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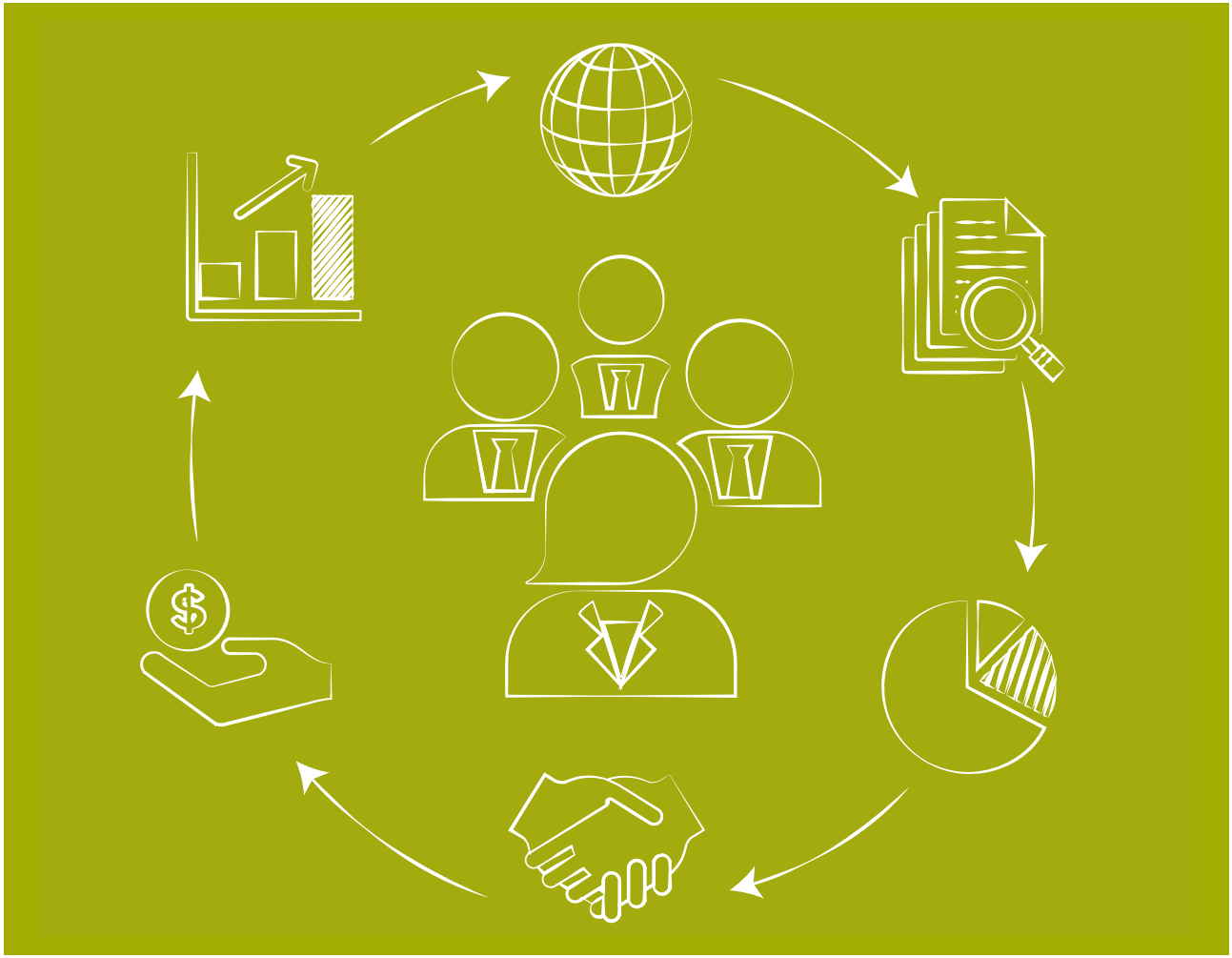

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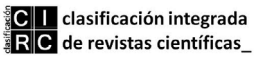

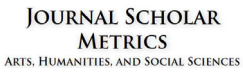

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IMPACTO Y BENEFICIOS DERIVADOS DEL USO DE CRM POR PARTE DE LAS EMPRESAS DEL SECTOR DE LA CONSTRUCCIÓN EN ESPAÑA (PROYECTO CRM-CONSTR-ES)

IMPACT AND BENEFITS DERIVED FROM THE USE OF CRM BY COMPANIES IN THE CONSTRUCTION SECTOR IN SPAIN (CRM-CONSTR-ES PROJECT)

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RESUMEN

Se presenta en este artículo la estructura y plan de acción de un proyecto (CRM-CONSTR-ES) cuyo objetivo es analizar, dentro del sector de la construcción en España, cual es el impacto que tiene usar soluciones Customer Relationship Management (CRM) para la gestión de las relaciones con los clientes. Se pretende comprobar empíricamente si es real la presunción de un escaso ratio de adopción de soluciones CRM por parte de estas empresas, y aportar criterios que demuestren la valía de estas soluciones como elementos de gestión claves para mejorar la competitividad de estas empresas. El estudio no abarca solamente la declaración de intenciones del proyecto, sino también el grado de avance del mismo y los resultados iniciales. Con la finalidad de hacer lo más práctico y aplicable posible este estudio, se ha trabajado juntamente con un Partner tecnológico de referencia, especializado no solo en el despliegue de soluciones CRM sino también en el sector de la Construcción. Tras elegir la muestra de empresas representativas del sector, se ha diseñado un formulario para la recogida de datos, que serán analizados siguiendo el método científico. En una etapa inicial del proyecto, el ratio de respuesta y las primeras conclusiones confirman un bajo nivel de adopción de CRM por parte de estas empresas, así como un elevado grado de satisfacción por parte de las que usan CRM como herramienta de gestión de sus relaciones con los clientes.

PALABRAS CLAVE

Construcción, Transformación Digital, Customer Relationship Management, CRM, Competitividad, Desempeño Organizacional.

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ABSTRACT

This article presents the structure and action plan of a project (CRM-CONSTR-ES) whose objective is to analyze, within the construction sector in Spain, what is the impact of using Customer Relationship Management (CRM) solutions for managing customer relationships. The aim is to empirically test whether the presumption of a low rate of adoption of CRM solutions by these companies is real, and to provide criteria that demonstrate the value of these solutions as key management elements to improve the competitiveness of these companies. The study does not only cover the declaration of intentions of the project, but also the degree of progress of the project and the initial results. In order to make this study as practical and applicable as possible, we have worked together with a leading technological Partner, specialized not only in the deployment of CRM solutions but also in the Construction sector. After choosing the sample of companies representing the sector, a form has been designed to collect data, which will be analyzed following the scientific method. In an initial stage of the project, the response rate and the first conclusions confirm a low level of adoption of CRM by these companies, as well as a high degree of satisfaction on the part of those who use CRM as a tool for managing their relationships with the clients.

KEYWORDS

Construction, Digital Transformation, Customer Relationship Management, CRM, Competitiveness, Firm Performance.

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1. INTRODUCCIÓN

El uso de las TIC (Tecnologías de la Información y Comunicación), por parte de las empresas, como factor determinante para potenciar sus capacidades de innovación y adaptación al entorno (Nambisan *et al.*, 2017; Ribeiro-Navarrete, 2021), es uno de los factores clave en el proceso de transformación digital que están afrontando las empresas de todo el mundo en su afán por sobrevivir y mantener su posición en el mercado (Dew *et al.*, 2011; AlQershi *et al.*, 2020).

La globalización, que facilita el acceso de todos los actores del mercado, no solo a información (en cantidad y en calidad) sino también a las propias transacciones mercantiles, hace que toda empresa que quiera perdurar en el mercado y mantener su ventaja competitiva, deba afrontar cuanto antes su propio proceso de transformación digital (Kane *et al.*, 2015).

En este sentido, y no sólo dentro del mercado español, la experiencia y los estudios muestran que existen ciertas barreras y dificultades, relacionadas con la inercia y la resistencia al cambio, que actúan como barreras de entrada de ciertos sectores a este tipo de proceso de transformación (Müller *et al.*, 2018) que va a ser clave para su subsistencia en un mundo cada vez más dinámico y exigente para con sus actores, en especial dentro de las Pequeñas y Medianas Empresas (PYMEs).

Uno de los sistemas de gestión que se presenta como más eficiente y de mayor impacto para que las empresas puedan afrontar con éxito sus procesos de transformación digital, es la solución tecnológica CRM, que surge (junto con los sistemas ERP) como una de las soluciones de negocio con mayor impacto y relevancia en la actualidad (Vicedo *et al.*, 2020; Gil-Gomez *et al.*, 2020). CRM es una de las tecnologías clave en este proceso de transformación digital, tanto por las mejoras de gestión internas que puede y debe atraer a la empresa (en cuanto a mejora y más eficiente gestión de las relaciones con los clientes) como por el impacto que ello puede tener en el mantenimiento y potenciamiento de la ventaja competitiva de la empresa en el mercado (Guerola-Navarro *et al.*, 2020b).

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En las últimas décadas, CRM ha sido una de las soluciones tecnológicas más abordadas desde el punto de vista de la investigación científica (Guerola-Navarro *et al.*, 2020a; Guerola-Navarro *et al.*, 2021a), no sólo pro su amplio y exponencial crecimiento en el número de despliegues en las empresas, sino también por las modernas teorías del marketing relacional que ponen a la gestión de las relaciones con los clientes en el centro de las decisiones de toda empresa que quiera sobrevivir en el mercado (Araújo *et al.*, 2018).

No obstante, y pese a que se han realizado estudios recientes sobre el impacto de uso de CRM en sectores con escaso nivel de adopción de CRM en diferentes entornos geográficos (Guerola-Navarro *et al.*, 2020c; Guerola-Navarro *et al.*, 2021b; Iazzi *et al.*, 2013; Belias *et al.* 2018; Crescimanno *et al.*, 2017; Ferrer-Lorenzo *et al.*, 2017), hay muchos sectores en los que queda mucho camino por recorrer en el estudio sobre el impacto de uso de CRM sobre sus resultados. En la presente ocasión, se presenta un proyecto de investigación que comprende un estudio empírico sobre el impacto del uso de CRM sobre el firm performance en el sector de la Construcción española.

Con la finalidad de realizar dicho estudio empírico de impacto de uso de CRM e innovación sobre firm performance, este proyecto se inicia con la definición del marco teórico sobre el que se desarrolla el estudio, tanto desde el punto de vista del sector de la Construcción en España (objeto de estudio) como desde el punto de vista de la tecnología CRM (tanto los sistemas tecnológicos CRM, como las principales dimensiones que lo identifican, inclusive la cultura de gestión de relaciones con los clientes). La siguiente etapa es la descripción taxonómica de la base de datos sobre la que se realiza el estudio, así como el proceso de selección de la muestra representativa de la población. En la fase siguiente se explica cuál es la metodología utilizada para la validación empírica de la relación entre las principales variables que definen el modelo de investigación elegido, para finalmente presentar los resultados, su discusión e interpretación para obtener las conclusiones empíricas de valor académico y empresarial.

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2. MARCO CONCEPTUAL

2.1. CUSTOMER RELATIONSHIP MANAGEMENT (CRM)

CRM ha demostrado ser una de las soluciones de gestión empresarial de mayor crecimiento en las últimas décadas, tanto en número de despliegues como en materia de interés para los investigadores (Guerola-Navarro *et al.*, 2020a; Gutiérrez Guevara y Romero Vargas, 2021; Guerola -Navarro *et al.*, 2021). El reconocimiento de los beneficios esperados del uso de CRM en el marco de la fidelización del cliente y el mantenimiento de los beneficios a largo plazo esperados mediante el refuerzo de la ventaja competitiva en el mercado (Gil-Gomez *et al.*, 2020) ha dotado a CRM con el halo de una herramienta de gestión clave para la supervivencia de las empresas en el mercado (Rahmadi *et al.*, 2021). Wahlberg *et al.* (2009) proporciona una imagen clara del CRM como un foco creciente de investigación científica, con una batería de estudios de referencia todavía no muy abundante, pero con una base de datos bibliográfica en continuo crecimiento que hace del CRM uno de los pilares básicos de estudio en el campo de la búsqueda de la excelencia empresarial a través de estrategias de gestión centradas en el cliente.

A pesar de que CRM nació como una solución básica para la automatización de la fuerza de ventas (Buttle, 2004), su evolución hacia modelos de gestión compleja de las relaciones con los clientes ha hecho del CRM un modelo de gestión que aporta tanto componentes de cultura empresarial como de tecnología. gestión, todos ellos directamente relacionados con la mejora del desempeño de la empresa y con ello de los resultados del negocio (Guerola-Navarro *et al.*, 2020b). Chen & Popovich, (2003) ya propusieron un modelo basado en los tres módulos que componen cualquier solución CRM: Ventas, Marketing y Servicios (Atención al Cliente y Soporte). Las teorías de gestión modernas basadas en estrategias centradas en el cliente han demostrado ser las más eficientes en los esfuerzos de las empresas por adaptar sus cadenas de valor a las necesidades y expectativas de los clientes, en línea con el propósito estratégico del CRM como herramienta de gestión. relaciones con los clientes (Joo, 2007). Huang y Lin (2005) proponen CRM como una de las herramientas clave para lograr la lealtad del cliente y que su

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confianza en la asociación a largo plazo trae beneficios operativos tanto para la empresa como para los clientes.

Como muestran las teorías modernas sobre el impacto que el marketing relacional tiene en la lealtad del cliente (Kurniawan *et al.*, 2021), se ha demostrado que la lealtad del cliente tiene un impacto esperado positivo y decisivo en el desempeño de la empresa. (Ramanathan *et al.*, 2017), por lo que se puede esperar que el despliegue de soluciones CRM en empresas de diferentes sectores productivos pueda desencadenar mejoras en el desempeño firme de las empresas que lo utilizan (Izquierdo *et al.*, 2015; Guerola-Navarro *et al.*, 2020c).

2.2. CRM Y EL SECTOR DE LA CONSTRUCCIÓN

Si bien es cierto que el proceso de transformación digital está afectando a todos los sectores, la construcción ha sido tradicionalmente un sector reactivo en la adopción y uso de la tecnología digital. A pesar de ser un sector altamente tecnológico, los datos indican que no se ha percibido el valor de la tecnología en un entorno digital, en la misma medida que en otros sectores, como el uso de software de gestión para el control de proyectos y costos (Marquesme, 2021). Siempre ha tenido una tendencia hacia la tecnología que podríamos calificar como "tecnología mecánica" (maquinaria, automóviles, herramientas, etc.).

Marquesme (2021) concluye que el sector de la construcción es uno de los menos digitalizados de España en la actualidad, situándose solo por delante del sector terciario, la pesca y la agricultura. La mayoría de los procesos en este sector tienen un componente mecánico manual, es un sector donde la mano de obra sigue siendo muy importante. Esta situación supone para las empresas, no solo en este sino en todos los sectores, un enorme sobrecoste en gestión y desvíos por falta de procesos automatizados que aporten valor a la gestión diaria. La tecnología suele verse como un coste o gasto para la empresa, especialmente toda aquella tecnología vinculada a un entorno digital. Cualquier iniciativa para demostrar que la tecnología digital es una inversión rentable es, por tanto, de gran importancia.

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2.3. ESTUDIOS PREVIOS SOBRE CRM Y EL SECTOR DE LA CONSTRUCCIÓN

El tema del impacto del uso de CRM en los resultados dentro del sector de la construcción no ha sido muy estudiado y hay relativamente pocas publicaciones al respecto. A pesar de que CRM ha sido ampliamente aceptado y aplicado con éxito en una variedad de sectores, ha habido muy pocos esfuerzos de investigación en el campo de CRM en la industria de la construcción. Sin embargo, existen ciertos estudios que tienen aspectos muy relevantes para contextualizar el presente estudio.

Respecto al sector de la construcción en general, Sear *et al.* (2007) presenta un caso de estudio en el que se evalúan los cinco factores de éxito que son claves para el éxito en las implementaciones de CRM en la Industria de la Construcción: implementar una estrategia comercial centrada en el cliente; crear una estructura organizativa compatible con CRM; establecer una cultura organizacional experta en CRM; asegurar el compromiso de la alta dirección; y definir medidas de éxito de CRM (Imhoff, 2001). Preece *et al.* (2015) revisa los beneficios y desafíos en las implementaciones de CRM en organizaciones de construcción, y proporciona una revisión de la filosofía y tecnología de CRM considerando las implicaciones, beneficios y desafíos para las organizaciones de construcción a un nivel estratégico comercial y operativo. En un mercado dinámico, en constante cambio y altamente competitivo, la implementación de CRM a lo largo del ciclo de vida de los activos puede proporcionar una gestión más eficaz de los clientes actuales y potenciales. Todo ello, dentro de la dinámica del sector de la construcción, debe orientar los esfuerzos del sector hacia un trabajo más colaborativo entre empresa y clientes.

En el área de la ingeniería civil, Melovic *et al.* (2015) busca las condiciones para incrementar la competitividad de las empresas, apareciendo el CRM como clave para cambiar el enfoque del producto al comprador y de esa manera construir relaciones de calidad, de largo plazo y rentables entre empresas y clientes, como más forma eficiente de mantener la ventaja competitiva en el mercado. La implementación de los sistemas CRM en este tipo de empresas está en correlación positiva directa con los resultados del negocio, enfocando todos los esfuerzos en el comprador y desplegando estrategias adecuadas de creación de relaciones a largo plazo, sostenibles y rentables con los compradores. De la misma forma,

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para la industria de la ingeniería civil, y enfocado principalmente al alcance básico de automatización de la fuerza de ventas, Jocovic *et al.* (2014) plantea que el CRM debe servir para planificar y gestionar procesos de ventas y fortalecer la competitividad al registrar todas las interacciones de la empresa con sus compradores y proveedores. Junto con las mismas tendencias, Okrepilov y Melovic (2015) también se esfuerzan por cambiar el enfoque en el sector de la ingeniería civil del producto al cliente, para crear relaciones sostenibles y beneficiosas para toda la vida con los clientes.

No existen estudios en la literatura que se refieran al impacto del uso de CRM en el desempeño de la empresa en empresas dedicadas a la construcción, ni, en consecuencia, vincular el CRM con la Innovación y el Desempeño de la Firma, lo que da originalidad y justifica el interés investigador de este estudio.

3. EL PROYECTO CRM-CONSTR-E

3.1. DEFINICIÓN DE OBJETIVOS Y PLAN DE TRABAJO

Objetivos

El objetivo principal, y que engloba a todos los demás, es analizar cual es el grado de adopción de las soluciones tecnológicas CRM por parte de las empresas del sector de la construcción en España, además de los beneficios de gestión que este tipo de soluciones están aportando a las empresas que lo usan, con el objetivo final de aportar argumentos científicamente obtenidos sobre los beneficios esperados del despliegue y uso de dichas soluciones en las empresas de dicho sector.

Comprobar si efectivamente, y tal y como se presupone y se asume, este sector es uno de los que menor grado de digitalización han afrontado (Marquesme, 2021), es el primer paso para tratar de analizar y demostrar si el uso de soluciones CRM puede ayudarles en su proceso de transformación digital, modernización, y mejora de la gestión empresarial.

