir conceptos que sirven como explicaciones y pueden ser explicados por otras variables. Además, PLS también puede emplearse con fines confirmatorios (Henseler, 2018; Schuberth et al., 2018; Hair et al., 2020). Pero fundamentalmente se utiliza porque los constructos utilizados responden a una naturaleza de compuestos, más que de factores, como es el caso de esta investigación.

Para el examen del modelo de medición y estimación del modelo estructural se empleó el software SmartPLS 3.3.3 (Ringle et al., 2015).

Esta metodología se ha aplicado en los tres estudios centrales de esta tesis, posibilitando la evaluación detallada de los modelos teóricos, en consonancia con los objetivos expuestos y las hipótesis de investigación que se explorarán en capítulos posteriores.

I.4. ESTRUCTURA DE LA TESIS DOCTORAL

Esta tesis doctoral se sustenta en cuatro pilares fundamentales como son la agilidad organizativa, la gestión del conocimiento, la eco-innovación y la resiliencia. La capacidad de información, con su componente tecnológico y la implicación de los clientes como fuente de información forman parte también de esta tesis, apuntalando algunos de estos conceptos. En la figura I.1. están incluidos todos ellos y se representa la importancia e interacción de estos en el conjunto de la investigación. A lo largo de esta tesis se analizarán las relaciones entre los distintos constructos y cómo estas repercuten en los resultados de las empresas y en la creación de productos ecológicos exitosos. Ofreciendo así estrategias que les permitan lograr ventajas competitivas para desarrollarse y perpetuarse en el tiempo, en un contexto de creciente volatilidad, incertidumbre, complejidad y ambigüedad, en esta *modernidad líquida*, utilizando el concepto acuñado por Bauman (2015).

El contenido de esta tesis doctoral se ha estructurado en seis capítulos que comprenden una introducción, un capítulo teórico, tres capítulos que incluyen otros tantos estudios empíricos y un capítulo de conclusiones a modo de cierre. De forma más precisa, además del presente capítulo introductorio, el resto de los apartados continúan como se explica a continuación.

En el capítulo II se aborda el marco teórico general, bajo el paraguas de la teoría de las Capacidades Dinámicas. En él se desglosan los principales constructos utilizados en esta tesis, realizando una revisión de la literatura relacionada con ellos e identificando aspectos que no han sido suficientemente analizados en estudios anteriores y que constituyen la base de partida para los tres modelos de investigación incluidos en los capítulos subsiguientes.

Figura I.1. Constructos investigados

El capítulo III incluye un primer modelo de investigación cuyo propósito es analizar la influencia de la agilidad organizativa en la eco-innovación. En este estudio se analizará la poco explorada conexión entre la agilidad y el desarrollo exitoso de nuevos productos ecológicos, así como las particularidades inherentes a la eco-innovación. Otro aspecto estudiado es la relación entre el conocimiento interno y externo y la agilidad organizativa, así como su influencia en la generación de productos eco-innovadores exitosos.

El estudio incluido en el capítulo IV presenta un segundo modelo que aborda tres aspectos insuficientemente explorados en la literatura previa. En primer lugar, afronta la carencia de investigación sobre cómo la agilidad puede promover la innovación ecológica y su potencial impacto positivo en los resultados empresariales. En segundo lugar, examina la participación del cliente como un factor moderador y sus efectos en la relación entre la agilidad organizativa y la eco-innovación en productos y procesos, así como entre la eco-innovación de producto y el rendimiento organizativo. En tercer lugar, se introduce la teoría de las Capacidades Dinámicas mediante el concepto de agilidad para explorar el contexto dinámico eco-ambiental.

En el capítulo V, se presenta por primera vez un modelo que integra las estrategias de información, gestión del conocimiento, agilidad, resiliencia y eco-innovación bajo la teoría de las Capacidades Dinámicas. Además, se desarrolla una nueva escala de medición de la agilidad basada en los principios de las metodologías ágiles. Este estudio trata de aportar evidencia empírica acerca de cómo las capacidades de información y gestión del conocimiento facilitan la implementación de la resiliencia y la agilidad organizativas en el desarrollo exitoso de productos ecológicos, y de cómo estos conceptos pueden contribuir a su vez a la creación de ventajas competitivas sostenibles.

En el capítulo VI se exponen las conclusiones derivadas de la exploración de la literatura y de los tres estudios empíricos previamente presentados. También se destacan las contribuciones de esta tesis a la investigación existente hasta el momento, se exponen sus implicaciones prácticas, se identifican las principales limitaciones de la investigación realizada y se proponen diversas áreas para investigaciones futuras.

El anexo final contiene el cuestionario base utilizado para la recogida de la información en la que se basan los tres estudios empíricos incluidos en la tesis doctoral.

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II. MARCO TEÓRICO GENERAL

II.1. OBJETIVOS Y CONTENIDO DEL CAPÍTULO

En este capítulo se aborda brevemente el marco teórico en el que se ha sustentado la investigación y en concreto los tres modelos estudiados, así como las relaciones entre los constructos principales que los componen.

En primer lugar, se efectúa una revisión de la literatura acerca de los cuatro principales pilares en los que se sustenta esta tesis: la agilidad organizativa, la gestión del conocimiento, la resiliencia organizativa y la eco-innovación.

A continuación, se estudia la Teoría de las Capacidades Dinámicas, en la que se fundamenta la investigación, que supone una evolución de la Teoría Basada en Recursos y Capacidades para adaptarse al nuevo contexto dinámico de los mercados actuales. Lejos de ser un enfoque teórico maduro aún está en plena configuración, por lo que se expondrán también algunas de las principales críticas que se le formulan.

Finaliza este capítulo con la presentación del modelo global en el que se apoya esta tesis doctoral, así como una síntesis de los modelos utilizados en los tres estudios empíricos integrados en esta investigación y que serán objeto de un capítulo específico.

II.2. LA VENTAJA COMPETITIVA EN ENTORNOS DINÁMICOS

II.2.1. Agilidad Organizativa

La agilidad organizativa constituye uno de los pilares clave de esta tesis y está presente, junto con la eco-innovación, en los tres estudios empíricos incluidos en la misma.

La economía actual se caracteriza por una intensa competencia global, la búsqueda constante de mercados alternativos por parte de las empresas, así como la necesidad de responder a los cambios continuos en los requerimientos de nuevos productos y servicios asociados, a las crecientes demandas de clientes, así como del resto de personas y organizaciones implicadas en su actividad. Aspectos como digitalización, industria 4.0, inteligencia artificial, eco-innovación y sostenibilidad están muy presentes en los actuales modelos de negocio exitosos y se muestran como ejes centrales en la

evolución y transformación de los sistemas y estrategias de producción contemporáneos y futuros.

Para abordar de forma exitosa este escenario turbulento, las compañías deben hacer frente a una complejidad del mercado cada vez mayor y a cambios que se suceden con gran velocidad. En esta coyuntura, las organizaciones innovadoras responderán de manera más rápida y serán capaces de crear nuevos productos y servicios, o de encontrar mercados emergentes, de forma más eficaz que las que no innoven. Esta capacidad es lo que se denomina *agilidad organizativa* (Conforto et al., 2016; Teece et al., 2016).

El concepto de *agilidad* fue introducido por Nagel y Dove (1991) del Instituto Iacocca en Estados Unidos, ligado a la fabricación. La agilidad se asoció principalmente con la producción rápida de nuevos productos, la producción bajo demanda y la oferta de una extensa gama de productos fundamentada en proyecciones de ventas. Asimismo, la agilidad también se ha relacionado con la construcción de relaciones estratégicas con clientes, vendedores y consumidores para obtener información valiosa que pueda ayudar a orientar la producción.

Por otro lado, la agilidad es considerada en la literatura como una capacidad dinámica que faculta a una organización para reaccionar de manera proactiva, flexible y rápida a los cambios y demandas de su entorno y de las partes interesadas, lo que le da una ventaja competitiva sobre sus competidores (Yaghoubi et al., 2011; Kuo et al., 2017; Chen et al., 2018; Gyemang y Emeagwali, 2020). La agilidad empresarial como capacidad dinámica implica capacidades de detección y de respuesta y un equilibrio adecuado entre ambas (Verma et al., 2017).

Se han creado diversos marcos teóricos para desarrollar la agilidad dentro de las organizaciones (Gunasekaran, 1998; Trinh et al., 2012; Harraf et al., 2015; Baškarada y Koronios, 2018; Teece, 2022). De igual manera, la agilidad organizativa se ha definido de diferentes formas en la literatura. Dove (1999) explicó por primera vez la agilidad como "*la capacidad de gestionar y aplicar el conocimiento de manera efectiva*". La agilidad no es posible si una organización no es capaz de reconocer y asimilar el cambio

rápidamente, integrando el nuevo conocimiento con la información existente para aprovechar estos cambios antes de que los competidores puedan hacerlo. Otros autores apoyan la idea de que la agilidad es el resultado de la interacción entre tres capacidades: la agilidad del cliente, la agilidad de asociación y la agilidad operativa (Sambamurthy et al., 2003). La agilidad organizativa también se define como la capacidad de una organización para desarrollar comportamientos de forma intencionada y eficiente en entornos cambiantes, no solo para reaccionar rápidamente al cambio, sino también para anticiparse y encontrar oportunidades, especialmente a través de la innovación y el aprendizaje (Felipe et al., 2016). Las dimensiones constitutivas de la flexibilidad y agilidad organizativa, sus facilitadores, prácticas y mecanismos de acción más significativos y su efectividad en el éxito global de las empresas son abordados en varios trabajos (Bottani, 2010; Elkareem et al., 2011; Lin et al., 2016; Oliveira, 2017; Heilmann, 2018; Schuh et al., 2018).

Un enfoque muy interesante derivado del concepto de agilidad organizativa y que ha permitido la implantación práctica en las organizaciones es el de las metodologías ágiles. A este respecto, la literatura ha tratado de aportar nuevas formas de mejorar los procesos de innovación mediante metodologías de gestión, alternativas a la planificación tradicional en cascada. Desde su origen, las metodologías ágiles están especialmente orientadas hacia la innovación (Fowler y Highsmith, 2001). Éstas se centran en las tareas que son realmente imprescindibles para el desarrollo de los proyectos y desglosan los mismos en etapas sucesivas o iteraciones que culminan siempre con un entregable totalmente funcional (Arell et al., 2012; Laanti, 2014).

Aunque en un principio las metodologías ágiles se desarrollaron en el ámbito de la programación y el desarrollo de software, varios autores han sugerido que sus técnicas, prácticas y herramientas pueden ser adaptadas a otros tipos de productos y ámbitos de proyectos (Bustard, 2012; Fitzgerald et al., 2013; Conforto et al., 2014; Jurado-Navas y Munoz-Luna, 2017; Masood et al., 2018). Hoy en día son ya una realidad presente en muchas organizaciones, permitiendo articular en la práctica los conceptos teóricos propios de la agilidad organizativa. Todas ellas buscan maximizar la eficiencia y la productividad y minimizar los costes, consiguiendo la involucración del cliente final en cada etapa del desarrollo del producto (Roberts y Grover, 2012; Baumann et al., 2015;

Brhel et al., 2015; Abrell et al., 2016; Huijgens et al., 2016; Mehdibeigi et al., 2016; Anning-Dorson, 2018; Morgan et al., 2018).

Existen actualmente más de de una veintena de metodologías ágiles y de múltiples derivaciones de estas (Dybå y Dingsøyr, 2008; Campanelli y Parreiras, 2015; Rasnacis y Berzisa, 2016; Hoda et al., 2017). Como cualquier técnica, el uso de metodologías ágiles en los procesos de innovación presenta ventajas e inconvenientes que es preciso tener en cuenta a la hora de su adopción en una organización determinada (Boehm, 2002; Reifer, 2002; Janes y Succi, 2012; Serrador y Pinto, 2015; Douglass, 2016; Appelbaum et al., 2017a; Appelbaum et al., 2017b). Así mismo, la implementación de metodologías ágiles y la transformación de una organización convencional en una organización ágil necesita a su vez de la presencia de determinados elementos materiales, de una misión, visión y valores alineados con este propósito y de un equipo humano que la haga posible (Teece et al., 1997; Moran, 2015; Forés y Camisón, 2016; Gelhard y von Delft, 2016; Cummins, 2017).

Los fundamentos de la agilidad se basan principalmente en dos elementos interdependientes en una empresa dinámica: una gestión empresarial que sea capaz de combinar y recombinar tecnologías, y unas estructuras flexibles que pueden cambiar rápidamente (Teece et al., 2016). La agilidad se puede aplicar tanto a aspectos estratégicos como operativos, por lo que la agilidad empresarial también proporciona una mayor flexibilidad estratégica (Overby et al., 2006; Fan et al., 2007) y el uso de prácticas de agilidad y flexibilidad contribuye positivamente a la fortaleza competitiva (Oliveira, 2017; Gyemang y Emeagwali, 2020). Además, la agilidad está vinculada a la capacidad de respuesta que tenga una cadena de suministro en situaciones de interrupción y emergencia (Christopher y Peck, 2004; Ponomarov y Holcomb, 2009).

II.2.2. Gestión del Conocimiento

El segundo pilar de esta tesis lo constituye el sistema de gestión de conocimiento. Su existencia y eficacia de funcionamiento son esenciales para dar respuestas ágiles, para generar eco-innovación y para la reorganización constante de recursos que posibilite la generación de ventajas competitivas.

Desde una perspectiva global, podemos considerar la empresa como un entorno de aprendizaje (Senge, 1990; Lahtinen, 2007) en el que interactúan diferentes elementos, se dispone de diferentes instrumentos y convergen diferentes fuentes de información. En ella tienen lugar múltiples procesos simultáneos cuyos resultados implican, entre otras cosas, la creación de conocimiento, la evolución de la estructura organizativa y la creación de nuevos productos o servicios como respuesta a las demandas del mercado, clientes o *stakeholders*. La generación de nuevo conocimiento y la innovación están íntimamente ligadas a diferentes tipos de conocimiento, como el tácito/explícito o el interno/externo, la preponderancia de unos u otros, así como a los modos en los que aprenden los miembros de una organización. En este sentido, la investigación ha relacionado la presencia de sólidas capacidades de aprendizaje con el éxito en la innovación (Damanpour, 1991; Zhou et al., 2015).

Podemos apoyarnos en la Psicología Cognitiva del aprendizaje significativo, que forma parte del pensamiento constructivista, para explicar cómo aprenden las organizaciones. Articulada inicialmente por Ausubel en la década de 1960, posteriormente ha sido reformulada y aplicada por otros autores (Novak, 2002; Pande y Bharathi, 2020). Esta teoría se ha utilizado para explicar el aprendizaje en entornos educativos pero también en otros ámbitos de actividad (Urquidi-Martin y Aznar, 2017). Según esta teoría, el aprendizaje tiene lugar cuando los nuevos conocimientos se relacionan con conceptos preexistentes procedentes de diversas fuentes, como la experiencia, el estudio, etc. Cuando se relacionan diferentes tipos de conocimiento, se establece una nueva conexión. A esto se le llama *aprendizaje significativo*. Además, tiene la característica de permanecer a largo plazo y se fundamenta en la experiencia y el conocimiento previos.

La literatura sugiere que el aprendizaje está condicionado por varios factores endógenos y exógenos (Alegre y Chiva, 2008; Ferreras-Méndez et al., 2015). La capacidad de aprovechar las competencias internas y de absorber valiosos conocimientos externos (*capacidad de absorción*) es la piedra angular de los enfoques estratégicos que incorporan el aprendizaje y la innovación en el contexto organizativo (Cohen y Levinthal, 1990; Zahra y George, 2002). La *capacidad de absorción* es clave en la gestión del aprendizaje y la innovación (Lane y Lubatkin, 1998; Lane et al., 2001). Esta capacidad puede determinar la afluencia, el aprovechamiento, la influencia y el uso del

conocimiento, que tienen un impacto sensible en el proceso de innovación y en los resultados empresariales (Kostopoulos et al., 2011; Ferreras-Méndez et al., 2015). Por esta razón, la capacidad de absorción, junto con las actividades de investigación y desarrollo, son determinantes clave de la innovación, y las empresas deben estimular y promover continuamente dichas actividades y las capacidades asociadas a las mismas (Fabrizio, 2009; Miroshnychenko et al., 2020).

De este modo, el fortalecimiento de la capacidad de absorción en una empresa facilitará la obtención y aplicación de conocimientos en la creación de eco-innovaciones (Hashim et al., 2015; Aboelmaged y Hashem, 2019). La capacidad de añadir nuevos conocimientos a los existentes está condicionada también por la conciencia ambiental interna y el nivel de madurez de aprendizaje que tenga una empresa (Flor et al., 2018). Las nuevas combinaciones de conocimientos que conducen a nuevos productos ecológicos exitosos están vinculadas así a los conocimientos previos.

Este conocimiento puede obtenerse tanto de fuentes internas (investigación y desarrollo interno, colaboración entre departamentos, etc.) como externas (clientes, proveedores, asociaciones, etc.). Además, las particularidades internas y externas de las empresas, así como la cultura de las mismas desempeñan un papel fundamental en la comprensión de su desarrollo (Albers et al., 2018; Michaelis et al., 2018). Los niveles de inteligencia y conocimiento de una empresa se construyen como resultado de la interacción entre los empleados que comparten sus experiencias (Laviolette et al., 2016; Bogers et al., 2018; Schweisfurth y Raasch, 2018), el *know-how*, los procedimientos acumulados durante la vida de una organización y la concienciación externa de múltiples fuentes, intensificada por el crecimiento exponencial de internet.

En la literatura podemos encontrar varias referencias que aluden a la contribución positiva de ambos tipos de conocimiento, interno y externo, para fomentar la eco-innovación (Vega-Jurado et al., 2008; Shearmur y Doloreux, 2013). Asimismo, el aprendizaje y la gestión del conocimiento son fundamentales para que las empresas sean más ágiles (Sherehiy et al., 2007; Bahrami et al., 2016). Algunos autores sugieren que la exploración y explotación equilibradas en términos de estrategias de innovación posibilita a las empresas incorporar nuevos conocimientos mediante nuevos productos,

mientras que se implementan criterios de eficiencia, que tienen en cuenta la conciencia disponible dentro de una empresa (Jimenéz-Jimenéz et al., 2018).

Además, algunos estudios muestran una asociación fuertemente positiva entre las capacidades presentes en empresas de tecnologías de la información y el desarrollo exitoso de nuevos productos (Mauerhoefer et al., 2017). Por lo tanto, el conocimiento interno y externo es necesario para construir organizaciones ágiles (Tooranloo y Saghafi, 2019). Igualmente, el aprendizaje y la gestión del conocimiento son fundamentales para que las empresas sean más ágiles (Sherehiy et al., 2007; Bahrami et al., 2016).

Se ha comentado que en la creación de las eco-innovaciones son necesarios tanto el conocimiento preexistente dentro de las organizaciones como el conocimiento externo. Sin embargo, muchos autores afirman que el acceso al conocimiento ambiental, a nuevas tecnologías y a materias primas menos contaminantes se produce principalmente a través de las redes sociales y profesionales, de los proveedores, de los socios, de los clientes y de las patentes (Enkel et al., 2009; Husain et al., 2016).

Hoy en día, las empresas operan en un entorno altamente competitivo a nivel mundial en el que los avances tecnológicos y las necesidades de los clientes evolucionan de forma constante. Necesitan mantenerse al día de estos cambios regenerando constantemente sus conocimientos. Contar con un sistema de gestión del conocimiento que sea eficaz permite a una empresa aplicar nuevos conocimientos para mejorar sus operaciones internas. En esta línea, la combinación de ambos tipos de conocimiento - interno y externo - contribuye a fomentar la eco-innovación (Vega-Jurado et al., 2008; Shearmur y Doloreux, 2013).

Para desarrollar esta capacidad dinámica, las empresas deben ser capaces de renovar sus conocimientos y experiencia en diferentes áreas operativas como pueden ser el conocimiento del mercado, las necesidades de los clientes (Awan et al., 2021) o los procesos internos. El resultado debe ser un enriquecimiento de sus conocimientos que conduzca a mejores resultados. Desde el enfoque de las Capacidades Dinámicas, es imperativo que las empresas construyan, integren y reconfiguren continuamente sus competencias y habilidades. Esto les permite adaptarse a su entorno y mantener una

ventaja competitiva (Eisenhardt y Martin, 2000). Las capacidades dinámicas se consideran capacidades centradas en la empresa y se reconocen como un elemento indispensable para la integración de las responsabilidades de tipo ambiental y social dentro de la cadena de suministro (Beske, 2012).

Aunque permiten a las empresas encontrar oportunidades de formas nuevas y efectivas, las capacidades dinámicas por sí solas no garantizan el éxito de la organización (Zahra et al., 2006). La gestión del conocimiento, interno y externo, a través de soluciones informáticas, se ha convertido en un factor de influencia relevante en las capacidades dinámicas y en un importante catalizador para mejorar la calidad y lograr la excelencia empresarial (Sher y Lee, 2004). En esta línea, se ha comprobado que el intercambio de conocimiento ecológico fomenta el desarrollo de capacidades dinámicas en las empresas, lo que contribuye a un uso más eficiente de sus recursos, al desarrollo de la eco-innovación y a la consecución de una ventaja competitiva eco-innovadora (Lin y Chen, 2017).

Finalmente, algunos autores identifican la gestión del conocimiento como un claro indicador de resiliencia y agilidad organizativas. Para ellos, la adquisición, el intercambio y la aplicación de nuevos conocimientos ayudan a crear un entorno propicio para la participación del personal en actividades proactivas y adaptativas de agilidad y resiliencia (Ibrahim Ismael et al., 2021). En esta línea, algunos autores han encontrado que la capacidad dinámica de gestión del conocimiento correlaciona positivamente con el desempeño de la empresa, debido a la mediación de la agilidad organizativa, especialmente en nuevos entornos altamente competitivos (Liu et al., 2014; Gyemang y Emeagwali, 2020).

II.2.3. Resiliencia Organizativa

El tercero de los cuatro grandes pilares que sustentan esta tesis es la capacidad dinámica de la resiliencia organizativa.

La resiliencia organizativa es un área crítica de interés en los estudios empresariales, especialmente a raíz de los desafíos globales, como las incertidumbres económicas, las disrupciones tecnológicas y los cambios ambientales. El reto para las organizaciones

radica en reconocer que muchos elementos de adaptabilidad ya están integrados en su capital humano y en sus procesos, a la espera de que se manifiesten plenamente con los apoyos necesarios (Home y Orr, 1997).

En términos generales, la resiliencia representa una habilidad fundamental que permite tanto a personas como a organizaciones superar retos y adaptarse a las modificaciones de su entorno. El término resiliencia se utiliza en varias esferas de la actividad humana (Ponomarov y Holcomb, 2009; Bhamra et al., 2011; Kamalahmadi y Parast, 2016). Desde una perspectiva psicológica, se refiere a la capacidad de las personas para afrontar situaciones adversas y salir fortalecidas de ellas. En el contexto empresarial, se refiere a la capacidad de una empresa para adaptarse a las transformaciones del mercado y mantener su competitividad. En el campo de la ingeniería, se asocia con la capacidad de los sistemas para recuperarse de manera efectiva después de una falla.

Desde el punto de vista organizativo, la resiliencia fue definida por Fiksel (2003) como la capacidad del sistema para soportar las disrupciones manteniendo su estructura y funcionalidad, promoviendo la diversidad, la eficiencia, la adaptabilidad y la cohesión interna, y reduciendo la vulnerabilidad a factores imprevistos. En el contexto empresarial, la capacidad de resiliencia de una organización contribuye no solo a sobrevivir, sino también a adaptarse y prosperar ante cambios significativos e impredecibles (Fiksel, 2006). El concepto de resiliencia organizativa es multidimensional y abarca la capacidad de una organización para anticiparse, prepararse, responder y adaptarse a los cambios graduales y a las interrupciones imprevistas con el fin de sobrevivir y prosperar (Arunga, 2023).

La resiliencia es ampliamente reconocida como una práctica valiosa para manejar el riesgo y la incertidumbre dentro de entornos empresariales complejos, así como para aliviar las interrupciones que se produzcan en las cadenas de suministro. En este sentido, Ponomarov y Holcomb (2009) ofrecieron una definición multidisciplinar de la resiliencia de la cadena de suministro como la capacidad de adaptarse, anticiparse de manera proactiva a sucesos imprevistos, abordar de manera efectiva las interrupciones y restaurar las operaciones al tiempo que se preserva el nivel deseado de conectividad y control sobre su estructura y función. En una reciente revisión de la literatura acerca de

la resiliencia en la cadena de suministro Al-Banna et al. (2023) ofrecen una definición de resiliencia como la capacidad de una cadena de suministro para anticiparse a las interrupciones y reaccionar ante eventos imprevistos, soportar perturbaciones, restaurar las operaciones y recuperar rápidamente los costos mientras mantiene niveles de crecimiento favorables. En nuestro estudio empírico hemos adoptado la conceptualización de resiliencia de Ambulkar et al. (2015), acorde con nuestra perspectiva dinámica, que la definen como la capacidad de la empresa para reconocer, adaptarse y reaccionar de manera efectiva a las alteraciones causadas por una interrupción de la cadena de suministro.

Blackhurst et al. (2011) estudiaron numerosos facilitadores y reductores de la resiliencia. Identificaron trece facilitadores que organizaron en recursos humanos, organizativos, interorganizativos y de capital físico. En cuanto a los reductores, reconocieron siete reductores que se incluyeron en las actividades de flujo, las unidades de flujo y las unidades de fuente de flujo. Las empresas podrían minimizar el impacto de los reductores de la resiliencia. Sin embargo, los reductores de resiliencia pueden estar fuera del alcance y del control de las empresas, por lo que estos autores creen que podría ser más efectivo que las empresas centren sus esfuerzos y recursos en los potenciadores de la resiliencia.

El papel que juega la resiliencia en las interrupciones de la cadena de suministro varía según el impacto de la interrupción según Ambulkar et al. (2015). En las disrupciones de bajo impacto, la mera provisión de una infraestructura organizativa y la disponibilidad de recursos pueden ayudar a mitigar sus efectos. Sin embargo, en situaciones de alto impacto disruptivo, el nivel de resiliencia de la empresa es crucial, porque determinará cómo se organizarán las estructuras y los recursos existentes y cómo se configurarán para minimizar los impactos negativos que tienen las interrupciones en la cadena de suministro (Ambulkar et al., 2015). El paradigma tradicional de gestión de riesgos que utilizan las empresas para protegerse de riesgos predecibles como incendios o cortes de energía es inadecuado en el complejo y turbulento contexto económico y ambiental global actual. Ante la complejidad y las turbulencias, cuando las interrupciones son a menudo inescrutables e impredecibles, la evaluación de riesgos se vuelve inmanejable y las prácticas tradicionales de gestión de riesgos dejan de ser adecuadas. Tiene que

complementarse con una perspectiva de gestión de la resiliencia (Fiksel, 2015). En esta línea, la adaptabilidad, la flexibilidad y la agilidad son conceptos implícitos incluidos en todas las estrategias de resiliencia (Kamalahmadi y Parast, 2016).

Las organizaciones resilientes a menudo se caracterizan por un liderazgo fuerte y visionario que fomenta una cultura de adaptabilidad, aprendizaje continuo e innovación (Ohlsson et al., 2020). Los líderes de las organizaciones resilientes están llamados a desempeñar un papel fundamental a la hora de establecer el tono de la adaptabilidad y la capacidad de respuesta (Southwick et al., 2017). Fomentan la comunicación abierta, la resolución colaborativa de problemas y capacitan a los empleados para que tomen la iniciativa. Esta forma de liderazgo ayuda a construir una cultura organizativa sólida que pueda resistir y adaptarse a los cambios. Además, en estas organizaciones los procesos de toma de decisiones suelen estar descentralizados, lo que les permite respuestas rápidas y flexibles ante acontecimientos inesperados (Sienkiewicz-Małyjurek, 2022).

La perspectiva de la resiliencia tiene implicaciones significativas para las empresas que buscan mejorar su sostenibilidad (Wu y Tham, 2023). Debe conducir a cambios graduales que balanceen de forma adecuada los objetivos empresariales y los beneficios sociales (Fiksel, 2003). En esta línea, se hace necesario desarrollar políticas y estrategias adaptativas que permitan a las instituciones sociales e industriales hacer frente a desafíos inesperados, equilibrando su necesidad de prosperar y crecer con las preocupaciones a largo plazo sobre el bienestar humano y ecológico.

II.2.4. Eco-innovación

El cuarto elemento, con igual importancia que la agilidad organizativa, y que constituye el binomio en torno al que se articula toda la investigación es la eco-innovación.

La eco-innovación surge como una oportunidad clave en la economía actual, superando la dicotomía entre objetivos económicos y ambientales. Esta contraposición soló tenía sentido en un paradigma de mercado estático, donde la tecnología, el producto, el proceso y las necesidades del cliente fuesen relativamente estables. En este marco estable las empresas se centrarían en la minimización de costes y cualquier regulación medioambiental conduciría inevitablemente a un aumento de los mismos (Porter y van

der Linde, 1995). Sin embargo, en la cambiante economía actual la contaminación y los residuos son considerados indicadores de ineficiencia, y la eliminación de estos residuos, lejos de ser un coste inevitable, representa una oportunidad para mejorar la rentabilidad y la competitividad de las empresas (Porter y van der Linde, 1995).

En la literatura, términos como innovación verde, innovación ambiental, innovación sostenible o eco-innovación se refieren a conceptos similares con ligeros matices entre ellos (Schiederig et al., 2012). Algunos autores proponen centrarse más en cómo hacer esta transición hacia la sostenibilidad y en su aplicación práctica que en su definición inequívoca (Hallin et al., 2021). En esta línea, el término *eco-innovación* parece consolidarse como el más utilizado en las investigaciones recientes. Además, las instituciones europeas e internacionales han coordinado esfuerzos para clarificar el concepto, la tipología, los impulsores e indicadores de la eco-innovación, y para medirla de forma similar a la innovación general.

Fussler y James (1996) propusieron una definición de eco-innovación como el desarrollo de nuevos productos, procesos o servicios con un impacto ambiental significativamente menor, que aporte valor a los clientes y a las empresas. Kemp y Pearson (2008) ampliaron la reducción de los impactos medioambientales a todo el ciclo de vida del producto. En esta línea, Chen y Chang (2013) introducen el término *capacidades dinámicas verdes* como la capacidad de la empresa para aprovechar sus recursos y experiencia actuales, para la mejora y evolución de sus capacidades organizativas ambientalmente sostenibles, en respuesta a la dinámica del mercado en constante cambio. Por su parte, la cuarta edición del Manual de Oslo habla de tres tipos de innovación: de producto, de proceso y de modelo de negocio (OECD, 2018). Según dicho documento, un producto se considera innovador si difiere significativamente de los productos o servicios anteriores puestos en el mercado por la empresa. Esta clasificación es igualmente aplicable a aquellas innovaciones generadas por empresas preocupadas por el medioambiente.

De este modo, la eco-innovación se concibe como una excelente oportunidad para reestructurar las empresas a través de la adopción de nuevos procesos productivos y tecnologías, el fomento de nuevos conocimientos, productos y servicios, así como la mejora de los resultados empresariales, en un horizonte más sostenible. De hecho, las

eco-innovaciones pueden contribuir a reformular por completo el proceso de innovación (Carrillo-Hermosilla et al., 2010). Del mismo modo, la eco-innovación se correlaciona de forma positiva con el rendimiento empresarial y la eco-capacidad dinámica, creando valor para clientes y empresas (Li, 2022). No obstante, para Tsai et al. (2020), la relación entre las prácticas ambientales y el desempeño de las empresas se ha intensificado en los últimos años debido a una regulación ambiental más exigente (Horbach et al., 2012), la creciente demanda de productos ecológicos por parte de los clientes y el avance de las tecnologías ecológicas, y especialmente en los países más desarrollados. De esta forma, las empresas eco-innovadoras obtendrían una mayor rentabilidad de sus activos y retendrían sus beneficios en menor medida.

La mejora general de la eco-innovación requiere una estrategia combinada que incluya herramientas y políticas de innovación, investigación y medio ambiente (Jové-Llopis y Segarra-Blasco, 2018). Las crecientes regulaciones internacionales y el incremento del interés de los consumidores por la protección del medio ambiente están impulsando a las empresas a desarrollar productos respetuosos con el entorno (Chen y Chang, 2013). En esta línea, Sezen y Çankaya (2013) encontraron que la eco-innovación contribuye de manera positiva al desempeño ambiental y social. Además, se ha encontrado que las innovaciones ecológicas de productos y procesos se relacionan positivamente con la ventaja competitiva y el éxito de los nuevos productos ecológicos (Kam-Sing Wong, 2012; Hang et al., 2022). Así mismo, los resultados obtenidos por la eco-innovación en productos y procesos han sido asociados positivamente con una ventaja competitiva y con mejores resultados por otros autores (Chen et al., 2006; Pujari, 2006; Ilker Murat, 2012; Kam-Sing Wong, 2012).

La eco-innovación de productos incorpora la preservación del medio ambiente mediante la elección de materias primas, el diseño del producto, el empaquetado y otros elementos de la cadena de valor, disminuyendo el impacto adverso del producto en el entorno a lo largo de su ciclo de vida (Dangelico y Pujari, 2010; Lin y Chen, 2017). La innovación en procesos ecológicos pretende minimizar la generación de sustancias nocivas, disminuir la emisión de contaminantes y mejorar la eficiencia energética mediante la optimización de los procesos de producción existentes o la creación de nuevos procedimientos (Xie et al., 2019).

No obstante, no todos los tipos de eco-innovación parecen estar igualmente vinculados a resultados empresariales positivos. Según algunos autores, la eco-innovación impacta positivamente en el rendimiento ambiental y la competitividad de la empresa, aunque este efecto no es uniforme para todos los tipos de eco-innovación (Dong et al., 2014). De la misma manera Almeida y Wasim (2023) constataron que solo la eco-innovación en productos y procesos y los sistemas de eco-innovación contribuirían positivamente al rendimiento sostenible de las pequeñas y medianas empresas, no así las tecnologías medioambientales o las eco-innovaciones organizativas. Un sistema de eco-innovación promueve tecnologías y prácticas sostenibles para abordar desafíos ambientales. Integra procesos, políticas y actores para desarrollar y difundir soluciones respetuosas con el medio ambiente en diferentes áreas de la sociedad. Finalmente, aunque diversos estudios establecen una relación positiva entre el conocimiento ambiental, las prácticas medioambientales y las eco-innovaciones con un mejor desempeño financiero (Bansal, 2005; Gligor et al., 2015; Liao, 2018; Almeida y Wasim, 2023; Dharmayanti et al., 2023), otros autores (Sezen y Çankaya, 2013) no han encontrado pruebas de ello.

En síntesis, la eco-innovación, ya sea en productos o procesos, debe contribuir significativamente a los resultados organizativos. Esto incluye la disminución del uso de materias primas y energía, la minimización de residuos, la optimización de procesos, la reducción de los tiempos de producción y el desarrollo de productos y servicios eco-innovadores más exitosos, alineados con las nuevas demandas de los consumidores y los mercados.

II.3. TEORÍA DE LAS CAPACIDADES DINÁMICAS

La teoría de las Capacidades Dinámicas tiene uno de sus principales precedentes en la Teoría Basada en Recursos y Capacidades ó RBV (acrónimo en inglés de Resources-Based View), cuyo planteamiento inicial era más estático, centrando sus esfuerzos en determinar los requisitos que estos recursos debían tener para generar ventajas competitivas sostenibles en el tiempo, su identificación y evaluación (Barney, 1991; Peteraf, 1993; Grant, 1999). Los recursos de una empresa son definidos por Amit y Schoemaker (1993) como los elementos disponibles que pertenecen a la empresa o que están bajo su control. Estos activos se transforman en productos o servicios finales

mediante el uso de otros recursos y mecanismos, como la tecnología, los sistemas de información de gestión, sistemas de incentivos y la confianza entre los trabajadores, entre otros. Por otro lado, las capacidades se refieren a la habilidad para desplegar estos recursos, generalmente combinándolos a través de procesos organizativos, con el fin de alcanzar un objetivo deseado. Estas capacidades se fundamentan en información específica, ya sea tangible o intangible, propia de cada empresa, y se desarrollan a lo largo del tiempo a través de interacciones complejas entre los diversos recursos de la empresa (Amit y Schoemaker, 1993). En la medida en que la empresa posea recursos valiosos, no habituales en otras empresas del sector o competidores, difíciles de imitar y no fácilmente sustituibles ó VRIN (acrónimo en inglés de V*alue*, R*areness*, *Inimitability* y N*on-substitutability)* y estos se incorporen a los procesos productivos, se transformarían en capacidades, siendo el origen de ventajas competitivas y de logros exitosos (Barney, 1991).

Sin embargo, esta perspectiva pronto se manifestó insuficiente en su aplicación en contextos más competitivos y dinámicos (Priem y Butler, 2001; Barreto, 2010), dándose la paradoja de que empresas que contaban a priori con recursos y condiciones para generar ventajas competitivas no conseguían evolucionar en los nuevos mercados mucho más dinámicos y disruptivos.

A nivel teórico, dos artículos han influenciado decisivamente las distintas corrientes de pensamiento en torno a las capacidades dinámicas, y la mayor parte de los artículos publicados en los últimos treinta años relacionadas con este constructo se alinean en su mayor parte con uno u otro planteamiento (Peteraf et al., 2013). El desarrollo teórico de las capacidades dinámicas comenzó a gestarse en los años noventa (Teece, 1990; Teece y Pisano, 1994), formalizándose en 1997 en el artículo "Dynamic capabilities and strategic management" (Teece et al., 1997) una primera definición de las capacidades dinámicas como "*habilidades de una empresa para integrar, construir, y reconfigurar competencias internas y externas para afrontar rápidamente entornos cambiantes*". El concepto de las capacidades dinámicas intentaba responder inicialmente a cómo las organizaciones pueden conseguir la actualización y renovación de sus recursos base y mantener así una ventaja competitiva en contextos de rápidos cambios tecnológicos. Estas capacidades cumplían con las condiciones de una ventaja competitiva sostenible

formuladas por Barney (1991): valor, rareza, inimitabilidad y no sustituibilidad. Unos años después se publica el trabajo denominado "Dynamic capabilities: what are they?" por Eisenhardt y Martin (2000) en el que estos autores hacen una reconceptualización de las capacidades dinámicas tal y como habían sido formuladas anteriormente y cuestionan aspectos relacionados con la sostenibilidad de la ventaja competitiva en mercados dinámicos. Para estos autores las capacidades dinámicas son condición necesaria pero no suficiente para alcanzar ventajas competitivas, son más determinantes en entorno dinámicos intermedios y están influenciadas por la experiencia y el conocimiento acumulados en la propia organización.

Aunque podemos encontrar varias revisiones de la literatura relativa a las capacidades dinámicas no son muchos los trabajos que se dedican a abordar esta controversia e intentar buscar planteamientos complementarios que ahonden en la armonización de criterios en torno a una conceptualización común de las capacidades dinámicas (Ambrosini et al., 2009; Barreto, 2010; Peteraf et al., 2013; Gremme y Wohlgemuth, 2017; Zhang et al., 2023).

En esta tesis doctoral hemos optado por una visión integradora de las distintas perspectivas en torno al constructo de capacidades dinámicas. Reseñamos a continuación algunas de las definiciones más influyentes en la literatura y destacamos algunos aspectos de las capacidades dinámicas que las relacionan con el resto de los constructos de nuestra investigación y que articulan el sustrato teórico de la misma.

Como hemos comentado anteriormente Teece et al. (1997) definen inicialmente las capacidades dinámicas como la habilidad de una empresa para integrar, desarrollar y reconfigurar competencias tanto internas como externas, lo que le permite adaptarse ágilmente a los cambios en su entorno. Por su parte, para Eisenhardt y Martin (2000) las capacidades dinámicas se refieren a las prácticas organizativas y estratégicas rutinarias mediante las cuales las empresas alcanzan nuevas configuraciones de recursos en consonancia con la evolución de los mercados. Para Zollo y Winter (2002) consisten en un patrón conjunto de actividades colectivas mediante las cuales la organización genera y modifica de manera sistemática sus prácticas operativas con el fin de mejorar su eficacia. Para Helfat et al. (2007) las capacidades dinámicas son las capacidades que tiene

una organización para crear, ampliar o modificar de forma intencionada sus recursos base. El concepto de capacidad dinámica incluye también para ellos la competencia para identificar una necesidad u oportunidad de cambio, construir una respuesta a dicha necesidad y actuar poniéndola en marcha. Para Barreto (2010) hacen referencia al potencial de una empresa para enfrentar de manera sistemática los desafíos, destacándose por su capacidad para identificar oportunidades y amenazas, tomar decisiones oportunas y orientadas al mercado, y adaptar su base de recursos.

Desde la perspectiva de las capacidades dinámicas, es imperativo que las empresas construyan, integren y reconfiguren continuamente sus competencias y habilidades (Teece, 2007). Esto les permite adaptarse a su entorno y mantener una ventaja competitiva sostenible (Eisenhardt y Martin, 2000). Las capacidades dinámicas se consideran capacidades centradas en la empresa y se reconocen como un elemento indispensable para la integración de las responsabilidades medioambientales y sociales en la cadena de suministro (Beske, 2012). En consecuencia, las capacidades dinámicas permiten a las empresas generar, implementar y resguardar activos intangibles que aseguren un rendimiento empresarial superior a largo plazo, dado que son difíciles de desarrollar e implementar (Teece, 2007).

Si bien estas capacidades dinámicas tienen características comunes en todas las empresas, las formas específicas de buscarlas, desarrollarlas y aplicarlas difieren de unas empresas a otras, lo que da lugar a resultados organizativos diferenciados (Eisenhardt y Martin, 2000).

Además, si tenemos en cuenta todas las capacidades que operan en el conjunto de una organización podríamos establecer dos niveles (Winter, 2003):

- Un nivel base de *capacidades ordinarias* que permiten el funcionamiento habitual de la organización y toda su operativa básica de gestión, administración y producción.
- Un segundo nivel de capacidades dinámicas que se podría subdividir a su vez en *microfundamentos* y en *capacidades de orden superior* (Teece, 2007).

- Los *microfundamentos* permiten el ajuste y la recombinación de las capacidades ordinarias, así como el desarrollo de otras nuevas. Estos microfundamentos serían considerados como capacidades dinámicas de segundo orden (desarrollo de nuevos productos, expansión a nuevos territorios, ...) y se corresponden con decisiones de la dirección en situaciones de incertidumbre.
- Por encima de ellas estarían las *capacidades dinámicas de orden superior*, las competencias de detección, aprovechamiento y transformación que agregan y dirigen las distintas capacidades ordinarias y las capacidades dinámicas de segundo orden. Las capacidades de orden superior son aquellas en las que la alta dirección debe focalizarse. Tienen que ver con procesos organizativos, planes de futuro, nuevos modelos de negocio, decisiones estratégicas, etc., y son las más relevantes en términos de innovación y abordaje de problemas y oportunidades para la empresa (Teece, 2018).

Aunque las capacidades dinámicas posibilitan a las empresas encontrar nuevas oportunidades y ser más eficaces, no garantizan por sí solas el éxito organizativo. Factores como el conocimiento organizativo, las habilidades, la interacción entre las distintas capacidades y el dinamismo del entorno son más determinantes (Zahra et al., 2006). La gestión del conocimiento, interno y externo, a través de las herramientas informáticas, se ha revelado también como un importante factor de influencia en las capacidades dinámicas y un importante catalizador para mejorar la calidad y alcanzar la excelencia empresarial (Sher y Lee, 2004).

Por otro lado, las empresas con sólidas capacidades dinámicas son intensamente emprendedoras. No solo se adaptan a los ecosistemas empresariales, sino que también los moldean mediante la innovación y la colaboración con otras empresas, entidades e instituciones (Teece, 2007). Las capacidades dinámicas evolucionan a través de tres mecanismos de aprendizaje organizativos: la acumulación de conocimiento tácito basado en la experiencia acumulada, la articulación o gestión del conocimiento existente y la transformación de procesos basada en el conocimiento organizativo (Zollo y Winter, 2002). En esta línea, las capacidades dinámicas son vitales no solo para abordar la

competencia y los rápidos cambios tecnológicos, sino también para afrontar la incertidumbre sobre las oportunidades tecnológicas y de mercado así como los crecientes cambios normativos medioambientales nacionales e internacionales (Teece et al., 2016).

Así mismo, las capacidades dinámicas implican una combinación de rutinas organizativas y de gestión empresarial. La capacidad de los directivos para concebir nuevas combinaciones de estos elementos es cada vez más un factor clave para mantener la competitividad (Teece, 2022). La heterogeneidad de estas *capacidades cognitivas de gestión,* concepto introducido por Helfat y Peteraf (2015), puede producir así mismo heterogeneidad entre las capacidades dinámicas de gestión de los altos directivos, lo que puede contribuir a resultados dispares de las organizaciones en situaciones de cambio. Estas capacidades cognitivas de gestión actuarían como mediadoras entre el cambio organizativo y el cambio estratégico, incidiendo en los resultados.

Algunas de las tendencias de futuro en el campo de la teoría de las Capacidades Dinámicas se centrarán posiblemente en la integración de las tecnologías avanzadas y la digitalización en la gestión estratégica de las empresas. Con la esperada evolución de la Inteligencia Artificial y el Big Data, se prevé que las capacidades dinámicas se orienten a la capacidad de las empresas para adaptarse y reconfigurarse tecnológicamente. Teece (2022) argumenta que la adaptabilidad tecnológica será crucial para mantener una ventaja competitiva. Por su parte, Helfat y Raubitschek (2018) subrayan la influencia de las capacidades dinámicas en la innovación abierta y la colaboración interorganizativa, sugiriendo un cambio de orientación hacia un enfoque más colaborativo en la gestión empresarial. Por otro lado, la sostenibilidad y la responsabilidad social corporativa se están conformando como elementos esenciales de las capacidades dinámicas, y deben formar parte de las estrategias de negocio (Beske y Seuring, 2014). Finalmente, la incertidumbre geopolítica y los desafíos medioambientales globales probablemente requerirán que las empresas redefinan sus capacidades para ser más resilientes y flexibles ante tales desafíos. Esta tendencia a la adaptabilidad y sostenibilidad señala un futuro en el que las capacidades dinámicas se orienten cada vez más hacia la resolución de problemas complejos y globales.

La teoría de las Capacidades Dinámicas, aunque ampliamente reconocida en la gestión estratégica, enfrenta críticas significativas que requieren mayor atención y desarrollo (Fainshmidt et al., 2016) no estando aún suficiente maduro su corpus teórico.

En este sentido, la falta de una definición coherente y clara ha sido una crítica fundamental hacia la teoría de las Capacidades Dinámicas, generando debates continuos sobre su conceptualización precisa (Peteraf et al., 2013). Ya ha sido comentado como los autores se han alineado del lado de Teece o Eisenhardt, por citar a los primeros autores, como corrientes más influyentes con sus trabajos seminales en este campo del conocimiento. Así mismo, la medición y la operacionalización de las capacidades dinámicas presentan desafíos significativos debido a su naturaleza intangible, lo que limita la capacidad de probar teorías relacionadas con ellas (Barreto, 2010). Otra crítica a esta teoría es el énfasis que pone en la adaptabilidad y la flexibilidad, lo que puede llevar a algunas empresas a descuidar otras características importantes como la eficiencia y la estabilidad (Protogerou et al., 2012). En este sentido, la constante reconfiguración de recursos para mantener la ventaja competitiva puede generar inestabilidad organizativa y una cierta desorientación estratégica (Helfat y Peteraf, 2015). Otros autores, como Di Stefano et al. (2014), señalan la dificultad de integrar la teoría de las Capacidades Dinámicas con otras perspectivas y teorías de gestión. Otro aspecto crítico importante que señalaban Eisenhardt et al. (2010) es el de que las empresas a menudo se enfrentan a desafíos a la hora de aplicar los principios de las capacidades dinámicas, debido a la falta de directrices claras y de herramientas concretas para ello. La creación de métodos robustos de medición y análisis de las capacidades dinámicas es otro de los desafíos que se debería afrontar (Pavlou y El Sawy, 2011; González-Samaniego et al., 2023). Por último, encontrar el equilibrio adecuado entre estabilidad y cambio es un desafío clave en la aplicación de las capacidades dinámicas (Zollo y Winter, 2002).

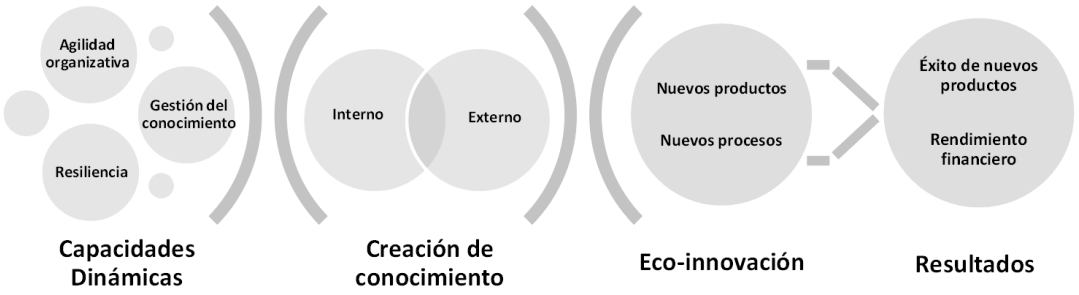
A modo de síntesis podríamos concluir que, aunque la teoría de las Capacidades Dinámicas ha aportado aspectos valiosos sobre la gestión estratégica y la adaptabilidad organizativa, se enfrenta a críticas significativas en términos de definición, medición y aplicabilidad práctica. La investigación futura en este campo debería abordar estas críticas, proporcionando claridad conceptual y metodológica, y buscando una

integración más efectiva con otras teorías de gestión. El objetivo debería ser el desarrollo de una teoría más cohesionada y de mayor aplicabilidad que ayude a guiar a las empresas en el actual complejo y dinámico mercado global.

II.4. MODELO GENERAL DE LA TESIS DOCTORAL

Recogiendo las recomendaciones extraídas de la literatura y analizando las carencias detectadas en la investigación relacionada con los conceptos expuestos presentamos a continuación de forma sintética el modelo teórico general abordado en esta tesis (Figura. II.1), objeto de desarrollo a lo largo de los tres estudios empíricos expuestos en los capítulos siguientes y cuyas conclusiones constituyen la principal aportación de esta tesis.

Figura II.1. Modelo teórico general



El modelo teórico propuesto destaca la importancia de gestionar las capacidades dinámicas, como la agilidad, la gestión del conocimiento – integrando los clientes y las tecnologías de la información - y la resiliencia, para promover la eco-innovación y el éxito empresarial sostenible. Al desplegar estas capacidades de manera integral, las organizaciones pueden generar conocimiento tanto interno como externo, crucial para impulsar la creación de procesos y productos eco-innovadores. La agilidad empresarial permite así adaptarse rápidamente a los cambios del mercado, mientras que la gestión del conocimiento fomenta la colaboración y el aprendizaje continuo. La resiliencia empresarial, por su parte, capacita a las empresas para superar adversidades y mantener el enfoque en la sostenibilidad y la innovación. En conjunto, una gestión consciente de estas capacidades dinámicas puede impulsar de manera significativa la eco-innovación y el éxito a largo plazo de las empresas en el contexto actual.

Para poder analizar con mayor precisión este modelo, se han desarrollado tres estudios empíricos más concretos que estudian parcialmente las relaciones implícitas propuestas en el modelo general, y que se precisan a continuación.

El primero de los estudios analiza la relación insuficientemente explorada entre la agilidad organizativa y la creación exitosa de nuevos productos ecológicos a través de la generación de conocimiento medioambiental interno y externo. Las particularidades inherentes a la eco-innovación suscitan la necesidad de nuevos estudios sobre la creación de conocimientos específicos para su promoción. Así mismo, explora las tensiones derivadas de la dicotomía entre conocimiento interno y externo, y en qué fuente es más eficaz asignar recursos cuando estos son escasos. Se analiza también la posible influencia entre ambos tipos de conocimiento y su relación con el desarrollo exitoso de eco-innovaciones de producto.

El segundo modelo cubre tres lagunas previamente identificadas en la literatura. En primer lugar, suple una falta de investigación acerca de cómo la agilidad podría fomentar la eco-innovación, y cómo esto podría impactar positivamente en los resultados empresariales. En segundo lugar, estudia un factor moderador, la implicación del cliente (como fuente de conocimiento) y sus efectos sobre la relación entre la agilidad organizativa y la eco-innovación de producto y proceso, así como entre la eco-innovación de producto y el rendimiento organizativo. En tercer lugar, introduce la teoría de las Capacidades Dinámicas a través del concepto de agilidad para estudiar el contexto dinámico del eco-entorno.

El tercer modelo empírico introduce por primera vez las estrategias IKARG (Información, Conocimiento, Agilidad, Resiliencia y Verde) en un mismo modelo de investigación, analizando diversas relaciones entre los distintos constructos. Además, implementa una nueva escala de estimación de la agilidad organizativa, que evalúa la aplicación por parte de las empresas de los principios de las metodologías ágiles. Se analiza también la influencia que puede tener la existencia de un sistema de gestión del conocimiento resiliente y ágil, en el que se inserta la capacidad de información mediante el uso de tecnologías, en la capacidad de respuesta a los cambios y demandas internos y externos y en la eco-innovación exitosa de productos.

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III. ORGANISATIONAL AGILITY, ENVIRONMENTAL KNOWLEDGE AND GREEN PRODUCT SUCCESS[1]

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III.1. INTRODUCTION

Nowadays, climate change is an undeniable reality. Growing public awareness and the coordinated action of national governments are causing customers to demand ecological or less polluting and reusable products. Companies are adapting their production processes to new regulations to manufacture more sustainably and reduce the polluting emissions they release into the atmosphere. Businesses are also decreasing energy consumption in processing and transport as a response to customer demands (Huang et al., 2016; Ben Arfi et al., 2018; Li et al., 2018; Wang et al., 2020). To implement this strategy, the new knowledge creation and knowledge management are essential for the companies (Moaniba et al., 2020).

Previous studies have emphasised creating new knowledge for business success (Abbas and Sağsan, 2019). Incorporating this knowledge helps companies explore innovative approaches and exploit existing capabilities more effectively to gain competitive advantages through innovations (Andreeva and Kianto, 2011; Yaghoubi et al., 2011). Therefore, the literature concludes that companies should find the mechanisms necessary to acquire and integrate new knowledge with existing knowledge to strengthen organisational skills and become more competitive (Tsai and Hsu, 2014; Chen et al., 2016).

This context is even more relevant for innovative companies. The constant need to develop new products puts pressure on companies to increase and refurbish their knowledge, technology, and skills to offer products with new specifications that renew the confidence of existing consumers or allow businesses to join other segments or markets. Prior studies have reported the impact of the new knowledge on the innovation success and the ambidextrous tensions between knowledge exploration and exploitation involved in integrating or replacing previous internal knowledge with new knowledge (Menon and Pfeffer, 2003; Rosell David et al., 2017; Bresciani et al., 2018). Indeed, the difficulties resulting from an organisation's limited resources mean that firms must decide whether to invest in one activity or another. Like the ambidexterity concept suggested by March (1991) and applied to innovation (Jansen et al., 2006), firms must also decide whether to devote their resources to generating or acquiring knowledge

internally. This tension extends to decision-making, where both types of knowledge are available.

The present research focuses on the study of eco-innovation. Increasingly stringent environmental regulations and consumer group interest in environmental protection are prompting companies to develop green products (Chen and Chang, 2013). The OECD defines eco-innovation as "*the development of new products, including goods and services, procedures, marketing modes, organisational structures and institutional arrangements, that lead to environmental improvements over pre-existing alternatives"* (OECD, 2010).

Studies have found that eco-innovation is somewhat different and more complex in novelty, uncertainty and variety than non-green technologies and is also influenced by different sets of drivers (Fernández et al., 2021). Introducing novel products and processes to reduce environmental impact signifies a growing technological frontier that companies can only navigate by assimilating new and diverse resources. Regarding internal innovation resources, a pre-established research and development framework assumes a more pivotal role in fostering eco-innovations than other forms of innovation development (Cainelli et al., 2015). The existing literature seems to make this clear.

Additionally, and in contrast to other types of innovations, an open innovation approach is even more necessary with eco-innovations due to the need to capture specific and constantly evolving external knowledge flows, making it more complicated for companies to develop new green products without paying attention to the environment (Horbach, 2008; Marchi and Grandinetti, 2013; Cuerva et al., 2014). Moreover, developing new green products requires a culture of open-mindedness to new knowledge (Cegarra-Navarro et al., 2019), in this case, of an environmental nature.

Although its relevance seems obvious, this aspect has not been dealt with in depth in previous studies, especially those concerning the success of new green products. Successfully developing these eco-innovations is a complex and costly task involving various factors and actors, and in which new ideas are essential (Cooper and Kleinschmidt, 2007; Oke, 2013). This type of environmental knowledge is particular and

requires a more precise approach to its internal development or external acquisition (Cherifi et al., 2019).

In this study, we analyse the effects of internal and external knowledge on the success of new green products and contribute to the prior understanding of how internal knowledge can serve as a stimulus to external knowledge, positively affecting the creation of new products. Furthermore, regarding the generation of new knowledge for the advancement of new environmentally friendly products, earlier research has underscored the significance of fostering specific dynamic capabilities, such as organisational learning (Albort-Morant et al., 2016), absorption capacity (Lane and Lubatkin, 1998; Hashim et al., 2015; Albort-Morant, G. et al., 2018) or organisational agility (Hamad and Yozgat, 2017). According to the dynamic capabilities framework, Teece et al. (2016) define agility as an organisation's capacity to efficiently and effectively reallocate or redirect its resources to activities that generate, safeguard, and capture value, adapting to internal and external circumstances. Conforto et al. (2016) characterise the agility construct as the capability to swiftly adapt to customers' or stakeholders' needs and market or technological demands to enhance product performance within an innovative and dynamic environment. Although previous studies have explored the importance of this capacity for company innovation or competitiveness (Burchardt and Maisch, 2019), its effects on eco-innovation remain unexamined. To fill this gap in the literature, we delve deeper into this capability by examining the organisational agility impact on the generation of internal and external environmental knowledge. Our study seeks to build on the existing literature by examining how this dynamic capacity can serve as a basis for creating functional and environmentally friendly green knowledge.