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Los objetivos concretos, tal y como aparecen en la Figura 1, que se plantéan en este ámbito de trabajo de investigación sobre el sector de la construcción en España son:

1. Con la ayuda de bases de datos oficiales y de Partners tecnológicos de referencia y de elevada solvencia en el mercado, identificar la muestra de estudio apropiada para validar el impacto de uso de CRM sobre el desempeño organizacional de las empresas del sector que lo usan internamente para gestionar sus relaciones con sus clientes.

2. Seleccionar el modelo de investigación adecuado para validar las condiciones y resultados de impacto del uso de CRM sobre los resultados empresariales.

3. Realizar el estudio empírico que demuestre en qué condiciones el uso de CRM trae a la empresa mejoras en el desempeño organizacional.

Figura 1. Objetivos del estudio.
Fuente: elaboración propia.

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Plan de trabajo

El presente proyecto se estructura siguiendo las fases que se muestran en la Figura 2.

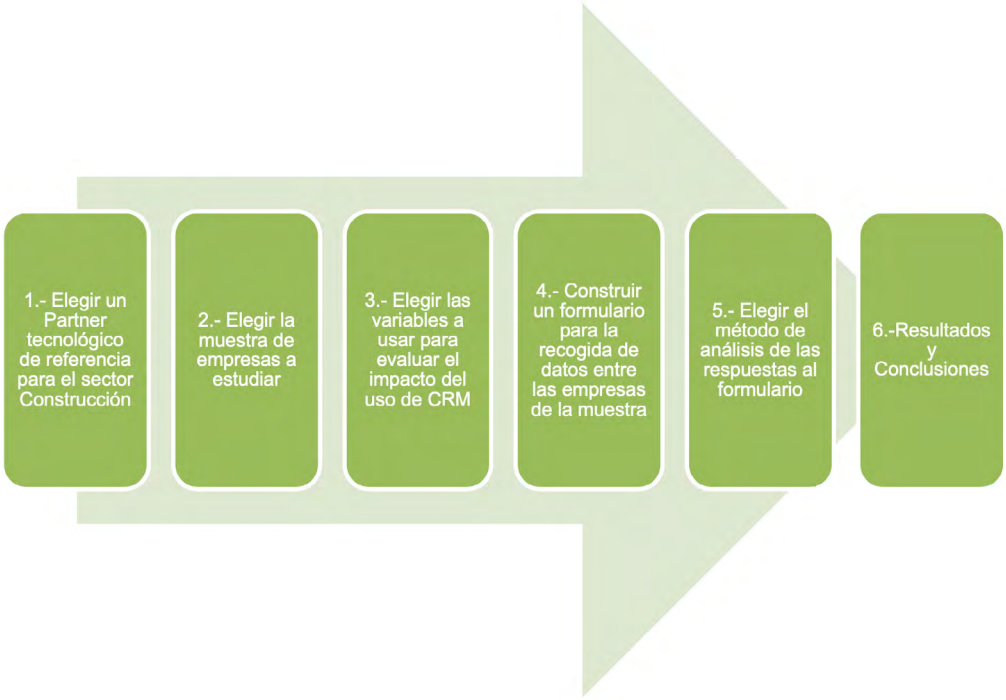

Figura 2. Plan de trabajo.
Fuente: elaboración propia.

Del espíritu claramente práctico y aplicado del presente proyecto, cuya finalidad última es aportar criterios de valor a las empresas del sector que afronten la decisión de implementar un sistema CRM, deriva la necesidad de establecer una alianza con al menos un Partner tecnológico de referencia y suficiente experiencia y arraigo en el sector de la Construcción española. A través de esta alianza se pretenden conseguir varios aceleradores del proyecto:

- Seleccionar la muestra apropiada de empresas.

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- Favorecer la ratio de respuesta al formulario.

A continuación, se definen las líneas maestras de este plan de trabajo.

3.2. ELECCIÓN DE LOS DATOS Y LA MUESTRA MEDIANTE ALIANZA CON UN PARTNER TECNOLÓGICO ESPECIALIZADO

El paso previo a la elección del método de análisis de resultados es conocer la población disponible para realizar el estudio empírico, así como los detalles de la muestra con la que se va a trabajar. Con el fin de validar empíricamente el impacto del uso de CRM en el desempeño de la empresa en el sector de la Construcción español, se ha de identificar el segmento más representativo dentro de dicho sector de la Construcción en España.

Este proyecto pretende aportar no solo una evidencia empírica y científica del cumplimiento de las expectativas sobre los beneficios esperados del uso de CRM (Gil-Gomez *et al.*, 2020), sino que pretende también (e incluso principalmente) obtener argumentos de valor y de referencia para que los Partners tecnológicos que trabajan en el ámbito de la transformación digital de las empresas de este sector. Es por ello que ya de inicio en este proyecto se involucra a este tipo de Partners, con el objetivo de:

- Identificar el ámbito de estudio que pueda tener mayor impacto en las empresas del sector.
- Establecer una alianza de colaboración que permita una mejor llegada a las empresas que formen parte de la muestra de estudio.

Tras entrevistar a algunos de los Partners tecnológicos con mayor número de clientes en el sector de la construcción en España, y atendiendo a su conocimiento y experiencia en el sector, así como a los estudios más recientes al respecto (Marquesme, 2021) se ha seleccionado una muestra listada de empresas que incluye aquellas que estos Partners tecnológicos proponen como:

- Las que mayor impacto deberían observar en sus indicadores de desempeño organizacional en caso de usar CRM.

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- Las que disponen de estructuras organizativas y de propiedad más favorables a los proyectos de adopción de soluciones de CRM.

Atendiendo pues a esta propuesta, y para poder realizar una validación empírica del impacto de uso de CRM, el estudio ha seleccionado como población objeto de estudio empresas nacionales del sector de la Construcción e Inmobiliario con una facturación anual en el rango de 10 a 200 millones de euros, y registradas en el Instituto Nacional de Estadística (INE) con el siguiente CNAE:

4110. PROMOCIÓN INMOBILIARIA

4121. CONSTRUCCIÓN DE EDIFICIOS RESIDENCIALES

4122. CONSTRUCCIÓN DE EDIFICIOS NO RESIDENCIALES

4211. CONSTRUCCIÓN DE CARRETERAS Y CARRETERAS

4212. CONSTRUCCIÓN DE VÍAS SUPERFICIALES Y SUBTERRÁNEAS

4213. CONSTRUCCIÓN DE PUENTES Y TÚNELES

4221. CONSTRUCCIÓN DE REDES PARA FLUIDOS

4222. CONSTRUCCIÓN DE REDES ELÉCTRICAS Y DE TELECOMUNICACIONES

4299. CONSTRUCCIÓN DE OTROS PROYECTOS DE INGENIERÍA CIVIL

Mediante el estudio del impacto de uso de CRM sobre el desempeño organizacional en esta muestra, se tratará de aportar argumentos de impacto que ayuden a los tomadores de decisión de las empresas que aún no han decidido aportar por CRM como solución tecnológica clave para su gestión de relaciones con sus clientes.

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3.3. ELECCIÓN DE LAS VARIABLES

Atendiendo a estudios previos sobre diferentes modelos de validación empírica sobre el impacto de uso de CRM (Guerola-Navarro *et al.*, 2020b; Valmohammadi, 2017; Calantone *et al.*, 2002; Zegarra, 2014), se ha considerado elegir las siguientes variables de studio:

- Grado de uso de CRM.
- Capacidad de Innovación.
- Mejoras en el Desempeño Organizacional.

Analizados los diferentes modelos, en los referenciados entre los estudios más relevantes publicados en revistas de prestigio, se eligen estas variables como las que mayor se adecúan al objeto último que persigue el presente estudio.

En primer lugar, por Grado de uso de CRM entendemos (Valmohammadi, 2017) en qué medida utiliza la potencia de gestión de CRM aquella empresa que tiene y usa un sistema CRM de cualquier tipo y fabricante. En concreto, Valmohammadi (2107) propone medir el grado de uso de CRM a través de los siguientes elementos identificativos del uso de características y herramientas de CRM:

- El intercambio de información.
- Involucramiento del cliente.
- Asociación a largo plazo.
- Resolución conjunta de problemas.
- CRM basado en tecnología.

En referencia a la segunda variable, la Capacidad de Innovación, también identificada en general como "Innovación", Calantone *et al.* (2002) la define como la capacidad que tiene la empresa de adaptarse a nuevas circunstancias de Mercado, tanto si vienen de parte del producto (bienes y servicios ofertados al mercado) como si vienen de part de los procesos internos (tanto procesos productivos como de gestion.

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Calantone *et al.* (2002) propone una escala de medición de la capacidad de innovación a través de los siguientes elementos:

- Nuestra empresa prueba con frecuencia nuevas ideas.
- Nuestra empresa busca nuevas formas de hacer las cosas.
- Nuestra empresa es creativa en sus métodos de operación.
- Nuestra empresa es a menudo la primera en comercializar nuevos productos y servicios.
- La innovación en nuestra empresa se percibe como demasiado arriesgada y se resiste.
- Nuestra introducción de nuevos productos ha aumentado en los últimos 5 años.

Finalmente, como variable de impacto que se propone para medir cómo se puede esperar que el uso de CRM mejore los resultados empresariales, Zegarra (2014) propone el Desempeño Organizacional. Este modelo utiliza la escala de Nakata *et al.* (2008), que compara el desempeño de la organización con el de otros competidores y se compone de los siguientes ítems:

- La calidad del producto o servicio.
- El éxito de nuevos productos o servicios.
- La tasa de retención de clientes.
- El nivel de ventas.
- La rentabilidad del capital.
- Margen de utilidad bruta.
- El retorno de la inversión

Una vez identificadas las variables de medición que puedan relacionar el impacto de uso de CRM sobre el desempeño organizacional, con la intervención de la capacidad de innovación, el siguiente paso será construir un formulario de recogida de datos entre las empresas de la muestra, y seleccionar un modelo de análisis de las respuestas obtenidas.

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3.4. CUESTIONARIO Y METODOLOGÍA DE ANÁLISIS DE DATOS

Con el objeto de recoger los datos que den lugar a conclusiones sobre el impacto del uso de CRM en las empresas del sector de la construcción en España, se propone el diseño de un formulario en función de constructos e ítems que ya hayan sido validados previamente en la literatura científica. De entre las alternativas revisadas en la literatura, se ha elegido tomar como base el cuestionario de Guerola-Navarro *et al.* (2020b), cuyo carácter general y objetivo hace que sea idóneo para el actual proyecto con la adición de dos nuevas secciones específicas para el sector en estudio.

El cuestionario propuesto cuenta con las 7 secciones que se muestran en la Figura 3, de las cuales las dos últimas son fruto de la aportación del Partner tecnológico por su conocimiento del sector.

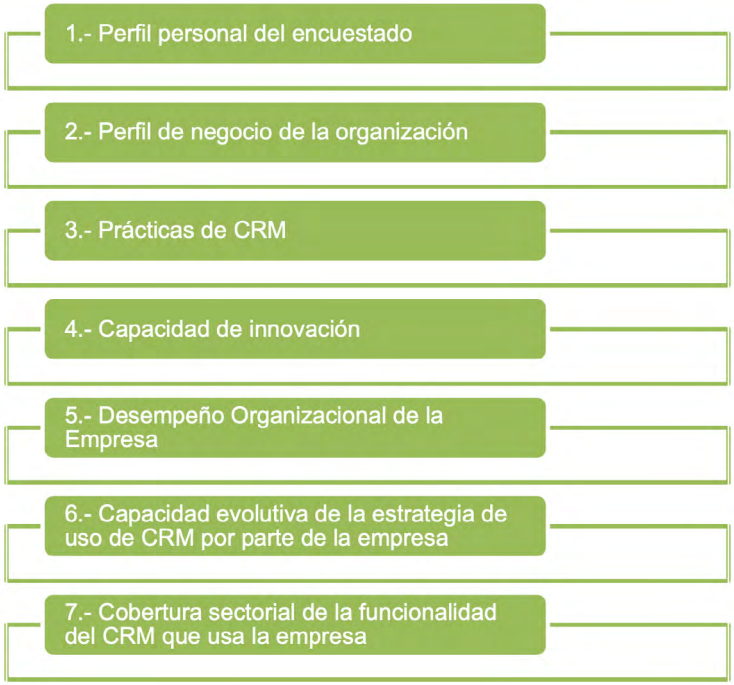

Figura 3. Secciones del formulario de recogida de datos.
Fuente: elaboración propia.

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En cuanto a la metodología a seguir para analizar las respuestas obtenidas a través del cuestionario, se propone elegirla en función del volumen de respuestas obtenidas a través del formulario. Los diferentes enfoques cuantitativos, cualitativos, y mixtos (Sampieri, 2018) dan multitud de alternativas para que la metodología de análisis de los datos sea acorde a la representatividad de la muestra poblacional elegida y la ratio de respuesta al cuestionario.

4. RESULTADOS Y ESTADO ACTUAL DEL PROYECTO

Como resultado de las acciones llevadas a cabo, y siguiendo el orden de cada una de las etapas del Plan de Trabajo propuesto, se ha llegado a los siguientes resultados:

1. Se ha elegido un Partner tecnológico con elevado prestigio y gran penetración de mercado en el área de las Tecnologías de Información y Comunicación (TIC), que tiene el mayor número de referencias de clientes del sector de la construcción en España, y que cuenta con un equipo y una estrategia específica y diferenciada para dicho sector. Se ha establecido una alianza con este Partner para colaborar de forma desinteresada en la ejecución del proyecto.

2. Se ha elegido la muestra de empresas que van a participar en el estudio del grado de impacto del uso de CRM sobre el desempeño organizacional. Esta selección de empresas se ha realizado en colaboración con el Partner estratégico, atendiendo a criterios de CNAE (código estadístico de actividad económica registrado oficialmente en el Instituto Nacional de Estadística) y a criterios de facturación.

3. Se han seleccionado las variables que se consideran relevantes en el estudio, siguiendo los estudios científicos previos publicados. En concreto se han elegido 3 variables: Grado de uso de CRM, Capacidad de Innovación, y Desempeño Organizacional.

4. Se ha construido un formulario para la recogida de datos, en base a un cuestionario previamente testeado y validado científicamente y empíricamente. Sobre este cuestionario se ha añadido

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dos secciones recomendadas por el Partner tecnológico de referencia. En el momento actual el proyecto se encuentra en fase de recogida de respuestas a través de un formulario web.

5. Queda por definir, en función de la ratio de respuesta, cual será la metodología más apropiada para analizar los datos obtenidos.

6. Se espera obtener unos resultados y conclusiones que aporten criterios de decisión valiosos a los Tomadores de Decisión de las empresas del sector de la Construcción que deban valorar la idoneidad de afrontar proyectos de implementación de soluciones CRM.

5. CONCLUSIONES

El presente artículo muestra el objetivo, plan de trabajo, y estado actual del proyecto CRM-CONSTR-ES, cuyo objetivo fundamental es analizar el grado de adopción de las soluciones tecnológicas CRM por parte de las empresas del sector de la Construcción en España, así como obtener conclusiones sobre el impacto que sobre el desempeño organizacional puede tener el uso de dichas soluciones CRM.

Por la especificidad del sector en estudio, así como por sus especiales características, se ha buscado una alianza estratégica con un Partner tecnológico altamente especializado en el sector. Siguiendo las directrices del método científico, y con la aportación de la experiencia y conocimiento del Partner estratégico, se ha avanzado en la línea de la definición de objetivos, muestra y listado de empresas en estudio, selección de las variables de análisis, y construcción de un formulario para la recogida de datos.

Como futura línea de investigación, y en una fase posterior a la conclusión de la recogida de respuestas al formulario, el análisis de dichas respuestas a través de la metodología más apropiada a la muestra elegida deberá de proporcionar elementos de juicio y decisión a las empresas del sector construcción que en un futuro se planteen desplegar alguna solución CRM.

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EFFICIENT AND SUSTAINABLE IMPROVEMENT OF A SYSTEM OF PRODUCTION AND COMMERCIALIZATION OF ESSENTIAL MOLLE OIL (SCHINUS MOLLE)

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ABSTRACT

This research describes the relationships between the design of an efficient production cycle of metabolites from the Schinus molle plant, from extraction, processing, product formulation to the final disposal of its residues, and the project's environmental sustainability. The target population in this research was limited to small farmers-producers, marketers of natural products, technicians of the municipalities related to the MYPES, and students of engineering and careers related to agriculture and its processing, which were convened by a digital marketing system via Facebook, reaching a total of 300 participants in total. The sample chosen was non-probabilistic and consisted of 94 participants who gave their informed consent. The research design was pre-experimental. The results obtained through self-applied instruments in the control and experimental groups, under the application of an intervention program were subjected to hypothesis tests of mean differences with Wilcoxon statistics for related samples, reaching the general conclusion that the application of counseling and training programs in green business models based on the extraction and processing of Shinus molle essential oil positively influences the perceptions of stakeholders on the environmental sustainability of projects of this nature.

KEYWORDS

Environmental sustainability, Environmental concern, Ecological dimension, Sustainable development, Sustainability.

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1. INTRODUCTION

Ecological agriculture requires innovation processes in collaborative networks as an imperative need of a global nature framed in the complexity paradigm. This metamorphosis has to occur within a learning process (Tisenkopfs & Kunda, 2015) that can re-energize the ecosystemic balances, which the endemic eagerness of compulsive consumerism has dangerously modified. Unfortunately, the discussion between organic and conventional agriculture is still antithetical and occurs at all levels in structuring state policies. While the former prioritizes ecosystem balances, the latter is based on increasingly demanding globalized markets (Ramón *et al.*, 2012), suggesting the beginnings of the Anthropocene era (Meng *et al.*, 2021).

Considering agroecology as a sustainable paradigm, there are still insufficient studies of micro, small business, and startup models that are congruent with production and marketing models within the agroecological rationale, with closed-cycle processes, within the paradigm of the circular economy about minimizing the production of waste and in any case to manage it for its reincorporation into the production chain.

The innovation process evaluated in this research is based on structuring collaborative networks between farmers, academia, and civil society, where experiences are exchanged and learning processes for transformation occur (Hediger & Knickel, 2009). Unfortunately, while it is true that Peru is one of the most biodiverse countries, this importance has not helped the economic progress of farmers. Among the reasons given is the ineffectiveness of the state for its inability to articulate the regions with sectors of civil society and academia to promote the development and prosperity of farmers and rural areas.

According to the report published by IndustryARC (2019), in 2015 - 2022, the global essential oils market is expected to generate around USD 11.5 billion, at a CAGR of 10.1% between 2016 and 2022. Europe is the dominant market and is expected to be the major contributor to the global revenue of producing countries, owing to the revaluing trend of essential oils on a worldwide scale.

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This research aims to evaluate the feasibility of optimizing the value-added chain for Schinus molle essential oil producers, as a transversal axis, through an eco-business proposal within the paradigm of environmental sustainability and in a framework that promotes endogenous sustainable development.

2. CONCEPTUAL FRAMEWORK

2.1. SUSTAINABLE DEVELOPMENT

The construct refers to the unavoidable metamorphosis that must take place about how we relate to the world around us. Therefore, it is urgent to define agendas of a globalized nature, capable of assuming new paradigms to systemically address the economic-social-environmental triad dimension with a vision of politicians and strategists capable of permeating the social-environmental size to the principles of the economic extent (Cordera, 2017). i.e., "Governments face the complex challenge of finding the right balance between competing demands on natural and social resources, without sacrificing economic progress" (Strange & Bayley, 2012, p. 33).

In the conceptualization of sustainable development, it is recognized that nature's reserves of availability are being depleted as a result of unplanned economic and technological development, which only takes into consideration current human needs and even within a habitual framework of compulsive consumerism to the detriment of nature. Consequently, it is urgent to initiate research projects with a different vision for the generation of applied knowledge in the state-academia-civil society triad to make the sustainability of agroecological projects viable (Gavito *et al.*, 2017).

Sustainable development does not involve a stationary or static desired equilibrium state, specified through sustainability indicators as guarantee standards (Hediger & Knickel, 2009). Instead, sustainable development is a dynamic, complex state immersed in the process of permanent change and reconfiguration based on the integrity of the system it represents (Hediger & Knickel, 2009).

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2.2. DIMENSIONS OF SUSTAINABLE DEVELOPMENT

According to González (2012), four dimensions should be considered to address sustainable development. These dimensions are society, environment, culture, and economy, which present dynamic relationships due to the complexity of the construct. According to this approach, man, by constructing himself socially and culturally, transforms himself, achieving a new cultural environment. On the other hand, Larrouyet (2015) argues that sustainable development "implies advancing simultaneously in five dimensions: economic, human, environmental, institutional and technological" (p. 24). Therefore, the characterization of the sustainable development profile to be designed depends on the socio-cultural context characteristics of the nations.

The present research considers three dimensions of sustainable development, which should be assumed as a systemic and indissoluble triad: economy, society, and environment (Carro-suárez & Sarmiento-Paredes, 2017). Regardless of the context, the fundamental premise for the introduction of sustainable development in state policies must be examined from the theory of systems, evaluating it in the non-decreasing function of its inputs and outputs, with evolutionary and increasingly demanding concepts and measurements, based on a drastic change of people's culture, with binding state policies concerning all the dynamic and indissoluble relationships of the variables of environmental sustainability. Some of these interdependencies can probably be temporarily bypassed, but history shows that before long, some alarm or crisis calls for a return to the path of sustainable development.

While it is true that this article addresses sustainable development based on three dimensions (Artaraz, 2001), a reductionist and non-systemic perspective, which for many researchers has a utilitarian approach, it is urgent to evaluate the interdependencies between the three pillars, wherein a prevalent analysis it establishes that social welfare and economic welfare nurture each other in correspondence of univocal relationships and that they only become sustainable within a balanced and sustainable ecosystem in time and space (Carro-Suárez & Sarmiento-Paredes, 2017). It is fundamental to understand complexity, based on the systemic model of sustainability (Kammerbauer, 2001), considering dynamic,

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diffuse relationships with a lot of uncertainty, since the stakeholders have conflicting interests and with a constitutive dominance of utilitarianism that intends to use the construct of Sustainable Development to perpetuate the market economy.

2.2.1. ECONOMIC DIMENSION

In the last decades, it can be observed that there has been a tendency to invoke the international community to develop state policies oriented to the sustainable development of countries. However, the term development alludes to its traditional context, economic development, which generates a conflict of interests between economic activity and the environment, with imprudent and foolish actions, such as assuming that nature is an inexhaustible source of resources and a bottomless sink for waste. Consequently, one of the weaknesses that must be reversed to achieve sustainable development is to rethink the structure of the state in such a way that the society-economy-environment triad restructures its principles from a market economy towards an environmental economy that can determine the guidelines of the modes of production, industrialization, and commercialization within environmental rationality in a relentless search for social equity (Carro-Suárez & Sarmiento-Paredes, 2017). Among the factors that energize the irrational utilitarian Peruvian economy is the culture with a lack of national identity, the lack of knowledge generation, which leads to technological obsolescence of the productive capacity of agribusiness, poor land-use planning, which has been exacerbated by environmental conflicts generated by mining with a purely extractive approach, the lack of competitiveness at the global level, are the main factors responsible for the poor management of agriculture in Peru (Gavito *et al.*, 2017).

The economic dimension from the sustainability approach should not continue to operate under the principle that nature is infinite and always tends to rebalance itself. The articulation of the economy-society-environment triad without prevalence levels (Balvanera *et al.*, 2017) should lead us to propose models or paradigms under the perspective of environmental accounting where prevention comes before remediation. The practical vision of the ecological problem is to reduce pollution and, in any case,

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manage it for the final deposition considering the most negligible environmental impact. Within the field of an economy that assumes ecological liabilities, what is intended is the constant search for sustainable alternatives with atomic efficiency, use of renewable energies within a closed system of production. About ecological economics (Castiblanco, 2007) argues that "it is a scientific discipline that integrates elements of economics, ecology, thermodynamics, ethics, and other natural and social sciences to provide an integrated and biophysical perspective of the interactions that are interwoven between economy and environment." (p. 8)

2.2.2. SOCIAL DIMENSION

It can be considered one of the least addressed pillars in discussions in international forums on sustainable development. Lehtonen (2004) argues that the human talent capabilities approach and social capital are the underlying bases of the social dimension. However, their practical implementation is not fully realized, even though these approaches propose a cultural partner articulation that should consider social sustainability, based on equity, which should be a transversal axis or the center of the social dimension and, in this perspective, intergenerational equity (Lehtonen, 2004) should be considered as an additional factor. Likewise, it is not enough to view social confluences about the dynamics of socio-environmental conflicts and consider citizen participation with legitimate and horizontally based dialogue among stakeholders as a binding condition for environmental sustainability. It should be emphasized that discussion must begin by recognizing the perversity of the inequitable distribution of resources between business people and society and between man and nature.

Finally, of the seventeen objectives of sustainable development, it can be affirmed that equity, social justice, and environmental conservation are the fundamental pillars of sustainable development and these three objectives constitute part of the social dimension of sustainable development, with equity and ecological integrity being recent, where the first is one of the principles extensively studied because it is a global problem that requires solutions on a local-regional-international and intergenerational scale

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and is based on responsible management based on respect for all forms of ecosystemic life, preventing or mitigating all environmental problems, reducing inequality, the main problem in society due to the exploitation and degradation of man and therefore of the environment. Currently, efforts are being made to promote socio-culturally integrated communities, inclusive of the human-nature dyad, thus providing access to social and environmental justice as the underlying basis for a genuinely lasting sustainable development.

2.2.3. ECOLOGICAL DIMENSION

A relevant premise for analyzing ecological sustainability is the second principle of thermodynamics related to the tendency of systems to move spontaneously towards equilibrium (Kammerbauer, 2001). However, the complex character of ecosystems does not admit Cartesian generalizations about states of peace projected by man (Kay, 1991, cited in Kammerbauer, 2001).

Again, from the position assumed in the present research of moderate anthropocentrism, concerning this dimension, sustainability presumes an accounting that also values environmental assets and liabilities, with a sound and productive circular system, trying to imitate nature (Alvarado *et al.*, 2020). In other words, it is urgent to introduce eco-designs in the modes of production based on rationality and environmental awareness.

The ecological dimension of sustainable development, about human beings, refers to the set of values, attitudes, and motivations that should govern the relations between society and nature and how these relations should be translated into systems of production and management of rational and closed-cycle productive resources, as well as in the regulation of individual and group behavior of humans, based on the consideration of all forms of ecosystemic life.

In the context of different social processes that perpetuate inequity and awareness of the confrontation between man and nature to the detriment of the environmental dimension of sustainable development, it is urgent to consider that the availability and potentiality of biogenetic resources are not infinite,

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nor that nature is a sink for its residues and that the uncontrolled predatory effects of natural man are reaching a state in which there is no return and nature and its internal ecological balance cycles will take actions to reestablish it without considerations of preservation of man and his future generations.

In this context, man's concepts of subsistence and entrepreneurial action must change his compulsive habits of consumption, which must undergo a metamorphosis of all his social systems of organization, production, commercialization, consumption, accumulation, transformation, and management of natural resources; as well as the deployment of his creative capacity to project himself beyond time and space always with considerations for otherness. At the same time, the concept of nature must include all sources and vital cycles of energy and biogenesis and other challenges that consider all living species, integrating everything in a single process of ecosystemic interrelations.

The decontextualization of the economy based on neoliberal utilitarianism has led to the unsustainability of the modern economy, and it is not enough to associate in the order of prevalence, the economy-ecology, or economy-social context binomial. Still, it is necessary to recover the web of dynamic and complex relationships of the economy-social context-ecology triad (Paredes *et al.*, 2020). This article argues that recovering a contextual understanding of the economy is essential for sustainability. Indeed, the loss of the ecosystemic context is at the root of the unsustainability of our current economic activity. It is not enough to recover only the ecological or social context in which economic activity takes place. Sustainability challenges us to recover the links of a dynamic nature between the three dimensions of sustainable development (Kammerbauer, 2001).

2.3. SCHINUS MOLLE

The molle, called the Peru tree, is appreciated as a plant native to Peru that covered the entire region of Tahuantinsuyo at the time of the Inca Empire. During the conquest and the viceroyalty, it spread to Ecuador, Chile, and Bolivia and the North to Mexico and the USA. The molle grows naturally in the Peruvian Andes and is necessary for reforestation of very degraded areas because it resists drought,

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frost, slightly saline soils, and is not edible for livestock. It also thrives in stony soils and contributes to soil formation. It is ideal for use as a windbreak defense and in the registration of soil erosion. It is a wild tree that does not need irrigation for its growth usually grows next to the Tara or Guarango plant creating fencing structures as shade in parks, green areas, roads (Bautista, 2018).

It is widespread in Peru. Schinus molle Linnaeus grows in full sun in temperate and dry subtropical regions and develops in areas from sea level to 3500 masl. The average annual temperature for its development is 15-20 °C, with an average yearly rainfall of 300-360 mm. However, it tolerates warmer temperatures and, once established, is extremely drought tolerant. It is also resistant to frost and temperatures as low as -10 °C. In nature, it occurs in semi-arid wastelands, riverbanks, along riverbanks, and on slopes up to 2,400 m altitude. Sandy and well-drained soils are preferred, but it is tolerant to saturated, poorly drained and infertile soils. It is also susceptible to alkalinity and salinity. Molle plantations have shallow roots and can be fragile; therefore, they are likely to blow over or break their branches in solid wind and need protection from wind. According to the family to which the plant belongs, the edaphological conditions and the ripening stage of the fruits contain up to 5 % of essential oils in fruits and 2 % in leaves (Bautista, 2018).

2.3.1. SCHINUS MOLLE ESSENTIAL OIL

They are odoriferous volatile liquid fractions, generally obtained by steam distillation, maceration, extraction by supercritical fluids, and constituted by a complex mixture of terpenoid compounds whose most important applications are in the cosmetics industry, fragrances, and as a flavoring agent in the culinary industry (Bautista, 2018). The fruit and leaves of Schinus molle contain many bioactive compounds with pharmacological properties proven in multiple investigations in Peru, Mexico, among other Latin American countries. Forty-six compounds were identified by gas chromatography in the essential oil obtained by steam distillation of Schinus molle fruits, including nine monoterpene hydrocarbons, one

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aromatic compound, one aliphatic acid ester, two monoterpene esters, 16 sesquiterpene hydrocarbons, and 17 other sesquiterpenoids (Bernhard *et al.*, 1983, cited in Lim, 2016).

The essential oil composition of Schinus molle fruits reports that the main compounds are 46.52 % -phellandrene, 20.81 % -phellandrene, 8.38 % -terpineol, 4.34 % pinene, 4.96 % -pinene, and 2.49 % p-cymene, respectively (Bendaoud *et al.*, 2010, cited in Lim, 2016).

2.3.2. USES OF SHINUS MOLLE

Among the most appropriate uses of the leaves or fruits can be mentioned as a flavoring agent because the whole plant has an intense characteristic odor due to essential oils. The cooking of leaves, branches, bark, and root is used for pale yellow dyeing of wool fabrics when alum is used as mordant, and the tonality can be changed, according to the type of mordant used (Bautista, 2018). The methanolic extract of Schinus molle leaves produces a complex mixture of metabolites, mainly constituted by 12 sesquiterpenoids, six tirucallane-type triterpenoids, and four flavonoids isolated from Schinus molle fruits exhibited antioxidant activity (Ono *et al.*, 2008, cited in Lim, 2016). Among them, three flavonoids exhibited antioxidant activity almost identical to -tocopherol by the ferric thiocyanate method. One flavonoid showed a more substantial radical scavenging effect on 1,1-diphenyl-2-picrylhydrazyl than that of -tocopherol.

Among the pharmacological activities, the components of Schinus molle essential oil exhibits cytotoxic activity against a human hepatocellular carcinoma cell line (Lim, 2016). Also, the hexane extract of Schinus molle leaves produces antidepressant-like effects that seem to depend on its interaction with serotonergic, noradrenergic, and dopaminergic systems (Machado *et al.*, 2007, 2008, cited in Lim, 2016). Further research indicated that the antidepressant-like effect of Schinus molle ethanolic extract is due to the presence of flavonoids, which was postulated to exert its antidepressant-like impact by increasing the availability of serotonin and noradrenaline in the synaptic cleft (Lim, 2016).

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The main pharmacological activity of Schinus molle essential oil is an antimicrobial activity because Schinus molle leaf oil exhibited maximum fungi harmful activity during the screening of some essential oils against some shared storage and animal pathogenic fungi (Bautista, 2018). On the other hand, the essential oil showed effective toxicity against animal pathogens and mild activity against storage fungi (Lim, 2016).

3. METHODOLOGY

According to the study's purposes, the type of research is classified as applied research. It is proposed to use the fundamentals of sustainable development to make proposals on an efficient and sustainable design of production and commercialization of products based on essential oils.

The level of research is explanatory-causal because the objective is to study the influence of an efficient and sustainable design of production and commercialization of products based on Schinus molle essential oil on the perceptions about the environmental sustainability of this type of agroecological business.

The research method used is hypothetical-deductive. It is intended to test the influence of an efficient and sustainable design of production and commercialization of products based on Schinus molle essential oil on perceptions of environmental sustainability.

The research design is pre-experimental. This type of design was carried out with a pre-test and post-test after applying for the training program in an efficient and sustainable model of production and commercialization of products based on Schinus molle essential oil to evaluate the variation of perceptions of environmental sustainability. The pre-experimental designs present a minimum degree of control, the manipulation of the independent variable is produced and what is intended is to observe its effects on the dependent variable. It should be noted that the difference with pure experimental designs is centered on the reliability assumed when establishing the control and experimental groups, according to Hernández *et al.* (2014), in this type of design, randomization is not introduced when assigning the

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experimental group since, due to logistical or other needs, unrelated to the experiment, they are chosen in a non-random manner. Therefore, the groups established for the research are not randomized and were covered by the quota sampling technique.

The formal and logical representation is:

	pre - test		post - test
G.E.	O_1	X	O_2

Legend:

X = Experimental variable: training program in the efficient and sustainable product design and commercialization of products based on Schinus molle essential oil.

O1 = Pre-test measurements: Environmental sustainability.

O2 = Post-test measurements: Environmental sustainability.

3.1. SAMPLE

3.1.1. PLANT SAMPLE

Schinus molle fruits were collected in the month of July 2019 in Huayucachi-Huancayo Junín, Luricocha-Huanta-Ayacucho, Huayllan-Pomabamba-Ancash, with a total weight of 50 kg (see Table 1). The protocol for each sample collected was to wash with potable water and dry outdoors for six days. After the natural drying time, they were packed in thick paper and cardboard box, to be sent to the Organic Chemistry laboratory of the Faculty of Chemical Engineering of the Universidad Nacional de Ingeniería. Finally, the sample was received at the organic chemistry laboratory, registering a net weight of 40 kg.

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Table 1. Molle fruit harvesting zones.

ID	Plant	Family	Part used	Place of collection	The initial weight of collected	sample Weight of dry sample*	Importance of dehulled and sieved sample*.
1	Shinus molle	Anacardia-ceae	Fruits	Huayucachi-Huancayo Junín	10 kg	9,4 kg	8,0 kg
2	Shinus molle	Anacardia-ceae	Fruits	Luricocha-Huanta Ayacucho	8 kg	7,5 kg	6,4 kg
3	Shinus molle	Anacardia-ceae	Fruits	Huayllan-Pomabam-ba-Ancash	7 kg	6,6 kg	5,6 kg
4	Shinus molle	Anacardia-ceae	Fruits	Peso total de fruto de Shinus molle a procesar	25 kg	23,5 kg	20 kg

Source: own elaboration.

3.1.2. STAKEHOLDER SAMPLE

Considering that the stakeholder population is limited due to the sui generis nature of the project, in the context of Covid-19, the target population was limited to small farmers-producers, natural product marketers, technicians from the municipalities related to the MYPES, and students of engineering and careers related to agriculture and its processing, which were convened by a digital marketing system via Facebook, reaching 300 participants. Therefore, the sample chosen was non-probabilistic and consisted of 94 participants who gave their informed consent.

3.2. ENVIRONMENTAL SUSTAINABILITY INSTRUMENT

The development of the instrument was based on the research of Silva-Santamaría and Ramírez-Hernández (2017), Becerril (2017), and De Los Rios-Carmenado *et al.* (2016), whose instruments were developed from others that have been used over the last 20 years in research on environmental sustainability, within the approach of the three most relevant dimensions of sustainable development: the economic dimension formed by three factors that collect information on productivity, producer welfare, and marketing; the social size that collect information on two factors, local-regional government

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and stakeholders and the ecological extent constituted by a single factor related to the sustainability of the project in general terms.

In developing the instrument, a self-application questionnaire was designed with a bipolar Likert scale, ranging from never to always with a total of 48 items. In addition to the three cross-cutting dimensions of environmental sustainability, the sociographic aspects of the sample elements were also considered.

The analysis of the instrument's internal consistency was statistically calculated by Cronbach's alpha with the SPSS-Statistics software, having carried out the verification by factors, dimensions, and by all the information collected by the instrument. Cronbach's alpha values are between 0.812 and 0.934, values between acceptable and high for research works of this nature (Hernández *et al.*, 2014). It should be noted that the correlations of the instrument-ecological dimension binomial are positive and more significant than the instrument-social dimension correlations, which in turn are higher than that of the instrument-economic dimension. Considering that the sample elements are constituted by 94 persons to whom the instrument has been applied in a pre-test and post-test, the internal consistency analysis indicates that the self-application of the device presents high internal consistency and high reliability of its results.

3.3. EXPERIMENTAL PART

3.3.1. EXTRACTION OF THE ESSENTIAL OIL

The experimental procedure for molle essential oil extraction was carried out with batches of 3.6 kg of molle fruits, an average molle actual oil extraction volume of 215.2 mL, and an average extraction yield of 4.8 % by mass.