Results reveal that organisational agility positively influences external and internal environmental knowledge. The findings also confirm that only external environmental knowledge favourably affects green product success. However, internal environmental knowledge moderates the connection between external environmental knowledge and green product success. Hence, this study contributes to the knowledge and the innovation literature by identifying several research gaps, highlighting the need to adopt agile approaches to foster organisational environmental knowledge. Undoubtedly, this

research underlines the tensions between internal and external knowledge in creating successful eco-innovations. This study provides new evidence arguing that while external knowledge is more valuable for the development of successful green products, the existence of internal knowledge can intensify this relationship. Our results corroborate that organisations should not neglect internal knowledge generation, as in Antonelli and Colombelli (2015). This is a relevant contribution to the existing literature on innovation, especially dealing with developing successful green products.

The subsequent sections of this chapter are structured as follows. The next section reviews the theoretical background and articulates the empirical hypotheses. Subsequently, we outline the methodology employed in the study and present the results of the empirical analysis. Finally, the most relevant conclusions derived from the research are presented.

III.2. LITERATURE REVIEW AND HYPOTHESES

Eco-innovation implicitly involves reduced environmental impact. It goes beyond organisational boundaries to influence social contexts through regulation changes, cultural values, behaviours and organisational structures (Pilat, 2009). Thus, eco-innovations should represent a significant step towards sustainable development by diminishing the production's impact on the environment, enhancing nature's resilience to environmental pressures, or promoting more efficient and responsible utilisation of natural resources (EU, 2019). Eco-innovation is expected to diminish environmental risks, pollution, or the adverse effects of resource utilisation (Kemp and Pearson, 2008). As these initiatives are implemented, their application becomes increasingly complex, and industries need to embrace an approach capable of integrating diverse knowledge elements to develop eco-innovation and maximise environmental benefits (OECD, 2010).

III.2.1. Organisational agility

The dynamic capability perspective acknowledges the influence of specific organisational capabilities in shaping and reconfiguring resources to align with a firm's dynamic environment (Teece et al., 1997), enabling the firm to introduce internal changes and remain competitive. Agility is widely regarded as a dynamic capability that

permits organisations to react proactively, flexibly and quickly to the changes and demands of their environment and stakeholders, giving them a competitive advantage (Yaghoubi et al., 2011; Kuo et al., 2017; Chen et al., 2018; Gyemang and Emeagwali, 2020). Enterprise agility is considered a dynamic capability comprised of sensing capabilities, responsiveness and maintaining an appropriate balance between the two (Verma et al., 2017). Many frameworks have been created to develop agility inside organisations (Gunasekaran, 1998; Trinh et al., 2012; Harraf et al., 2015; Baškarada and Koronios, 2018).

Similarly, organisational agility has been defined in various manners within the literature. This new concept was introduced by Nagel and Dove (1991) from the Iacocca Institute, United States. Agility was primarily associated with rapidly bringing out new products, producing on demand, and offering various products based on marketing projections. Agility has also been connected to building strategic relationships with clients, salespeople and consumers to obtain valuable information for product development. Dove (1999) explained agility as "*the ability to manage and apply knowledge effectively*". Agility is impossible if an organisation cannot recognise and assimilate change quickly, integrating new knowledge with existing information to take advantage of these changes before competitors do. Other authors support that agility results from interaction among three capabilities: customer, partnering, and operational agility (Sambamurthy et al., 2003). Organisational agility is also described as the ability to intentionally and efficiently develop behaviours in changing environments and react quickly to foresee and discover opportunities, particularly through innovation and learning (Felipe et al., 2016).

The constitutive dimensions of organisational flexibility and agility, their most significant facilitators, practices and mechanisms of action and their effectiveness in the global success of firms are addressed in several studies (Bottani, 2010; Elkareem et al., 2011; Lin et al., 2016; Oliveira, 2017; Heilmann, 2018; Schuh et al., 2018). The organisational agility can be perceived as a deliberately cultivated capability to respond to environmental fluctuations and the needs of clients, stakeholders, and other relevant organisations promptly, flexibly, and efficiently. It also involves responding to internal demands and anticipating them through the construction of learning and innovative competencies.

III.2.2. Organisational agility, environmental knowledge, and eco-innovation

There is growing global awareness about the need for environmental preservation and the development of green policies in most countries. International treaties and a broader body of environmental legislation cover all areas of human activity (Horbach, 2016). At the same time, citizens are demanding that governments and companies take measures to reduce the polluting effects of industries and cities (Jansson, 2011; Horbach et al., 2012). Companies are implementing social responsibility programmes to counteract the effects of the pollution they are causing and to produce more cleanly and efficiently (Costantini et al., 2017; Cai and Li, 2018). Likewise, the products companies develop use more recyclable and biodegradable materials in response to growing consumer demand (Fernando et al., 2019; Ch'ng et al., 2021). For these reasons, creating new environmental knowledge and eco-innovation is soaring. We can also see this in the literature, where research and published articles on the topic are growing (Díaz-García et al., 2015; Păcesilă and Ciocoiu, 2017; Jesus et al., 2018; Pacheco et al., 2018; Salim et al., 2019).

Moreover, the internal and external attributes of firms and organisational culture play a crucial role in comprehending the evolution of environmental knowledge and eco-innovation (Albers et al., 2018; Michaelis et al., 2018). Environmental knowledge is indispensable for successfully advancing green innovations. It encompasses a range of concepts, ideas, skills, and practices related to environmental issues and their impact on the society and the environment.

This knowledge may be obtained from internal (internal R&D, collaboration among departments, etc.) and external (customers, suppliers, etc.) sources. A company's levels of intelligence and knowledge are a result of the interaction among employees who share their expertise (Laviolette et al., 2016; Bogers et al., 2018; Schweisfurth and Raasch, 2018), the know-how and procedures accumulated over an organisation's lifetime and external awareness from multiple sources, intensified by the exponential growth of the internet.

Several authors have analysed how internal competition – cooperative competition – facilitates the development of new products or innovations in firms (Strese et al., 2016).

Their findings support the idea that cooperation among company functions, such as R&D, marketing or production, helps to provide solutions that improve a company's products. This type of collaboration is essential in eco-innovation (Carrillo-Hermosilla et al., 2010).

The literature refers to the positive contribution of internal and external knowledge to foster eco-innovation (Vega-Jurado et al., 2008; Shearmur and Doloreux, 2013). Likewise, learning and knowledge management are necessary to make enterprises more agile (Sherehiy et al., 2007; Bahrami et al., 2016). Some authors suggest that balanced exploitation and exploration in innovation strategies permit companies to incorporate new knowledge through new products when efficiency criteria that consider the awareness available inside a company are implemented (Jimenéz-Jimenéz et al., 2018).

As previously mentioned, agility implies responding rapidly and efficiently to environmental changes and managing internal and external knowledge and resources (Cegarra-Navarro et al., 2016) through solid IT capability and a widely implemented IT system (Lu and Ramamurthy, 2011; Lee et al., 2015; Ravichandran, 2018). Moreover, some studies show a strong, positive association between firms' IT capabilities and successful new product development (Mauerhoefer et al., 2017). Thus, internal and external knowledge is necessary to build agile organisations (Tooranloo and Saghafi, 2019). Likewise, learning and knowledge management are crucial for enterprises to become more agile (Sherehiy et al., 2007; Bahrami et al., 2016).

Considering the relevance of the environmental demands that companies face and given the importance that knowledge has for organisations' ability to react to market changes quickly, it is logical to assume that organisational agility will help companies to increase their environmental knowledge base. Thus, we propose that:

> *$H_{1:}$ Greater organisational agility is associated with greater internal and external environmental knowledge.*

III.2.3. Internal vs. external environmental knowledge and the success of green products

In a competitive environment, it is necessary to engage in new green product development projects that can be successful.

A green product is characterised as one that incorporates recycled resources (renewable, non-toxic, or biodegradable) in its design, attributes, production, or strategy, contributing to an improved environmental impact or a reduction in environmental damage throughout its life cycle (Durif et al., 2010; Sdrolia and Zarotiadis, 2018).

Typically, the success of a product has been measured against internal elements, such as budget forecasts or company objectives, or external elements, such as similar competitive products. The success of new green products should be based on other aspects like compliance with environmental regulations, stakeholder requirements or market competitiveness (Wong and Tong, 2012). Therefore, companies need to look for efficient ways to develop new knowledge and apply it to developing new green products.

As discussed above, pre-existing organisational and external knowledge is needed to develop eco-innovations. Literature has usually highlighted the importance of generating internal knowledge to develop any innovative project (Linder and Sperber, 2019). In recent decades, the need for departments and functions of firms to cooperate in transferring and sharing valuable knowledge to develop new products has been highlighted (Brettel et al., 2011; Strese et al., 2016). Better solutions are achieved with individual or cross-functional cooperation among company functions such as R&D, marketing, or production. Eco-innovations also involve this type of collaboration. Organisations must comprehend how to deploy environmentally friendly solutions that address challenges in product design, user behaviour, the relationship between products and services, the configuration of the value network, and the innovation development process without causing harm to the environment (Carrillo-Hermosilla et al., 2010).

Nevertheless, many authors claim that access to environmental knowledge, new technologies and less polluting raw materials come mainly from social and professional networks, suppliers, partners, customers, and patents (Enkel et al., 2009; Husain et al.,

2016). They emphasise the importance that an open innovation approach, mainly external collaboration, has on eco-innovation for creating highly innovative products (Horbach, 2008; De Marchi, 2012; Del Río et al., 2013; Cuerva et al., 2014). Especially significant is the case of collaboration with customers, partners and suppliers (Brettel and Cleven, 2011). Moreover, collaboration with organisational and individual networks facilitates radical innovations (Bahemia and Squire, 2010; Hemphälä and Magnusson, 2012; Venturini et al., 2013), as the diversity of ideas from multiple sources can lead to more innovative products. These products are often the ones that bring greater success to companies. Collaborative technological networks with suppliers, clients and research organisations are vital to increasing green product originality (Nieto and Santamaría, 2007). Thus, developing radical innovations tests the limits of internal knowledge, changing the focus to external knowledge with advanced and original green products. Moreover, cooperation with suppliers ensures input or components with green characteristics that might not be easily accessible in the market (Seuring and Müller, 2008; Albino et al., 2009). Collaboration with universities often helps companies to develop more complex forms of eco-innovation, be it product, process or organisational (Wagner, 2007; Triguero et al., 2013; Ardito et al., 2019). Customer participation makes it possible to identify aspects related to the life cycle, environmental impact and recyclability of products that can be included in the development of eco-innovations (Handfield et al., 1997; Thun and Müller, 2010). Consequently, cooperation among knowledge brokers and functional groups is necessary to access more diverse information and reach agreements (Hernández-Mogollon et al., 2010), ensuring greater chances of success in the eco-innovation process.

The literature considers that to eco-innovate, companies need greater access to externally generated knowledge (Cainelli et al., 2015). Environmental knowledge, new technologies and less polluting raw materials come mainly from social and professional networks, suppliers, partners, customers, and patents (Enkel et al., 2009; Husain et al., 2016). However, technological trajectories can provide a pathway for company innovation (Thrane et al., 2010). The literature concerning technological trajectories and path dependence (Nelson and Winter, 1982) asserts that companies might face limitations by their technologies. Previous studies suggest that companies reduce

opportunities for choice over time and eventually reach dead ends that prevent them from reacting to changing environmental conditions (Bohnsack et al., 2021). Tensions arise about whether to use internal knowledge that may lead to less innovative solutions or acquire external knowledge that is more distant from the company but may be more effective, especially in the case of eco-innovation, which is strongly influenced by external factors.

Some authors conclude that more successful eco-innovations require more external knowledge to generate proposals distinct from those previously implemented by companies (Chatterji and Fabrizio, 2014; Forés and Camisón, 2016). Thus, we suggest:

> *H_2: External environmental knowledge is more closely associated with the success of new green products than internal environmental knowledge.*

III.2.4. Internal knowledge as a mediator between external knowledge and the success of new green products

From a global point of view, we can consider an enterprise as a learning environment (Senge, 1990; Lahtinen, 2007) where different elements interact, different instruments are available, and different sources of information converge. Several concurrent processes occur, resulting in, among other outcomes, knowledge generation, organisational structure evolution, and the new products or services development in response to market, customer, or stakeholder demands. The generation of knowledge and innovation are closely linked to different types of knowledge, such as tacit/explicit or internal/external, the preponderance of one or the other and the learning modes of an organisation's members. Research has linked strong learning capabilities to successful innovation (Damanpour, 1991; Zhou et al., 2015).

One of the theories that can explain how organisations learn is the cognitive psychological theory of meaningful learning, which forms a part of constructivist thinking. Initially articulated by Ausubel in the sixties, other authors have reformulated and applied it (Novak, 2002; Pande and Bharathi, 2020). This theory has been used to explain learning in educational environments and other areas of activity (Urquidi-Martin and Aznar, 2017). According to this theory, learning occurs when new knowledge is

related to pre-existing concepts acquired through various sources, such as experience, study, etc. When different types of knowledge are related, a new connection is established, called meaningful learning. Moreover, it is permanent, long-term and based on experience and previous awareness.

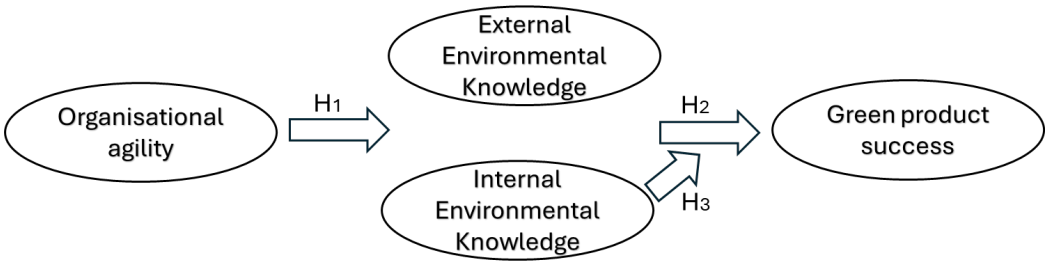
The literature suggests that learning is conditioned by several endogenous and exogenous factors (Alegre and Chiva, 2008; Ferreras-Méndez et al., 2015). Leveraging internal competencies and absorbing valuable external knowledge (absorptive capacity) is the cornerstone of strategic approaches to learning and innovating in the organisational context (Cohen and Levinthal, 1990; Zahra and George, 2002). Absorptive capacity is crucial to learning and innovation management (Lane and Lubatkin, 1998). This capacity can determine the inflow, harnessing, influence, and use of knowledge, which impact the innovation process and business outcomes (Kostopoulos et al., 2011; Ferreras-Méndez et al., 2015). Hence, promoting absorptive capacity and fostering R&D activities are crucial factors influencing innovation, emphasising the need for continuous encouragement and support of these activities and related capabilities within firms (Miroshnychenko et al., 2020). Therefore, increased absorptive capacity in a company will help it gain and use knowledge to develop eco-innovations (Hashim et al., 2015; Aboelmaged and Hashem, 2019). The capacity to add new knowledge to the existing knowledge is conditioned by internal environmental awareness and the level of learning maturity a company has (Flor et al., 2018). New knowledge combinations that lead to successful green products are linked to previous knowledge.

Thus, in integration and rebuilding processes, prior knowledge will condition a firm's capacity to capture and use external knowledge to promote environmentally sustainable innovation. Thus:

> *H_3: Internal environmental knowledge positively moderates the relationship between external environmental knowledge and the success of new green products.*

Figure III.1 shows the theoretical model and hypothesis of this research.

Figure III.1. Model and hypotheses



III.3. METHODOLOGY

The methodology for selecting the population, the sample chosen, the scales set to measure the model's variables and the statistical analysis method are discussed below.

III.3.1. Research sample

The study population comprises industrial companies located in Spain with more than 100 employees and at least five years of activity in the SABI database (Bureau van Dijk). SABI represents the most complete financial analysis database of Spanish and Portuguese companies with a 25-year history of annual accounts. This type of population was chosen to guarantee a broad enough group to generalise the conclusions obtained. The database showed a total of 2,318 Spanish companies with these characteristics.

The information was collected using an online survey located on the university's corporate website and based on a pre-tested, structured questionnaire. An external marketing research company gathered the information. This company has been working with our university research team for several years, so we are confident of its methods in surveying. The information was collected after familiarisation with the questionnaire and a series of pre-tests (analysis of the questions, identification of errors or understanding of content) with trusted companies. To do this, companies were sent a letter to present the project (where extensive information about it and its connection to the research team was explained) and provided access to the website. Companies that did not respond in the first instance were sent a reminder, inviting them again to participate in the survey. Similarly, errors detected in the contact addresses of some enterprises were corrected. The option of surveying by telephone was also given, with

the information being collected directly by the marketing research company. Contact with the companies on the list was random. The next company was phoned if a company could not be contacted, or the interviewee refused to participate in the study.

The study was directed to the head of innovation or the person who managed organisational knowledge in the company. The average respondent is male (87%), with an average length of time in the job of nine years and sixteen years' average experience in the company. The collection process lasted three months, and information from 184 companies was collected. A power analysis with G*Power was run with a power of 0.8 and an alpha of 0.05, and given a medium effect size; this sample surpasses the minimum requirement of sample size (Faul et al., 2009). Except in three cases, the companies deal in international import and export; on average, the sample comprises companies with more than 39 years of seniority. The average share capital is €17,886,943.69, operating income €310,839,969.30 and results €18,433,258.18. The average economic profitability is 8.36%, the financial return is 21.19%, and the company size is more than 520 employees.

III.3.2. Measurement and scales

The measurement of the constructs used in our study was carried out with 7-point Likert scales. Specifically, Mode A composites have been used to operationalise these measures.

Organisational agility is understood as the capacity to detect changes in the market and make decisions. Using Liu et al. (2018) study, we calculate it as a second-order construct from three first-order constructs that comprise the measures of operational agility (4 items), partnering agility (6 items) and customer agility (5 items). These constructs have been measured reflectively.

Environmental knowledge refers to the knowledge created from internal sources (training, internal R&D, collaboration among departments, etc.) or external sources (customers, suppliers, competitors, consultants, etc.) that provide new solutions to environmental problems, less polluting products, or green programmes. From the studies by Pedersen et al. (2011) and Martínez-Martínez et al. (2015), two reflective

scales of 5 items each have been proposed to measure internal and external environmental knowledge.

We also measure *green product success* as an indicator of eco-innovation performance. Using Wong (2012) study, we include five measures related to compliance with green directives, stakeholder requirements, revenue, profitability and success.

We have incorporated four control variables, each represented by a single indicator, to explain the three endogenous variables of the model. They were *Seniority* of the company, based on the number of years since its creation; *Size,* measured by the number of employees; *Activity,* with a variable that includes industrial sub-sectors; and an *environmental management system*.

III.3.3. Statistical analysis

The partial least squares (PLS) path model was used to test the model. This is a variance-based structural equation modelling (SEM) methodology that allows different latent (unobserved) variables derived from the hypotheses to be measured (Cepeda-Carrion et al., 2019). These variables are measured using several indicators collected in the sample (Cepeda-Carrión et al., 2016). According to Rigdon (2016), PLS-SEM is adequate when the data are not necessarily normal when making an exploratory study of relationships not strongly consolidated in the literature and when reflective variables are used to measure concepts they can explain and other variables can explain. Moreover, PLS can be used in a confirmatory way (Henseler, 2018). SmartPLS 3.3.3. software (Ringle et al., 2015) was employed to evaluate the measurement model and estimate the structural model.

III.4. RESULTS

The application of the PLS-SEM methodology generally involves a global analysis of the model. It checks the reliability and validity of the measurements and analyses the relationships established in the structural model (Henseler et al., 2016). We will now analyse the measurement and structural models.

III.4.1. Measurement model

Initially, various assessments were conducted to validate the measurement model, as outlined by Henseler et al. (2016). These analyses, involving the saturated model, yielded a standardised root mean squared residual (SRMR = 0.065), unweighted minimum squares discrepancy (d_{ULS} = 0.726), and geodetic discrepancy (dG = 0.544) values well within acceptable thresholds (below the percentile levels established through 95% bootstrapping). Consequently, it can be inferred that the model exhibits satisfactory adjustment in the context of PLS-SEM, as highlighted by Albort-Morant, Gema et al. (2018).

Various tests have been applied to check the reliability and validity of the reflective composite scales (Mode A). First, the individual reliability of the indicators (Table III.1) that adopt values higher than 0.7 (Chin, 1998) has been verified. Cronbach's alpha (α) and the composite reliability index (CR) have been used to verify the reliability of internal consistency, observing that their values are higher than 0.7 (Bagozzi and Yi, 1998). The average extracted variance index (AVE), with values greater than 0.5 (Bagozzi and Yi, 1998), shows the existence of convergent validity (Fornell and Larcker, 1981).

Table III.1. Reliability and validity

Construct	*Items*	*Coef.*	*Std*	*t-st*	*Reliability & validity*
Operational agility	We can quickly respond to changes in our customers' products or service needs.	0.829	0.037	22.611	α: 0.964 CR: 0.907 AVE: 0.710
	We fulfil demands that require a rapid response and include special requests of our customers whenever such demands arise; our customers are confident in our ability.	0.793	0.039	20.357	
	We can quickly scale our production/service levels up or down to support fluctuations in market demand.	0.855	0.028	30.400	
	When a disruption occurs in our production or service, we can quickly make necessary alternative arrangements and internal adjustments.	0.890	0.021	42.760	
Partnering agility	Employees learn more soft skills that are required to manage customer encounters.	0.735	0.039	18.924	α: 0.886 CR: 0.914 AVE: 0.640
	We can quickly implement new governance structures.	0.847	0.027	31.665	
	We can combine, recombine, and create new business processes with little notice.	0.874	0.020	44.488	
	Through online, rapid, and up-to-date communications among partners, we can reduce information discrepancies.	0.702	0.050	13.973	
	It allows us to innovate our service offerings technologically.	0.770	0.058	13.343	
	It brings us about new ways of managing organizational structures and partnerships.	0.857	0.023	37.815	

Table III.1. Reliability and validity (cont.)

Construct	Items	Coef.	Std	t-st	Reliability & validity
Customer agility	We can quickly make and implement appropriate decisions in the face of market/ customer changes.	0.776	0.044	17.652	α: 0.888
	We can quickly respond to changes in our customers' products or service needs.	0.913	0.019	47.181	CR: 0.923
	Co-opting with customer gives us greater contextual ability to explore opportunities and options.	0.871	0.033	26.139	AVE: 0.751
	Partnering with customer makes the customer service experience more memorable.	0.901	0.020	44.708	
External environmental knowledge	New solutions to environmental problems.	0.880	0.025	35.363	α: 0.939
	New less polluting product/service.	0.916	0.021	42.845	CR: 0.953
	New less polluting processes.	0.899	0.018	50.630	
	A green program (waste management, control of effluents, inventory of pollution sources).	0.892	0.020	44.696	AVE: 0.803
	A drafting of environmental emergency plans and measures	0.893	0.018	50.090	
Internal environmental knowledge	New solutions to environmental problems.	0.872	0.033	26.354	α: 0.933
	New less polluting product/service.	0.888	0.029	31.052	CR: 0.949
	New less polluting processes.	0.905	0.016	56.955	
	A green program (waste management, control of effluents, inventory of pollution sources).	0.884	0.022	40.736	AVE: 0.789
	A drafting of environmental emergency plans and measures	0.892	0.022	41.139	
Green product success	They are in compliance with green directives.	0.846	0.028	29.698	α: 0.900
	They meet the green requirements set by stakeholders.	0.869	0.032	27.263	CR: 0.926
	They bring in more revenue than competing products.	0.867	0.030	29.275	
	They are more profitable than the competing products.	0.818	0.043	19.201	AVE: 0.713
	They are successful.	0.822	0.036	22.769	

Notes: Bootstrapping with 5000 resamples; Coef.= Path coefficient; Std= Standard deviation; t-st =Student's t value; α= Cronbach alpha; CR= composite reliability; AVE= average variance extracted

Discriminant validity was confirmed through two tests. The first test, a conventional method proposed by Fornell and Larcker (1981), assessed the mean extracted variance and correlations among latent variables. As indicated in Table III.2, the square root of each Average Variance Extracted (AVE) value exceeded the correlations among the variables. Additionally, Table III.2 presents results from the second test, indicating that the Heterotrait-Monotrait Ratio (HTMT) values were all below 0.85, in line with the criteria established by Henseler et al. (2015). Both tests provide evidence supporting the discriminant validity of the constructs.

We also assess the potential for Common Method Biases (CMV) following prior studies (Podsakoff et al., 2003; Chin et al., 2013). Harman's Single-Factor Test is commonly employed to investigate CMV, wherein all model indicators are loaded onto a single

common factor (Liang et al., 2007). The findings indicate that CMV is not a significant concern in this study (Chang et al., 2010).

Table III.2. Correlations and discriminant validity

	1	2	3	4	5	6
1 Operational Agility	0.843	0.561	0.558	0.440	0.407	0.249
2 Partnering Agility	0.492	0.800	0.577	0.561	0.518	0.366
3 Customer Agility	0.492	0.508	**0.867**	0.481	0.417	0.386
4 External Environmental Knowledge	0.398	0.516	0.440	**0.896**	0.736	0.568
5 Internal Environmental Knowledge	0.367	0.477	0.380	0.689	**0.888**	0.406
6 Green Product Success	0.225	0.333	0.350	0.531	0.380	**0.845**

Notes: The diagonal elements (highlighted in bold) represent the square root of the shared variance between constructs and their measures. Below the diagonal are the correlations between constructs, while above the diagonal are the values of the Heterotrait-Monotrait Ratio (HTMT).

We also assess the potential for Common Method Biases (CMV) following prior studies (Podsakoff et al., 2003; Chin et al., 2013). Harman's Single-Factor Test is commonly employed to investigate CMV, wherein all model indicators are loaded onto a single common factor (Liang et al., 2007). The findings indicate that CMV is not a significant concern in this study (Chang et al., 2010).

Finally, we have checked for the existence of the endogeneity problem following the recommendations by Hult et al. (2018). The results of the Gaussian cupola analysis do not show significant indications of this problem. In any case, we have used four control variables to mitigate omitted variables as the primary source of endogeneity (Hult et al., 2018).

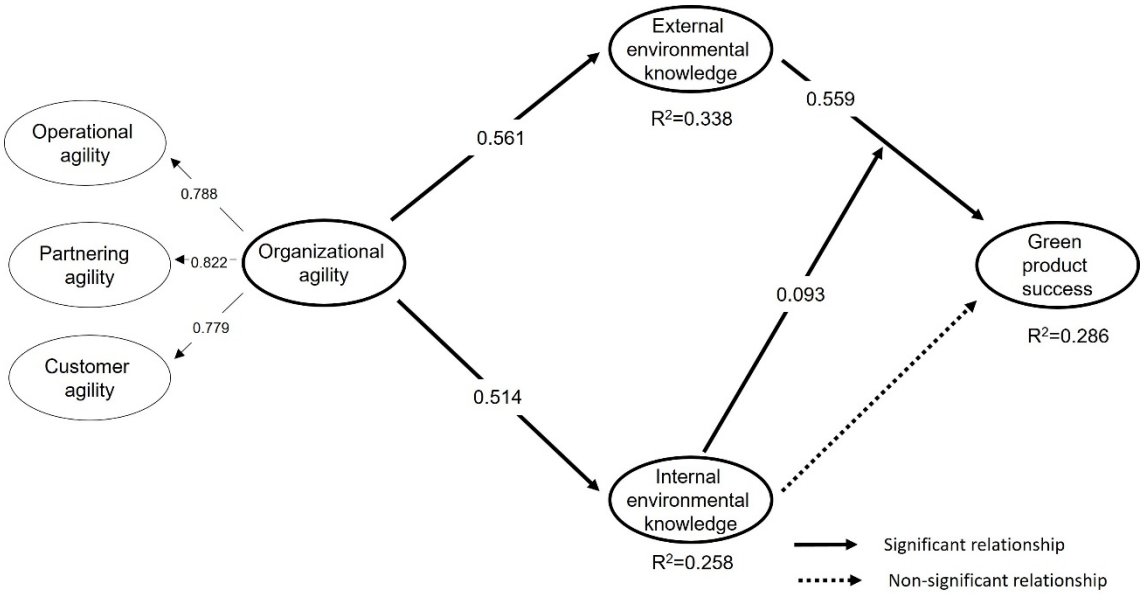
III.4.2. Structural model

The results of this study have been obtained with the SmartPLS 3.3.3 software package. Figure 2 shows the structural model derived from the PLS-SEM analysis. The significance of the parameters that analyse the relationship between each construct has been obtained with bootstrapping using 5,000 resamples for one tail of the t-student. Figure 2 demonstrates how most of the paths are significant, and the R^2 of each construct is explained. Organisational agility was modelled as a second-order factor significantly reflected in three first-order constructs. Furthermore, the moderating effect (external

and internal environmental knowledge) was calculated using this software with the two-stage calculation method and as the standardised product of the terms.

The structural analysis model results are shown in Figure III.2.