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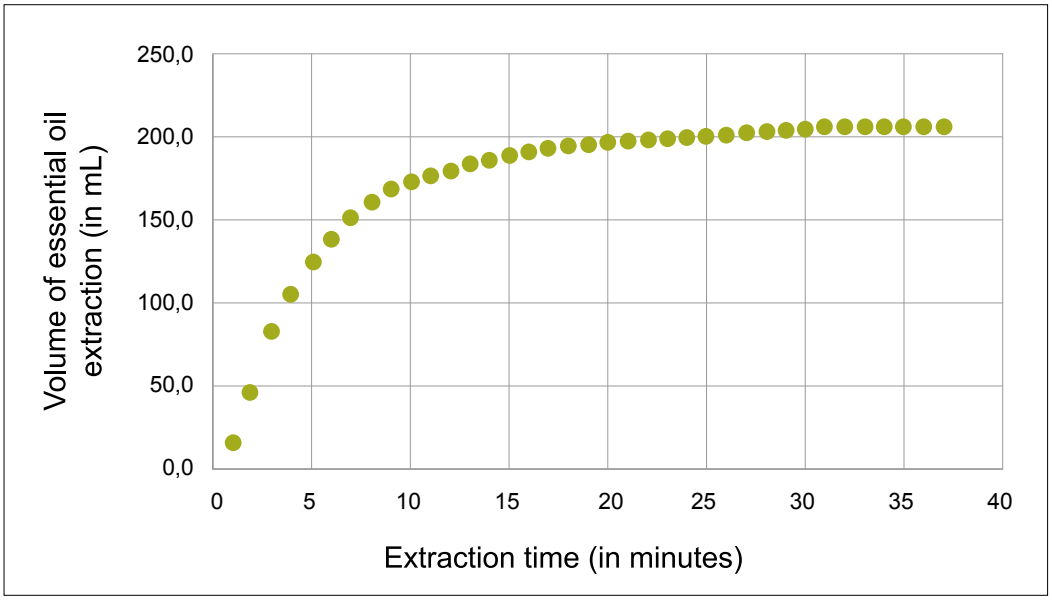

Figure 1. Extraction profile of Schinus molle L. essential oil.
Source: own elaboration.

The extraction procedure was carried out with steam extraction equipment with internal steam production of 16 L capacity. After a preliminary treatment of washing, drying, dehulling, and grinding, ground molle fruit with a particle diameter < 4 mm, an average bulk density of 0.42 kg/L, and a power of 2000 W was obtained. Figure 1 shows the profile of the extraction curve extrapolating an average extraction time of 35 minutes, the optimum time of 21 minutes for the extraction of 97 % of the essential oil.

3.3.2. GREEN BUSINESS MODEL VALUE CHAIN

The proposed production microindustrialization commercialization model is framed within the robust sustainability paradigm where "the substitutability of natural capital is seriously limited by ecological characteristics such as integrity, irreversibility, uncertainty and the existence of critical components of natural capital that make a unique contribution to human well-being" (Castiblanco, 2015, p. 4).

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The present research aims to establish a closed-cycle production and commercialization model about minimizing waste production and, in any case, to manage it for its reincorporation into the productive chain. This approach is framed within the guidelines of the eco-efficient output. It is aimed at promoting manufacturing processes based on prevention rather than remediation, where eco-efficiency is evaluated at each stage of the process about reducing energy and water consumption and reducing waste generation and, last but not least, to the proposal of adequate waste management until the formation of compost, closing the production cycle sustainably and sustainably, offering competitive products about quality.

Figure 2 shows the flow diagram of the closed-loop production cycle of the value chain of the business model based on the molle essential oil.

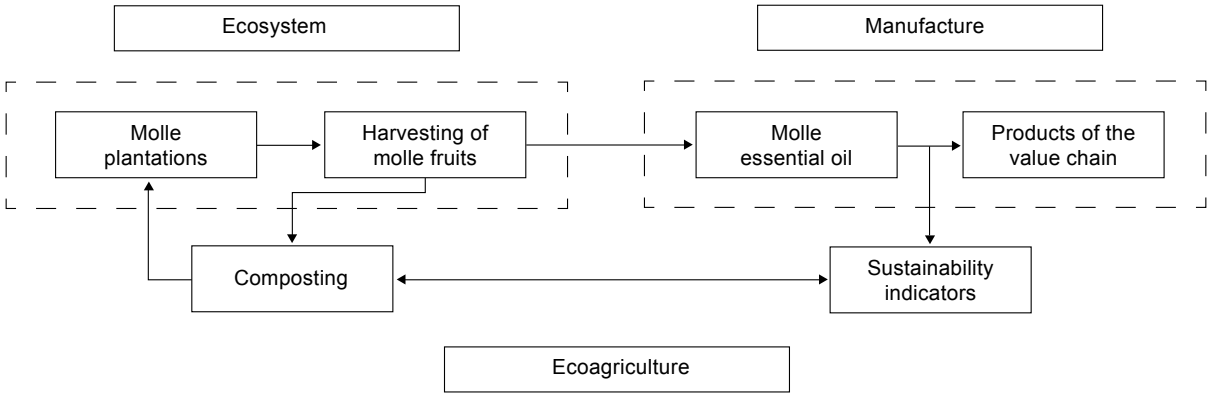

Figure 2. Model for efficient and sustainable production and marketing of molle essential oil and its commercial products.
Source: own elaboration.

In this context, we intend to contribute a grain of sand to the training of farmer-entrepreneurs in the central region of Peru, who require technical assistance to solve challenging problems, forge, outline prototypes and discover sustainable solutions, which is why they must add environmental, social and economic value to their proposals.

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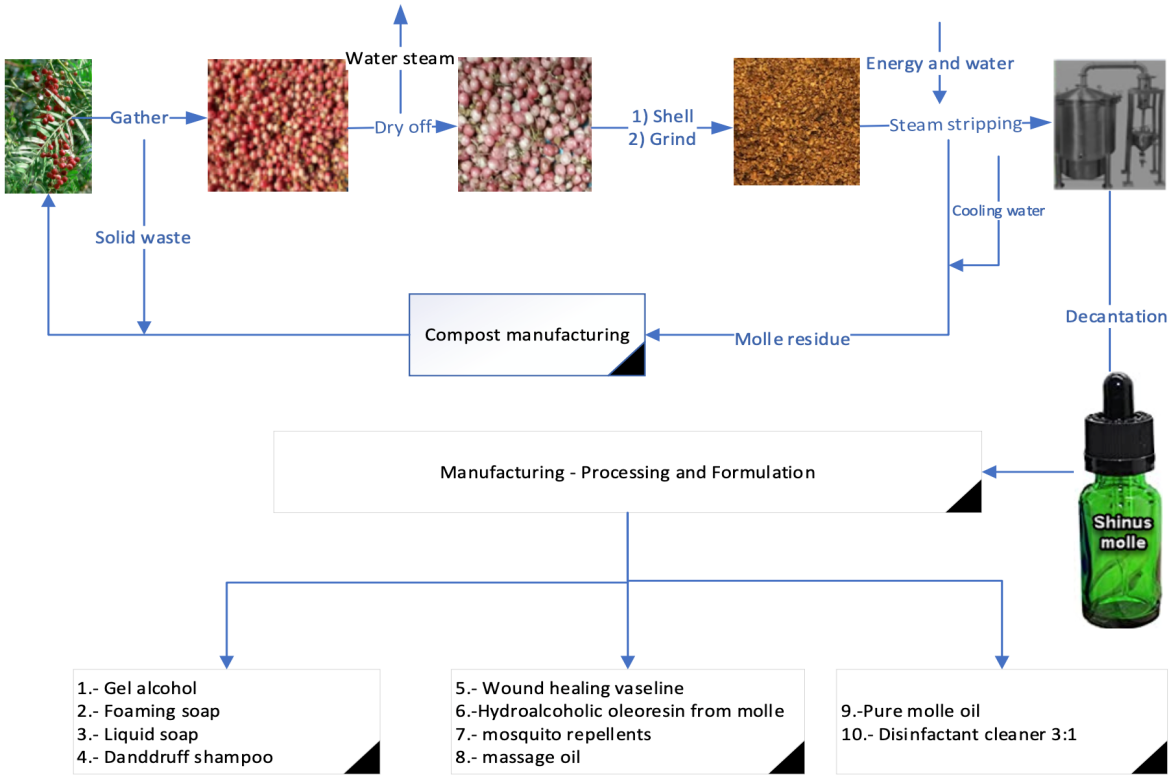

Figure 3. Closed production model for commercial products.
Source: own elaboration.

Figure 3 shows the production diagram of the whole business model. The agroecological model's sustainability is affiliated with a series of formalisms that include social, environmental, and economic aspects of the system (Castiblanco, 2015). The business model based on sustainable agriculture is based on an integrated management system of organic agricultural production processes, in that molle plantations do not require chemical pest control, maintain productivity naturally, protect green areas from pollution, robust rural smallholder farming systems (Altiere, 2018). The proposal is based on promoting, in a self-managed manner and with the support of academia and civil society, business models established

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based on natural agricultural resources under sustainable agriculture (Silva-Santamaría & Ramírez-Hernández, 2017).

Figure 3 shows the production cycle of Schinus molle essential oil and its transformation into commercial products within a closed process. The model is based on forming strategic alliances with agricultural associations, trade associations, state agencies, and universities. The value chain focuses on quality culture, which implies continuous technological and commercial development and innovation.

4. RESULTS

4.1. RESULTS ON THE ECONOMIC DIMENSION

Table 2 shows the descriptive statistics of the factors that make up the economic dimension, productivity, farmer welfare, and marketing, indicating a positive evolution of perceptions from the pre-test to the post-test.

Table 2. Descriptive statistics between the factors of the economic dimension.

Factors	Factor: productivity		Factor: Farmer welfare		Factor: marketing		Total average of the economic dimension	
Type of test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Mean	3,10	3,22	3,60	3,77	3,83	4,01	3,37	3,58
Median	3,17	3,22	3,67	3,83	4,00	4,00	3,45	3,60
Mode	3,00	3,11	3,67	3,67	4,00	4,00	3,80	3,35
Std. Dev.	0,81	0,68	0,89	0,61	0,93	0,61	0,78	0,49

Source: own elaboration.

Figure 4 shows the box-and-whisker plot for the results of the total economic dimension. Again, the graph shows an increase in the median relative to the perception between the pre-test and post-test on the green business model approach.

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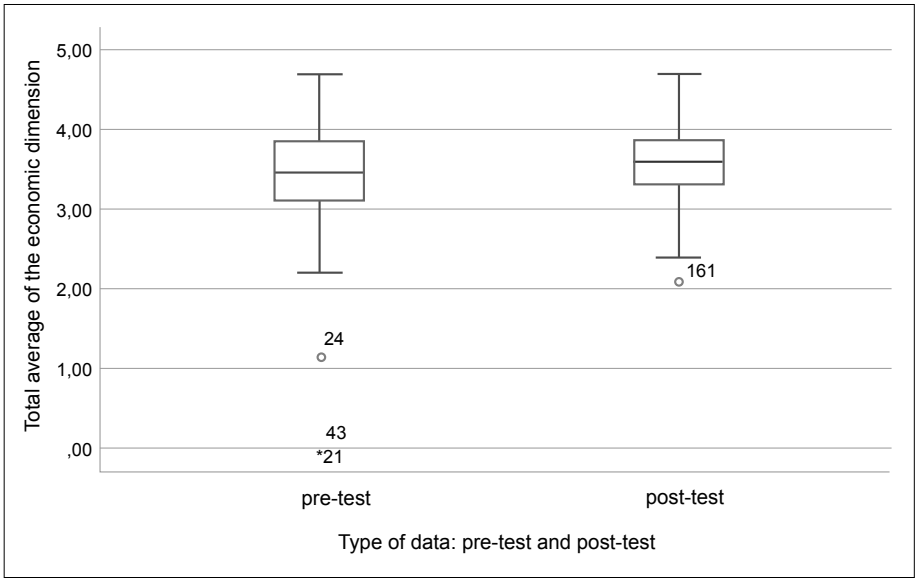

Figure 4. Box-and-whisker plot for the economic dimension.
Source: own elaboration.

The application of median comparisons with the Wilcoxon test for related samples shows a value of the Wilcoxon statistic of Z= - 1.646 with Sig. = 0.100. The statistical test shows no statistically significant evidence to reject the null hypothesis of equality of medians. Consequently, it can be stated that there is no statistically reliable evidence to assume that the implementation of training programs in green business models influences the perception of the economic dimension of the instrument.

This result is related to the fact that green projects do not have a utilitarian media purpose; their objectives are medium or long term because, based on the knowledge of the consumption practices of the 21st century, the entrepreneurs of this type of project have a higher degree of environmental awareness and replace paradigms of media capitalization projects by others of capitalization in sustainable green assets in the future (Castañeda, 2014).

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One of the factors related to these results is centered on the influence exerted by the training program, with content focused on training with environmental responsibility, environmental awareness, environmental ethics, ecological rationality, with business models based on the circular economy, which promote economic-social-ecological sustainability (Velayos-Castelo, 2008).

In the opinion of Arias (2006), the business model to be implemented is based on the rational use of molle plantations that grow naturally and without significant care in the central zone of Peru, without encouraging the agro-industry that promotes monoculture and encouraged by compulsive consumerism. In the same line of conclusions as Castañeda (2014) it can be inferred that the economic dimension is of lesser weight for those stakeholders committed to environmentally sustainable projects because their concerns for the environment, before their problems for financial profits, underlie an impelling force of prognosis about the intentions of their undertakings and that is based on the "theory of planned behavior" (Velayos-Castelo, 2008). That is, projecting their decisions on the trends of the ever-increasing green consumer behavior.

While it is true that the implementation of technical assistance programs from universities to producers regarding the introduction of essential oils to agro-based business models is strategic, the perception of the respondents is not focused on the economic profitability that could cause the implementation of these projects, but are based on socio-environmental rationality.

4.2. RESULTS ON THE SOCIAL DIMENSION

The results in Table 3 show that the mean of the perception on the social dimension from a green business model approach has a valuation in the pre-test of the standard of 2.02 for the factor national, regional, and local government and 2.56 for the stakeholder's dimension and these statistics increase for the post-test.

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Table 3. Descriptive statistics among the factors of the social dimension.

Factors	Average of the social dimension: national-regional-local government(D4): G21-G28		Average of the social dimension: stakeholders (D5): T29-T31		Total average of the social dimension	
Type of test	**Pre-test**	**Post-test**	**Pre-test**	**Post-test**	**Pre-test**	**Post-test**
Mean	2,02	2,58	2,56	2,77	2,17	2,60
Median	2,00	2,50	2,67	2,83	2,18	2,63
Mode	1,50	2,25	3,00	3,00	2,55	2,73
Std. Dev.	0,90	0,70	1,02	,86	0,85	0,57

Source: own elaboration.

The application of median comparisons with the Wilcoxon test for related samples shows a value of the Wilcoxon statistic of Z= - 4.044 with Sig. = 0.000, as shown in Figure 5. Thus, the statistical test indicates statistically significant evidence to reject the null hypothesis of equality of medians. Consequently, it can be concluded that the application of the training program in green business models has a positive influence on the perception of the social dimension about the fact that strategic farmer-civil society-university alliances make green business projects viable.

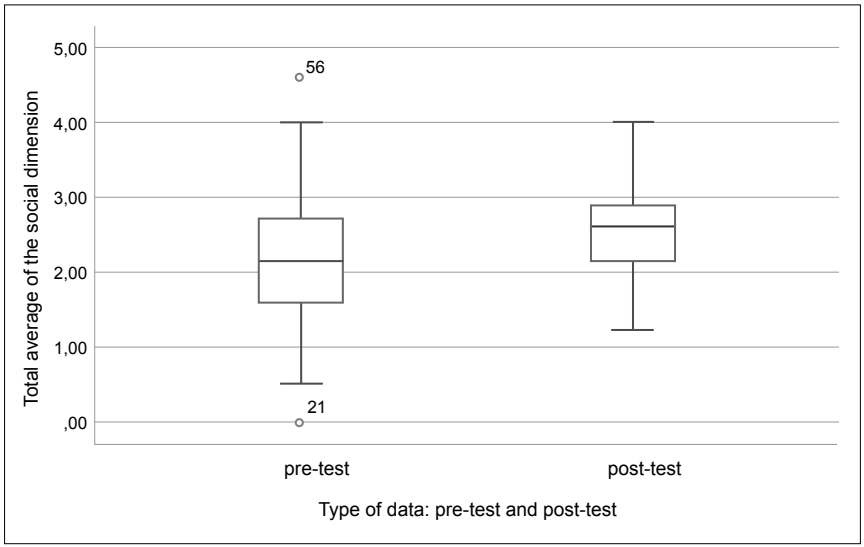

Figure 5. Box-and-whisker plot for the social dimension.
Source: own elaboration.

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4.3. RESULTS ON THE ECOLOGICAL DIMENSION

Figure 6 shows the box-and-whisker plot of the median distribution on the ecological dimension with a median valuation of 2.38 in the pre-test to a value of 3.06 for the post-test. After applying for a green business model training program, the perception of the feasibility of ecologically sustainable business models significantly improves.

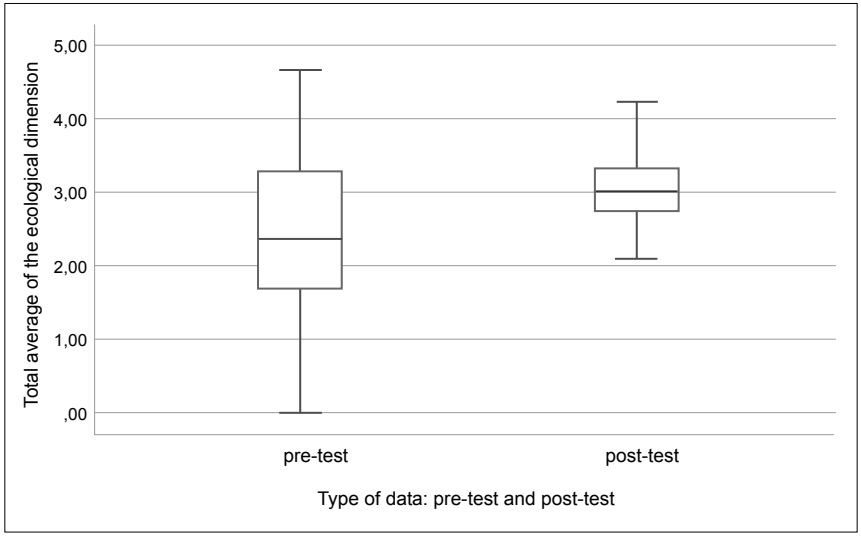

Figure 6. Box-and-whisker plot for the ecological dimension.
Source: own elaboration.

The application of median comparisons with the Wilcoxon test for related samples shows a value of the Wilcoxon statistic of Z= - 4.959 with Sig. = 0.000. The statistical test shows statistically significant evidence to reject the null hypothesis of equality of medians. Consequently, it can be concluded that the application of the training program positively influences the perception of the ecological dimension of a business model with environmental sustainability, with a design of an efficient production cycle of metabolites from the Shinus molle plant, from extraction, processing, product formulation, to the final disposal of its residues.

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Of the three dimensions evaluated, the ecological dimension is the one that evolves positively in the most significant ways, indicating that training programs in green business models based on environmental responsibility provide a greater degree of ecological awareness to offer solutions to the needs of alternative commercial products for consumption and export. In this context, the research aims to promote alternatives to sustainably producing inputs from the agricultural sector without promoting monocultures and without affecting ecosystems. For example, Molle plantations are an alternative that does not require sophisticated technologies or chemical substances that can change the ecological balance. In other words, if we only plant this plant and with minimal and natural care, we can develop and provide the raw material sustainably for those based on essential oils.

4.4. RESULTS ON THE ENVIRONMENTAL SUSTAINABILITY INSTRUMENT

Table 4 and Figure 7 show the average ranges. The sum of positive fields presents a value of 3461.50 higher than that of the negative degrees, with a value of 1003.50, showing significant differences between the medians of the post-test the pre-test.

Table 4. Wilcoxon signed-rank test for the environmental sustainability instrument.

		N	Average rank	Sum of ranks
Total average of the post-test instrument - Total average of the pretest instrument - Total average of the post-test tool - Total average of the pretest instrument	Negative ranges	28	35,84	1003,50
	Positive Ranks	66	52,45	3461,50
	Ties	0		
	Total	94		

Source: own elaboration.

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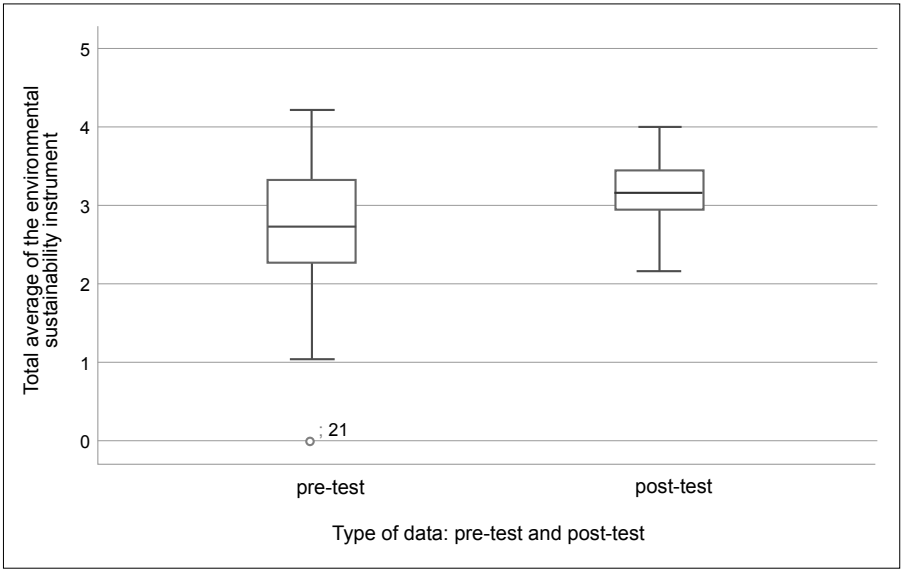

Figure 7. Box-and-whisker plot for the environmental sustainability instrument.
Source: own elaboration.

The application of median comparisons with the Wilcoxon test for related samples shows a Wilcoxon statistic value of Z= - 4.635 with Sig. = 0.000. The statistical test shows statistically significant evidence to reject the null hypothesis of equality of medians. Consequently, it can be concluded that the application of the training program positively influences the perception of environmental sustainability of business models with a design of an efficient production cycle of metabolites from the Shinus molle plant, from extraction, processing, formulation of products, to the final disposal of their residues.

The ecological sustainability on which this study is based is based on the rationality and resilience of molle, which grows wild and without significant care. The first refers to the capacity to drastically reduce the models of consumerism based on sustainable use of natural resources. The second relates to changes in the rural dynamics so that the ecological balance is not irreversibly disturbed. It should be noted that the most devastating disturbances of ecosystems are the demanding culture of society for more demanding products in terms of quality and cost, which leads to maximizing production to reduce

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costs. It can be observed that commercial and industrial activities optimize waste management without reducing consumerism, which makes nature an inexhaustible source of resources, far from what the sustainable development paradigm implies.

6. CONCLUSIONS

About the pre-experimental design of the present research on a model of efficient and sustainable improvement of a production and commercialization system of molle essential oil (Schinus molle), the Wilcoxon Z value, with a value of Z= - 4.635 with Sig. = 0.000 shows statistically significant evidence to reject the null hypothesis on the equality of medians. Based on the statistically significant results, it can be concluded that the application of strategic training programs from the academy, promoting production and commercialization systems of molle essential oil, Schinus molle, is practical, improving the levels of perception about the viability of promoting and managing endogenous, ecologically sustainable green business models.

Strategic planning for the development of endogenous agricultural zones requires research to rediscover the singularities of each rural zone. With proposals for self-managed or self-reliant development policies, Peru's sustainable development can be promoted. This conclusion constitutes a shared vision of a viable future that permeates and articulates civil organizations and their regional and rural institutions, the academy, which under the auspices of the state, can evaluate more research projects on endogenous and sustainable development models that contribute, first and foremost, to the welfare of farmers and rural areas.

About the economic dimension of the model of efficient and sustainable improvement of a production and commercialization system of molle essential oil (Schinus molle), the Wilcoxon Z value, with a Z= - 1.646 with Sig. = 0.100. The statistical test shows no statistical evidence to reject the null hypothesis on the equality of medians of the economic dimension. It can be concluded that the implementation of the programs on a business model with environmental sustainability framed in a design of an efficient

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production cycle of metabolites of the Schinus molle plant, from the extraction, processing, formulation of products, to the final disposal of their waste does not significantly influence the economic dimension about the fact that they should promote only economic returns. In other words, environmental awareness through globalization concludes that it is urgent to initiate projects on the rethinking and restructuring of business models focused on unsustainable utilitarianism over time to transform them into agroecological models with high sustainability indexes.

About the social dimension of the efficient and sustainable improvement model of a molle (Schinus molle) essential oil production and commercialization system, the Wilcoxon Z-value, with a value of Z= - 4.044 with Sig. = 0.000. The statistical test shows statistical evidence to reject the null hypothesis on the equality of medians of the social dimension. It can be concluded that the implementation of the programs on a business model with environmental sustainability framed in a design of an efficient production cycle of metabolites of the Schinus molle plant, from the extraction, processing, formulation of products, to the final disposal of their residues, does positively influence the social dimension of the instrument.

These significant differences between the pre-test and post-test, about the social dimension of the environmental sustainability instrument, lead to the conclusion that any vision of sustainable development should consider the social dimension as a strategic factor and structuring axis of sustainable development, reversing the status quo that is based from its origins mainly on addressing the binomial economic dimension and ecological dimension to the detriment of social justice as an indissoluble part of ecological justice, i.e., socio-ecological sustainability should be pursued.

About the ecological dimension of the efficient and sustainable improvement model of a molle (Schinus molle) essential oil production and commercialization system, the Wilcoxon Z value, Z= - 4.959 with Sig. = 0.000. The statistical test shows that there is statistical evidence to reject the null hypothesis on the equality of medians of the ecological dimension, and it can be concluded that the implementation of the programs on a business model with environmental sustainability framed in a design of an efficient

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production cycle of metabolites of the Schinus molle plant, from the extraction, processing, formulation of products, to the final disposal of its residues, does positively influence the ecological dimension of the instrument.

The significant differences in the medians between the pre-test and post-test of the ecological dimension show that based on permanent intervention and advisory programs, it is possible to develop green business systems more balanced about considerations and respect for nature, with a higher degree of resilience, less vulnerable to the contexts of supply and demand, with a great capacity for adaptation and reinvention, always in the search for the well-being of the farmer in reconciliation with his habitat.

As a conclusion, concerning the contrast of the hypotheses of this research, it is concluded that it is necessary to implement and strengthen interdisciplinary alliances of researchers in the academy, transcending their disciplinary field to generate transdisciplinary strategies based on the needs of social actors, the fundamental basis of endogenous sustainable development.

The training program on the canvas of business models for efficient and sustainable improvement of a production and marketing system for essential oils has shown that the articulation of projects between academia, civil society, and small farmers has potential, concerning the possibility of promoting sustainable development in an endogenous way insofar as agricultural sustainability must consider in a prevalent way the social dimension, the ecological size and finally the economic dimension. The present research results show that social and environmental awareness are strategic dimensions for initiating green enterprises.

From the results of the canvas application on models based on agricultural products, it is concluded that it is necessary to activate sustainable development strategies of endogenous nature, from rural areas to cities. Therefore, the guidelines that promote environmentally sustainable microenterprise models are viable to the extent that the projection and social extension systems of the universities fulfill the role of being the driving force so that, in a technical manner and following the purposes and goals of each green

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business model based on the agricultural system, it can be made viable through the promotion of the State.

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AN OPTIMIZED DEEP NEURAL NETWORK-BASED FINANCIAL STATEMENT FRAUD DETECTION IN TEXT MINING

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ABSTRACT

Identifying Financial Statement Fraud (FSF) events is very crucial in text mining. The researcher's community is mostly utilized the data mining method for detecting FSF. In this direction, mostly the quantitative data has utilized by research i.e. the financial ratio is presented for detecting fraud in financial statements. On the text investigation there is no researches like auditor's remarks present in published reports. For this reason, this paper develops the optimized deep neural network-based FSF detection in the qualitative data present in financial reports. The pre-processing of text is performed initially using filtering, lemmatization, and tokenization. Then, the feature selection is done by the Harris Hawks Optimization (HHO) algorithm. Finally, a Deep Neural Network-Based Deer Hunting Optimization (DNN-DHO) is utilized to identify the fraud or no-fraud report in the financial statements. The developed FSF detection methodology executed in Python environment using financial statement datasets. The output of the developed approach gives high classification accuracy (96%) in comparison to the standard classifiers like DNN, CART, LR, SVM, Bayes, BP-NN, and KNN. Also, it provides better outcomes in all performance metrics.

KEYWORDS

Financial statements, Fraud, Non-fraud, Text mining, Deep neural network, Deer hunting optimization.

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1. INTRODUCTION

Financial fraud is a major challenging task for different administrations across industries and in several states as it takes vast destruction to business. Due to financial fraud, billions of dollars are lost every year in the bank of America, for instance approves to pay $16.5 billion for solving the case of financial fraud (Rezaee & Kedia, 2012). Material omissions resultant from an intentional failure to report financial data in accordance with usually acknowledged secretarial ethics are termed as FSF (Dalnial *et al.*, 2014). The companies provide the financial statements that include the textual data in the form of auditors' remarks and expose as records with financial proportions. The qualitative data consist of indicators of fraudulent financial reporting in the form of intentionally located idioms. The agents use the adverbial phrases, selective sentence constructions, and selective adjectives to cover the fraudulent activity (Throckmorton *et al.*, 2015; Song *et al.*, 2014). To identify fraudulent financial fraud, financial statement users and regulators expect external auditors. Financial statements are the organization's elementary documents to reflect its fiscal rank (Kanapickienė & Grundienė, 2015).

A careful analysis of the financial accounts can denote whether the corporation is running efficiently or is in crisis. If the corporation is in crisis, financial accounts can show if the maximum dangerous entity handled by the organization is profit or cash or something different (Perols & Lougee, 2011). In every quarter and every year, most of the organizations are needed to publish their financial statements (Gray & Debreceny, 2014).

FSF can be executed to build stock values or to acquire loans from banks. It may be done to allocate smaller profits to investors. One more feasible reason might be to stay away from the expense of assessments (Manurung & Hardika, 2015). Recently, different organizations are creating usage of fraud financial reports to cover up their real fiscal rank and create self-interested improvements at the expenditure of shareholders. In the detection of FSF, financial ratios are prime elements because they present a pure image of the financial strength of the corporation (Hajek & Henriques, 2017).

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The economy of an organization is caused by the illegal task of FSF. In determining capitalizing in a corporation, the investigation of financial reports helps the contributors to the investment market (Omar *et al.*, 2014). The performance of the company provided by the data presented in these statements in terms of fiscal rank to the creditors, shareholders, and auditors.

In worldwide organizations, finding and prevention of FSF have become a significant challenge (Gupta *et al.*, 2012a). In the failure of the prevention process, the detection of fraudulent financial reporting is a challenging issue. Though, the prevention of FSF is a better method (Asare *et al.*, 2015). The interior and exterior auditors have to play a significant task in the discovery and prevention of FSF. But they cannot be said only accountable for the identification and detection of FSF (Gupta *et al.*, 2012b). Study about fraud detection and antecedents is significant since it adds to the sympathetic about fraud. To enhance the auditors' and regulators' capability, it has the potential to identify the fraud either directly or by helping as a basis for future fraud research that does (Ravisankar *et al.*, 2011). Better-quality fraud detection can assist the defrauded organizations, and their workers, investors, and creditors curb costs linked with fraud and also enhance the efficiency of the market. This knowledge is interest to auditors once delivering guarantee about whether financial accounts are free of substantial misstatements affected by fraud (Ngai *et al.*, 2011), mainly during audit planning and client selection.

Several researchers have been analysed the quantitative data for the recognition of false financial reporting (Jan, 2018). Therefore, the text mining technique is utilized to recognize fraud and non-fraud financial reports in the qualitative contents of financial statements (Lin *et al.*, 2015). Text mining is the method of mining significant structured data from unstructured text. It can be utilized for finding the fraud or non-fraud reports and also it can examine the words (Gupta *et al.*, 2012c). At present, extensive data is produced from different sources in the Internet-dependent world. In an unstructured format, a vast amount of data is obtainable. Text mining and data mining methods can permit well decision making for analysing unstructured data (Kumar & Ravi, 2016). Different types of tasks involved in text mining, for example, text summarization, web page classification, sentiment analysis, detection

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of plagiarism, malware analysis, classification of the document, detection of a topic, patent analysis, etc. In the financial statements, the textual data is unstructured (Dong, Liao, & Liang, 2016). Before applying any data mining approaches like classification or clustering, the text is must be transformed into structured data because the form of text is shapeless for the discovery of FSF.

This work contributes mainly:

- In finding the solution of the financial report fraud discovery.
- To design the model for identifying the fraudulent and non-fraudulent statement.
- To use optimal feature selection approaches to get high accuracy.
- To model a new hybrid classifier for financial statement fraud discovery.

The remaining work of this paper is shown in following sections: Section two defines the recent works related to this paper. The proposed method to detect the FSF is given in section three, the section four provides the outcomes of the simulation and conclusion and future scope is given in section five.

2. RELATED WORKS

An interpretable fuzzy rule-based system was presented by Hajek (2019) for detecting FSF. The developed fuzzy rule-based detection approach combines the rule extraction and element of feature selection to obtain the granularity and rule complexity. A genetic feature selection method is utilized to eliminate the irrelevant features. A qualified investigation of fuzzy systems was performed with evolutionary fuzzy rule-based schemes and FURIA. The developed system leads both desirable interpretability and good accuracy. The result provides significant effects for auditors and other operators of discovery structures of FSF.

Fraud detection was introduced by Chen *et al.* (2019) for economic reports of business groups. For fraud discovery, this article suggests a methodology in the financial reports of business assemblies. The established technique to improve the welfares of investment for creditors and investors and to lessen the

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investment losses and risks. The learning points were obtained by the subsequent stages: (i) construct an effective model for fraud discovery in the financial reports of business assemblies, (ii) different fraud finding methods were applied in the financial reports, and (iii) valuation of the developed system.

A Financial Fraudulent Statements (FFS) detection was developed by Temponeras *et al.* (2019) using the deep dense Artificial Neural Network (ANN). This system reviews the financial statements of multiple companies. A deep dense ANN is derived from the decisions about conceivable accounting fraud. To accurately classify the FFS, the data is obtained from 164 Greek companies. Therefore, the main objective was to test a neural system structure in the forecasting FFS. In the classification FFS task, the developed approach provides superior outcomes than other earlier classifiers in investigating the Greek data.

A CHAID, SVM (Support Vector Machine), and C5.0 were discussed by Chi *et al.* (2019) for FSF detection. Through an active detection scheme, an approach of C5.0, SVM, and CHAID are applied to the discovery of FSF. From the Taiwan Economic Journal (TEJ), the research data is obtained. The source sample contains 28 companies involved in FSF and 84 corporations are not intricate in such frauds on the Taipei Exchange and the Taiwan Stock Exchange amid the investigation time. Before constructing the system, the paper chooses key variables with C5.0 and SVM. For FSF, the non-financial and financial variables are utilized to improve the precision of recognition.

An application of a cooperative Random Forest (RF) classifier was presented by Patel *et al.* (2019) for identifying financial report management of Indian registered corporations. Recently, the investigator has tried to discover the different modelling methods for FFS detection. The researcher has selected a 92 non-FFS and 86 FFS of manufacturing corporations to accomplish the test. From the Bombay stock exchange, the research data were obtained for the dimension of 2008-2011. For the identification of non-FFS and FFS companies, the auditor's report was deliberated. The T-test utilises 31 significant financial proportions. The training dataset is employed to train the model and the trained model is used for classification with better accuracy.

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3. METHODOLOGY

The group of financial statements is considered as the input in the text mining systems. Here, the fraud and non-fraud types of financial reports are gathered to classify fake financial reports.

The financial statement fraud discovery includes four steps such as text pre-processing, feature extraction, feature selection, and text classification. the workflow of the proposed approach is shown in Figure 1.

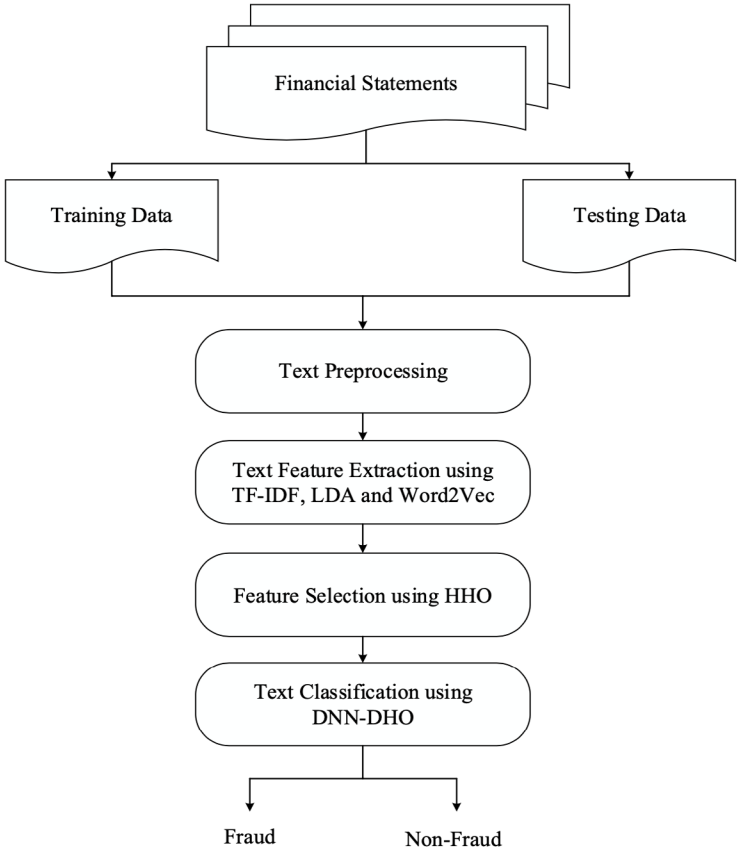

Figure 1. Overall proposed Methodology.
Source: own elaboration.

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In-text mining, pre-processing plays a major role. The high quality of the pre-processing step provides better results. The pre-processing step includes the number of roles such as filtering, tokenization, and lemmatization. The words in all documents are transformed into the lower case during pre-processing. Then the TF-IDF, LDA and Word2vec approach is utilized for feature extraction. It describes the text to have a set of measurable dimensions like frequency of words. The process of feature selection is utilized to enhance the performance of a text classifier and also decrease the dimension of the feature. Here, the HHO algorithm is used for feature selection. Finally, the new hybrid classifier of DNN-DHO is proposed to identify the fraud and non-fraud financial statements for classification. In the DNN, weights are updated using the DHO algorithm. This hybrid classifier concept minimizes the error during classification.