Figure III.2. Empirical model results



The first hypothesis suggested a positive relationship between organisational agility and environmental knowledge. The results in Table III.3 show that the path coefficients of the relationship between agility and external ($H_{1a:}$ $\beta = 0.561$, $p<0.001$) and internal ($H_{1b:}$ $\beta = 0.514$, $p<0.001$) environmental knowledge are positive and significant, which supports our first hypothesis. This means that a company's awareness of external changes and ability to make internal adjustments to respond to them are very useful ways to create knowledge on environmental matters. In other words, the generation of this knowledge depends mainly on regulations, social demands, and technological advances. Therefore, companies that detect and respond to these changes will be more agile in acquiring new specific knowledge directly from external sources, or they will be able to create that knowledge internally from environmental changes.

In hypothesis two, it was proposed that given the external nature of environmental knowledge, external environmental knowledge would have a more significant effect on the success of new products than internal environmental knowledge. The results support these arguments by identifying a significant relationship only between external

knowledge and the success of green products (β=0.568, p<0.001). The absence of a significant association with internal knowledge could be explained by the fact that this knowledge often leads to less innovative products. New ideas are necessary to launch products not previously produced. Furthermore, we have verified the mediating importance of this type of environmental knowledge in the relationship between organisational agility and the success of green products. Table III.3 shows an indirect effect only for external knowledge (β=0.319, p<0.001), indicating that this knowledge could mediate this relationship.

Table III.3. Structural model results

	Coef.	Std	t-st	LL	UL
Direct effects					
Organisational agility → External Environmental Knowledge	0.561***	0.059	9.542	0.462	0.655
Organisational agility → Internal Environmental Knowledge	0.514***	0.056	9.149	0.422	0.607
External Environmental Knowledge → GP success	0.568***	0.091	6.211	0.419	0.718
Internal Environmental Knowledge → Green Product Success	0.022	0.099	0.226	-0.131	0.192
*EEK * IEK → Green Product Success*	0.093*	0.048	1.962	0.015	0.172
Indirect effects					
Organisational agility → External Environmental Knowledge → Green Product Success	0.319***	0.062	5.151	0.222	0.425
Organisational agility → Internal Environmental Knowledge → Green Product Success	0.011	0.052	0.221	-0.067	0.103
Significant control variable effects					
Envir. management system → External Environmental Knowledge	0.178**	0.058	3.051	0.087	0.280
Size → Green Product Success	0.076*	0.037	2.052	0.026	0.147

Notes: Coef.= Path coefficient; Std= Standard deviation; t-st =Student's t value; *p<0.05; **p<0.01; ***p<0.001; t(0.05;4999)=1.6451; t(0.01;4999)=2.327; t(0.001;4999)=3.091; LL=Lower 95% percentile confidence interval; UL= Upper 95% percentile confidence interval; EEK * IEK= interaction effect of External and Internal Environmental Knowledge

However, this does not mean that internal knowledge is unimportant since, as proposed in hypothesis three, internal knowledge can help better use external knowledge in innovation processes. The results show that internal knowledge positively moderates the relationship between external knowledge and the success of green products (H_3: β=0.093, p<0.05). This also suggests that internally developed knowledge helps companies exploit external knowledge. New external knowledge, even with great value, will not be adequately exploited if there is no previous experience and basic knowledge to recognise and apply what has been acquired externally.

Finally, we have identified some relevant information by introducing the four control variables. Although there seems to be no significant influence between the age or industrial activity of the firm on internal or external environmental knowledge or the success of green products, our results do show that the existence of an environmental management system facilitates the acquisition and reformulation of external environmental knowledge (β=0.178, $p<0.01$). This result supports the need to implement such management systems in companies to promote eco-innovations. A relationship between size and green product success has also been identified (β=0.076, $p<0.05$). This could indicate that larger firms have more resources to acquire external knowledge and develop the internal innovation activities necessary for green product success.

III.5. CONCLUSIONS

This study explores how agile organisations can create conditions that enhance eco-innovation processes. Drawing on the Dynamic Capabilities Theory (Teece and Pisano, 1994), it explores how organisational agility becomes a dynamic element in environmental knowledge creation processes to develop new green products. Indeed, many of the findings derive from the ability of firms to understand external changes and react to them quickly by creating new green products.

The findings derived from a sample comprising industrial companies in Spain seem to support our assumptions in a context where various internal and external sources compete for scarce resources. As in organisational ambidexterity, the combination of external and internal knowledge is not always feasible, and tensions arise from using both types of knowledge sources. First, we have found that organisational agility affects new internal environmental knowledge creation. A company's ability to identify changes, trends or opportunities will lead to the incorporation of new external knowledge (Ben Arfi et al., 2018). Determinants of eco-innovation and aspects such as new materials, technological improvements, legal changes, or external collaboration networks with different agents allow new sources of environmental knowledge to be identified. This knowledge can be helpful in eco-innovation processes (Păcesilă and Ciocoiu, 2017; Pacheco et al., 2018). Most of this developed knowledge must be

incorporated into the company. However, this is only possible if a company is agile enough to detect, introduce, and use it. Moreover, organisational agility encourages the creation of knowledge that must be developed internally. In companies with R&D departments accustomed to internally developing their knowledge, rapidly detecting changes in the market can guide these learning processes and help to develop knowledge oriented towards these environmental trends. For this reason, organisational agility is a powerful tool in creating new environmental knowledge.

Second, it has become clear that external knowledge is more relevant to the successful development of green products. Reliance on this type of knowledge is appropriate because green products must incorporate knowledge about regulations, trends, and technological developments to be successful. Organisational path dependency from a focus on internal knowledge can reduce the possibilities of creating novel eco-innovations tailored to external requirements. This result is in line with those obtained in other studies, which emphasise the predominant importance of external sources of knowledge for eco-innovative enterprises (De Marchi, 2012; De Marchi and Grandinetti, 2013; Chatterji and Fabrizio, 2014; Forés and Camisón, 2016). Therefore, organisational agility indirectly contributes to success since it allows companies to identify and apply this new knowledge to develop successful eco-innovations.

However, our results also highlight the importance of developed internal knowledge. This prior knowledge makes it easier for companies to understand and apply external knowledge. With prior knowledge, companies can produce new products more efficiently than starting from scratch. Our research shows that internal knowledge serves as a positive moderator, enhancing the impact of external knowledge on the new products success. This suggests that an internal orientation towards producing innovative products might not be efficient compared to an open innovation perspective. However, companies with high internal knowledge development will better apply new external knowledge. These results are consistent with other studies that show R&D activity and internal knowledge to be more critical for the development of eco-innovations than for non-ecological innovations (Horbach, 2008; Pihlajamaa et al., 2017; Aboelmaged and Hashem, 2019).

Exciting ideas for academics and practices emerge from this research. First, this research contributes to the line that highlights the advantages of organisational agility. This study provides evidence of environmental knowledge, a fundamental element in developing organisational agility. Therefore, this dynamic capacity becomes strategic for developing internal and external environmental knowledge. Second, this research helps to understand the tensions between internal and external knowledge. The literature has attempted to clarify the advantages of both types of knowledge for the development of innovations (Menon and Pfeffer, 2003; Monteiro et al., 2011). The study focuses on the necessary knowledge to develop eco-innovations that, due to their characteristics, have a more excellent external orientation. Although internal knowledge could lead to path dependency (Teece et al., 1997) or organisational resistance to environmental changes (Leonard-Barton, 1992) and limit the creation of new products, this internal knowledge facilitates the applicability of external knowledge. We contribute to the literature by highlighting the roles that both types of knowledge play. The tensions between internal and external knowledge are evident since, although the latter is more effective for developing green products, the former acts as a catalyst for external knowledge.

Second, companies with more dynamic capabilities will have an easier time fostering the organisational agility needed to deal with environments of great uncertainty and change (Teece et al., 2016). Agility and knowledge acquisition have a cost. For this reason, managers must prepare their firms to sense, search, seize, shift and shape (Baškarada and Koronios, 2018), choosing the most suitable strategy to make their organisations agile. Likewise, the conclusions are evident for those innovative companies involved in projects sensitive to the environment. They must promote open innovation orientations to acquire environmental knowledge from external sources (Lopes et al., 2017). This means that they must be agile and dynamic organisations. They must be aware of the environment and establish collaborative relationships with external agents to introduce this new knowledge quickly, apply it to the development processes of new products and not rely exclusively on internally generated knowledge.

This study is not without limitations. First, a cross-sectional sample is used, which makes it impossible to indicate causality in the relationships studied. Additional research with longitudinal studies would resolve this issue. The sample used in our study is drawn from

the Spanish industrial sector. It would be interesting to replicate the survey in other sectors and countries to check whether the results obtained could be extrapolated. It is also essential to consider that only one key informant has been used, although this person was well-informed about the issues relevant to the research. The study would be more robust if the information obtained from various company sources and data from other objective sources to measure the relevant constructs had been incorporated. Also, additional variables in the questionnaire could strengthen common method variance analyses with a latent marker variable approach (Chin et al., 2013). Moreover, the effects on some variables are difficult to assess in the short term, especially in the success of new green products. Finally, the methodology shows only the linear effects between the studied variables.

An interesting future line would be to continue delving deeper into internal and external environmental knowledge tensions. The incorporation of curvilinear effects and the decision about what type and amount of knowledge to promote when faced with limited resources could help to clarify how environmental knowledge contributes to the success of eco-innovations. In this case, further progress could be made on the possible synergistic effects of using both knowledge sources beyond the direct and moderating effects described in this study.

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IV. PERFORMING IN GREEN: TOWARDS ECO-INNOVATION THROUGH AGILITY AND CUSTOMER INVOLVEMENT[2]

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IV.1. INTRODUCTION

In the 1990s, a new technological and economic paradigm began to emerge, the *greening paradigm*, which brought enormous changes in the creation of new knowledge and technologies and is currently affecting the entire global economy (Andersen, 2002). The production of more sustainable goods and services, firstly seen as growing demand from a small group of consumers, has become an inherent part of the production itself and a mandatory component of the strategic objectives of many companies (Chen and Chang, 2013). The growing global environmental awareness and the fight against climate change, the increase in the cost of raw materials and energy, the rise in the cost of greenhouse gas emission rights and the pressure from states with increasingly restrictive legislation on the non-permissiveness of polluting modes of production have all contributed to this.

Regarding the factors influencing a company's adoption of an eco-innovation strategy, Del Río et al. (2016) found that most studies prioritise external determinants, particularly public policies and stakeholder influences, over internal factors such as resources, capabilities, and competencies. Pacheco et al. (2017) highlighted six determinants as critical: governmental policies, availability of resources, perception of the strategic relevance of eco-innovation, technological eco-consulting, eco-innovation approaches focusing on products and processes, collaboration and strategic alliances within supply networks. Janahi et al. (2021) review eco-innovation literature linked to manufacturing firms and identify design, organisation, and regional networks as central topics in its implementation. Finally, digital orientation and networking are critical for SMEs to adopt eco-innovation (Triguero et al., 2013; Fernández et al., 2021; Nasiri et al., 2022).

Adopting an environmental strategy has many positive results on organisations' environmental and economic performance (Adomako et al., 2021). It is not only a necessary response to pressure from stakeholders and competitors but also implies a progressive decrease in the environmental impact of their activity, a reduction in costs (Horbach et al., 2012), a higher employment level (Horbach and Rennings, 2013) which contributes to the achievement of better results through social reputation, new knowledge and organisational capabilities (Barba-Sánchez and Atienza-Sahuquillo,

2016). In this respect, companies with a proactive environmental strategy are more inclined to pursue the advantages of eco-innovation actively, reflecting their reinforcement or reorientation of business strategies in their commitment to ecological issues and in the creation of an ecological corporate image (Tsai and Liao, 2016). According to the literature, the adoption of strategic green innovation approaches and the development of innovative green products and processes in companies enable them to gain competitive advantages, reduce costs and improve environmental conditions, but also achieve better business performance (Porter and Van der Linde, 1995a; Pujari et al., 2003; Chiou et al., 2011; Lin and Chen, 2017; Sellitto et al., 2020).

Likewise, a primary objective of environmental innovation is to cultivate green dynamic capabilities and incorporate them into production processes. Companies should enhance their green dynamic capabilities to improve their performance in developing environmentally friendly products (Chen and Chang, 2013). This way, developing dynamic green capabilities positively influences competitive green advantage (Lin and Chen, 2017). In this regard, agility is considered a dynamic capability (Teece et al., 2016) that emerges in response to a firm need to improve its green innovation capabilities (Hart and Dowell, 2011). This concept entails the ability to swiftly and efficiently adapt to prevailing market demands while taking proactive steps to pioneer new markets ahead of key competitors (Bessant et al., 2001). Moreover, agility in people, teams and organisations is widely considered the most effective tool for management in VUCA (volatility, uncertainty, complexity and ambiguity) environments (Baran and Woznyj, 2021). Thus, agility could be considered a quick response to market and stakeholders' demands and an essential factor for organisational success (Overby et al., 2006; Denning, 2019).

Additionally, regulatory influence and pressure from customers and industry leaders are considered by several authors as the primary external triggers for green innovation in firms (Delmas and Toffel, 2008; Xianbing et al., 2010; Fernando and Wah, 2017). Environmental regulations and public subsidies promote ecological businesses and eco-innovative products and positively influence consumers, competition, management, and ecological processes (Achmad et al., 2023). Another critical factor is the market demand level. When demand is high, adopting a proactive environmental strategy is more critical

for companies aiming to gain a competitive advantage based on their green reputation through eco-innovation (Tsai and Liao, 2016). We analyse different relationships among customers' implications and other factors of our investigation model that can contribute positively to the results. Customer participation could be a way to integrate customer pressure and promote green product innovation (Chen and Liu, 2019). Besides, customer agility enables firms to act quickly in changing environments (Roberts and Grover, 2012).

Moreover, customer engagement appears to exert a favourable influence on both technical quality and the pace of innovation (Carbonell et al., 2009). The most significant effectiveness of customer involvement in new product development seems to be in the ideation and launch phases, directly influencing the financial performance of the new product and indirectly reducing time to market (Chang and Taylor, 2016). Besides, customers can create value in internal and external processes and develop new products and services by playing an active role (Du and Chen, 2018; Denning, 2019). This way, the advantages of customer engagement in new product development are intricately tied to the organisation's capacity to internalise customer feedback, analyse it, and convert it into actionable business objectives (Morgan et al., 2018).

In a recent green innovation literature review, Oduro et al. (2022) identify some gaps in the literature, including the lack of moderating variables between green innovation and firm performance as well as the need to introduce other theories, different from Porter's, RBV or Institutional among others, such as dynamic capabilities to explore dynamic contexts like ecological environments. In this vein, our investigation covers the lack of literature on the relationship between agility in organisations and eco-innovation development, as processes and products have been insufficiently studied (Franco et al., 2022), considering agility as a dynamic capability. Additionally, our model shows the mediator role that customers' involvement plays in these green innovations and the effects of eco-innovations on business results, confirming previous conclusions in this line to ensure successful innovations. We will delve into examining several factors influencing eco-innovation and the beneficial impacts of eco-innovation on firm performance, thus contributing to broadening the body of research analysing this relationship and opening a path to a business orientation that is no longer a trend but a global necessity for the sustainability of the planet.

In the following sections, this study introduces a theoretical framework with the relevant concepts of the model and presents the hypotheses under study. Hereunder, the research methodology, the selection of the sample, and the procedure for obtaining the study data are presented. It continues with the chosen measures and scales, the data processing and the measurement and control tests of the research model. In the next section, we discuss the obtained result and the evaluation of the formulated hypotheses. We conclude with the main of the study, its limitations, and recommendations for future research in line with the study carried out.

IV.2. THEORETICAL BACKGROUND AND HYPOTHESES

IV.2.1. Eco-innovation and firm performance

In the literature, terms such as green, environmental, sustainable, or eco-innovation refer to similar concepts (Schiederig et al., 2012). Hallin et al. (2021) propose to focus more on how to make this transition to sustainability and its practical application than on its unambiguous definition. Eco-innovation seems to be consolidating as the term most frequently used in recent research. Besides, European and International Institutions have coordinated efforts to clarify the eco-innovation concept, typology, drivers, and indicators to measure it similarly to general innovation.

Fussler and James (1996) proposed a former definition of eco-innovation. They considered eco-innovation as developing new products, processes or services with a significantly less environmental impact, providing value to customers and businesses. Kemp and Pearson (2008) extended the reduction of environmental impacts to the whole product life cycle. In its 4th edition (OECD, 2018), the Oslo Manual distinguishes three types of eco-innovation: product, process, and business model innovation. They can be considered a true innovation when they differ significantly from others in the market.

However, not all types of eco-innovation are equally related to positive business outcomes. Some authors affirm that eco-innovation positively impacts a firm's environmental performance and competitiveness, although its effects vary across different types of eco-innovation (Dong et al., 2014). Likewise, Almeida and Wasim

(2023) findings indicate that only product and process eco-innovation and green innovation systems positively contribute to sustainable performance in small and medium enterprises, but not for environmental technologies or organisational eco-innovations.

For investigation objectives, eco-innovation, focusing on green products and process innovation, has been measured. Several authors have found that results in green product and process innovation are linked to competitive advantage and improved outcomes (Chen et al., 2006; Pujari, 2006; Ilker Murat, 2012; Kam-Sing Wong, 2012). Green product innovation integrates environmental protection through raw material selection, product design, packaging and other elements of the value chain by reducing the negative impact of the product on the environment across its life cycle (Dangelico and Pujari, 2010; Lin and Chen, 2017). Green process innovation intends to minimise the generation of harmful substances, reduce the emission of pollutants and improve the efficiency of used energy by improving existing production processes or developing new processes (Xie et al., 2019).

In this line, the dichotomy between economic and environmental objectives could make sense in a static market paradigm, where technology, product, process, and customer needs are static. Companies focus on cost minimisation in this fixed framework, and any environmental regulation will inevitably lead to higher costs (Porter and van der Linde, 1995b). The pollution and waste generated in manufacturing processes indicate that resources have not been used efficiently. Companies then need to devote resources to the disposal of this waste, which becomes sunk costs masked in production processes. However, in today's changing economy, eco-innovation thus becomes an opportunity to improve the profitability of companies, making them more competitive (Porter and Van der Linde, 1995a). It entails a comprehensive review of the entire production process, encompassing design, raw material selection, manufacturing processes, and waste reduction or repurposing, including creating other products or their marketing.

Thus, eco-innovation appears as an excellent opportunity to restructure firms by implementing new production processes and technologies, developing new knowledge, products, and services, and improving companies' results in a more sustainable future.

Indeed, eco-innovations can contribute to reformulating the whole innovation process (Carrillo-Hermosilla et al., 2010). Likewise, eco-innovation positively correlates with firm performance and dynamic eco-capacity, creating value for customers and enterprises (Li, 2022). Notwithstanding, for Tsai et al. (2020), the strength of the association between environmental practices and firm performance has been higher in recent years – due to more exigent environmental regulation (Horbach et al., 2012), growing demand for green products by customers and the advance of green technologies – and in higher developed countries. That way, eco-innovative companies would obtain a higher return on their assets and retain their profits to a lesser extent.

Although several studies have found a positive relationship between environmental knowledge, practices, and eco-innovations with better financial performance (Bansal, 2005; Gligor et al., 2015; Liao, 2018; Almeida and Wasim, 2023; Dharmayanti et al., 2023), other authors (Sezen and Çankaya, 2013) have not found pieces of evidence of it.

To summarise, eco-innovation – in product and process – should contribute significatively to the organisational results in terms of reducing the consumption of raw materials and energy, the resulting wastes, optimising processes, shortening production times, achieving more successful products and services, in line with new consumers and markets demands. It seems plausible to assume a positive association between eco-innovation and business results.

Thus, the first group of hypotheses are formulated as follows:

$H_{4:}$ Eco-innovation is positively associated with organisational performance.

$H_{4a:}$ Product eco-innovation is positively associated with organisational performance.

$H_{4b:}$ Process eco-innovation is positively associated with organisational performance.

IV.2.2. Organisational agility and eco-innovation

The agility concept and its organisational application are being extended to the whole organisation as a reaction to disruptive markets, globalisation, new knowledge and

technologies and customers' demands (Denning, 2019). Besides, the collaboration of agile companies with their stakeholders has proven to positively affect environmental results for themselves and the whole society (Bouguerra et al., 2019).

Several authors have conceptualised organisational agility by highlighting some common aspects and emphasizing some differentiated ones. Dove (1999) first explained agility as "the ability to manage and apply knowledge effectively". This initial definition is later expanded and complemented by other authors. Sambamurthy et al. (2003) conceptualise agility as the result of three capabilities: customer, partnering, and operational agility. Teece et al. (2016) define agility as the ability of an organisation to effectively focus its resources on activities that create, protect and capture value for the organisation, according to internal and external circumstances. Conforto and Amaral (2016) define agility as the capability to swiftly adapt to customer or stakeholder requirements and market or technological shifts, aiming to enhance product performance within a dynamic and innovative setting. Felipe et al. (2016) characterise agility as the ability of an organisation to develop intentional and efficient behaviours in changing environments, reacting and anticipating change and finding opportunities, mainly through innovation and learning.

This way, agility is possible when organisations integrate new knowledge with existing information to benefit from changes before competitors do (Ashrafi et al., 2005). The dimensions of agility, triggers and enablers, practices and their effectiveness in firms' success have been analysed in several studies (Bottani, 2010; Elkareem et al., 2011; Lin et al., 2016; Oliveira, 2017; Heilmann, 2018; Schuh et al., 2018).

Dynamic capabilities theory acknowledges the role of specific organisational capabilities in shaping and reconfiguring resources for a firm's adjustment to dynamic changes in its environment (Teece et al., 1997). Moreover, agility has been considered a dynamic capability integrated with sensing capability, responsiveness and a balance between them (Teece et al., 2016; Verma et al., 2017). In this line, agility appears in the literature as a dynamic capability enabling organisations to respond proactively, flexibly and quickly to the changes and demands of the environment and stakeholders, giving it a

competitive advantage over its rivals (Bishop, 2017; Kuo et al., 2017; Chen et al., 2018; Gyemang and Emeagwali, 2020).

Previous research has studied the importance of agility for company innovation and competitiveness. The organisation's strategic flexibility has been found to be positively linked to its innovative capacity (Spanuth et al., 2020). Therefore, a firm's agility could be critical to creating competitive advantages and surviving in the changing, unstable, and uncertain business environment. Besides, committing to continuous transformation and agile strategy implies changes at organisational levels, in decision-making, in how leadership is exercised, and in the skills and interpersonal relationships of the people implementing agility. (Appelbaum et al., 2017a; Appelbaum et al., 2017b).

Some authors found that companies with a more innovative and agile profile in their processes and products and compile relevant market information are also more proactive to environmental innovation (De Marchi, 2012). Companies that launch eco-innovations develop more dynamic organisational capabilities to face changes in the environment rapidly (Wu et al., 2016). Agility is initially linked to flexibility (Fan et al., 2007). Flexibility has much to do with companies' sustainability and ability to adapt to social and environmental changes and generate green products and services that customers and markets increasingly demand. Eco-innovation or green innovation contributes decisively to sustainability by creating differentiated services and products that add value for the customer and contribute to sustainable development (Li, 2022), achieving competitive advantages.

Although the influences between eco-innovation and performance have been studied, there is a significant lack of studies analysing the link between organisational agility and eco-innovation. In a recent study, Franco et al. (2022) identified only one investigation in this line.

Considering the nature of the changing environmental demands that companies face and the importance of organisational agility to react to market changes quickly, it is feasible to consider that organisational agility should help companies increase their green innovation. Besides, eco-innovation implies changes in the processes, in the raw

materials, in the developed production processes, in the minimisation and reuse of waste and in the search for alternative products to replace the more polluting ones. Based on the above, the following hypotheses are stated:

H_5: Organisational agility is positively related to eco-innovation.

H_{5a}: Organisational agility is positively related to product eco-innovation.

H_{5b}: Organisational agility is positively related to process eco-innovation.

IV.2.3. The mediation/role of customer involvement

An agility strategy is highly pertinent for companies to proceed in today's turbulent environment (Glenn, 2009; Giones et al., 2019). This approach also focuses on a quick and efficient response to the environmental requirements of the governments and consumers themselves. The first principle of the Agile manifesto (Fowler and Highsmith, 2001) is focused on satisfying customers and giving them early and continuous value. In this regard, customers' involvement in the design and development of new products appears in most studies as a necessity to articulate more efficient responses and to detect emerging markets or niches. So, the firm's customer agility, the ability to sense and respond quickly to customers' opportunities for innovations, is crucial nowadays (Roberts and Grover, 2012).

Creating new business opportunities via eco-innovations hinges on the interplay of various dimensions—design, user engagement, product-service integration, and governance—alongside the involvement of critical stakeholders in the innovation process (Carrillo-Hermosilla et al., 2010). Biscione et al. (2021) found that the success of eco-innovation efforts was linked to cooperation among firms and institutional and external partners. Customer involvement has been considered significant in product and service development (Alam, 2006). Moreover, engaging customers enables the identification of factors on product life cycle, environmental impact, and recyclability, which can then inform the development of eco-innovations (Handfield et al., 1997; Thun and Müller, 2010).

In this line, the conception of consumers as passive recipients who buy and consume gives way to a new *user-centred paradigm* (von Hippel et al., 2011). Consumer innovators

are themselves the primary source of product innovation and market research. It is because they create new products, modify or add functionalities to the existing ones, share their innovations and become users of these new products by validating them. In many cases, they do not protect their creations with patents and selflessly share them through the Internet, sometimes even going viral. It presents an excellent opportunity for companies, from an agile perspective, to eco-innovate by collaboratively involving customers to develop and test new products and services before launching mass production and commercialisation, working on users' engagement with the brand (Gligor and Bozkurt, 2021). To the extent that new eco-products or eco-services provide their users with personal benefits - e.g. cost savings, energy savings, reparability, or health improvement - in addition to the general environmental ones, they will be more widely accepted and demanded (Kammerer, 2009). Users' involvement in the eco-innovation process will facilitate considering these private benefits.

In this same vein, Chatterji and Fabrizio (2014) consider product users as the most important source of knowledge, contributing to enhancing corporate product innovation, especially in radical innovations and new technology areas. So, the greater the complexity of the product is, the greater the involvement of customers in product development (Xiaohua and Richard, 2004). Due to investment in new technology, organisational changes, and new materials, investigations have a high cost. Companies tend to encourage customers to reduce uncertainty. Interaction between customers and manufacturers is nowadays easier with new technologies, leading to new product development models in which customers are involved as innovation partners (Nambisan, 2002).

Thus, customer demands serve as a significant driver of eco-innovations, particularly in the realm of products with heightened environmental attributes and process innovations aimed at enhancing material efficiency, reducing energy consumption, minimising non-reusable waste, and mitigating the use of hazardous substances in manufacturing processes (Horbach et al., 2012). Companies must reduce their resource consumption across sustainable materials and processes, eco-efficiency on new products, design decisions and pollution control, which directly affect the brand as an eco-label and can contribute to reaching new markets (Wu et al., 2016).

Incorporating the user perspective into eco-innovations brings them closer to the market, making them more likely to be accepted and, therefore, more successful (Carrillo-Hermosilla et al., 2010). Consumers' perception is one of the drivers of eco-innovation (Doran and Ryan, 2012). Besides, Customer involvement can be an alternative for SMEs as they can devote fewer resources to finance eco-innovation (Chen and Liu, 2019).

On the contrary, the involvement of customers in the new product development is no guarantee of their success. Carbonell et al. (2009) conclude that customer involvement does not directly boost market performance or sales; it indirectly influences the operational processes involved in developing new products or services. Campbell and Cooper (1999) results show that products developed with the participation of customers are no better than those developed solely in-house. Other authors argue that listening too much to customers can lead the most successful companies to focus solely on incremental innovations and overlook potential business opportunities in emerging markets (Chang and Taylor, 2016). For them, more significant advantages from customer participation in new product development performance are observed in turbulent markets, emerging economies, low-tech industries, business-to-business contexts, and small firms, particularly during the ideation and launch stages. Nevertheless, this is the best scenario for agility to work.

In short, markets are increasingly changing due to global trade interconnectedness. Demand for greener products and processes is widespread and reinforced by the growing awareness of climate change action by governments and citizens worldwide. Companies compete in more open markets and must stay ahead of their competitors by offering more environmentally friendly products throughout their entire production process and reusing products at the end of their useful life. In this objective, the participation of customers in the whole business process and the proximity to them can be the key to detecting new trends, new uses, and products and also to shaping the social projection of the company as a brand that contributes to the compatibility of its products and production processes with the improvement and maintenance of the environment. Furthermore, to do so agilely and ahead of the rest.

Thus, our sixth group of hypotheses is formulated as follows:

> *$H_{6:}$ Customer involvement mediates the relationship between organisational agility and eco-innovation.*
>
> > *$H_{6a:}$ Customer involvement mediates the relationship between organisational agility and product eco-innovation.*
> >
> > *$H_{6b:}$ Customer involvement mediates the relationship between organisational agility and process eco-innovation.*

IV.2.4. The moderator effect of customer involvement between product eco-innovation and organisational performance

The benefit of customer involvement extends beyond their contribution to developing new processes, products, or services. The literature points out that they can be a determining element in making such innovations successful.