3.1. PROBLEM STATEMENT

FSF is the main problem for society. The detection of FSF is a challenging process. FSF is not a victimless corruption, but instead leaves behind actual genuine economic losses that contain workers, shareholders, and investors. A trust in controllers, reduction in self-assurance and reduction in the reliability of financial markets are extensive costs to society. It leads to high transaction costs and minimum efficiency. In developing markets, the challenges of business-related with investing to improve the incentives for handling financial statements and also avoid the taxes in the home country. Recently, different cases of FSF have been increased. Every incidence is a dense disappointment to shareholders, and investors and it expenses the public extremely. So, the construction of an efficient scheme to identify FSF is a major concern.

3.2. TEXT PRE-PROCESSING

It is a significant role and a dangerous phase in text mining. To mining motivating, non-trivial, and information from amorphous text data, a pre-processing method is applied in text mining. The basic units of the fonts, words, and sentences are recognized in this phase and it's delivered to all further

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processing phases. The steps of pre-processing contain the number of roles, for example, filtering, lemmatization, and tokenization.

3.2.1. TOKENIZATION

A given text is broken into phrases, words, symbols, or other important components are known as tokens. It may be thrown away particular characters like punctuation marks. The main application of this process is to identify the significant keywords.

3.2.2. FILTERING

This process eliminates the particular words in the documents. The elimination of stop words is a common filtering approach. Stop words are repeatedly utilized common words like 'this', 'are', 'and' etc. They are not applicable in document classification. Therefore, they must be eliminated.

3.2.3. LEMMATIZATION

This process to eliminate inflectional terminations and to return the base form of a word, which is named as the lemma. This process refers to the usage of the dictionary and morphological study of words.

3.3. TEXT FEATURE EXTRACTION

Text feature extraction is the procedure of extracting list of words from the textual data for the feature selection in classifier. In-text classification, it plays a major role because it directly impacts the classification accuracy. The following methods are utilized for extracting features from text data.

3.3.1. TERM FREQUENCY AND INVERSE DOCUMENT FREQUENCY (TF-IDF)

TF-IDF is an important weighting method in text mining (Kalra *et al.*, 2019). A word is frequent in the number of times in a text which denoted as the word frequency. To compute the reverse likelihood of finding a word, the IDF approach is employed in a text. The significance of a term in a text is denoted

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as TF-IDF within a corpus. Here, a document refers to a financial report, a term refers to a solitary word in a statement, and a corpus refers to the assortment of reports. In a document d, the weight of TF-IDF for a term t is computed by:

$$TF\ (t,d) = \frac{No.\ of\ times\ t\ appears\ in\ d}{Total\ number\ terms\ in\ d} \quad (1)$$

$$IDF\ (t) = \log\left(\frac{Total\ number\ of\ documents}{No.\ of\ documents\ with\ t}\right) \quad (2)$$

$$TF - IDF\ (t,d) = TF\ (t,d) * IDF\ (t) \quad (3)$$

3.3.2. LATENT DIRICHLET ALLOCATION (LDA)

LDA is the topic modelling scheme (Jelodar *et al.*, 2019). It adopts that every text can be defined as a probabilistic distribution over hidden topic. In all documents, the common Dirichlet prior is shared by the topic distribution. A common Dirichlet prior shared by the word distributions of topics. Assumed a corpus D that contains M documents. Each document d having N_d words $d \in 1,\ldots, M$. This method based on the subsequent reproductive procedure:

- From a Dirichlet dissemination with factor β, choose a multinomial spreading φ for a topic $t(t \in 1,\ldots,T)$.
- For document $d(d \in 1,\ldots,M)$, select a multinomial spreading θ_d from a Dirichlet dissemination with factor a.
- Pick a topic z_n from θ_d and take a word w_n from φ_{zn} for a word w_n $(n \in 1,\ldots, N_d)$ in a document d.

Here, the words are only detected variables in documents whereas others are hyper factors (a and β) and hidden variables (φ and θ). The likelihood of perceived data D is calculated by:

$$p(D|\alpha,\beta) = \prod_{d=1}^{M}\int p(\theta_d|\alpha)\left(\prod_{n=1}^{N_d}\sum_{z_{dn}} p(z_{dn}|\theta_d)\,p(w_{dn}|z_{dn},\beta)\right)d\theta_d \quad (4)$$

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a the spreading of words over topics and β constraints of topic Dirichlet prior are obtained from Dirichlet dissemination. Here the number of topics is defined by T, the number of documents is denoted by M, and the size of the vocabulary is denoted by N. The Dirichlet-multinomial pair is considered as (a,θ) and (β,φ) for the corpus-level topic distributions and the topic-word distributions. The document-level variables are denoted by θ_d, and the word-level variables are represented by w_{dn}.

3.3.3. WORD2VEC

In this process, the depiction of a word as a vector plays a significant role. This process more helpful for discovering antonyms, synonyms, and sentence equivalent with comparable meaning. This process converting the word into a vector form (Wang, Ma, & Zhang, 2016). It contains two different models for constraint updation. One is Continuous Bag of Words (CBOW) and skip-gram. CBOW is used to forecast words utilizing contexts of its environments. The Skip-gram uses a word's data in forecasting of adjacent words. Three layers are used such as input, projection and output are used in both the methods. Here, the CBOW approach is considered as an instance to clarify the working of word2vec.

A sentence S is assumed as:

$S = \{w_{t-2}, w_{t-1}, w_t, w_{t+1}, w_{t+2}\} \in R^m$, where w_t refers to the target term. Then the input layer is defined as follows:

$$c(v(w_t)) = \{v(w_{t-2}), v(w_{t-1}), v(w_{t+1}), v(w_{t+2})\} \in R^m \quad (5)$$

Where $c(v(w_t))$ refers to the context of the term $v(w_t)$. Next, the projecting layer is used to construct a contextual vector $v(w_t)$ as follows:

$$v(w_t) = \sum_{i=t-2}^{t+2} c(v(w_i)) \quad (6)$$

A word is considered as a Leaf Node (LN) in a Huffman tree based on its event in the corpus in the output layer. Every word has a single path between the Root Node (RN) and the LN. Using the logistic

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model, the likelihood of choosing left or right child can be computed at every node excluding the leaf node which is given by:

$$\begin{aligned} &left\ child: \sigma(v(x_w)^T \theta) = \frac{1}{1+e^{-v(x_w)^T \theta}} \\ &right\ child: 1-\sigma(v(x_w)^T \theta) \end{aligned} \tag{7}$$

At every node, using an invention of likelihoods $p(v(x_w)c(v(x_w)))$ can be learned in the tree which is given by:

$$p\left(v\left(x_w\right)\middle|c\left(v\left(x_w\right)\right)\right) = \left[\sigma\left(v\left(x_w\right)^T \theta_{j-1}^w\right)\right]^{1-d_j^w}\left[1-\sigma\left(v\left(x_w\right)^T \theta_{j-1}^w\right)^{d_j^w}\right] \tag{8}$$

Here, the j^{th} digit in word $w's$ Huffman code is defined by $d_j^w \in [0,1]$ and any node on the path is denoted as j excluding as the LN.

By enhancing the log-likelihood, the objective purpose can be erudite by (9). Then the gradient descent approach is utilized to improve θ, $v(x_w)$ and its relative words.

$$F = \sum_{w \in c} \log \prod_{j=2}^{n} \left\{\left[\sigma\left(v\left(x_w\right)^T \theta_{j-1}^w\right)\right]^{1-d_j^w}\left[1-\sigma\left(v\left(x_w\right)^T \theta_{j-1}^w\right)^{d_j^w}\right]\right\} \tag{9}$$

3.4. FEATURE SELECTION USING HHO

It is a crucial step for text classification and it is the procedure of choosing a certain subcategory of terms of the training set and these are utilizing for further classification procedure. It also lessens the size of information, improves the classification accuracy by removing noisy features, eliminates overfitting problem and it makes the training faster. The HHO algorithm is introduced in the feature selection process to choose the optimal finest features for text classification. This algorithm analyses the number of features to obtain more relevant features.

3.4.1. HARRIS HAWKS OPTIMIZATION ALGORITHM

HHO is inspired by the behaviour of Harris hawks to discover the prey, surprise pounce, and dissimilar violence methods in the environment (Heidari *et al.*, 2019). The hawks are denoted as the applicant solutions and the finest solution is termed as prey. Using their powerful eyes, the Harris hawks effort to

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trail the prey and execute the surprise pounce to hook the prey detected. In this process, three features such as TF-IDF, LDA, and word2vec are taken as input. These three features are not similar to each text. Therefore, the HHO is utilized to select the optimal feature for the classification of text.

Generally, HHO includes the exploration and exploitation stages. The HHO algorithm can be transferred from exploration to exploitation. The exploration behaviour is improved based on the escaping energy of prey (E) and it is given by:

$$E = 2E_0\left(1-\frac{t}{T}\right) \tag{10}$$

$$E_0 = 2r-1 \tag{11}$$

Here the present iteration is denoted by t, the maximum number of iterations is represented by T, the initial energy is defined by E_0 that lies between [-1, 1] and r denoted as a random number in [0, 1].

3.4.1.1. EXPLORATION PHASE

Through the arbitrary position, the location of the hawk is modernized which can be given as:

$$X(t+1) = \begin{cases} X_k(t) - r_1\left|X_k(t) - 2r_2X(t)\right| & q \geq 0.5 \\ \left(X_r(t) - X_m(t)\right) - r_3\left(lb + r_4(ub-lb)\right) & q < 0.5 \end{cases} \tag{12}$$

Here, the location of the hawk is defined by X, the location of the arbitrarily chosen hawk is denoted as X_k, and the location of the prey is defined as X_r. The lower and upper limits of hunt space are signified by lb and ub individually. In the range of [0, 1], the five independent arbitrary numbers are defined by r_1, r_2, r_3, r_4, and q. The ordinary location of the present populace of hawks is defined by X_m and it is given by:

$$X_m(t) = \frac{1}{N}\sum_{n=1}^{N} X_n(t) \tag{13}$$

Here, the n^{th} hawk is denoted as X_n and the number of hawks is defined by N.

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3.4.1.2. FITNESS FUNCTION

The fitness value is computed for each hawk and stored for future reference. The fitness function of this feature selection process is computed by:

$$F(x) = Max\{TF - IDF, Word2Vec, LDA\} \tag{14}$$

3.4.1.3. EXPLOTATION PHASE

According to the four dissimilar conditions, the location of the hawk is improved in this process. This process is accomplished only depends on the chance of prey is effectively escaping ($r < 0.5$) or not effectively escaping ($r \geq 0.5$) beforehand surprise bounce and the escaping energy of prey (E).

- Soft Besiege

If $|E| \geq 0.5$ and $r \geq 0.5$, this stage only occurs. Here, the location of the hawk is updated by the subsequent expression:

$$X(t+1) = \Delta X(t) - E\left[JX_r(t) - X(t)\right] \tag{15}$$

Here, the dissimilarity between the current hawk and the position of the prey is denoted as ΔX and the jump strength is denoted by J. Both parameters can be defined as:

$$\Delta X(t) = X_r(t) - X(t) \tag{16}$$

$$J = 2\left(1 - r_5\right) \tag{17}$$

Where r_5 is a constant value in the range of 0 and 1 that changes unevenly in every single iteration.

- Hard Besiege

If $|E| < 0.5$ and $r \geq 0.5$, this phase only happens. Here, the location of the hawk is updated by the following expression:

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$$X(t+1) = X_r(t) - E\left|\Delta X(t)\right| \tag{18}$$

- Soft Besiege with Progressive Rapid Dives

If $|E| \geq 0.5$ and $r < 0.5$, this stage is happened. The hawk gradually picks the finest probable dive to catch the prey. Here, the two different solutions are produced by,

$$Y = X_r(t) - E\left[JX_r(t) - X(t)\right] \tag{19}$$

$$Z = Y + \alpha \times Levy(D) \tag{20}$$

Here, the newly produced hawks are denoted by Y and Z. the total number of dimensions is denoted as D, a is an arbitrary vector and Levy is the function of levy flight which is given by:

$$Levy(x) = 0.01 \times \frac{\mu\sigma}{|v|^{1/\beta}} \tag{21}$$

Here, u and v are the self-governing arbitrary numbers produced from the standard distribution and σ is given by:

$$\sigma = \left(\frac{\Gamma(1+\beta) \times \sin\left(\frac{\pi\beta}{2}\right)}{\Gamma\left(\frac{1+\beta}{2}\right) \times \beta \times 2^{\left(\frac{\beta-1}{2}\right)}} \right)^{\frac{1}{\beta}} \tag{22}$$

Where β is a constant value fixed to 1.5. Here, the location of the hawk is reorganized by:

$$X(t+1) = \begin{cases} Y & if \ F(Y) < F(X(t)) \\ Z & if \ F(Z) < F(X(t)) \end{cases} \tag{23}$$

Where the fitness function is defined as $F(.)$, Y and Z are two different solutions gained from Equations (19) and (20).

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- Hard Besiege with Progressive Rapid Dives

If $|E| < 0.5$ and $r < 0.5$, this process is occurred. The two different solutions are made by:

$$Y = X_r(t) - E\left[JX_r(t) - X_m(t)\right] \tag{24}$$

$$Z = Y + \alpha \times Levy(D) \tag{25}$$

The location of the hawk is updated by:

$$X(t+1) = \begin{cases} Y & if\ F(Y) < F(X(t)) \\ Z & if\ F(Z) < F(X(t)) \end{cases} \tag{26}$$

Where Y and Z are two fresh solutions achieved from Equations (24) and (25).

3.5. OPTIMIZED DNN BASED CLASSIFICATION USING DHO

The structure of DNN includes the input layer, hidden layers, and output layer as exposed in Figure 2. By the exertion of weight fitness, the network is constructed. DNN updates the weight value in the hidden layer using the DHO algorithm (Brammya *et al.*, 2019). Owing to the improved training repetitions, this system frequently fits the considered training information's judgment border. The total quantity of nodes is evaluated in the hidden layers which are given as:

$$n = \sqrt{a+b} + c \tag{27}$$

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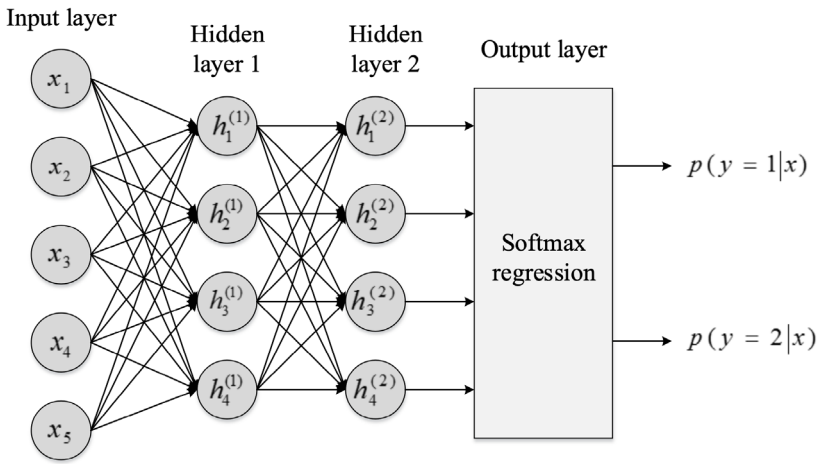

Figure 2. DNN with SoftMax regression.
Source: own elaboration.

Here, the sum of the hidden layer is n, the layer of input is a, the layer of output is defined as b and c is a constant where $0 \leq c \geq 1$. The sigmoid utility is used as an activation function for empowering the non-linear capability which is computed as:

$$S = \frac{1}{1+e^{-x}} \tag{28}$$

The input information of the system is considered as and the mapping function is defined as M_f.

$$M_f = sigm(\omega_i x + \beta_i) \tag{29}$$

In this w is weight matrix, and β is bias between output and hidden layer. A data model (x, l) can be taken and the loss form computed as:

$$S(W_s, b_s; x, l) = \frac{1}{2m}\sum_{j=1}^{m}\left\| h_j(W_s, b_s; x) - l_j \right\|_2^2 \tag{30}$$

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Here, W_s and b_s are bias subsets, hidden layer nodes are m the sum of neurons in the hidden layer is signified as m. The Cross-Entropy (CE) for the testing and training of the model is taken as loss form for the deep neural network. This can be estimated as:

$$C_E = \frac{1}{n}\sum_{k=1}^{n}\left[Y_k \log \hat{Y}_k + (1-Y_k)\log(1-\hat{Y}_k)\right] \quad (31)$$

Here sample of training is n, the k^{th} output is y_k from training set and the expected k^{th} output is $\hat{Y}_k$. The network weight value is estimated by the DHO method.

Then the old and fresh solutions are compared. Only the best solutions are considered for the next iteration. Furthermore, it simply needs the alteration of the population dimensions. The number of iterations updates the calculation in only one stage.

In DHO the two hunters one is leader and other is successor must be at their best position. For this they update their angle and position hunt the deer. the leader updates his angle and position as:

$$Y_{i+1} = Y^{lead} - p\left|\cos(v) \times Y^{lead} - Y_i\right| \quad (32)$$

Where, Y_i is the current position, Y_{i+1} is the next position, p is a random number belongs to [0, 2]. Leader present position is Y^{lead} from a present population.

The position can be updated by successor position as:

$$Y_{i+1} = Y^{successor} - X.p.\left|L \times Y^{successor} - Y_i\right| \quad (33)$$

Where successor position is $Y^{successor}$. The coefficient factors can be calculated as:

$$X = \tfrac{1}{4}\log\left(i + \frac{1}{i_{\max}}\right)b \quad (34)$$

$$L=2.c \quad (35)$$

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i_{max} is maximum repetition, b is an arbitrary number between -1 to 1, here c is a number from 0 to 1. The mean value of leader and successor can be used for weight updation:

$$Mean = \frac{Position\ of\ the\ leader + Position\ of\ the\ successor}{2} \tag{36}$$

The current and earlier solution are compared. It will replace the earlier solution if the earlier solution is enhanced otherwise, it will keep the earlier solution. This procedure is frequent up to the end condition is satisfied. DHO algorithm for weight estimation is shown in Figure 3.

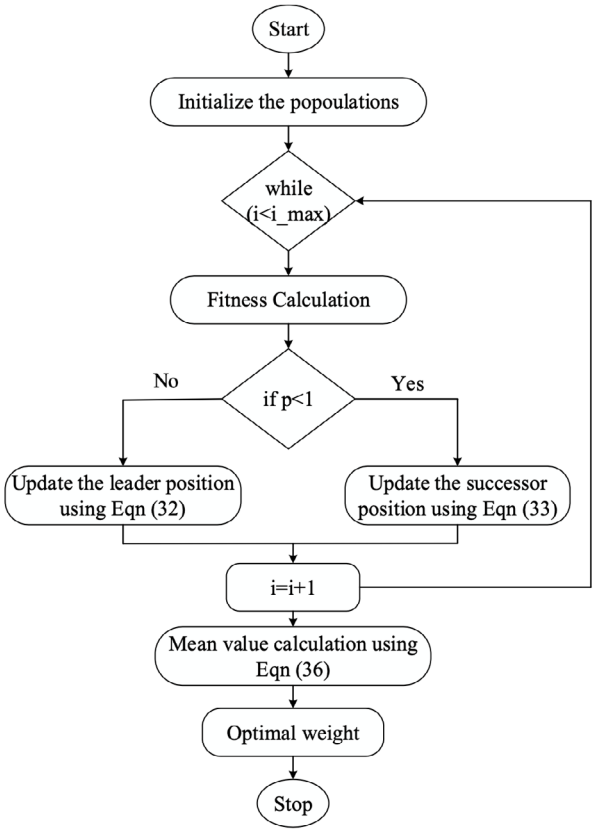

Figure 3. DHO for weight updation.
Source: own elaboration.

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3.6. DATASET DESCRIPTION

The standard datasets are utilized for FSF detection. The full dataset is taken from the link https://surfdrive.surf.nl/files/index.php/s/m34LCElefSj6M8y. Here annual reports are stored in two zip files. One file contains the annual reports in the 'fraud' category and other files in the 'no fraud' category. 1646 statements are included in the datasets. It contains 1319 no fraud statements and 327 fraud statements. For this work 70% data is used for training purpose and 30% data is used for testing purpose.

4. RESULTS

DNN-DHO methods are proposed here to optimize the DNN model for detection of FSF. Different classifiers such as DNN, K-nearest neighbour (KNN) SVM, backpropagation neural network (BP-NN), classification and regression tree (CART), Bayes classifier (Bayes), and logistic regression (LR) are compared with the proposed approach and a comparative evaluation performance is made.

4.1 PERFORMANCE ANALYSIS

The proposed (DNN-DHO) approach is executed on the financial statement dataset. The proposed scheme correctly identifies the fraud and non-fraud statement. Initially, the pre-processing step is executed on the text data. It includes the number of tasks such as tokenization, filtering, and lemmatization. These stages are performed on the text. After that, different feature extraction methods like TF-IDF, LDA, and word2vec are utilized. Then, the HHO algorithm selects the optimal. The features selected optimally is used by DNN-DHO algorithm to classify the financial statement. The proposed method provides better outcomes compared to the standard classifiers like CART, DNN, SVM, NB, LR, BP-NN, and KNN. The performance metrics are evaluated for different classifiers. The accuracy obtained by this method is better (96%) than other standard classifiers.

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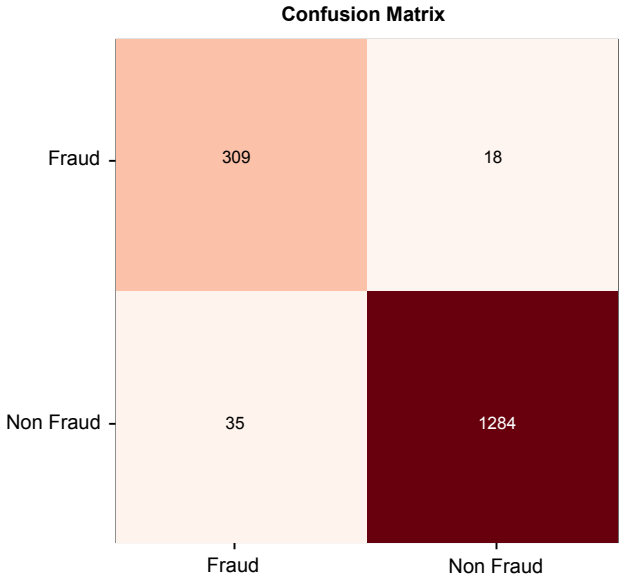

Figure 4. Confusion Matrix.
Source: own elaboration.

The confusion matrix obtained by the proposed method is shown in Figure 4. The financial statements consist of 327 fraud statements and 1319 non-fraud statements. In 327 fraud statements, 309 financial statements are correctly identified as a fraud statement remaining 18 financial statements are wrongly identified as a non-fraud statement. Similarly, in the 1319 non-fraud statements, 1284 financial statements are correctly identified as a non-fraud statement remaining 35 financial statements are wrongly identified as a fraud statement. Therefore, the proposed scheme properly identifies the fraud or non-fraud in the financial statements. The accuracy evaluation is shown in Figure 5.

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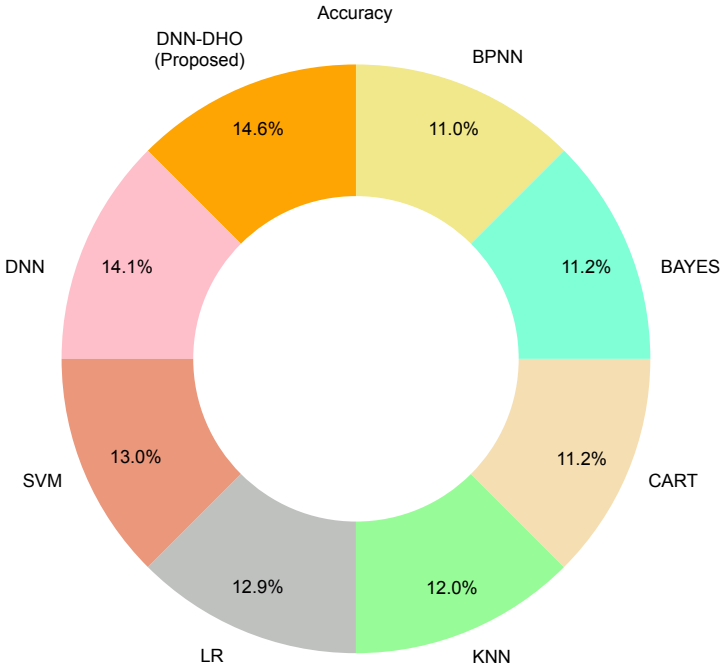

Figure 5. Accuracy evaluation.
Source: own elaboration.

The outcomes of the proposed classifier and standard classifiers like SVM, CART, Bayes, BP-NN, DNN, LR, and KNN is shown in Table 1 and Figure 6. The performance of accuracy is 96% for the DNN-DHO, 93% for DNN, 86% for SVM, 74% for CART, 73% for BP-NN, 85% for LR, 74% for Naïve Bayes and 79% for KNN. DNN-DHO method outperforms in all other parameters also. The proposed approach is better in comparison to the existing classifiers for classification of FSF.

Table 1. performance comparison among DNN-DHO classifier and others.

Performance parameters	DNN-DHO (Proposed)	DNN	SVM	LR	KNN	CART	Bayes	BPNN
Accuracy	0.9678	0.93	0.86	0.85	0.79	0.74	0.74	0.73
Sensitivity	0.9734	0.94	0.89	0.87	0.82	0.83	0.82	0.81
FPR	0.055	0.065	0.16	0.16	0.23	0.34	0.34	0.35

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FNR	0.0265	0.06	0.106	0.12	0.17	0.16	0.17	0.18
Precision	0.9861	0.93	0.84	0.84	0.77	0.71	0.70	0.69
F1 score	0.9797	0.93	0.87	0.85	0.80	0.76	0.76	0.75
Specificity	0.9449	0.935	0.84	0.83	0.76	0.66	0.65	0.64
BER	0.0321	0.0625	0.133	0.14	0.20	0.25	0.25	0.26
AUC	0.9423	0.9178	0.8725	0.86	0.79	0.78	0.75	0.72

Source: own elaboration.

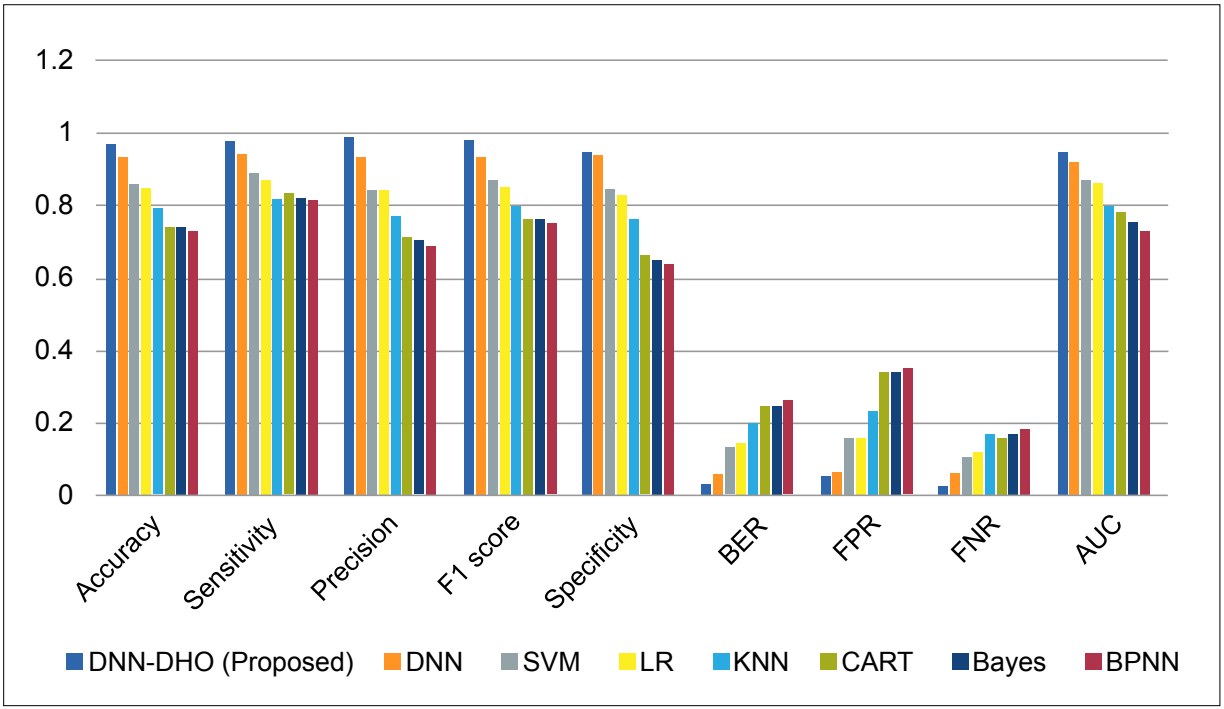

Figure 6. performance comparison among DNN-DHO classifier and others.
Source: own elaboration.

5. CONCLUSIONS

In this paper, an optimized deep neural network based FSF discovery in text mining has been proposed. The model of fraud detection initiates with an assortment of financial reports for both fraud and no-

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fraud administrations. The pre-processing stage is performed through lemmatization, filtering, and tokenization. Then the TF-IDF, LDA and word2vec approach is used for mining the data concealed in the document for fraud and no-fraud administrations. Further, the HHO procedure is utilized to select the finest features. Then the DNN-DHO classifier utilises these features with a SoftMax classifier for classification of fraud and no-fraud statements. In the classification process, the weight of the whole network is updated by the DHO algorithm. The outcomes shows that the proposed method is the best model for detecting FSF. The accuracy (96%), Sensitivity (97%), precision (98%), F1 score (97%), Specificity (94%), BER (0.03), FPR (0.05), FNR (0.026) and AUC is 0.94 are calculated for the developed method and it's compared to the existing classifiers. The proposed approach is to provide the best performance results than other classifiers of BP-NN, DNN, CART, SVM, LR, KNN, and Bayes.

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FORMATIVE METHOD FOR THE DEVELOPMENT OF ENVIRONMENTAL BEHAVIOR IN UNIVERSITY STUDENTS LIMA-PERU

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ABSTRACT

This research aims to determine the influence of the method of the formative project in the development of environmental behaviors in undergraduate students of a private university, 2020. This is because in the current educational system, teaching focused on developing competencies was established in the mid-nineties; despite this, some private academic centers can follow the traditional model for the fulfillment of objectives. The use of the formative project method, which is characterized by its permissibility feature, for which a plan of action is designed, data was collected through a questionnaire based on the Likert scale before and after the application of the project with a sample of 168 students. The results based on the Wilcoxon Ranges statistical analysis showed that there were no students with Low scores in the pre-test, but students with a Medium level of 44.05% (74); and 55.95% (94) presented a High level, and in the post-test, the number of Medium levels decreased by 3.57% (6) and the High level increased by 96.43% (162) students. They conclude that the method of the formative project influences the environmental behavior and concerning the dimensions of the Practices and improves the behavior of the students either in the recognition and analysis of the problem, the approach, and formulation of strategies.

KEYWORDS

Method of training projects, Environmental behavior, Eco-efficient practices, Environmental identity.

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1. INTRODUCTION

The exercise of teaching should be transcendent since higher education is not absent from research and with it the continuous improvement of methods and processes to optimize this task; that is why, at present, different didactic methods and techniques are analyzed and evaluated to achieve significant learning. (Ambrosio & Silvano, 2018) According to those above, the present research emphasized the use of the formative project method, which is characterized by its characteristic of allowing students to develop capacities such as observation, analysis of the different problems in their personal, interpersonal, community, work, and ecological context; therefore, a plan of action is designed, and when it is executed, it generates viable solutions, by allowing an autonomous position with initiative and collaborative character. That is why the environmental approach of using the project method in the Environmental Culture course (present in the curriculum of all professional schools in the institution where the research was carried out) will allow students, in the exercise of their profession, to evaluate the impact of their actions on the environment (Ambrosio & Silvano, 2018).

In our country's educational system, teaching focused on developing competencies was established in the mid-nineties; however, until today, there are private academic centers within the regular primary education that follow the traditional model by fulfilling objectives (Amigo *et al.*, 2018).

In the efforts of the "Ministry of Education" to train teachers nationwide on competency-based education, we can observe the free calls on the Minedu platform on the content of the National Curriculum Design, as well as other documents such as the curriculum framework, the "framework of good teaching and management performance", records that guide and orient uniformly the education we want for our country (Barcelo, 2018).

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2. METHOD

2.1. QUANTITATIVE APPROACH

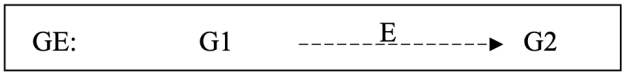
Quantitative: It "uses data collection to test hypotheses based on the numerical measurement and statistical analysis to establish patterns of behavior and test theories." (Villamil, 2018)

2.2. RESEARCH DESIGN

The design for the present research is "pre-experimental," based on pre-and post-tests. In addition, it is worth mentioning that the Method of formative projects has been used to study its effect on the dependent variable Responsible environmental behavior and to measure the influence of the dependent variable on the independent variable; a pre-test will be carried out before starting the Environmental Culture course with this methodology and a post-test at the end of the academic semester (Caceres, 2018).

"Pre-test and Post-test with a single group":

Where:



GE: "Experimental Group"

G1: "Pre-test group."

G2: "Post-test group"

E: "Stimulus" (Application of the Formative Project Method)

2.3. POPULATION AND SAMPLE

The total population of students in the VII cycle receiving the environmental culture course consisted of 297 students, while the sample consisted of 168 students (Carmona *et al.*, 2017). To calculate the size of the piece, which is extracted from the population, the following formula was applied:

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$$n = \frac{n_o}{1 + \frac{n_o}{N}} \quad where: \quad n_o = p^*(1-p) * \left(\frac{z\left(1-\frac{\alpha}{2}\right)}{d}\right)^2$$

Formula 1. Sample size.

Where:

n = sample size

Z = Confidence level at 95%, which is equal to 1.96

N = Size of the population (297 students)

p = Probability of occurrence (0.5)

α = confidence level (95%)

3. RESULTS

Table 1. Kolmogorov-Smirnov One Sample Test.

	PRETEST	POSTEST	DIFERENCES
N	168	168	168
Media	101,29	123,90	22,61
Dev. Deviation	14,281	10,717	15,775
Variance	203,942	114,858	248,861
Z (K – S)	0,067	0,080	0,111
P value	,066	,011	,000

Source: own elaboration.

In Table 1, we can observe that the p-value is, 000 and less than 0.05, the sample does not have a normal distribution; therefore, a non-parametric test can be applied to discredit the hypotheses, in this case, the "Wilcoxon Ranges Non-parametric Test" (Cardona, Velez & Tobon, 2016).

The "formative projects method" significantly influences the development of responsible environmental behavior, in the dimension eco-efficient practices, in the dimension environmental identity, in the

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dimension environmental awareness in undergraduate students of the VII cycle - Los Olivos – 2018 (Colombo, Rusca and Quiroz, 2016; Carmona *et al.*, 2017).

Table 2. Comparative Analysis of the Environmental Behavior Variable.

			Test	
			Pre Test	Pos Test
Environmental Behavior	Medium	Frequency	74	6
		% total	44,0%	3,6%
	High	Frequency	94	162
		% total	56,0%	96,4%
Total			168	168

Source: own elaboration.

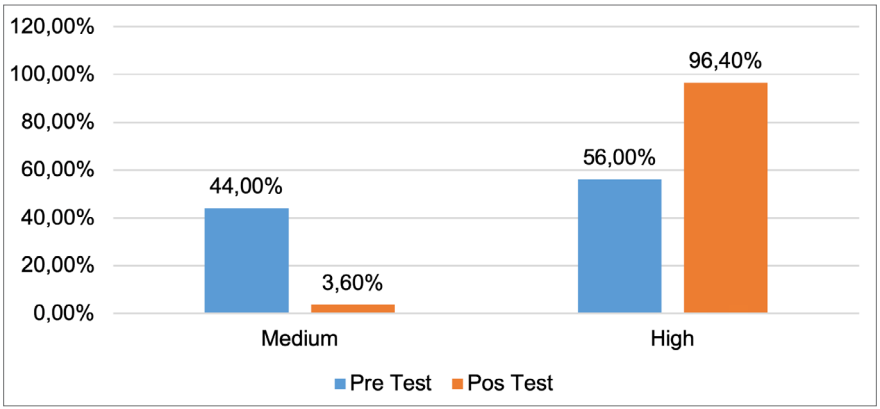

Figure 1. Graph of the Comparative Analysis of the Environmental Behavior Variable.
Source: own elaboration.

The data obtained in Figure 1 shows that, due to the application of the formative project method, the students improved their scores. In the pre-test, there were almost equal amounts of students with scores of Medium and High levels (De la Cruz & Mamani, 2015). Then with the application of the formative project, the number of students with scores of High level increased and less amount of Medium level; therefore, this method influences the improvement of the Environmental Behavior of the undergraduate

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students of the VII cycle - district Los Olivos, which is visualized in Table 2 and Figure 1 (Florez & Quebranta, 2017).

In the case of the variable "Method of Formative Projects," as part of the evaluation by the teacher in charge of the Environmental Culture course, the following Table 3 and Figure 2 show the compliance and development of the indicators of the program to demonstrate its influence on the environmental behavior of the students (Fong, Acevedo & Severiche, 2016; Gomez & Tobon, 2017).

Table 3. Assessment of the achieved level of the capability Promotes a culture of sustainability through actions related to the care and defense of the environment.

		Frequency	%	% Valid	Cumulative %
Valid	In Process	4	2,4	2,4	2,4
	Achieved	75	44,6	44,6	47,0
	Highlighted	89	53,0	53,0	100,0
	Total	168	100,0	100,0	

Source: own elaboration.