The generation of new processes is usually mainly focused on internal aspects of the company, while the creation of new products aims to meet external needs (Teece, 1989; Teece and Pisano, 1994). However, product innovations are not always successful in the market. They must be perceived as helpful and valued by the end user. This way, the customers' participation in some of the stages of the product development will influence their degree of satisfaction with it and the possibility of producing a valuable product. Otherwise, new products with low market acceptance may be generated.

Customer engagement across various phases of the product lifecycle has been widely presented in the literature as a source of obtaining innovative knowledge, generating ideas for new products or services and their contribution to the creation of competitive advantages and obtaining better and more significant results in organisations (Xiaohua and Richard, 2004; Thun and Müller, 2010; Roberts and Grover, 2012). Additional researchers identified the most significant benefits of customer involvement in new product development within turbulent projects, emerging markets, low-tech industries, business-to-business sectors, and small businesses (Chang and Taylor, 2016). Other authors found that to be effective in eco-innovation performance. Enterprise customer

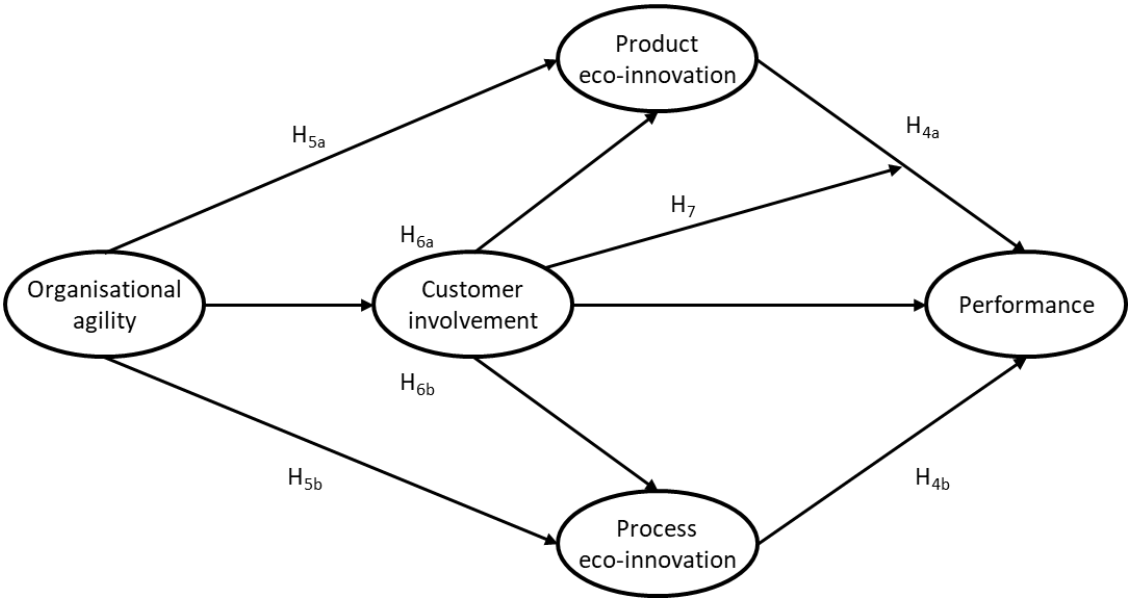
collaboration has to be aligned with science-based and supplier collaboration (Kobarg et al., 2020).

Many of the innovations that companies undertake are not usually successful for them. Which of these implemented innovations have the involvement and knowledge of the customer? Why? Because it helps design an innovation that is profitable for the company and the customer. We hypothesise that innovations that satisfy customers' needs who have contracted with the company will also be accepted by other customers and be more profitable. Thus, the effect of eco-innovation on the company's bottom line will be more significant when customers are involved. Consequently, we formulate this new hypothesis.

> *$H_{7:}$ The customer's involvement positively influences the correlation between green product innovation and organisational performance.*

Figure IV.1 shows the theoretical model and hypotheses of this study.

Figure IV.1. Model and hypotheses



IV.3. RESEARCH METHODOLOGY

IV.3.1. Sample and data collection

The study sample consists of industrial companies based in Spain, each employing over 100 individuals and having been active for at least five years. They were drawn from the source study population included in the SABI (Bureau van Dijk) database, one of the most comprehensive databases in Spain and Portugal, which collects financial analysis data based on annual accounts for the last 25 years. This choice was made to extrapolate the conclusions obtained to generalised conclusions valid in this sector of activity. The resulting database includes 2.318 enterprises.

An online survey hosted on the corporate website of the University of Murcia was used to compile the data. A pre-tested structured questionnaire was implemented. An external market research company, a regular collaborator with the university in this type of work, collected the information. After familiarisation with the questionnaire and a series of pre-tests (analysis of the questions, identification of errors or understanding of the content) with partner companies, we took in the information.

The procedure was carried out as follows. The companies were sent a letter introducing the project, with extensive information about the investigation and its connection to the research team, including the link to the online questionnaire. We reminded companies that did not respond initially, inviting them to participate in the study again. Errors in the contact addresses of some companies were also corrected. The option of surveying by telephone interview was also given. The companies were selected randomly. The following company was contacted if it was impossible to contact the selected company or the person declined to participate.

The inquiry was directed to the innovation responsible or, failing that, to the person who managed organisational knowledge. The average profile surveyed was male (87%), with an average length of service of 9 years and an average of 16 years of experience. The collection process lasted three months, and data was finally obtained from 260 companies. A power analysis was performed with G*Power, yielding power results of 0.8 and an alpha of 0.05, and, given the medium effect size, this sample meets the

minimum sample size requirement (Faul et al., 2009). Further details about the sample composition can be consulted in Table I.1, in Chapter I, page 27.

IV.3.2. Measurement and scales

The assessment of the constructs included in our investigation was carried out with a 7-point Likert-type scale. Model A composites have been used to operationalise these measures.

Organisational agility is known as a capacity linked to detecting changes in the market and making decisions. Based on Liu et al. (2018) work, we assess it as a second-order construction from three first-order constructions that comprise the measures of operational agility (4 items), partnering agility (6 items) and customer's (5 items) agility. These constructs have been obtained reflectively.

Customers' involvement refers to their participation in the design, specifications, development, and adequacy of the product or service to the final clients' needs. It has been additionally measured through a reflective scale of 5 items from Heirati et al. (2016) and Heirati and Siahtiri (2019).

For research proposals, *eco-innovation* has been measured, focusing on green products and process innovation. Both constructs are positively associated to the extent that new products lead to new processes and vice versa (Abernathy and Clark, 1985; Nielsen, 2008; Chiou et al., 2011). Using Wong (2012)' study, we include two reflective scales of five items to assess *green product innovation* and *process innovation*. The definition of eco-innovation in our study is based on the 4th edition of the Oslo Manual and the conceptualisation of green products, green processes, or green model innovation. It is a comprehensive definition reflected in the scale used to measure the related constructs.

Finally*, firm performance* is measured in comparison with the firm main competitors through the five items scale from Wang et al. (2015)'s study.

IV.3.3. Statistical analysis

The partial least squares (PLS) path model was used to examine the model. It consists of a structural equation methodology (SEM) that allows measuring different latent - not

directly observable - variables derived from the hypotheses to be measured (Cepeda-Carrion et al., 2019). These variables are measured by various indicators included in the sample (Cepeda-Carrión et al., 2016).

Following (Rigdon, 2016), PLS-SEM is an appropriate method when the data are not necessarily normal, in an exploratory study of relationships that are not widely contrasted in the literature is being carried out, or when the reflective variables are used to measure concepts that can both explain and be explained by other variables. In addition, PLS can be used for confirmatory purposes (Henseler, 2018).

Software SmartPLS 3.3.3 (Ringle et al., 2015) was used to evaluate the measurement model and estimate the structural model.

IV.4. RESULTS

The PLS-SEM methodology usually implies a global analysis of the model. It verifies the reliability and validity of the measurements and examines the relationships included in the structural model (Henseler et al., 2016). We are now evaluating the measurement and structural models.

IV.4.1. Measurement model

Various assessments were conducted following the approach outlined by Henseler et al. (2016) to validate the measurement model. Specifically, these analyses, employing the saturated model, yielded a standardised root mean squared residual (SRMR = 0.066), unweighted minimum squares discrepancy (d_{ULS} = 0.837), and geodetic discrepancy (dG = 0.359) values that fell within acceptable limits (values below the percentile levels established through 95% bootstrapping). These findings affirm that the model demonstrates satisfactory PLS-SEM adjustment, as Albort-Morant et al. (2018) indicated.

The reliability and validity of the reflective composite scales (Mode A) have been tested using different criteria. The results are shown in *Table IV.1*. Individual reliability of all indicators has higher than 0.7 values (Bagozzi and Yi, 1998). In the same way, the

average extracted variance index (AVE) also reaches values above 0.5 (Bagozzi and Yi, 1998), showing the existence of convergent validity (Fornell and Larcker, 1981).

Likewise, the discriminant validity has been verified through a pair of tests. On the one hand, we have applied the test of the mean extracted variance and the correlations of the latent variables (Fornell and Larcker, 1981). *Table IV.2* shows that the square root of each AVE value is higher than the correlations of the variables. On the other hand, it also includes the results of the second test, showing that the heterotrait-monotrait ratio (HTMT) values are lower than 0.85 (Henseler et al., 2015). Based on these two criteria, discriminant validity in our model has been confirmed.

Table IV.1. Reliability and validity

Construct	*Items*	*Coef.*	*Std*	*t-st*	*Reliability & validity*
Operational agility	We are able to quickly respond to changes in our customers' products or service needs.	0.817	0.030	27.179	α: 0.860 CR: 0.905 AVE: 0.704
	We fulfil demands that require a rapid response and include special requests of our customers whenever such demands arise; our customers are confident in our ability.	0.802	0.030	26.762	
	We can quickly scale our production/service levels up or down to support fluctuations in market demand.	0.849	0.027	31.773	
	When a disruption occurs in our production or service, we can quickly make necessary alternative arrangements and internal adjustments.	0.886	0.015	60.959	
Partnering agility	Employees learn more soft skills that are required to manage customer encounters.	0.744	0.034	21.797	α: 0.889 CR: 0.915 AVE: 0.644
	We are able to quickly implement new governance structures.	0.835	0.025	33.682	
	We can combine, recombine, and create new business processes with little notice.	0.845	0.022	39.061	
	Through online, rapid, and up-to-date communications among partners, we are able to reduce information discrepancies.	0.744	0.037	20.216	
	It allows us to innovate our service offerings technologically.	0.793	0.045	17.607	
	It brings us about new ways of managing organizational structures and partnerships.	0.845	0.022	38.738	
Customer agility	We can quickly make and implement appropriate decisions in the face of market/ customer changes.	0.783	0.038	20.507	α: 0.882 CR: 0.926 AVE: 0.758
	We can quickly respond to changes in our customers' products or service needs.	0.913	0.013	68.062	
	Co-opting with customer gives us greater contextual ability to explore opportunities and options.	0.884	0.022	40.240	
	Partnering with customer makes the customer service experience more memorable.	0.895	0.018	50.998	
Customer involvement	Assist customers to define the product/service specifications	0.909	0.019	47.238	α: 0.898 CR: 0.936 AVE: 0.830
	Interact with our customers to jointly deploy (e.g., implement, operate) the product/service	0.905	0.021	42.768	
	Work with customers to improve the efficiency of the deployed service / the adequation of product offered	0.920	0.017	54.913	
Green product	We use less or non-polluting/toxic materials	0.704	0.050	14.184	α: 0.855 CR: 0.897 AVE: 0.635
	We use environmentally friendly packing	0.822	0.026	31.650	
	When designing new products, we take recycling and disposal at the end of life into account	0.857	0.019	44.776	
	We use recycled materials	0.745	0.041	17.943	
	We use recyclable materials	0.848	0.024	34.781	

Table IV.2. Reliability and validity (cont.)

Construct	Items	Coef.	Std	t-st	Reliability & validity
Green process	They consume less resources (e.g. water, electricity etc.) than those of our competitors	0.769	0.034	22.930	α: 0.840 CR: 0.887 AVE: 0.612
	We recycle, reuse and remanufacture materials or parts.	0.686	0.052	13.216	
	They use cleaner or renewable technology to make savings (such as energy, water and waste)	0.827	0.029	28.835	
	We redesign our production and operation processes to improve environmental efficiency	0.857	0.023	36.515	
	We redesign and improve our products or services to meet new environmental criteria or directives (such as WEEE Directive, RoHS Directive etc.)	0.761	0.033	23.095	
Organizational performance	Sales growth	0.896	0.020	45.336	α: 0.870 CR: 0.918 AVE: 0.789
	Profit growth	0.880	0.024	37.385	
	Return on investment	0.889	0.019	46.990	

Notes: Bootstrapping with 5000 resamples; Coef.= Path coefficient; Std= Standard deviation; t-st =Student's t value; α= Cronbach alpha; CR= composite reliability; AVE= average variance extracted

Table IV.3. Correlations and discriminant validity

	1	2	3	4	5	6	7
Operational Agility	**0.839**	0.539	0.586	0.489	0.371	0.377	0.416
Partnering Agility	0.473	**0.802**	0.599	0.391	0.398	0.377	0.427
Customer Agility	0.512	0.529	**0.870**	0.628	0.442	0.439	0.489
Customer involvement	0.434	0.349	0.562	**0.911**	0.397	0.417	0.329
Green product	0.323	0.350	0.387	0.349	**0.797**	0.743	0.365
Green process	0.322	0.329	0.385	0.360	0.626	**0.782**	0.379
Organizational performance	0.366	0.379	0.430	0.296	0.321	0.347	**0.888**

Notes: The diagonal elements (bold figures) represent the square root of the shared variance between the constructs and their respective measures. Below the diagonal, you find the correlations between constructs, while above the diagonal are the Heterotrait-Monotrait Ratio (HTMT) values.

In the end, we have reviewed the existence of the endogeneity problem following the suggestions by Hult et al. (2018). The Gaussian cupola analysis results do not show relevant indicators on this issue. Nevertheless, we have used four control variables to diminish the presence of omitted variables as sources of endogeneity (Hult et al., 2018).

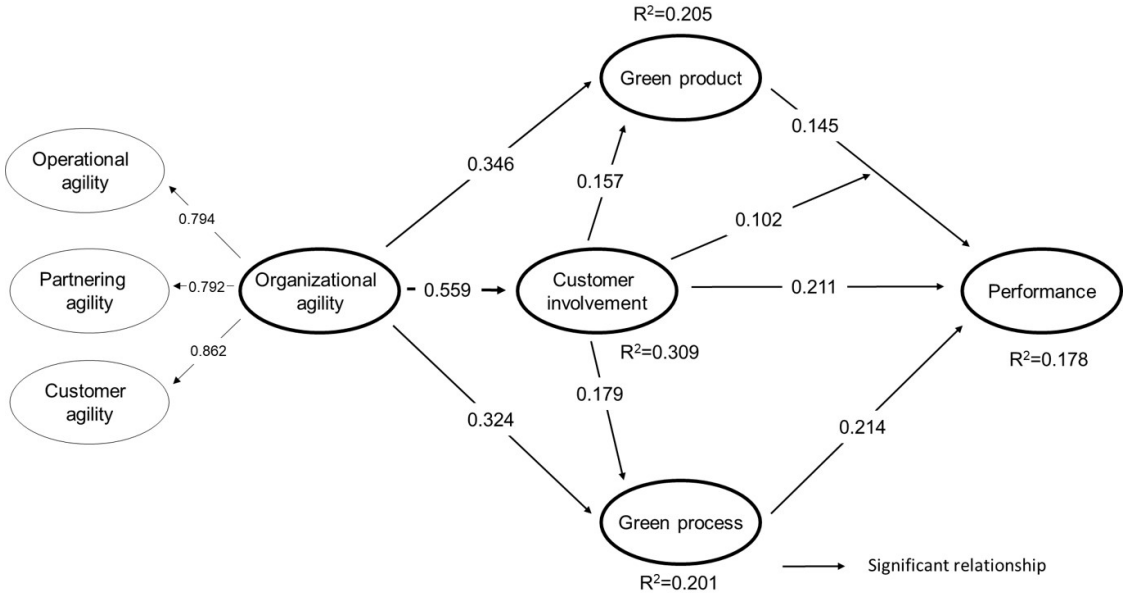
IV.4.2. Structural model

Figure IV.2 presents the resulting structural model from the PLS-SEM analysis. The significance of the parameters that examine the relationship among the different constructs has been obtained through bootstrapping using 5.000 resamples for one tail of the t-student. Figure IV.2 shows the significance for most of the paths, and the R^2 for each construct is explained. Organisational agility was confirmed as a second-order

factor, significantly manifested in three first-order constructs. Moreover, the moderating effects were calculated using this software with the two-stage calculation method and as the standardised product of the terms.

The fourth hypothesis suggested a positive correlation between eco-innovation and organisational performance. The results indicate that the path coefficients of the relationship between green product ($H_{4a:}$ β = 0.145, p<0.05) or green process ($H4_{b:}$ β = 0.214, p<0.01) and organisational performance are positive and significant, which supports our first hypothesis. Companies' efforts in generating and developing new products or improving environmentally oriented processes positively impact their business performance (Huang and Li, 2017; Almeida and Wasim, 2023).

Figure IV.2. Empirical model results



We analysed the relationship between organisational agility and eco-innovation in the fifth hypothesis. Again, our results show that organisational agility has a positive relationship with both green products ($H_{5a:}$ β = 0.346, p<0.001) and green processes ($H_{5b:}$ β = 0.324, p<0.001). These results support the assumption that a more agile organisation facilitates the creation of eco-innovative products and processes following Aboelmaged and Hashem (2019)'s study.

An agile company demonstrates a greater capacity to implement changes in its forms of organisation and production, to generate new internal knowledge and integrate

external one, to respond nimbly to the demands of its stakeholders and the markets in which it operates, and to detect new business opportunities in products and market niches.

Table IV.4. Structural model results

	Coef.	Std	t-st	LL	UL
Direct effects					
Green product → Org. performance	0.145*	0.084	1.735	0.009	0.284
Green process → Org. performance	0.214**	0.081	2.629	0.078	0.345
Org. Agility → Green product	0.346***	0.077	4.472	0.217	0.471
Org. Agility → Green process	0.324***	0.076	4.272	0.201	0.447
Org. Agility → Customer involvement	0.559***	0.052	10.752	0.471	0.642
Customer involvement → Green product	0.157*	0.081	1.942	0.024	0.291
Customer involvement →Green process	0.179*	0.082	2.184	0.048	0.316
Customer involvement → Org. performance	0.211***	0.064	3.277	0.104	0.313
*Customer involvement * Green product → Org. performance*	0.102*	0.047	2.154	0.023	0.180
Indirect effects					
Org. Agility → Customer involvement → Green product	0.087*	0.048	1.830	0.013	0.171
Org. Agility → Customer involvement → Green process	0.100*	0.050	2.000	0.025	0.187
Org. Agility → Green product→ Org. performance	0.050	0.034	1.463	-0.001	0.114
Org. Agility → Green process→ Org. performance	0.069*	0.034	2.040	0.020	0.130
Org. Agility → Customer involvement → Org. performance	0.118**	0.039	3.031	0.057	0.183

Notes: Coef.= Path coefficient; Std= Standard deviation; t-st =Student's t value; *p<0.05; **p<0.01; ***p<0.001; t(0.05;4999)=1.6451; t(0.01;4999)=2.327; t(0.001;4999)=3.091; LL=Lower 95% percentile confidence interval; UL= Upper 95% percentile confidence interval

The sixth hypothesis centres on the mediating function of customer involvement. Several significant relationships have been found that support this idea. First, organisational agility is significantly related to customer involvement (β = 0.559, p<0.001). Second, customer involvement also has a positive effect on both green product (β = 0.157, p<0.05) and green process (β = 0.179, p<0.05). Finally, our results show a significant indirect effect from organisational agility to both green products ($H_{6a:}$ β = 0.087, p<0.05) or green process ($H_{6b:}$ β = 0.100, p<0.05) through customer involvement. These results indicate the importance of involving customers in the product or service life cycle (Carbonell et al., 2009; Morgan et al., 2018; Chen and Liu, 2019).

Hereunder, we have tested with the seventh hypothesis the moderating effect of customer involvement on the relationship between green product and organisational

performance. Table IV.3 reveals a positive and significant effect (H_7: $\beta = 0.105$, $p<0.05$), which suggests that the involvement of the customer in the development of product eco-innovations guarantee the success of this new product and the positive returns to the company (Chang and Taylor, 2016).

The results also support the previous literature that sustains the importance of customer involvement in the improvement of organisational performance ($\beta = 0.211$, $p<0.001$) (Ngo and O'Cass, 2013).

Finally, we have identified some relevant information from the observation of the indirect effects of organisational agility on organisational performance through green process ($\beta = 0.069$, $p<0.05$) and customer involvement ($\beta = 0.118$, $p<0.01$), although we have not found this effect through green product. These results reveal the importance of organisational agility as an organisational capacity for introducing organisational changes that improve organisational performance (Hizarci-Payne et al., 2021; Li, 2022).

IV.5. CONCLUSIONS

This research first explores the relationship between eco-innovation and organisational performance. Our investigation has found a positive relationship between both constructs in line with previous studies (Bansal, 2005; Gligor et al., 2015; Liao, 2018). Nowadays, implementing green processes and knowledge in companies and developing eco-innovation in processes and products is imperative in the search for better results and an unavoidable response to the new environmental demands and the growing ecological awareness of consumers (Chen and Chang, 2013). This way, companies focused on eco-innovation could obtain better results by implementing new processes and enriching their internal and external knowledge management.

Furthermore, this study addresses various gaps previously identified in the literature. In this vein, we introduce dynamic capabilities theory applied to the organisational agility construct (Oduro et al., 2022) and its relationship with eco-innovation development in processes and products, which has not been studied enough (Franco et al., 2022). This investigation highlights the positive influence of organisational agility in promoting and generating eco-innovations in companies and the beneficial effects of these on the firm

results. Perhaps the main contribution to the literature of this study is the exploration of the link between agility and green innovation. Agility can additionally contribute to develop successful new green products, increasing the company results with a lower environmental impact.

Moreover, regarding the lack of moderating variables between green innovation and firm performance (Oduro et al., 2022), our model illustrates the mediating function of customer involvement in green innovations, emphasising the influence of eco-innovations on business results. They support the assumption that customer involvement not only positively moderates the effect of organisational agility on new green processes and products but also makes green product innovations more successful for current clients and similar future demands.

Managerial implications

Organisations should adapt their structures, practices and production processes to react more agilely to changes in markets and new green trends in products and services (Denning, 2018; Denning, 2019). In this context, integrating agile methodologies and practices across all facets of the organisation has emerged as a fitting response to the advancement of eco-innovation within companies. Organisations that develop eco-innovations are more agile to face market changes (Wu et al., 2016). To this end, the gradual introduction of agile practices in strategic management models will facilitate companies' adaptation to the new demands of their stakeholders. It will encourage the flow of internal knowledge creation and the acquisition of new knowledge to transform their business through sustainability. In this line, we share the recommendation that Chiou et al. (2011) propose that companies engage in green innovations to enhance their environmental performance and gain a competitive edge in a dynamic global market.

Companies' managers should lead a shift from the current environmentally hostile paradigm to a radically different one (Pujari et al., 2003) that pushes organisations to redesign their processes and products, with the participation of users, turning their products and services into a sustainable activity. This new "user-centred innovation paradigm" recognises consumers as the primary source of product innovations (von

Hippel et al., 2011). For this reason, companies should integrate consumer-develop innovations in the innovation procedures and products, giving them an active role and recognising their contributions to performance success.

Limitations

This research is not without limitations, which, in turn, could lead to additional future research lines too. Firstly, the availability of more than one point of view per company would enrich the study and perhaps provide more precise information from each participating firm. Secondly, the peculiarity of the Spanish context in terms of innovation and eco-innovation policies, financing, environmental regulation, ..., would not allow the results to be extrapolated to other countries without replicating the study and establishing similarities and differences with the results obtained from our sample. Thirdly, broadening the study beyond the industrial sector to examine potential intersectoral variations would be exciting. It would also be interesting to extend the study to other sectors than industry to analyse possible intersectoral differences. Commercial and public firms could be two attractive sectors to explore, especially the second one. There are few known experiences in applying agility in public agencies and enterprises. Fourthly, the availability of longitudinal data would also allow a more balanced analysis of the maintenance of specific eco-innovation strategies in organisations. It is not unreasonable to assume that the strategic decisions of the participating companies and those worldwide were affected by this situation. In some way, they may also have conditioned the perception and responses of the participating subjects.

Future research lines

Future investigation lines could begin by analysing the influence of innovation strategy on the synergy between agile processes and eco-innovation success. While certain companies face significant challenges in process restructuring, they can still attain eco-innovation success through agile development. Investigating the critical factors driving companies to adopt agile methodologies could be particularly interesting. Additionally, future studies could delve into how agility and customer involvement affect the different types of eco-innovation (product, process, organisational). Finally, it could also be

interesting to explore the impact of robotics, artificial intelligence and new technologies in "agility" and "green" perceptions, and how the new business models will evolve in the future.

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V. DYNAMIC KNOWLEDGE MANAGEMENT CAPABILITIES FOR SUCCESSFUL PRODUCT ECO-INNOVATION

V.1. INTRODUCTION

The global economy is influenced by conflicts and situations which, even if they occur in one part of the world, will have repercussions for all the actors involved, regardless of where they live. Local or regional economies are affected by war, logistical or environmental problems with international consequences. Facing these situations, companies seek different strategies to deal with them successfully and to perpetuate and develop over time.

Lessons learned from recent crises have highlighted the need to focus on knowledge-generation processes that help keep organisations resilient to environmental changes and agile in managing their processes to obtain innovations quickly. Supply chains face increased volatility and competition. Besides, accurate customer demand estimation is challenging due to shifting preferences and shorter product lifecycles. This way, managing demand and supply uncertainties is crucial for customer satisfaction and cost control (Merzifonluoglu, 2015).

In this line, a growing global awareness pushes companies and society to develop processes and products that are more respectful of the environment, going deeper into the economy of resources, material recycling, and the global sustainability of human activity. Besides, the most innovative and environmentally conscious companies are increasingly aware that in addition to meeting the demands of risky innovation processes in turbulent environments, they must also introduce technology that allows them to be more environmentally friendly. Thus, information technology and enhancing the organisation's digital capabilities are crucial to optimise the supply chain (Aldoghan, 2023).

The inclusion in the organisational strategy of approaches that consider agility and resilience as complementary and compatible in their simultaneous application on the supply chain can help maintain the organisation's competitive edge in a dynamic and uncertain business landscape (Carvalho et al., 2012; Altay et al., 2018; Dubey et al., 2018; Aldoghan, 2023). This study adopts that double approach, too. Agility pertains to an organisation's capacity to swiftly adapt and innovate in response to evolving

circumstances. At the same time, resilience assures the organisation's ability to endure and recover from adversity, disruption, or crisis. In such a way, resilience implies flexibility and agility (Christopher and Peck, 2004).

Organisations should permanently maintain processes of reconfiguration, creation, and integration of skills to achieve a long-term competitive advantage while their environments evolve (Eisenhardt and Martin, 2000; Teece, 2007). In particular, in today's global economy, marked by escalating technological advancements and business globalisation, the presence of dynamic capabilities in organisations is crucial for enduring success (Luo, 2000). Dynamic capabilities were principally described as the organisational capacity to effectively manage, integrate, and reconfigure both internal and external competencies to adapt to changes in the business environment (Teece et al., 1997). Coordinating or integrating, learning and reconfiguring – three managerial processes – were proposed as base elements of the dynamic capabilities (Teece and Pisano, 1994; Teece et al., 1997). Eisenhardt and Martin (2000) broaden the notion of dynamic capabilities to encompass familiar organisational and strategic processes, such as alliances or product development, which derive strategic significance from their capacity to leverage existing resources for the creation of value-generating strategies.

Based on the dynamic capabilities view, this study shows empirical evidence of how information capability and knowledge management capacities could facilitate the implementation of organisational agility and resilience to develop successful green products and how they all contribute developing competitive advantages enduring in time (Dubey et al., 2018). Dynamic capabilities are considered strategic elements of business performance in today's changing environment, especially with high turbulence and disruption (Hendry et al., 2019; Wamba et al., 2020).

Two main contributions are noteworthy in this study. On the one hand, it is the first to address a model that simultaneously investigates the use of IKARG strategies (Information, Knowledge Management, Agility, Resilience and Green Innovation) in the same organisation—extending the former application of former LARG strategies in the supply chains referenced by various authors in the literature (Carvalho et al., 2011; Duarte and Cruz-Machado, 2013; Sharma et al., 2020; Anvari, 2021; Sonar et al., 2022).

Additionally, a new organisational agility assessment scale has been developed and tested based on the application, within organisations, of the agile methodologies principles (Fowler and Highsmith, 2001).

This study proceeds as follows. Firstly, we introduce the theoretical bases and the relevant constructs of the investigation model and present the formulated hypotheses. Secondly, we expose the procedure regarding sample and data compilation. Thirdly, chosen measures and scales, data processing, and control test of the model are shown. Fourthly, we discuss the results and evaluate the hypotheses. Finally, we summarise the findings, main contributions to the literature, limitations, and suggestions for future research based on the constructs examined in the study.

V.2. THEORETICAL BACKGROUND AND HYPOTHESES

V.2.1. Eco-innovation

Growing international regulations and consumer interest in environmental protection drive companies to develop environmentally friendly products (Chen and Chang, 2013). In this line, Sezen and Çankaya (2013) found that eco-innovation positively affects environmental and social performance. Moreover, green product and process innovations are positively associated with both green product competitive advantage and the success of new green products (Kam-Sing Wong, 2012; Hang et al., 2022).

The fourth edition of the Oslo Manual incorporates three categories of innovation: product, process, and business model innovation (OECD, 2018). According to Oslo Manual, a product is considered an innovation if it significantly differs from the previous goods or services introduced on the market by the firm. We focus our study on successful green product innovation. The key role of effective green product development lies in its contribution to the success of environmental strategies and in helping companies to achieve environmental sustainability (Pujari et al., 2003). According to Albino et al. (2009), companies that develop green products show a higher adoption of strategic environmental approaches compared to those that do not. In this sense, companies are paying more attention to the development of green products due to the growing public awareness of environmental issues. And if companies can offer products or services that

meet their customers' environmental requirements, then those customers would be more inclined to buy their products or services (Chen, 2010).

Eco-innovation general improvement requires a combined strategy that includes innovation, research and environmental tools and policies (Jové-Llopis and Segarra-Blasco, 2018). In this sense, eco-innovation has differential characteristics concerning other types of innovation. Developing eco-innovations requires greater use of external knowledge (Chatterji and Fabrizio, 2014; Forés and Camisón, 2016) through external sources of information by assimilating research and development from external firms and via cooperation formulas, also from outside the supply chain such as research institutions, universities, and competitors (De Marchi and Grandinetti, 2013).

On the other hand, inspired by Teece et al. (1997) dynamic capacities definition, green dynamic capacities could be conceptualised as the company's capacity to leverage its current resources and expertise for the enhancement and evolution of its environmentally sustainable organisational abilities in response to the ever-changing market dynamics (Chen and Chang, 2013). Several authors enhance the benefits of this type of dynamic capabilities and their effects on the competitiveness of companies and the drive for innovation (Farzaneh et al., 2022; Pundziene et al., 2022).

Not surprisingly, in a competitive context, resilience and agility, two dynamic capabilities, contribute positively to the development of eco-innovation. On the one hand, resilient organisations are needed to survive crises and must generate innovations that offer new products in response to new demands. On the other hand, companies must show agility, fast processes, and leaders and employees that facilitate the successful development of innovations. In the current highly unstable, changing, or turbulent global economic context, the combination of resilience in the face of challenges and agility in decision-making can be powerful tools for general innovation and eco-innovation.

V.2.2. Resilience and green innovation

Adaptability has been an acknowledged virtue throughout the history of humanity. Organisations, essentially human entities, find a valuable perspective in the concept of adaptability to address the complexities of organisational change. The challenge for

organisations lies in recognising that many elements of adaptability are already integrated into their human capital and processes, just waiting for the necessary support to manifest themselves (Home and Orr, 1997). The term resilience is used in several spheres of human activity (Ponomarov and Holcomb, 2009; Bhamra et al., 2011; Kamalahmadi and Parast, 2016). From a psychological perspective, it refers to people's ability to face adverse situations and emerge stronger. In the business context, it relates to a company's ability to adapt to market changes and sustain its competitive position. In engineering, it is associated with the ability of systems to recover effectively after a failure. In general terms, resilience represents a fundamental skill that enables individuals and organisations to overcome challenges and adapt to environmental changes.

From an organisational perspective, resilience was defined by Fiksel (2003) as the system's ability to endure disruptions while maintaining its structure and functionality, promoting diversity, efficiency, adaptability and internal cohesion, and reducing vulnerability to unforeseen factors. In the business context, the enterprise resilience ability of an organisation contributes not only to survival but also to adapting and thriving in significant and unpredictable changes (Fiksel, 2006). Resilience is widely recognised as a valuable practice for managing risk and uncertainty within complex business landscapes and alleviating supply chain disruptions.

In this sense, Ponomarov and Holcomb (2009) provided a multidisciplinary definition of supply chain resilience as the capability to adapt, proactively anticipate unforeseen events, efficiently manage disruptions, and restore operations while maintaining the desired level of connectivity and control over its structure and function. Likewise, in a recent review of supply chain resilience literature, Al-Banna et al. (2023) provide a thorough definition of supply chain resilience, encompassing the capability of a supply chain to anticipate disruptions and react to unforeseen events, endure disturbances, restore operations, and promptly recuperate costs while sustaining favourable growth levels. Finally, we have adopted Ambulkar et al. (2015) conceptualisation of resilience, that is, according to our dynamic perspective, defining it as the firm's ability to promptly recognise, adapt to, and effectively react to alterations caused by a supply chain disruption.

A great resilient supply chain not only enables the anticipation of unforeseen events but also ensures its continuous operation, swift recovery from disruptions, and the enhancement of competitive advantage (Namdar et al., 2017). Some authors have found that companies that engage in green supply chain management recover earlier from stock-outs (Fasan et al., 2021) and reduce the time to recover from the economic and financial effects of crises such as COVID-19, improving their financial and organisational resilience (Irfan et al., 2022).

Blackhurst et al. (2011) studied numerous resilience enablers and reducers. They identified thirteen enablers: human organisational, inter-organisational and physical capital resources. Regarding the reducers, they recognised seven included in flow activities, flow units, and source of flow units. Firms could minimise the impact of resilience reducers. However, resilience reducers may be beyond the control of the companies, so these authors believe that it might be more effective for companies to focus their efforts and resources on developing resilience enhancers.

The criticality of resilience in supply chain disruptions varies according to the impact of the disruption. So, in low-impact disruptions, the mere provision of an organisational infrastructure and the availability of resources can mitigate their effects. However, in situations of high disruptive impact, the firm's level of resilience is crucial because it will determine how existing structures and resources are arranged and how they are configured to minimise the negative impact of disruptions in the supply chain (Ambulkar et al., 2015). The traditional risk management paradigm that companies use to protect themselves from predictable risks such as fires or power outages needs to be revised in today's complex and turbulent global economic and environmental context. Amidst complexity and turbulence, where disruptions frequently appear inscrutable and unpredictable, the task of risk assessment becomes unmanageable, rendering traditional risk management practices unsuitable. It has to be complemented by a resilience management perspective (Fiksel, 2015). In this line, adaptability, flexibility and agility are implicit concepts in all resilience strategies (Kamalahmadi and Parast, 2016).

The resilience perspective carries significant implications for companies aiming to enhance their sustainability (Wu and Tham, 2023). It should lead to incremental changes

that neither harm nor substantially benefit the enterprise or society (Fiksel, 2003). Developing adaptive policies and strategies is essential for societal and industrial institutions to navigate unforeseen challenges effectively. It balances their imperative for growth and flourishing while concurrently addressing long-term human and ecological well-being considerations. In this line, our eighth hypothesis is formulated as follows:

$H_{8:}$ Organisational resilience is positively related to green product success.

V.2.3. Agility and green innovation

Sometimes, not always consciously, companies implement strategies and mechanisms that could be described as agile to deal with the problems that arise, adapt to environmental changes, and meet the demands of not only their customers but also their stakeholders. That is why, in this study, we propose a new form of organisational agility validation by testing the application in organisations of the principles of agile methodologies (Fowler and Highsmith, 2001) in the company. Agile companies must be able to perceive how environmental changes affect their operations and implement timely improvements to safeguard them.

Eco-innovation contributes to sustainable development by creating new sustainable services and products whose added value is perceived by the customers (Li, 2022). Some authors have observed that increased investment in green product and process innovation correlates with enhanced competitive advantage for the company (Chen et al., 2006; Pujari, 2006; Ilker Murat, 2012; Kam-Sing Wong, 2012). Integrating environmental innovation into a firm's strategy establishes a positive correlation between product and process innovation and competitive advantage (Skordoulis et al., 2020). That is especially relevant in companies that adopt environmental strategies involving the whole organisation (Albino et al., 2012).

On the contrary, Aragón-Correa and Sharma (2003) emphasise the importance of the broader business environment in moulding a proactive environmental strategy's dynamic capability and moderating influence on deriving competitive advantages from such a strategy. They contend that the association between an active ecological strategy and competitive advantage may not consistently be unconditionally positive, as it is

contingent on the impact of diverse features of the overall business environment, including uncertainty, complexity, and munificence. In this line, Mady et al. (2023) argue that internal dynamic capacities do not always lead to sustainable competitive advantage and that organisational capabilities do not significantly impact eco-innovation.

The fundamentals of agility are mainly based on two interdependent elements in a dynamic enterprise: business management that combines and recombines technologies and flexible structures that can change quickly (Teece et al., 2016). This agility can be applied to both strategic and operational aspects, so business agility also provides greater strategic flexibility (Overby et al., 2006; Fan et al., 2007) and the use of agility and flexibility practices contributes positively to competitive strength (Oliveira, 2017; Gyemang and Emeagwali, 2020). Besides, agility is associated with supply chain responsiveness during disruptions and emergencies (Christopher and Peck, 2004; Ponomarov and Holcomb, 2009).

Sustainability is an economic and social imperative nowadays. Companies must consider environmental and social changes to adapt and respond efficiently to their customers' demand for eco-friendly products to achieve this. Eco-innovation thus acquires importance as a contributing factor to the sustainability of organisations. Eco-innovation develops distinctive products and services, ensuring sustainable value delivery to customers (Li, 2022). Furthermore, it fosters the more effective administration of business processes and technology, delivering a sustainable competitive advantage to the company and creating social and environmental value for its customers and suppliers (Lazaretti et al., 2020). In this way, companies can benefit from implementing efficient practices, creating new products and services that meet changing consumer demands, protecting the environment, and increasing their ability to adapt to unpredictable business environments (Kiranantawat and Ahmad, 2022).

Firms' agility positively impacts environmental performance by acting as an intermediary between organisational strategy, customer satisfaction and financial performance. Moreover, fostering this connection means advancing by adopting new technologies, defining new strategies, satisfying customers, and ensuring the economic benefit and

implementation of environmental policies (Mirghafoori et al., 2017). Hence, companies aiming to enhance their operational performance by adopting environmentally friendly practices should prioritise investments in developing agility capabilities (Salandri et al., 2022). In this line, while eco-innovation and its relationship with company results have been widely studied, a recent review of the literature reveals that there needs to be more research on the relationship between organisational agility and eco-innovation (Franco et al., 2022).

Considering the above argumentation, we hypothesise that:

H_9: Organisational agility is positively related to green product success.

V.2.4. Knowledge management dynamic capability

Nowadays, companies operate in a globally competitive environment in which technological advances and customer needs are constantly changing. They need to keep up with these changes by continually regenerating their knowledge. An effective knowledge management system enables a company to apply new knowledge to improve its internal operations. In this line, internal and external knowledge combinations foster eco-innovation (Vega-Jurado et al., 2008; Shearmur and Doloreux, 2013). Companies should be able to renew their experience and knowledge in different operational areas such as market knowledge, customers' needs (Awan et al., 2021), or internal processes. The result should enrich their know-how, leading to better outcomes. From the perspective of dynamic capabilities, it is imperative for companies to continuously build, integrate, and reconfigure their competencies and skills. That enables them to adapt to their environment and maintain a competitive advantage (Eisenhardt and Martin, 2000). Dynamic capabilities are considered enterprise-focused and indispensable for integrating environmental and social responsibilities within the supply chain (Beske, 2012).

We have followed the knowledge-based dynamic capabilities conceptualisation and scale (Zheng et al., 2011) for the research proposal. They define it as the ability to acquire, generate and combine knowledge resources that enable the organisation to perceive, explore and cope with environmental changes. Additionally, they distinguish

three sub-capabilities - knowledge acquisition, knowledge creation and knowledge integration - that together make up the dynamic capabilities of a firm. Although these dynamic capabilities have common characteristics across firms, the specific ways in which they seek, develop and apply them differ from firm to firm, leading to differentiated organisational outcomes (Eisenhardt and Martin, 2000).

While dynamic capabilities empower companies to identify opportunities in novel and effective manners, they do not ensure organisational success (Zahra et al., 2006). Through information technology applications, knowledge management, internal and external, has been a significant influencer on dynamic capabilities and a major catalyst for enhancing quality and achieving business excellence (Sher and Lee, 2004). In this line, research has shown that sharing green knowledge stimulates the cultivation of dynamic capabilities within firms, leading to more effective resource utilisation, the advancement of green innovation, and the attainment of a competitive edge in sustainability (Lin and Chen, 2017).

According to Dangelico (2016) literature review, top management commitment, collaborative networking, improving internal and external knowledge management, inter-functional integration, and resource and capacity building are the critical factors for success in green product innovation. Likewise, green product innovation can lead to cost savings, increased market share, sales, turnover, profit, exports, reputation, productivity, and competitive advantage.

Nevertheless, it is necessary to clarify if the green innovation performance effect on the corporate competitive advantage is always linear, as Chen et al. (2006) obtained. On the contrary, in a later study, Chen and Chang (2013) found that it was proper for companies with a low green innovation performance but not for firms with a high level. In the first case, they could obtain a better competitive advantage by investing in green innovation, which sometimes happens to more green innovating organisations.

On the other hand, some authors identify knowledge management as a clear indicator of organisational resilience and agility. For them, the obtaining, sharing and application of novel knowledge help to create an environment conducive to staff engagement in

proactive and adaptive agility and resilience activities (Ibrahim Ismael et al., 2021). In this line, knowledge management dynamic capability is correlated with improved firm performance with the mediation of organisational agility, especially in highly competitive new environments (Liu et al., 2014; Gyemang and Emeagwali, 2020).

We are turning now to the relationships between these dynamic capabilities.

Knowledge and agility

Nowadays, agility in organisations is no longer a goal or a strategy but rather a strategy, but as something consubstantial to their survival. Organisations have always had to be agile enough to adjust to their changing environment or cease to exist. Today, however, the environment is evolving even faster than it used to, and the most worrying thing is that most organisations need help adapting to this continuous change (Dove, 1999). It is essential to cultivate agility as an active mindset, adapting it effectively to the particular needs and circumstances of the organisation to achieve efficient results (Dove, 2006).

In this line, an appropriate knowledge management capacity will positively impact business performance. The level of organisational agility plays a crucial mediating role in this relationship, especially in creating new opportunities and exploring innovations in highly competitive markets. (Liu et al., 2014). Organisational agility significantly impacts business performance in changing environments (Tallon and Pinsonneault, 2011; Verma et al., 2017). Speed is vital in managing unexpected risk situations such as disasters (Dal Mas et al., 2022) or supply chain disruptions. Nevertheless, achieving speed necessitates the establishment of a swiftly advancing knowledge stream. In this context, barriers to knowledge impede the exchange of critical information and the application of knowledge to address specific problems (Riege, 2005). Re-synthesising externally acquired knowledge is essential to create new opportunities (Baškarada and Koronios, 2018). In this way, learning and knowledge are determinants for becoming more agile (Sherehiy et al., 2007; Bahrami et al., 2016).

Knowledge and resilience

Knowledge could also hedge against risks, disruptions, or adversities within organisations. Through sequential knowledge management practices (acquisition,

assimilation, and application), it develops an organisational culture of risk management that contributes positively to the resilience of the supply chain in risk situations affecting it (Ali et al., 2023).

Other researchers have identified a positive and substantial correlation between knowledge management and organisational resilience, enhancing organisational adaptation and learning (Godwin et al., 2013). For instance, when staff see benefits in risk reduction programmes and are motivated to implement them, they actively participate in knowledge development actions, improving their ability to integrate new knowledge and manage supply chain risks more effectively (Ambulkar et al., 2016), thus contributing to increased organisational resilience. In this line, in environments where uncertainty prevails, a firm's survival depends on acquiring and harnessing the right capabilities.

Understanding innovation capability as a dynamic internal capability for success, innovative firms not only build resilient supply chains and adopt significant innovations but also respond strongly to shocks, and the severity of shocks influences the magnitude of innovation (Gölgeci and Ponomarov, 2013). Managers would consider utilising innovative capacities to structure the supply chain more effectively and ensure a more efficient and enduring response to adverse incidents (Gölgeci and Ponomarov, 2015). Nevertheless, Mafabi et al. (2012) do not find a direct relationship between knowledge management and organisational resilience, although both are positively linked through the mediation of corporate innovation.

Knowledge and product eco-innovation

Finally, it is widely argued that knowledge management facilitates the development, acquisition, transformation, and utilisation of new knowledge, thereby promoting organisational innovation (Jiménez-Jiménez and Sanz-Valle, 2011). Therefore, embracing eco-innovation is a significant opportunity for firms to rebuild themselves by implementing novel production processes and technologies, adopting new knowledge, products, and services, and enhancing company outcomes for a more sustainable future. Internal and external knowledge appear in the literature as positive contributors to improving eco-innovation (Vega-Jurado et al., 2008; Shearmur and Doloreux, 2013).

Furthermore, unlike other innovation models, adopting an open innovation strategy becomes imperative in eco-innovations (Cegarra-Navarro et al., 2019). That is primarily due to the requirement of harnessing distinct and continually evolving external knowledge streams. Companies face heightened challenges in creating new environmentally friendly products if they refuse the crucial aspect of environmental considerations to novel knowledge acquisition (Horbach, 2008; De Marchi and Grandinetti, 2013; Cuerva et al., 2014; Cegarra-Navarro et al., 2019). Nevertheless, Awan et al. (2021) identify a lack of research on how particular knowledge is considered more valuable and how it influences eco-innovation outcomes. It would be necessary to enhance our comprehension of the crucial aspects of eco-innovation, mainly focusing on eco-innovation in products and processes.

Summarising the above considerations, acquiring knowledge could improve the organisation's ability to solve problems and make decisions that help it achieve its objectives more agilely. Knowledge management would also prepare the company to react better to unforeseen situations by increasing its resilience, and it would contribute to successful green product creation. Based on this argumentation, we make the following assumptions:

H_{10}: Knowledge-based dynamic capabilities are positively related to some dynamic capabilities and eco-innovation.

H_{10a}: Knowledge-based dynamic capabilities are positively related to organisational resilience.

H_{10b}: Knowledge-based dynamic capabilities are positively related to organisational agility.

H_{10c}: Knowledge-based dynamic capabilities are positively related to green product success.

V.2.5. Information capability through information and communication technologies.

Information capability has acquired a strategic importance in contemporary business. Companies react to rapid changes in their environment by implementing knowledge management technologies that improve their ability to adapt and increase their chances of survival. The improvement in a company's market performance is enhanced by the ability to embed the information system in its management process, particularly as

market turbulence increases (Wang et al., 2015). Knowledge management tools are needed to attain agility, enable organisations to anticipate and adjust to the evolving dynamics of the market, and empower them to adapt more swiftly than the economic sectors in which they operate (Ashrafi et al., 2006). In this line, investments in information technology (IT) are crucial in promoting supply chain integration and cooperation, as highlighted by (Fawcett et al., 2011). IT systems enhance the potential for continuous innovation and establish a supportive environment to attain organisational agility (Tan et al., 2017) and act as knowledge management facilitators (Sher and Lee, 2004).

In this study, we embrace the definition by Wang et al. (2015) of information capability, which refers to the processes within a company utilising technology to acquire, process, and transmit information. The aim is to bolster decision-making, enhance business operations, and streamline communication and coordination with external partners. Knowledge management systems should provide an efficient flow of information to improve productivity, quality, innovation and business excellence, enhancing dynamic capabilities (Sher and Lee, 2004).

Resilience reflects the strength of internal and external connections based on adaptive alternative learning behaviour in the organisation's physical, emotional and resource domains (Home and Orr, 1997). Organisational culture and internal processes, including human resource practices, can provide a reasonable basis for resilience. That requires the existing information systems to respond flexibly to rapid environmental changes (Riolli and Savicki, 2003). Flexibility and resilience are closely linked. Flexibility increases resilience when disruptions occur and usually brings benefits and operational efficiency. Enhancing their adaptability to fluctuations in supply and demand enables companies to become more flexible and bolsters their resilience, and the reverse is equally true (Sheffi and Rice Jr, 2005). In organisations with a resilient culture, resilience also takes a proactive approach, not just a reactive one, with the managerial challenge being that the practices that constitute it are also applied in day-to-day operations and processes (Annarelli and Nonino, 2016). Resilient organisations not only anticipate customer needs but do so by creating an innovative orientation integrated into the company's culture. Moreover, this resilient orientation leads firms to create competitive advantages in a

permanent way based on innovations. Companies that effectively manage innovation can balance continuity and change on a spectrum (Teixeira and Werther, 2013).

Moreover, an organisation with enough competencies in knowledge management and change, both well-balanced, will be sufficiently agile to navigate in ever-changing times (Dove, 1999). IT skills enhance enterprises' ability to anticipate, interpret, and respond to opportunities and challenges proactively and reactively, thus contributing to business agility (Sambamurthy et al., 2003; Cai et al., 2019). In this line, Chakravarty et al. (2013) argue that IT competencies play a dual role in organisational agility. On the one hand, IT competencies complement agility by facilitating the harnessing of this dynamic capability to adapt to changing business conditions or to launch new competitive actions. On the other hand, IT competencies activate the company's agility capabilities and improve its performance.

Likewise, knowledge management through information technology improves dynamic capabilities, positively impacting business performance and competitive strength (Sher and Lee, 2004). This way, companies with an efficient knowledge management system strengthen their capacity for innovation in creating new products and processes (Chen et al., 2010). To attain operational agility, organisations need to cultivate skills by creating business frameworks and interconnections that empower managers to negotiate and wield influence over the utilisation of IT (Tan et al., 2017).

Summarising, in the contemporary business landscape, information capability is pivotal, with companies utilising knowledge management technologies to adapt, improving survival and market performance swiftly. Integrating information systems into management processes, especially in turbulent markets, is crucial, driven by IT investments that enhance supply chain integration, fostering innovation and organisational agility. Furthermore, resilience, reliant on robust connections, is reinforced by flexible information systems for proactive responses. Besides, resilient organisations, taking a proactive approach, cultivate a culture of innovation for lasting competitive advantages. Finally, achieving operational agility requires knowledge management and change competencies supported by effective IT and dynamic capabilities utilisation. Based on these ideas, we formulate the following hypotheses:

H_{11}: Information capability is positively related to some dynamic capabilities.

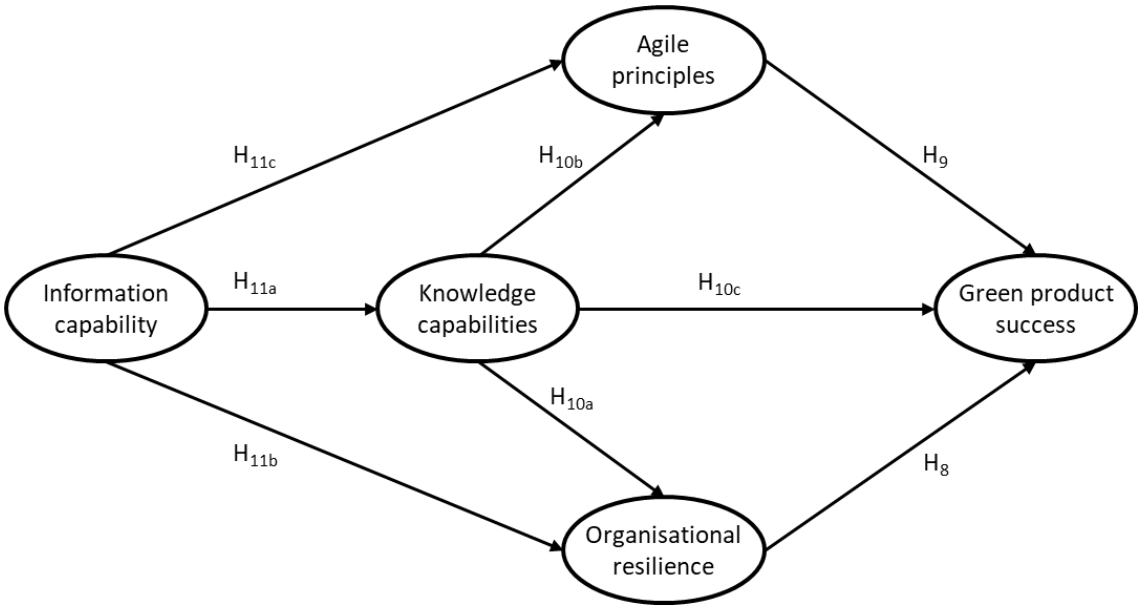
H_{11a}: Information capability is positively related to knowledge-based dynamic capabilities.

H_{11b}: Information capability is positively related to organisational resilience.

H_{11c}: Information capability is positively related to organisational agility.

Figure V.1 shows the theoretical model of this chapter.

Figure V.1. Theoretical model



V.3. RESEARCH METHODOLOGY

V.3.1. Population

The data used in this research was comprised of Spanish industrial companies from different economic subsectors. The aim was to generalise the findings to the broader sector.

The population chosen for hypothesis testing was extracted from the SABI database (Iberian Balance Analysis System), a comprehensive repository of financial analysis data covering the past 25 years in Spain and Portugal. The companies should follow two

criteria. Firstly, companies must have over 100 employees - it is assumed that a firm of this size has a well-developed structure with several policies implemented-. Secondly, they should have at least five years of operational history, mitigating variations arising from establishing new businesses. The resulting database was composed of 2,318 enterprises. More details about sample sectors can be consulted in Table I.1.

V.3.2. Sample and data collection

Information acquisition was conducted through personal interviews with the innovation responsible or, if unavailable, those managing organisational knowledge, utilising a pre-structured questionnaire featuring closed-ended questions. The company served as the unit of analysis. Data was collected through an online survey using a pre-tested structured questionnaire hosted on the University of Murcia's corporate website. An external market research company, a regular collaborator with the university, facilitated the data collection.

Following questionnaire familiarisation and pre-tests with partner companies, data collection commenced. Two previous introductory letters were sent to companies, providing extensive information about the project and its connection to the research team. A link to the online questionnaire was included too. Companies not responding initially received reminders, and corrections were made for errors in contact addresses. The option of a telephone interview survey was also offered. Firms were assured of the confidentiality of provided information, guaranteeing that it would solely be utilised for study purposes. Companies were randomly selected, and if contact was not possible or participation declined, the next company in line was approached.

After a three-month data collection period, 260 valid questionnaires were collected, resulting in 11,22 % of the total sample population.

V.3.3. Measurement and scales

The study employed seven-point Likert scales as the primary measurement tool for assessing the various components within the research framework. These Likert scales served as the instruments to assess the constituent constructs of the research model, enabling a thorough assessment of the model's variables and their interconnectedness.

A seven-point scale provided a nuanced and detailed perspective, facilitating a more in-depth understanding of the research constructs and their associations.

Information capability is measured by the use of information and communication technologies – ICTs - on the business in comparison with the competitors, following the four items scale applied by Wang et al. (2015).

Knowledge-based dynamic capabilities are conceptualised as a second-order reflective construct following Zheng et al. (2011) scale. According to these authors, knowledge management capabilities are defined with three components: knowledge acquisition, generation and combinations capabilities are measured. Each one of these three first-order reflective constructs is measured by five items.

Firm resilience is characterised as the firm's ability to promptly recognise, adapt to, and effectively react to alterations caused by a supply chain disruption (Ambulkar et al., 2015). This scale includes four items to evaluate.

Organisational agility refers to the capacity of an organisation to recognise changes in its environment and respond to them promptly and proficiently, both reactively and proactively, which has been measured by slightly adapting the wording of the twelve principles included in the Agile Manifesto (Fowler and Highsmith, 2001) to the research purpose. This way, a new scale of organisational agility has been validated, testing the application of the agile methodologies' principles in the sample firms. Due to its nature, this construct was computed as formative based on 12 items that assume the possible implementation in the organisation of the principles contained in the *Agile Manifesto*.

Green product success is assessed following Wong (2012) scale. It includes five pertinent measures for green product success. These measures encompass compliance with green directives, alignment with stakeholder requirements, financial performance in revenue and profitability, and overall success in eco-friendly product development and adoption.

V.3.4. Statistical analysis

The Partial Least Squares (PLS) path model was applied to scrutinise the investigation model. This approach utilises Structural Equation Methodology (SEM), facilitating the measurement of latent variables that are not directly observable but are inferred from

our underlying hypotheses (Cepeda-Carrion et al., 2019). These latent variables are assessed using a range of indicators within the sample (Cepeda-Carrión et al., 2016).

As suggested by Rigdon (2016), PLS-SEM is a suitable method when dealing with non-normally distributed data, conducting an exploratory study of relationships lacking extensive literature support, or when reflective variables are employed to gauge concepts that both serve as explanations and can be explained by other variables. Furthermore, PLS can also be employed for confirmatory purposes (Henseler, 2018; Hair et al., 2020).

To assess the measurement model and estimation of the structural model, we employed SmartPLS 3.3.3 software (Ringle et al., 2015).

V.4. RESULTS

Applying the Partial Least Squares Structural Equation Modelling methodology (PLS-SEM) involves comprehensively examining the entire model. This process entails validating the reliability and validity of measurements while scrutinising the relationships incorporated within the structural model (Henseler et al., 2016). Hereunder, our focus is on evaluating both the measurement and the structural models.