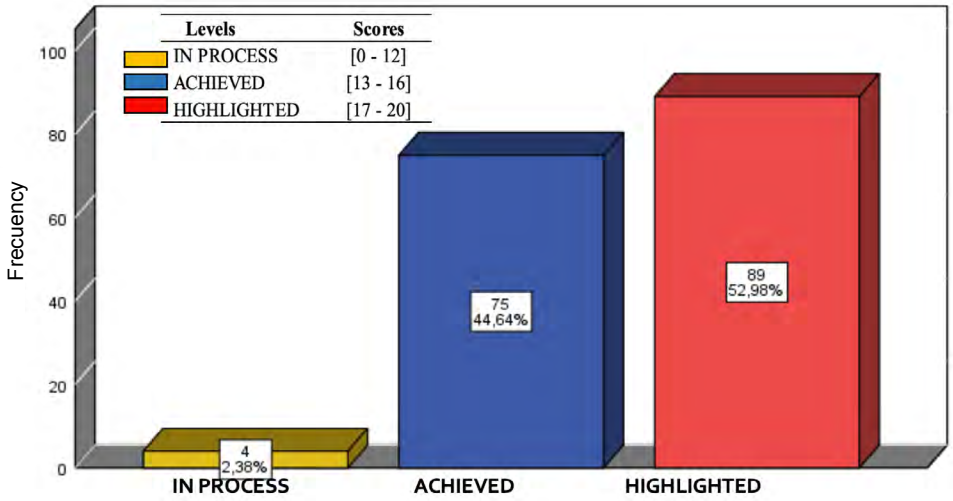

Figure 2. Evaluation of the level achieved for the skill "Promotes a culture of sustainability through actions related to the care and defense of the environment.

Source: own elaboration.

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With the information in Table 3 and Figure 2, we have the average post-test scores of the students evaluated concerning the skill "Promotes the culture of sustainability through actions related to the care and defense of the environment to guarantee ecological well-being, valuing the balance between the individual and his or her social environment"; of which 2.38% (4) are still In Process, 44.64% (75) of them in the Achieved level and a majority of 52.96% (89) of them presented an Outstanding level concerning the capacity analyzed. This questionnaire is part of the evidence of the evaluation process during the Environmental Culture course by the teacher (Gonzales, 2017; Huaylla, 2019).

Table 4. Comparative analysis of the Eco-efficient Practices dimension.

Test				
			Pre Test	**Pos Test**
Eco-efficient Practices	Low	Frequency	1	
		% total	0,6%	
	Medium	Frequency	68	7
		% total	40,5%	4,2%
	High	Frequency	99	161
		% total	58,9%	95,8%
Total			168	168

Source: own elaboration.

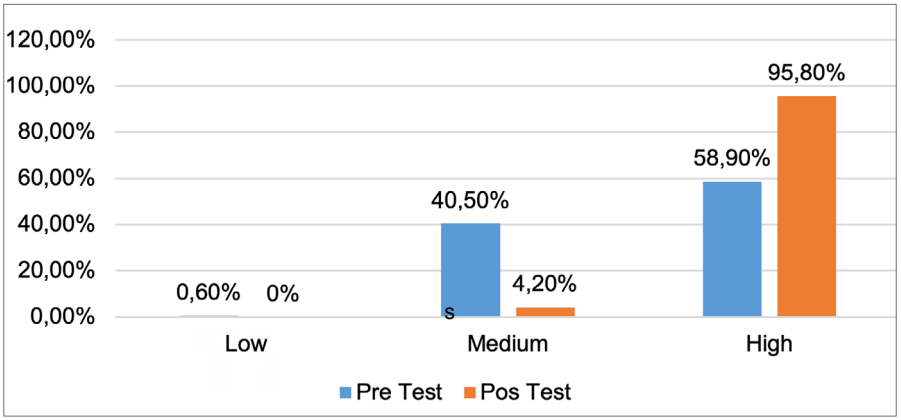

Figure 3. Graph of the Comparative Analysis of the Eco-efficient Practices dimension.

Source: own elaboration.

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Concerning the data obtained, it can be observed that, due to the application of the training project method, the students improved their scores, since in the pre-test there were scores at Low, Medium, and High levels and that with the application of the training project the number of students went on to have scored at Medium level and with a more significant number at High level. Therefore, this method influences the improvement of the Eco-efficient Practices dimension of the undergraduate students of the VII cycle - Los Olivos district, which is visualized in Table 4 and Figure 3 (Ibarra, Segredo & Juarez, 2018).

Table 5. Comparative analysis of the Environmental Identity dimension.

			Test	
			Pre Test	**Pos Test**
Environmental Identity	Medium	Frequency	60	11
		% total	35,7%	6,5%
	High	Frequency	108	157
		% total	64,3%	93,5%
Total			168	168

Source: own elaboration.

In Table 5, which is visualized, therefore, this method influences the improvement of the Environmental Identity dimension of the undergraduate students of the VII cycle - Los Olivos district.

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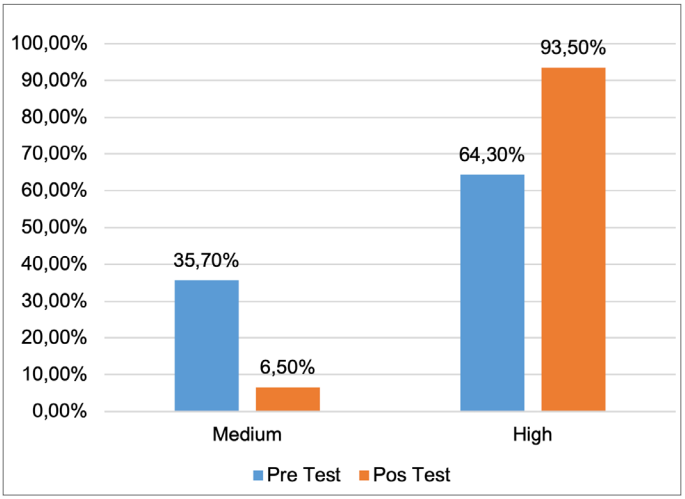

Figure 4. Graph of the Comparative Analysis of the Environmental Identity dimension.
Source: own elaboration.

Concerning the data obtained, it can be observed that the students improved their scores due to the application of the formative project method (Ibarra, Segredo & Juarez, 2018). Being so that in the pre-test, there were scores of Medium and High and that with the application of the constructive project, most students went on to have scores of High level and fewer in the Medium level; and Figure 4 (Juarez & Torres, 2016).

Table 6. Comparative analysis of the Environmental Awareness dimension.

			Test	
			Pre Test	**Pos Test**
Awareness Environmental	Low	Frequency	1	
		% total	0,6%	
	Medium	Frequency	90	18
		% total	53,6%	10,7%
	High	Frequency	77	150
		% total	45,8%	89,3%
Total			168	168

Source: own elaboration.

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Table 6 visualized this method influences the improvement of the dimension "Environmental Awareness" of the undergraduate students of the VII cycle - Los Olivos district.

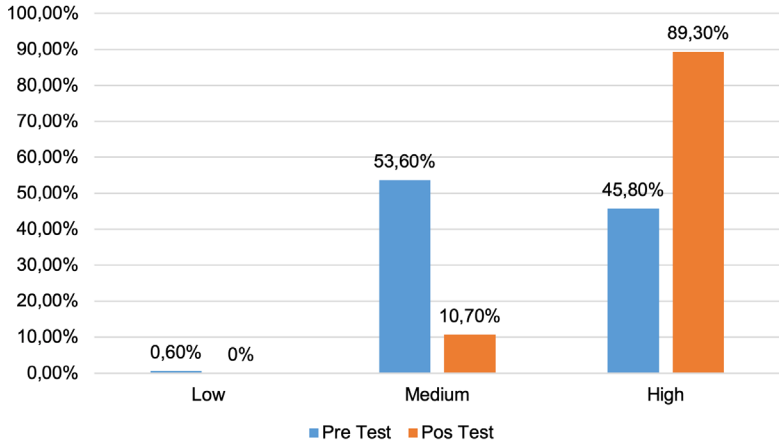

Figure 5. Graph of the Comparative Analysis of the Environmental Awareness dimension.
Source: own elaboration.

Figure 5 show the data obtained; it can be observed that, due to the application of the formative project method, the students improved their scores, being so that in the pre-test, there were scores of Low, Medium and High and that with the application of the formative project the number of students went on to have scored only High and Medium level (Leyva, Inante & Alonso, 2019; Martinez, 2015; Martinez, 2017; Modejar & Vargas, 2018).

4. DISCUSSION

To begin this section, we will start with the general objective obtained, as a result, the acceptance of the general hypothesis (Moyano *et al.*, 2017; Musitu, Leon, & Callejas, 2019) states, "The method of formative projects significantly influences the development of responsible environmental behavior in undergraduate students of the VII cycle - Los Olivos - 2018", using the Wilcoxon Ranks Test, thus

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determining that these data differ with the application of the project, in favor of this (Paredes *et al.*, 2017; Porras & Perez, 2019).

Therefore, from the above mentioned, according to the studies already conducted both internationally and nationally that have been found as reference for the development of this study, there is a relationship and concordance with this research work. The research found as Colombo, Velez, and Tobon (2016), agrees with the results obtained since they specify that "there is a high level of satisfaction with the methodology used, while the breakdown of the logbook attesting to the successful implementation of the proposed mechanism concerning the attitude and performance achieved (Rivera & Garces, 2018). In the same way, it was possible to identify possibilities for improvement that could be given to future implementations or modifications", this statement is related since it mentions that the methodology of formative projects is adequate, beneficial, and successful when applied.

Similarly, it agrees with Amérigo, Garcia, and Cortes (2017). They state in their documentary analysis that "such projects should be conceived as didactic strategies that should be oriented towards the ability to develop competencies based on being able to identify, argue, interpret and solve various problematic issues under the approach of the proposal of the contents based on entrepreneurship proposals and the development of their context", which shows that "formative projects" methodologically speaking influence the improvement of students in different areas (Rivera & Garces, 2018).

Furthermore, Acuña and Severino (2018) states that the "formative projects methodology has significantly influenced in the substantial improvement in front of solving context problems in students of the secondary level," as it reveals concordance with the present research thus corroborating, that the method of the formative project influences the student in their behavior as other aspects.

In this section, the specific hypotheses accepted to be mentioned below are: the first specific hypothesis "The method of formative projects significantly influences the dimension eco-efficient practices in undergraduate students of the VII cycle - Los Olivos - 2018. "In this case, the research related to this

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result was by Colombo el al. (2016), who states that "the learning supported by the methodology of the formative projects integrated to the curriculum allows concatenating transcendent facts of the student's context, enabling a lasting learning obtained from their formative experience", since this developed research agrees in some way since as a formative project it will have a positive response and part of this is in the student's behavior, whatever the subject matter is (Rodriguez, Mendoza & Cargua, 2019; Vanegas *et al.*, 2018).

5. CONCLUSIONS

The program used based on the formative project significantly influences environmental behavior, which was evidenced in the results, not having students with scores of Low level, but Medium level with 74 (44.0%) and High level with 94 (56.0%) students; according to the post-test the results differed in favor of the application of the formative program presenting a decrease of students with scores of Medium level with 6 (3.57%) mainly passing with scores of High level 96.43% (162). This demonstrates the effectiveness of this method and its implementation in institutions, thus improving the role of people in the environmental field.

The methodology of training projects used and applied to the dimension of Eco-efficient Practices presented a result with respect to the pre-test of 1 (0.6%) student in the "Low level," 68 (40. In the case of the post-test, there were no students in the "Low level," 7 (4.2%) in the "Medium level," and 161 (95.8%) in the "High level," all this shows that after the application of the training project, the dimension of Eco-efficient Practices improved in the students and therefore there is a significant influence on this dimension.

According to the Environmental Identity dimension that has been tested, in the pre-test, there were no students with "Low level," 60 (35.7%) students with "Medium level," 108 (64.3%) students in the "High level"; for the post-test, there were no students with "Low level," 11 (6.5%) students with "Medium level" and 157 (93.5%) students with "High level"—concluding that the formative project methodology

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influences environmental behavior leading to the dimension of Environmental Identity in students, which complies and works positively and the importance of the proper methods in the formation of students in the environmental field.

Finally, for the dimension of Environmental Awareness, the result obtained in the pre-test there was 1 (0.6%) student in the "Low level," 90 (53.6%) in the "Medium level," and 77 (45.8%) students with "High level"; for the post-test, the result obtained was that there were no students with Low scores, but there were 18 (10.7%) students with "Medium level" and 150 (89.3%) students with "High level." The conclusion is that the training method is positive and that its application is booming since the results show that after carrying out the training project, most of the students scored high; that is, it influences the dimension of Environmental Awareness, which is part of the Environmental behavior.

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MODEL BASED ON BALANCED SCORECARD APPLIED TO THE STRATEGIC PLAN OF A PERUVIAN PUBLIC ENTITY

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ABSTRACT

The objective of this research is to propose a design of a model based on a Balanced Scorecard (BSC) applied to the strategic plan of a Peruvian public entity. There is a deficiency of compliance with the objectives of the strategic plan, which results in the low acceptance of public institutions by citizens. The methodology used for this design proposal was based on the BSC management tool. To test the model, a prototype of a solution based on BSC was built for the institutional strategic plan; in the interface, the following results were obtained; the year 2019, the average of the programmed goals of the indicators was 59, the standard of the execution of the plans was 58, this means an execution percentage of 97% for 2019. Therefore, it is proposed to reach 100% by 2020 with the implementation of the proposal..

KEYWORDS

Balanced Scorecard, Strategic map, Strategic plan, Public entity.

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1. INTRODUCTION

The government effectiveness index captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies (The Global Economy, 2021).

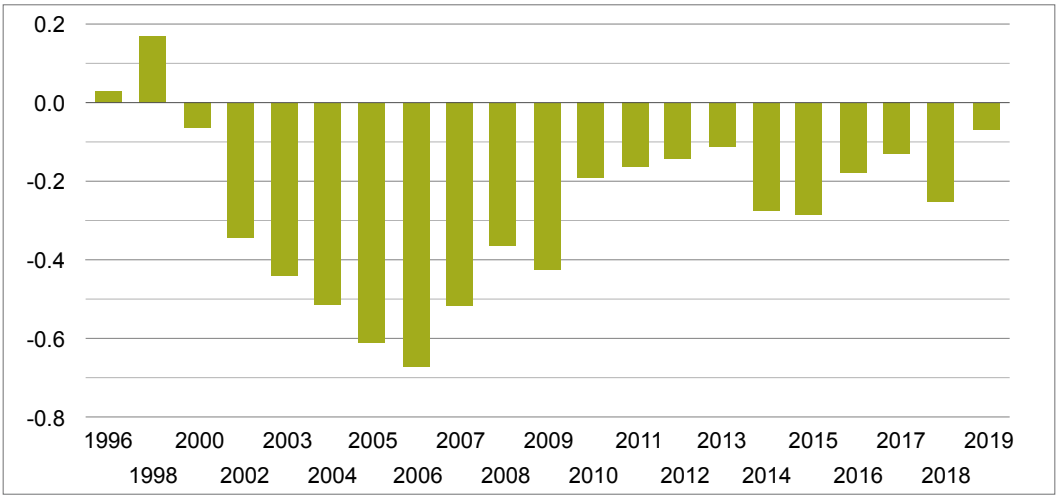

Figure 1. Peru - Government Effectiveness Index 1996-2019.
Source: (The Global Economy, 2021).

Figure 1 shows that Peru's government effectiveness index has been negative in the last two decades. This research work proposes a tool for monitoring the institutional strategic plan based on BSC to reverse these results.

The change in management itself, by following the BSC, implicitly implies an intense activity of internal process improvement and would be subject to operational indicators to measure its evolution. The binomial, customer and stakeholder satisfaction and financial survival require a great effort and a permanent philosophy of optimization (Foncubierta-Rodríguez, Galiana-Tonda, & Galiana, 2020); globalization has caused that having a vision, mission, objectives, or goals is not enough for the efficient

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fulfillment of the functions. Instead, it requires tools and techniques that make this activity a process capable of complying with strategic management that serves as a source of information for future decision making, particularly the BSC (Moreira & Murillo, 2020), it is recommended that before the implementation of the model, a review and, if applicable, an adaptation of the map and its strategic objectives, as well as the valuations and weightings of the indicators, since these may also vary according to the needs and priorities of each organization (Murillo, 2020), since its appearance and during the period 1992-2010, the BSC has undergone constant evolution, It emerged as a comprehensive evaluation tool based on economic value, and its continuous development has originated an aligned and global measurement model that allows guiding the organization towards the creation of value, thus responding to the demands of its stakeholders (Pérez, Guillén, & Bañón-Gomis, 2017).

For the first time since May 2018, Peru has a formal declaration of the General Governance Policy - PGG to 2021. Every public entity must take care of the consistency of its policies and plans with the PGG and the SINAPLAN framework within the firm intention of progressively institutionalizing State policies and best practices at the service of the population in the territory (Centro Nacional de Planeamiento Estratégico (CEPLAN), 2019).

2. LITERATURE REVIEW

Balanced Scorecard (BSC)

The BSC ensures alignment between finance, market, technology, and innovation. At the same time, it is indispensable as a communication strategy, management control device, and corporate strategy (Abad, 2019), within the multiple tools that help in decision making in an organization is the BSC, which allows translating the organization's strategy into concrete objectives that can be measured, which can be both financial and non-financial (Castillo, Rodríguez, & Osma, 2017).

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Strategic Plan

It is common for strategies to be contained in a strategic plan, a tool that is a process comprising the study of the current and future environment of the internal situation, the establishment of goals for a horizon more significant than one year, and the choice of decisions that represent investments, to sustainably satisfy the reason why a company exists or was created (Villajuana, 2013), the strategic plan is a document used to communicate the company's objectives and actions necessary to achieve them (Turban, Volonino, & Wood, 2015).

Strategic Map

An essential element for the elaboration of the BSC is the elaboration of a strategic map, which constitutes a graphic presentation of the organizational perspectives with the strategic objectives in a cause-effect manner (Ramos *et al.*, 2020), the new framework, which we call strategic map, is a logical and complete structure to describe a strategy, it provides the basis for designing a BSC (Kaplan & Norton, 2016).

3. METHODOLOGY

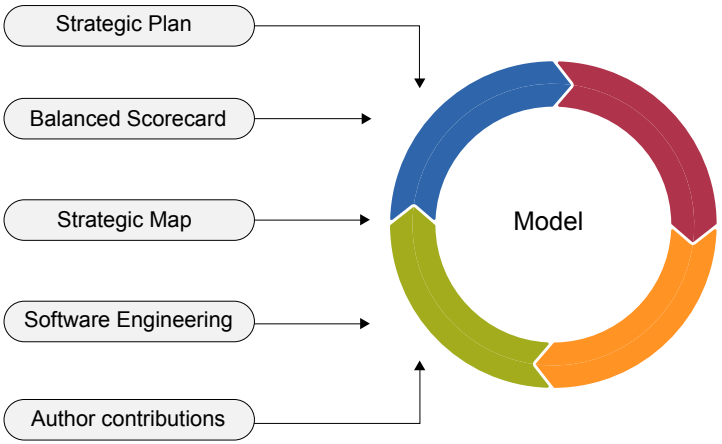

Figure 2. Model based on BSC.
Source: own elaboration.

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Figure 2 shows the methodology proposed in this research, which consists of designing a model based on the BSC management tool and basic software engineering principles. To test it, a prototype of a BSC-based solution for the institutional strategic plan of a Peruvian public entity was built. This implementation includes the following activities.

3.1. IDENTIFICATION OF THE ELEMENTS OF THE STRATEGIC PLAN