V.4.1. Measurement model

Various tests have been conducted to validate the measurement model (Henseler et al., 2016). Specifically, these analyses utilising the saturated model yielded standardised root mean square residual (SRMR = 0.061), unweighted least squares discrepancy (d_{ULS} = 1.394), and geodesic discrepancy (dG = 0.591) values.

The reliability and validity of compounds in Mode A were examined, as outlined in Table V.1. Individual indicators demonstrated reliability values surpassing the recommended threshold of 0.7, as suggested by Chin (1998) and Chin (2010). Internal consistency reliability was evaluated using the composite reliability index proposed by Bagozzi and Yi (1998), with all values exceeding the suggested minimum of 0.7. Additionally, Cronbach's alpha values exceeded the recommended threshold of 0.7, as Roldán and Sánchez-Franco (2012) indicated. Convergent validity was assessed through the average

variance extracted index (AVE) proposed by Fornell and Larcker (1981), with all construct AVE values surpassing the minimum threshold of 0.5 as per Bagozzi and Yi (1998).

Discriminant validity was validated through two approaches. Initially, in line with Fornell and Larcker (1981) recommendation, the average variance extracted for each construct surpassed the corresponding correlations, as indicated in Table V.1. Additionally, employing the heterotrait-monotrait (HTMT) criterion (Henseler et al., 2015), values above the diagonal in Table V.1 were below the recommended threshold of 0.85. This observation signifies appropriate discriminant validity for all variables.

Table V.1. Correlation matrix, statistics, and reliability of reflective constructs

	Information capability	***Knowledge capability***	***Organizational resilience***	***Green product success***
Information capability	**0.880**	*0.536*	*0.242*	*0.322*
Knowledge capability	0.473	**0.833**	*0.510*	*0.484*
Organizational resilience	0.234	0.453	**0.917**	*0.372*
Green product success	0.299	0.415	0.349	**0.863**
Notes: The bold diagonal elements in the correlation matrix represent the square root of the shared variance between the constructs and their measurements. Below the diagonal, you can find the correlations between constructs, while above the diagonal are the values of the Heterotrait-monotrait (HTMT) criterion.				
Mean value	5.473	5.556	5.538	5.022
Standard deviation	1.075	0.829	1.091	1.191
Cronbach's Alpha (α)	0.904	0.781	0.937	0.885
Composite reliability	0.932	0.871	0.955	0.921
Average variance extracted	0.775	0.694	0.841	0.745

Regarding the formative construct, the variance inflation factor (VIF) for each indicator of agile principles was examined and determined to be below the limits recommended by the literature, signifying the absence of collinearity issues. Moreover, an analysis to examine potential Common Method Biases (CMV) was conducted, following the approaches suggested by Podsakoff et al. (2003) and Chin et al. (2013). Utilising Harman's Single-Factor Test, which explores a single common factor encompassing all model indicators as proposed by Liang et al. (2007). The results indicated that CMV is not a significant concern in this study, aligning with the findings of Chang et al. (2010).

V.4.2. Structural model

The outcomes of the PLS-SEM analysis for the structural model can be found in Table V.2, showcasing standardised path coefficients (β) and p values. A one-tailed test is applied under the assumption that the coefficient for the hypothesis is associated with a positive sign, as Kock (2015) recommended.

Table V.2. Structural model results

Paths	*Std Coef.*	*Std deviation*	*T value*	*Confidence interval*	
				LL	*UL*
Hypotheses					
H_8. Or. resilience→ Green pr. success	0.155*	0.080	1.936	0.018	0.281
H_9. Agile principles → Green pr. success	0.265**	0.113	2.351	0.119	0.487
H_{10a}. Knowledge capab. → Or. resilience	0.441***	0.064	6.936	0.340	0.547
H_{10b}. Knowledge capab. → Agile principles	0.524***	0.073	7.177	0.411	0.650
H_{10c}. Knowledge capab. → Green pr. success	0.176*	0.079	2.227	0.026	0.286
H_{11a}. Information capab. → Knowledge capabilities	0.473***	0.061	7.714	0.368	0.571
H_{11b}. Information capab. → Org. resilience	0.025	0.090	0.279	-0.125	0.173
H_{11c}. Information capab. → Agile principles	0.241**	0.085	2.816	0.107	0.388
Second order constructs					
Knowledge capab. → Knowledge acquisition capab.	0.741***	0.056	13.241	0.640	0.824
Knowledge capab. → Knowledge combination capab.	0.903***	0.014	63.083	0.876	0.923
Knowledge capab. → Knowledge generation capab.	0.847***	0.029	29.696	0.794	0.887
Main indirect effects					
Information capab. → Knowledge capab. → Org. resilience	0.209***	0.047	4.480	0.138	0.293
Information capab. → Knowledge capab. → Agile principles	0.248***	0.050	4.956	0.173	0.337
Information capab. → Knowledge capab. → Green pr. success	0.083*	0.040	2.087	0.012	0.141
Knowledge capab. → Or. resilience→ Green pr. success	0.068*	0.038	1.790	0.008	0.134
Knowledge capab. → Agile principles→ Green pr. success	0.139*	0.061	2.279	0.066	0.264

Notes: ***p<0.001 **p<0.01 *p<0.05 based on a Student's t(4999) distribution with one tail [t(0.05, 4999) = 1.645, t(0.01, 4999) = 2.327, t(0.001, 4999) = 3.092)]. Bootstrapping based on n = 5.000 subsamples; LL=Lower bias corrected bootstrap 95% confidence interval; UL= Upper bias corrected bootstrap 95% confidence interval.

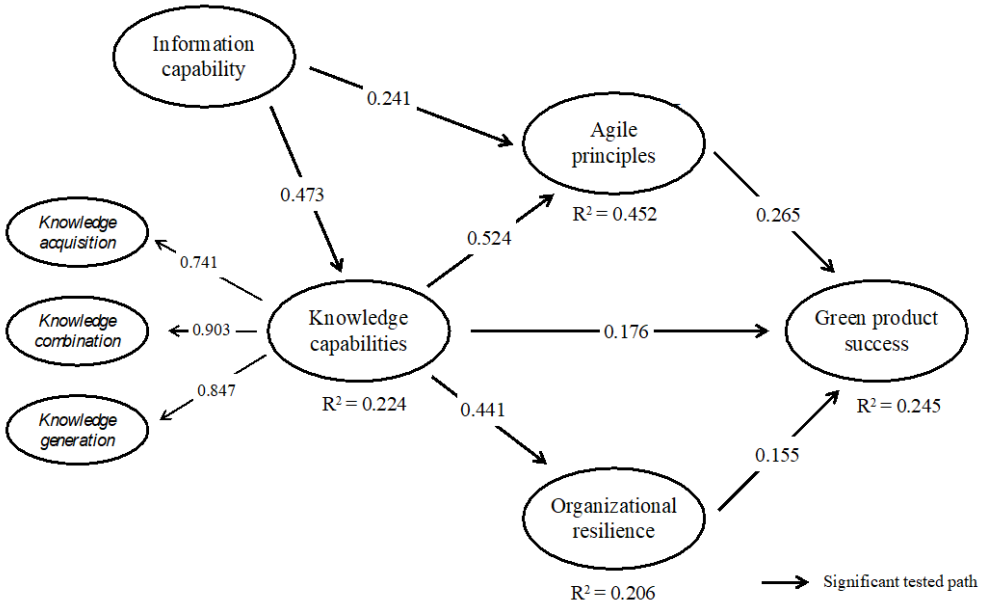
Bootstrapping resampling, involving 5,000 subsamples, is employed to assess the significance of the interaction effects, following the approach outlined by Chin (1998). R-square values exceed 0,20 (Falk and Miller, 1992).

As can be seen in Table V.2, the results offer empirical evidence to sustain the eighth hypothesis (β = 0.155, p <0.05) and the ninth hypothesis (β = 0.265, p <0.01). Hypothesis eight shows a positive and significant relationship between organisational resilience and green product success, and hypothesis nine indicates a favourable effect of agility, measured through agile principles, on green product success. Both strategies, resilience,

and agility, contribute positively to obtaining successful results on eco-innovation in products. They enable the company to respond quickly and flexibly in crises or market changes, contributing to business stability.

Figure V.2 shows the empirical model results.

Figure V.2. Empirical model results



In the tenth hypothesis, we analysed the influence of the knowledge capability on three other constructs. There is a positive relationship between knowledge capability and organisational resilience (H_{10a} β = 0.441, p <0.001), knowledge capability and agile principles (H_{10b} β = 0.524, p <0.001) and knowledge capability and green product success (H_{10c} β = 0.173, p <0.05). Knowledge management emerges as a pivotal factor in the connections among the various constructs of the model, underscoring its significance in articulating any business strategies.

The eleventh hypothesis relates information capability with three other model constructs. Information capability presents a positive correlation with knowledge capability (H_{11a} β = 0.473, p <0.001) and agile principles (H_{11c} β = 0.241, p <0.01). Although the direct relationship with organisational resilience is not significant (H_{11b} β = 0.241), it is with the mediation of information capacity, as commented below.

Table V.2 also shows some of the main indirect effects that help us to understand the relationships discussed. First, it is observed that information capability has a significant, positive, and indirect effect on organisational resilience ($\beta = 0.209$, $p < 0.001$), agile principles ($\beta = 0.248$, $p < 0.001$) and green product success ($\beta = 0.083$, $p < 0.05$) through knowledge capabilities. Consequently, the latter capabilities help to understand how information capability allows value to be generated. Even though no evidence of the relationship proposed in H_{11b} has been found, information capability will indirectly affect organisational resilience.

On the other hand, knowledge capabilities not only have a positive and direct effect on green product success, as shown in H_{10c}, but also act directly through organisational resilience ($\beta = 0.068$, $p < 0.05$) or agile principles ($\beta = 0.139$, $p < 0.05$).

V.5. CONCLUSIONS

This research provides an answer to where companies need to focus to respond in an agile and flexible way to changing demands internally, from their workforces and the economic environment in which they operate. The catalyst for the different options is an effective knowledge management system supported by an adequate level of technology, a resilient culture and organisation, and agile decision-making processes articulated to generate innovative green products in the face of growing global concern about climate change.

The dynamic capabilities perspective is applied to information capacity, knowledge management, agility, and resilience in an ecological orientation, which allows us to build an integrative model of all of them - IKARG strategies -. The relationship among these concepts is present in the literature, as we have exposed in the introductory part. However, as we have done in our research, their interactions have yet to be simultaneously analysed. Knowledge management appears to be the core element to articulate the rest of the management proposals for eco-innovation. In this sense, Ibrahim Ismael et al. (2021) consider knowledge management a significant predictor of agility and resilience.

The results show positive relationships between dynamic capabilities such as knowledge management, resilience, agility, and successful green products. Knowledge management capabilities enable organisations to develop agility, enhancing green product generation. These results are aligned with those obtained by Rafi et al. (2022).

Organisations must build resilience and agility capabilities into their culture and structures to foster successful green product innovation by incorporating technologies into their knowledge management systems. However, the information provided by information technologies is not helpful for an agile or resilient response to change if it is not mediated by processing that information through knowledge-based dynamic capabilities. Information technology can be easily imitable, but integrating information technology and knowledge management capabilities is crucial for achieving greater agility (Panda and Rath, 2018).

Finally, the developed scale to measure organisational agility based on agility principles (Fowler and Highsmith, 2001) has been tested, and its validity and reliability support its use in future research, providing an alternative way of assessing agility.

Managerial implications

This study has some implications for managers. Firstly, they should promote knowledge management systems and strategies to develop dynamic capabilities that leverage emerging eco-innovation opportunities within the prevailing volatile economic climate, which is in line with Sher and Lee (2004) recommendation. Secondly, having information system technology is only helpful if it is managed effectively and integrated into properly managing that information. In other words, managers must be concerned with having a system that collects internal and external information and knowledge and how this information will contribute to developing new eco-innovation in the organisation. Thirdly, managers should promote an agile and resilient culture and organisational structure. In this sense, the implementation of training policies and the involvement of managers and the rest of the staff in developing new eco-innovation in the organisation should be a priority.

Limitations

The current study possesses certain limitations. First, the sample is restricted to the Spanish industrial sector, which suggests the desirability of replicating the survey in other sectors and countries to assess the generalisability of the findings. Sectors such as commercial and public enterprises could provide valuable insights and broaden the scope of the exploration. Second, the reliance on a single key informant, albeit well-informed about the relevant research issues, suggests an opportunity to strengthen the study by including input from diverse company sources and data from different objective sources to measure relevant constructs. Third, the study's acknowledgement of its short-term focus, especially in assessing the success of new green products, highlights the possibility of incorporating longitudinal data for a more comprehensive analysis. This approach would allow a nuanced understanding of the sustainability of knowledge management and eco-innovation strategies within organisations over the long term.

Future research lines

Future lines of investigation derived from this study would begin by trying to overcome the limitations noted in the previous section, giving greater solidity to the study's conclusions. In addition, an exciting direction for future studies would be to conduct more in-depth research on staff perceptions, utilisation, and engagement concerning knowledge management systems, resilience, agility, and eco-innovative approaches in companies. In this sense, the emergence of artificial intelligence is a novel field expanding the data management field for decision-making and developing innovative products and models. Besides, it would be interesting to replicate the organisational agility measurement scale developed especially in this study to test its validity and reliability in other productive and geographical contexts. Also, exploring which sources of knowledge contribute most significantly to improving practices related to resilience, agility and eco-innovation approach becomes a crucial question for further exploration. This future line of research could shed light on the complex dynamics between organisational resilience and agility strategies, knowledge utilisation and sustainable innovative practices.

V.6. BIBLIOGRAPHY

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VI. CONCLUSIONES

VI.1. INTRODUCCIÓN

El contexto mundial actual en su conjunto y la economía en particular presentan, quizá, una de los periodos más inestables y llenos de incertidumbre de la historia. Los cambios en las tendencias de los mercados se suceden de forma vertiginosa y la nueva revolución industrial impulsada por el nuevo paradigma digital amenaza con cambiar radicalmente los modos de producción y las dinámicas de intercambio de bienes y servicios. Así mismo, la creciente concienciación ecológica derivada del evidente cambio climático lleva también a adoptar el paradigma ecológico como rector de toda la actividad humana.

En este contexto, las organizaciones buscan estrategias que les permitan responder de manera ágil y estable a los cambios en su entorno y en las demandas de sus clientes, al tiempo que producen bienes y servicios de manera más sostenible. Y contribuyendo así a la creación secuencial de ventajas competitivas que garanticen su permanencia y su desarrollo como organización viva en constante evolución. Para ello deben fomentar la implicación de su plantilla, la participación en redes de conocimiento y la integración del punto de vista de los clientes en sus procesos de generación de innovación ecológica.

El propósito fundamental de esta tesis doctoral es el de examinar la relación entre la agilidad organizativa y la eco-innovación, y analizar *cómo la agilidad organizativa puede facilitar una respuesta rápida y eficaz de la empresa a los cambios repentinos que se producen en mercados y clientes, innovando en procesos y productos medioambientalmente más sostenibles, y promoviendo así la generación de ventajas competitivas*.

Esta tesis, adoptando el enfoque de la teoría de las Capacidades Dinámicas, apuesta por la agilidad organizativa, la gestión del conocimiento, la resiliencia y la eco-innovación, como los principales pilares en los que deberían basar sus estrategias las empresas. Estos conceptos se han puesto en relación con otros como la implicación de los clientes en los procesos productivos y la capacidad de información, encontrándose algunas influencias mediadoras interesantes en estas relaciones y validando su influencia positiva en la generación de eco-innovación exitosa.

Para ello, se realizó una extensa y profunda revisión de la literatura relacionada con las capacidades dinámicas, la agilidad organizativa, la gestión del conocimiento, la eco-innovación, la resiliencia, la capacidad de información y la participación de los clientes.

Después de establecer un marco conceptual general, se creó un modelo teórico que incluye los conceptos mencionados anteriormente y sus interrelaciones. Este modelo sirvió como fundamento para el desarrollo de modelos teóricos más específicos, los cuales fueron examinados en los estudios empíricos comentados en los tres capítulos previos.

En síntesis, este estudio destaca la importancia de fomentar el desarrollo de ciertas capacidades organizativas como son la agilidad, la gestión del conocimiento y la resiliencia para el desarrollo exitoso de eco-innovaciones. Esto proporciona lecciones valiosas para la gerencia de las empresas que buscan adaptarse a un entorno en constante cambio y evolución y obtener ventaja de las oportunidades que surgen en situaciones de incertidumbre.

A continuación, se exponen las conclusiones principales de esta tesis, diferenciando entre las obtenidas de la parte más conceptual de aquellas que surgen de los estudios empíricos. Posteriormente, se resaltan las contribuciones más significativas, se destacan las implicaciones clave para la gerencia, y se exponen las limitaciones de esta investigación. Por último, se identifican algunas líneas futuras de investigación que se derivan de este trabajo.

VI.2. CONCLUSIONES GENERALES

De la revisión de la literatura se desprenden varias ideas rectoras principales que se exponen a continuación y que constituyen los fundamentos de la investigación acometida por esta tesis.

Existe un consenso generalizado en la literatura acerca de que las organizaciones se encuentran en un momento en el que los cambios y la incertidumbre son el denominador común de los mercados. En este entorno, las empresas buscan estrategias para sobrevivir y adecuar sus procesos productivos y sus productos a los cambios en la

reglamentación y en las demandas de clientes y mercados, y todo ello de un modo más respetuoso con el medio ambiente.

En el plano teórico, la Teoría de los Recursos y Capacidades presentaba una visión estática del negocio que no estaba en consonancia con estos nuevos tiempos. Es por ello que autores como Teece et al. (1997) y Eisenhardt y Martin (2000) formulan las bases iniciales de la teoría de las Capacidades Dinámicas. Este nuevo enfoque plantea alternativas de actualización y renovación constante de los recursos y capacidades de las empresas de forma que les permita responder a los cambios en demandas y necesidades de mercados y clientes y contribuya a la generación de ventajas competitivas sostenibles en el tiempo.

En esta línea de pensamiento, la agilidad es considerada en la literatura como una capacidad dinámica que posibilita a una organización reaccionar de manera proactiva, flexible y rápida a los cambios y demandas de su entorno y partes interesadas, lo que le da una ventaja competitiva sobre sus competidores (Yaghoubi et al., 2011; Chen et al., 2018; Gyemang y Emeagwali, 2020). La agilidad está vinculada también a la capacidad de reacción de la cadena de suministro en interrupciones y emergencias (Christopher y Peck, 2004; Ponomarov y Holcomb, 2009).

Así mismo, la eco-innovación aparece hoy día como una excelente oportunidad para reestructurar las organizaciones mediante la implementación de nuevos procesos productivos y tecnologías, el desarrollo de nuevos conocimientos y de nuevos productos y servicios, incidiendo en el progreso de los resultados de las empresas, propiciando un futuro más sostenible en el horizonte. Las eco-innovaciones pueden contribuir positivamente a reformular todo el proceso de innovación (Carrillo-Hermosilla et al., 2010), creando valor para los clientes y las empresas (Li, 2022). En esta línea, algunos autores han encontrado que cuanto mayor es la inversión en eco-innovación en productos y procesos, mayor es la ventaja competitiva obtenida por las empresas (Chen et al., 2006; Pujari, 2006; Ilker Murat, 2012; Kam-Sing Wong, 2012).

A pesar de que se han examinado las conexiones entre la eco-innovación y el rendimiento, existe una notable carencia de investigaciones que exploren la relación

entre la agilidad organizativa y la eco-innovación (Franco et al., 2022). Por otro lado, la irrupción de las nuevas tecnologías, la digitalización de las empresas, la inteligencia artificial, y otras tendencias, hace imprescindible contar con fuentes adecuadas de información, tanto internas como externas. En este sentido, la incorporación de los clientes a los procesos de diseño, producción y comercialización de procesos, productos y servicios es una fuente imprescindible de conocimiento (Du y Chen, 2018; Denning, 2019).

En los procesos de eco-innovación se ha constatado que el conocimiento externo es especialmente relevante (Chatterji y Fabrizio, 2014; Forés y Camisón, 2016), debido, entre otras razones, a la necesidad de incorporar legislación, tecnología, y nuevos materiales y procesos. En este sentido, la participación en redes de colaboración externas, así como la colaboración con proveedores e instituciones educativas es de vital importancia (Brettel y Cleven, 2011; Husain et al., 2016; Ardito et al., 2019). No obstante lo anterior, la presencia de adecuados niveles de conocimiento interno y de mecanismos y estructura de gestión interna de este tipo de conocimiento va a facilitar las labores de exploración e integración del nuevo conocimiento externo (Cohen y Levinthal, 1990; Zahra y George, 2002). La combinación de ambos tipos de conocimiento contribuye a fomentar la eco-innovación (Vega-Jurado et al., 2008; Shearmur y Doloreux, 2013).

Toda esta información necesita ser gestionada de forma eficiente y ágil para ponerla a disposición de la gerencia y de las plantillas, debiendo estar también alineada con la estrategia empresarial. Por ello se hace ineludible contar con un adecuado sistema de gestión del conocimiento, apoyado en la tecnología, que facilite su procesamiento, que proporcione información útil de forma rápida y fiable y que permita incorporar fácilmente nuevo conocimiento externo eco-innovador.

Las organizaciones resilientes tienen la capacidad de desarrollar mecanismos para que en situaciones de crisis o interrupciones en la cadena de suministro puedan mantener una cierta estabilidad en su funcionamiento y al mismo tiempo reaccionar de forma rápida, flexible y eficaz a los imprevistos, mejorando incluso su ventaja competitiva (Namdar et al., 2017). Adoptar una perspectiva resiliente es crucial para las compañías enfocadas en fortalecer su sostenibilidad, según Wu y Tham (2023). Esta aproximación

debería favorecer la implementación de cambios progresivos, con un balance adecuado entre los beneficios económicos y los beneficios medioambientales y sociales, tal y como sugiere Fiksel (2003). En este sentido, es esencial formular políticas y estrategias flexibles que capaciten a las entidades sociales e industriales para afrontar retos imprevistos. Y todo ello haciendo compatible su desarrollo y expansión con la inquietud por el medio ambiente y el bienestar humano.

Para el desarrollo de la eco-innovación en un contexto competitivo, la resiliencia y la agilidad, dos capacidades dinámicas, parecen contribuir positivamente a ese proceso. Por un lado, las organizaciones resilientes son necesarias para sobrevivir a las crisis y deben generar innovaciones que ofrezcan nuevos productos en respuesta a las nuevas demandas. Por otro lado, las empresas deben mostrar agilidad, procesos rápidos y líderes y empleados que faciliten el desarrollo exitoso de innovaciones. En el actual contexto económico mundial altamente inestable, cambiante o turbulento, la combinación de resiliencia frente a los desafíos y agilidad en la toma de decisiones pueden ser herramientas poderosas para la innovación en general, y específicamente para la eco-innovación.

En el ámbito competitivo actual, donde se busca impulsar la eco-innovación, la resiliencia y la agilidad organizativas aparecen como dos capacidades dinámicas esenciales íntimamente ligadas (Azevedo et al., 2016; Altay et al., 2018; Gligor et al., 2019). Las organizaciones que demuestran resiliencia son más exitosas en el afrontamiento de situaciones de crisis y tienen mayor capacidad para generar innovaciones, incluyendo nuevos productos que respondan a demandas emergentes. Al mismo tiempo, las empresas ágiles, caracterizadas por procesos eficientes y la presencia de líderes y trabajadores imbuidos de esta filosofía, son capaces de impulsar con éxito el desarrollo de innovaciones. En el escenario económico global actual, marcado por su alta inestabilidad y constante cambio, la combinación de resiliencia para enfrentar desafíos y agilidad para tomar decisiones se convierte en herramienta fundamental no solo para la innovación en general, sino de forma especialmente relevante en el impulso hacia la eco-innovación.

Los capítulos que incluyen los estudios empíricos despliegan el modelo teórico general planteado en el capítulo II que desarrolla un modelo de relaciones lógicas derivado de la revisión conceptual expuesta anteriormente. A partir de ahí, se han planteado once hipótesis de investigación bajo tres modelos empíricos que ayudan a entender con mayor profundidad los objetivos planteados en esta investigación. De forma general se ha encontrado evidencia empírica total en nueve hipótesis y en una de forma parcial, mientras que no se ha llegado a aceptar una hipótesis. En consecuencia, estos resultados respaldan las ideas clave de esta investigación que sostiene las fuertes relaciones existentes entre la agilidad organizativa y la eco-innovación, así como el papel que juegan otras capacidades dinámicas.

VI.3. CONCLUSIONES DE LOS ESTUDIOS EMPIRICOS

Pasamos ahora a detallar las conclusiones específicas obtenidas de cada uno de los tres estudios empíricos expuestos en los capítulos III, IV y V.

VI.3.1. Conclusiones del capítulo III

Este estudio se focaliza en explicar cómo las organizaciones ágiles pueden crear condiciones que mejoren los procesos de eco-innovación. Basándose en la Teoría de las Capacidades Dinámicas (Teece y Pisano, 1994; Eisenhardt y Martin, 2000), el primer estudio empírico explora cómo la agilidad organizativa se convierte en un elemento dinámico en los procesos de generación de conocimiento ambiental para desarrollar nuevos productos verdes, derivado de la capacidad que puedan tener las empresas para comprender los cambios internos y externos y reaccionar rápidamente a ellos.

En este contexto, donde además los recursos son generalmente escasos y las empresas deben decidir dónde centrar sus inversiones, la combinación de conocimiento externo e interno no siempre es factible, y surgen tensiones por la utilización de ambos tipos de fuente de conocimiento.

En primer lugar, los resultados avalan que la agilidad organizativa tiene un efecto positivo para la generación de nuevo conocimiento medioambiental, tanto externo como interno. De este modo, la capacidad que tenga una empresa para identificar

cambios, tendencias u oportunidades conducirá a la incorporación de nuevo conocimiento externo (Ben Arfi et al., 2018). Los determinantes de la eco-innovación y aspectos como los nuevos materiales, las mejoras tecnológicas, los cambios legales o las redes de colaboración externa con diferentes agentes permiten identificar nuevas fuentes de conocimiento ambiental. Este conocimiento puede ser útil en los procesos de eco-innovación (Păcesilă y Ciocoiu, 2017; Pacheco et al., 2018). La mayor parte de este conocimiento desarrollado debería poder incorporarse a la empresa. Sin embargo, esto sólo será posible si la empresa es lo suficientemente ágil como para detectarlo, introducirlo y utilizarlo. Además, la agilidad organizativa fomenta la creación de conocimiento que debe desarrollarse internamente. Por ello, en las empresas con departamentos de investigación y desarrollo acostumbrados a desarrollar internamente sus conocimientos, la detección rápida de los cambios en el mercado puede guiar estos procesos de aprendizaje y ayudar a desarrollar conocimientos orientados hacia estas tendencias del entorno. Por esta razón, la agilidad organizativa es una herramienta poderosa en la generación de nuevo conocimiento ambiental.

En segundo lugar, los resultados avalan que el conocimiento externo es más relevante en el desarrollo exitoso de productos ecológicos. Una de las razones es que los productos ecológicos deben incorporar información y conocimiento sobre regulaciones, tendencias y desarrollos tecnológicos para ser exitosos. Consecuentemente, la dependencia excesiva de un enfoque centrado en el conocimiento interno puede reducir las posibilidades de crear nuevas innovaciones ecológicas que se adapten a los requisitos externos. Este resultado es coincidente con los obtenidos en otros estudios, que enfatizan la importancia predominante de las fuentes de conocimiento externas para las empresas eco-innovadoras (De Marchi, 2012; De Marchi y Grandinetti, 2013; Chatterji y Fabrizio, 2014; Forés y Camisón, 2016). De este modo, se puede afirmar que la agilidad organizativa contribuye indirectamente al éxito, ya que permite a las empresas identificar este nuevo conocimiento y aplicarlo en el desarrollo de eco-innovaciones exitosas.

Por otro lado, los resultados obtenidos también resaltan la importancia del conocimiento interno desarrollado. Este tipo de conocimiento previo facilita a las empresas la comprensión y la aplicación de los conocimientos externos. Con

conocimientos previos, las empresas pueden desarrollar nuevos productos de manera más eficiente que si comenzaran desde cero. Este estudio evidencia que el conocimiento interno actúa de forma positiva como moderador del efecto del conocimiento externo en el éxito de los nuevos productos. Como hemos comentado anteriormente, una orientación interna hacia el desarrollo de productos innovadores podría no ser eficiente en comparación con una perspectiva de innovación abierta, pero las empresas con un alto desarrollo de conocimiento interno también aplicarán mejor el nuevo conocimiento externo. Estos resultados son consistentes también con otros estudios que muestran que la actividad de investigación y desarrollo y el conocimiento interno son más importantes para el desarrollo de las innovaciones ecológicas que para las innovaciones no ecológicas (Horbach, 2008; Pihlajamaa et al., 2017; Aboelmaged y Hashem, 2019).

VI.3.2. Conclusiones del capitulo IV

Este modelo empírico explora, en primer lugar, la relación entre la eco-innovación y el rendimiento organizativo. Algunos autores no han encontrado una relación lineal entre ambos elementos (González-Benito y González-Benito, 2005; Wagner, 2005; Ryszko, 2016; Madaleno et al., 2020; Dharmayanti et al., 2023). Sin embargo, nuestros resultados sí avalan la relación positiva entre una estrategia eco-innovadora y los resultados empresariales. Esta conclusión está en línea con otros estudios previos (Bansal, 2005; Gligor et al., 2015; Liao, 2018; Almeida y Wasim, 2023; Dharmayanti et al., 2023). Es más, hoy en día, la implementación de procesos y conocimientos verdes en las empresas y el desarrollo de la eco-innovación en procesos y productos es imperativo en la búsqueda de mejores resultados y una respuesta ineludible a las nuevas demandas ambientales y a la creciente conciencia ecológica de los consumidores (Chen y Chang, 2013). De este modo, las empresas que se enfocan en la eco-innovación podrán obtener mejores resultados como consecuencia de la implementación de nuevos procesos y del enriquecimiento de su gestión del conocimiento interno y externo.

Además, este estudio aborda algunas lagunas previamente identificadas en la literatura. En esta línea, utiliza la Teoría de las Capacidades Dinámicas para resaltar la importancia del concepto de agilidad organizativa (Franco et al., 2022). Esta investigación destaca también la influencia positiva que tiene la agilidad organizativa en la promoción y

generación de eco-innovaciones en las empresas y los efectos beneficiosos de estas en los resultados de la empresa, siendo ésta quizás la principal contribución a la literatura de este estudio, esto es, la exploración del vínculo entre la agilidad y la eco-innovación. Gracias a la agilidad las organizaciones pueden adaptar sus estructuras, prácticas y procesos de producción para reaccionar de forma más rápida y sensible a la evolución de los mercados y a las nuevas tendencias ecológicas en productos y servicios (Denning, 2018; Denning, 2019), todo ello con un menor impacto medioambiental.

Así mismo, los resultados obtenidos soportan el papel mediador de la implicación del cliente en la relación entre agilidad organizativa y eco-innovación de producto y proceso, lo que refuerza la importancia de involucrar a los clientes a lo largo del ciclo de vida del producto (Carbonell et al., 2009; Morgan et al., 2018; Chen y Liu, 2019). En esta línea, la participación activa y continua de los clientes en el proceso de desarrollo de productos y procesos eco-innovadores puede influir en la capacidad de la organización para adaptarse rápidamente y generar productos amigables con el medioambiente. De este modo, las empresas que adopten este enfoque pueden obtener una ventaja competitiva al ofrecer productos y procesos que se alineen mejor con las expectativas y valores de sus clientes.

Por otra parte, y por lo que respecta a la falta de estudio de variables moderadoras entre la eco-innovación y el rendimiento de las empresas encontrada en la literatura (Oduro et al., 2022), nuestro modelo ilustra la función mediadora de la implicación del cliente en las innovaciones verdes, haciendo hincapié en la influencia de las eco-innovaciones en los resultados empresariales. Se apoya la hipótesis de que la participación del cliente no solo modera positivamente el efecto de la agilidad organizativa en los nuevos procesos y productos ecológicos, sino que hace que las innovaciones de productos ecológicos sean más exitosas, no únicamente para los clientes actuales, sino también para otras demandas similares en el futuro. La implicación de los clientes en las diferentes fases del ciclo del producto es considerada por varios autores (Xiaohua y Richard, 2004; Thun y Müller, 2010; Roberts y Grover, 2012) como una fuente de obtención de conocimiento innovador, de mejora de procesos, de generación de nuevas ideas para productos o servicios y de aportación al desarrollo de ventajas competitivas y a la obtención de mejores y mayores resultados en las organizaciones.

VI.3.3. Conclusiones del capítulo V

Este estudio presenta un modelo que busca abordar la cuestión de cómo las empresas pueden adaptarse de manera ágil y flexible a las cambiantes demandas tanto internas como externas del entorno económico en el que operan. El motor de esta capacidad de respuesta radica en la implementación de un sistema de gestión del conocimiento eficiente, respaldado por un nivel apropiado de tecnología, por una cultura y estructura organizativa resilientes, y por procesos ágiles de toma de decisiones. Estos elementos se combinan para impulsar la creación de productos innovadores y sostenibles, en respuesta a la creciente preocupación global por el cambio climático.

La perspectiva de las Capacidades Dinámicas se aplica a la capacidad de información, la gestión del conocimiento, la agilidad y la resiliencia en una orientación ecológica, lo que permite construir un modelo integrador de todas ellas que denominamos estrategias IKARG (acrónimo en inglés de Information, Knowledge, Agility, Resilience y Green). La relación entre estos conceptos está presente en la literatura, como se expone en la parte introductoria, pero las interacciones entre todos ellos no han sido analizadas simultáneamente, tal y como sí se ha hecho en el estudio planteado en este capítulo. La gestión del conocimiento aparece como el elemento central en torno al cual articular el resto de las propuestas de gestión de la eco-innovación. En este sentido, Ibrahim Ismael et al. (2021) consideran la gestión del conocimiento como un predictor significativo de agilidad y resiliencia.

Los resultados obtenidos muestran relaciones positivas entre capacidades dinámicas como la gestión del conocimiento con la resiliencia, la agilidad y los productos ecológicos exitosos. Las capacidades de gestión del conocimiento permiten así a las organizaciones desarrollar agilidad organizativa, lo que, a su vez, mejora la generación de productos eco-innovadores, coincidiendo con otras investigaciones anteriores (Rafi et al., 2022).

Para fomentar el éxito de la innovación en productos ecológicos, las organizaciones deben incorporar las capacidades de resiliencia y agilidad en su cultura y estructura, mediante la integración de tecnologías de la información en sus sistemas de gestión del conocimiento. Sin embargo, la información proporcionada por las tecnologías de la información no parece ser útil para una respuesta ágil o resiliente al cambio si no está

mediada por el procesamiento de esa información a través de capacidades dinámicas basadas en el conocimiento. Las tecnologías de la información pueden ser fácilmente imitables, pero la integración de éstas con las capacidades de gestión del conocimiento es crucial para lograr una mayor agilidad (Panda y Rath, 2018) y resiliencia.

VI.4. CONTRIBUCIONES DE LA TESIS DOCTORAL

Una vez comentadas las conclusiones más relevantes de los tres estudios empíricos se indican ahora las aportaciones más destacadas de esta tesis doctoral.

En primer lugar, se ha revisado de forma extensa y profunda la literatura existente relacionada con las capacidades dinámicas, agilidad organizativa, eco-innovación, gestión del conocimiento, resiliencia, capacidad de información e implicación de los clientes, así como sobre las relaciones entre todos ellos y su repercusión en los resultados de negocio. Esto contribuye a mejorar el campo científico relacionado con las capacidades dinámicas que sostienen las innovaciones verdes y su contribución a la sostenibilidad y rentabilidad de las empresas. Especialmente importante es que esta tesis doctoral se ha focalizado principalmente en el estudio de las relaciones entre agilidad organizativa y eco-innovación, insuficientemente estudiadas con anterioridad (Franco et al., 2022).

En segundo lugar, la perspectiva teórica de las Capacidades Dinámicas se ha mostrado válida para dar soporte a las investigaciones empíricas planteadas. La actualización permanente de los recursos y capacidades permite a las empresas responder de forma ágil a los cambios internos y de su entorno, generando ventajas competitivas. En un reciente trabajo Oduro et al. (2022) indican la necesidad de introducir otras teorías distintas de las de Porter, la perspectiva basada en recursos o la institucional para el estudio de la eco-innovación.

Estos mismos autores señalan la necesidad de estudiar factores moderadores en la relación entre eco-innovación y resultados organizativos (Oduro et al., 2022). En este sentido, se ha introducido en nuestro modelo la implicación del cliente, y sus efectos en la relación entre la agilidad organizativa y la eco-innovación en producto y proceso, así como entre la eco-innovación en producto y el rendimiento organizativo.

Así mismo, esta tesis explora las tensiones derivadas de la dicotomía entre conocimiento interno y externo, para determinar, cuando se cuenta con escasos recursos disponibles, cuál puede ser la fuente más eficaz. Aunque ambos tipos de conocimiento parecen ser igualmente relevantes, el conocimiento externo tiene un papel más significativo en el caso de la eco-innovación. Estos resultados son coincidentes con los obtenidos anteriormente por otros autores (De Marchi, 2012; De Marchi y Grandinetti, 2013; Chatterji y Fabrizio, 2014; Forés y Camisón, 2016). Si bien en esta investigación se ha puesto también de manifiesto el papel moderador del conocimiento interno, y la gran importancia que tiene su existencia para que el externo sea más efectivo.

Otra contribución relevante es la constatación de la influencia positiva que tiene la implicación de los clientes en la agilidad organizativa, su factor mediador en el desarrollo de procesos y productos eco-innovadores exitosos y en la obtención de mejores resultados empresariales. La participación continua de los clientes en la creación de productos eco-innovadores fortalece la adaptabilidad de las organizaciones y su capacidad para generar innovaciones ambientales, otorgándoles una ventaja competitiva al satisfacer mejor las expectativas y valores de sus clientes.

Adicionalmente, esta investigación estudia por primera vez, hasta donde alcanza nuestro conocimiento, las estrategias IKARG (siglas en inglés de Información, Conocimiento, Agilidad, Resiliencia y Eco-innovación) en un mismo modelo de investigación y las interacciones entre las mismas. Se ha constatado que la aplicación simultánea de estas estrategias lleva a la obtención de mejores resultados para las empresas y que les permite reaccionar de forma más ágil y sostenible a los cambios del entorno.

Por otro lado, partiendo de los principios de las metodologías ágiles (Fowler y Highsmith, 2001) se ha desarrollado una nueva escala de evaluación de la agilidad organizativa con un enfoque claramente aplicado a la praxis cotidiana en las empresas. Esta nueva medición de la agilidad, aunque debiera testarse en otros contextos facilita el análisis y la implementación de prácticas cotidianas de mejora.

Finalmente, se ha constatado la importancia clave para las empresas de contar con un sistema de gestión del conocimiento resiliente y ágil que les permita responder a los cambios y demandas internas y externas para ser eco-innovadoras. Este sistema, con la utilización de las nuevas tecnologías y la implicación de la gerencia y empleados proporciona a las empresas un apoyo eficaz en la aplicación de las estrategias de negocio y en la toma de decisiones, y de forma especial en entornos inestables como el actual.

VI.5. IMPLICACIONES PARA DIRECTIVOS

Esta tesis doctoral ofrece también sólidas implicaciones para aquellos directivos inmersos en proyectos sensibles con el medio ambiente.

En primer lugar, los resultados obtenidos ponen de relieve la necesidad de promover orientaciones de innovación abierta para adquirir un conocimiento ambiental de fuentes externas (Lopes et al., 2017). La gerencia de las empresas debe estar atenta al entorno, estableciendo relaciones de colaboración con agentes externos para introducir rápidamente este nuevo conocimiento, aplicándolo a los nuevos procesos y productos, no dependiendo exclusivamente del conocimiento generado internamente. Lo que les permitirá así ser organizaciones más ágiles y dinámicas. Sin embargo, no pueden obviar el conocimiento interno porque éste moderará el efecto del conocimiento externo adquirido sobre la innovación. Lo que demuestra la necesidad esencial de la asimilación del conocimiento externo en las estructuras y procesos internos para que su aportación sea útil.

Adicionalmente, otra implicación relevante derivada de esta investigación es que las organizaciones deberían adaptar sus estructuras, prácticas y procesos productivos para reaccionar de forma más ágil a las variaciones en los mercados y a las nuevas tendencias verdes en productos y servicios (Denning, 2018; Denning, 2019). En esta línea, la introducción de metodologías y prácticas ágiles en las distintas áreas de la organización ha demostrado ser una respuesta adecuada al desarrollo de la eco-innovación dentro de las empresas. Las organizaciones que desarrollan eco-innovaciones se muestran más ágiles para hacer frente a los cambios en los mercados. En esta línea, se apoya la recomendación que Chiou et al. (2011) hacen a las empresas para llevar a cabo

innovaciones verdes con el fin de mejorar su desempeño ambiental y lograr ventajas competitivas en un mercado global y cambiante.

Así mismo, los directivos deben promover una cultura y una estructura organizativa ágiles y resilientes. Ha quedado demostrado que la implementación de ambas estrategias no sólo es compatible sino deseable. En este mismo sentido, la implementación de políticas de formación y la implicación de los directivos y del resto de la plantilla en el desarrollo de nuevas eco-innovaciones en la organización debería ser una prioridad gerencial.

Otra propuesta relevante es la de exhortar a los directivos de las empresas a que lideren un cambio del actual paradigma hostil al medio ambiente a otro radicalmente diferente (Pujari et al., 2003), que empuje a las organizaciones a rediseñar sus procesos y productos, con la implicación de los usuarios, convirtiendo sus productos y servicios en una actividad sostenible. Este nuevo "*paradigma de innovación centrado en el usuario*" reconoce a los consumidores como la principal fuente de innovaciones de productos (von Hippel et al., 2011). Por esta razón, las empresas deberían integrar las innovaciones desarrolladas por el consumidor en los nuevos procedimientos y productos, otorgándoles un papel activo y reconociendo sus contribuciones al éxito de sus resultados.

Para gestionar todos estos cambios, la gerencia debería promover sistemas y estrategias de gestión del conocimiento que le permita desarrollar capacidades dinámicas que aprovechen las nuevas oportunidades de eco-innovación en el actual entorno económico inestable, lo que estaría en línea con la recomendación de Sher y Lee (2004). En este sentido, contar con sistemas de tecnología de la información no es útil en sí mismo si no se gestionan eficazmente y no se integran en una gestión adecuada de esa información. Ese es realmente el elemento diferenciador. En otras palabras, los directivos deben preocuparse no sólo por tener un sistema que recoja información y conocimiento interno y externo, sino también por cómo se utilizará esta información para contribuir al desarrollo de nueva eco-innovación en la organización.

VI.6. LIMITACIONES

Este estudio presenta ciertas limitaciones, algunas de las cuales se detallan a continuación.

El uso de una muestra transversal hace imposible concluir la causalidad en las relaciones estudiadas. Sólo con una investigación adicional, con estudios longitudinales, resolvería esta exigencia. La disponibilidad de datos longitudinales también permitiría un análisis más equilibrado del mantenimiento de determinadas estrategias de eco-innovación en las organizaciones, como podría ser la validación del éxito en el tiempo de los nuevos productos verdes.

También es importante considerar que sólo se ha utilizado un informante clave por empresa, aunque en nuestro caso ese directivo estaba bien informado sobre las cuestiones planteadas en el cuestionario utilizado para la investigación. El estudio sería más sólido aún, si la información procediese de diversas fuentes, o incluso si se hubiesen incorporado datos de otras fuentes objetivas para medir los constructos relevantes.

La muestra utilizada en nuestro estudio procede únicamente del sector industrial. Sería igualmente interesante replicar la encuesta en otros ámbitos de actividad y analizar las posibles diferencias intersectoriales. Las empresas comerciales y públicas podrían ser dos sectores interesantes para explorar. Especialmente el segundo, debido a que no se conocen muchas experiencias de aplicación de la agilidad en organismos y empresas públicos.

Por otro lado, la peculiaridad del contexto español en cuanto a políticas de innovación y eco-innovación, financiación, regulación ambiental, etc., no permitiría extrapolar, sin precaución, los resultados a otros países, lo que exigiría replicar el estudio y establecer similitudes y diferencias con los resultados obtenidos de nuestra muestra.

Finalmente, la metodología utilizada muestra únicamente los efectos lineales entre las variables estudiadas. Sería interesante analizar la presencia de efectos curvilíneos en las relaciones entre dichas variables con otro tipo de técnicas.

VI.7. LINEAS FUTURAS DE INVESTIGACIÓN

Como resultado del análisis bibliográfico y de las conclusiones derivadas de los modelos de investigación evaluados, se plantean a continuación algunas líneas de investigación para futuros estudios, más allá de los señalados en el apartado anterior.

En primer lugar, se podría profundizar en las tensiones que surgen entre el conocimiento ambiental interno y externo. La decisión sobre qué tipo y cantidad de conocimiento promover cuando las empresas cuentan con recursos limitados podría ayudar a clarificar cómo el conocimiento ambiental contribuye al éxito de las eco-innovaciones. En este caso, se podría avanzar en los posibles efectos sinérgicos del uso de ambos tipos de fuente de conocimiento más allá de los efectos directos y moderadores descritos en este estudio. Una línea de investigación adicional podría consistir en el análisis de la influencia de la estrategia de innovación en la sinergia entre los procesos ágiles y el éxito de la eco-innovación. Si bien algunas empresas se enfrentan a importantes desafíos en la reestructuración de procesos, aún pueden lograr el éxito de la eco-innovación mediante el desarrollo ágil. Investigar los factores críticos que impulsan a las empresas a adoptar metodologías ágiles podría ser de particular interés. Además, futuros estudios podrían tratar de profundizar en cómo los diferentes tipos de eco-innovación (producto, proceso, organización) se ven afectados por la agilidad y la implicación del cliente.

Por otra parte, se podría explorar el impacto de la robótica, la inteligencia artificial y las nuevas tecnologías en las percepciones de "agilidad" y "eco-innovación", y cómo pueden condicionar los nuevos modelos de negocio. Esto es, sin duda, uno de los temas que más interés está atrayendo al mundo académico y empresarial en la última década, requerido por la inminente aparición de la transformación digital a la que se van a enfrentar las empresas en los próximos años.

Así mismo, convendría investigar con mayor profundidad el papel del empleado, su compromiso e, incluso, las políticas de personal en la promoción de las capacidades dinámicas abordas en esta investigación. En este sentido, la irrupción de la inteligencia artificial es un campo novedoso que actualmente está ampliando el campo de la gestión de datos para la toma de decisiones y el desarrollo de productos y que va a condicionar

de forma decisiva no sólo los actuales modos de negocio de la empresa, sino cómo los empleados van a generar valor en ese nuevo contexto digital.

Finalmente, sería interesante incluir nuevas variables a los modelos estudiados de tal forma que se pueda analizar, de un lado la interacción existente entre las capacidades ordinarias y las dinámicas y, de otro, la moderación que ejercen las variables contextuales como la turbulencia de los mercados o la intensidad competitiva, a la hora de definir los procesos de eco-innovación y los cambios en los modelos de negocio necesarios para que la empresa siga siendo competitiva en el mercado, a la vez que respetuosa con el medio ambiente.

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ANEXO. CUESTIONARIO UTILIZADO

AGILIDAD EMPRESARIAL

INSTRUCCIONES PARA SU CUMPLIMENTACIÓN

- Le agradecemos sinceramente el que haya decidido participar en esta investigación.
- El cuestionario se contesta de forma sencilla en aproximadamente 10 minutos.
- Por favor, conteste a todas las preguntas. No existen respuestas incorrectas. Sólo queremos conocer su opinión.
- Toda la información obtenida será tratada de forma confidencial y global, para fines académicos.
- Si en alguna pregunta no está totalmente seguro/a de la respuesta no importa, nos interesa SU ESTIMACIÓN.

1. Su empresa es capaz de adquirir de fuentes externas (clientes, proveedores, competidores, consultores, …) conocimientos sobre…

	1-Muy en desacuerdo | 7-Muy de acuerdo						
Tecnología.	1	2	3	4	5	6	7
Marketing.	1	2	3	4	5	6	7
Gestión del negocio.	1	2	3	4	5	6	7
Fabricación y procesos.	1	2	3	4	5	6	7
Otros conocimientos y experiencia.	1	2	3	4	5	6	7

2. Su empresa es capaz de crear internamente nuevo conocimiento…

	1-Muy en desacuerdo | 7-Muy de acuerdo						
Tecnológico.	1	2	3	4	5	6	7
De marketing.	1	2	3	4	5	6	7
De gestión del negocio.	1	2	3	4	5	6	7
De fabricación.	1	2	3	4	5	6	7
De otro tipo.	1	2	3	4	5	6	7

3. Su empresa es capaz de combinar conocimiento…

	1-Muy en desacuerdo | 7-Muy de acuerdo						
Interno y externo.	1	2	3	4	5	6	7
Nuevo con el ya existente.	1	2	3	4	5	6	7
De diferentes segmentos, equipos e individuos.	1	2	3	4	5	6	7
Procedente de diferentes campos tecnológicos o de mercados.	1	2	3	4	5	6	7
Adaptando la estructura interna y los procesos de forma efectiva.	1	2	3	4	5	6	7
Coordinar las redes internas de trabajo y externas de colaboración de manera efectiva.	1	2	3	4	5	6	7

4. Ante interrupciones en la cadena de suministro, su empresa es capaz de…

	1-Muy en desacuerdo | 7-Muy de acuerdo						
Hacer frente rápidamente a los cambios provocados.	1	2	3	4	5	6	7
Adaptarse fácilmente a la nueva situación.	1	2	3	4	5	6	7
Responder rápidamente a las interrupciones.	1	2	3	4	5	6	7
Mantener bajo control la situación en todo momento.	1	2	3	4	5	6	7

5. Ante cambios que se producen en el mercado o en las demandas de los clientes, su empresa...

	1-Muy en desacuerdo | 7-Muy de acuerdo						
Responde rápidamente ante cambios en las necesidades (productos o servicios) de los clientes.	1	2	3	4	5	6	7
Cumple siempre con los pedidos que requieren una respuesta rápida o solicitudes especiales.	1	2	3	4	5	6	7
Permite adaptar rápidamente los niveles de producción/servicio a las fluctuaciones del mercado.	1	2	3	4	5	6	7
Realiza rápidamente los cambios necesarios ante una interrupción de la producción o del servicio.	1	2	3	4	5	6	7

6. Cuando su empresa trabaja con otras organizaciones…

	1-Muy en desacuerdo | 7-Muy de acuerdo						
Se adquieren más habilidades blandas (sociales, interpersonales,…) para gestionar las relaciones con los clientes.	1	2	3	4	5	6	7
Es capaz de implantar con rapidez nuevas formas de gestionar el negocio.	1	2	3	4	5	6	7
Se pueden combinar y crear nuevos procesos de negocio con rapidez.	1	2	3	4	5	6	7
Las discrepancias en la información se reducen mediante comunicaciones en línea, rápidas y actualizadas.	1	2	3	4	5	6	7
Permite innovar tecnológicamente nuestras ofertas de servicios.	1	2	3	4	5	6	7
Facilita el desarrollo de nuevas formas de organización y colaboración.	1	2	3	4	5	6	7

7. Cuando trabajamos junto con los clientes...

	1-Muy en desacuerdo | 7-Muy de acuerdo						
Podemos responder rápidamente a los cambios en las necesidades de productos o servicios.	1	2	3	4	5	6	7
Nos proporciona mayor habilidad para explorar oportunidades y opciones.	1	2	3	4	5	6	7
La experiencia de servicio al cliente se valora más.	1	2	3	4	5	6	7
Nos permite explorar oportunidades para nuevos servicios.	1	2	3	4	5	6	7

8. Para elaborar nuevos productos, su empresa trabaja conjuntamente con los clientes para...

	1-Muy en desacuerdo | 7-Muy de acuerdo						
Diseñar el producto/servicio que mejor se adapte a sus necesidades.	1	2	3	4	5	6	7
Ayudar a definir las especificaciones del producto/servicio.	1	2	3	4	5	6	7
Desarrollar conjuntamente el producto/servicio.	1	2	3	4	5	6	7
Mejorar la eficiencia del producto o servicio.	1	2	3	4	5	6	7

9. En comparación con su competencia, los conocimientos procedentes de fuentes INTERNAS (formación, I+D interna, colaboración entre departamentos, ...) de su empresa, permiten el desarrollo de...

	1-Muy en desacuerdo | 7-Muy de acuerdo						
Nuevas soluciones para el medio ambiente.	1	2	3	4	5	6	7
Productos o servicios menos contaminantes.	1	2	3	4	5	6	7
Procesos productivos menos contaminantes.	1	2	3	4	5	6	7
Programas verdes (gestión de residuos, control de efluentes, inventario de fuentes de contaminación).	1	2	3	4	5	6	7
Planes y medidas de emergencia ambiental.	1	2	3	4	5	6	7

10. En comparación con su competencia, los conocimientos procedentes de fuentes EXTERNAS (clientes, proveedores, competidores, consultores, ...) de su empresa, permiten el desarrollo de...

	1-Muy en desacuerdo | 7-Muy de acuerdo						
Nuevas soluciones para el medio ambiente.	1	2	3	4	5	6	7
Productos o servicios menos contaminantes.	1	2	3	4	5	6	7
Procesos productivos menos contaminantes.	1	2	3	4	5	6	7
Programas verdes (gestión de residuos, control de efluentes, inventario de fuentes de contaminación).	1	2	3	4	5	6	7
Planes y medidas de emergencia ambiental.	1	2	3	4	5	6	7

11. En comparación con sus competidores, indique en qué grado el uso de las tecnologías de la información de su empresa es útil para...

	1-Muy en desacuerdo | 7-Muy de acuerdo						
Agilizar los procesos de negocio.	1	2	3	4	5	6	7
Recoger y analizar los datos de negocio para la toma de mejores decisiones.	1	2	3	4	5	6	7
La comunicación eficiente con sus socios de negocio externos.	1	2	3	4	5	6	7
La coordinación entre organizaciones.	1	2	3	4	5	6	7

12. En la fabricación de nuevos productos...

	1-Muy en desacuerdo | 7-Muy de acuerdo						
No se utilizan materiales contaminantes/tóxicos.	1	2	3	4	5	6	7
Se usan embalajes amigables con el medio ambiente.	1	2	3	4	5	6	7
Se diseñan teniendo en cuenta el reciclaje y la eliminación de los mismos al final de su vida útil.	1	2	3	4	5	6	7
Se usan materiales ya reciclados.	1	2	3	4	5	6	7
Se usan materiales reciclables.	1	2	3	4	5	6	7

13. Los procesos de producción de su empresa...

	1-Muy en desacuerdo | 7-Muy de acuerdo						
Consumen menos recursos (agua, electricidad, etc.) que los de nuestros competidores.	1	2	3	4	5	6	7
Reciclan o reutilizan materiales o piezas.	1	2	3	4	5	6	7
Utilizan tecnologías más limpias o renovables para ahorrar energía, agua, desechos …	1	2	3	4	5	6	7
Están rediseñados para mejorar su eficiencia ambiental.	1	2	3	4	5	6	7
Permite cumplir ampliamente con la normativa de protección del medio ambiente.	1	2	3	4	5	6	7

14. En comparación con su competencia, ¿cómo han evolucionado los resultados siguientes?:

	1- Mucho peor que sus competidores | 7- Mucho mejor que sus competidores						
Las ventas.	1	2	3	4	5	6	7
Los beneficios.	1	2	3	4	5	6	7
La rentabilidad de los activos.	1	2	3	4	5	6	7
La rentabilidad financiera.	1	2	3	4	5	6	7
La productividad.	1	2	3	4	5	6	7

15. En el desarrollo de sus proyectos de innovación, con respecto a su competencia, su empresa...

	1-Muy en desacuerdo | 7-Muy de acuerdo						
Proporciona productos valiosos que satisfacen los requisitos reales del cliente.	1	2	3	4	5	6	7
Permite cambios en cualquier momento para mejorar el producto.	1	2	3	4	5	6	7
Realiza frecuentes entregas parciales del producto final durante el proyecto.	1	2	3	4	5	6	7
Mide el progreso y evolución de los procesos con indicadores detallados.	1	2	3	4	5	6	7
Garantiza la continuidad de la ejecución del proyecto a un ritmo constante.	1	2	3	4	5	6	7
Simplifica y reduce la complejidad de las actividades.	1	2	3	4	5	6	7

16. Para el desarrollo de sus proyectos de innovación, con respecto a su competencia, su empresa fomenta que...

	1-Muy en desacuerdo | 7-Muy de acuerdo						
Los líderes y las partes interesadas trabajen donde el proyecto lo requiera.	1	2	3	4	5	6	7
Los líderes se comuniquen con sus equipos de manera efectiva, frecuente y en persona.	1	2	3	4	5	6	7
Los equipos de trabajo tengan autonomía y puedan autogestionarse.	1	2	3	4	5	6	7
Los miembros del equipo se adapten a los cambios continuos que puedan surgir.	1	2	3	4	5	6	7
Los empleados estén muy motivados e involucrados en el proyecto.	1	2	3	4	5	6	7
Los empleados realicen el diseño, desarrollo y ejecución excelente y continuo de sus actividades.	1	2	3	4	5	6	7

17. Señale su grado de acuerdo sobre si los siguientes aspectos en su empresa han cambiado de forma considerable en los últimos tres años:

	1-Muy en desacuerdo |					7-Muy de acuerdo	
Sus clientes objetivo.	1	2	3	4	5	6	7
Su oferta de productos y servicios.	1	2	3	4	5	6	7
Su posicionamiento en el mercado.	1	2	3	4	5	6	7
Sus competencias y recursos clave.	1	2	3	4	5	6	7
Sus actividades internas para la creación de valor.	1	2	3	4	5	6	7
El papel de los socios en el proceso de creación de valor.	1	2	3	4	5	6	7
La distribución.	1	2	3	4	5	6	7
Las fuentes de ingreso.	1	2	3	4	5	6	7
La estructura de costes.	1	2	3	4	5	6	7

INFORMACIÓN DE CARÁCTER ESTADÍSTICO

Edad:
Sexo:
[ ] Hombre
[ ] Mujer

Cargo que desempeña en la empresa:
Número de años en el puesto actual:
Número de años trabajando en la empresa:
Número medio de empleados de la empresa: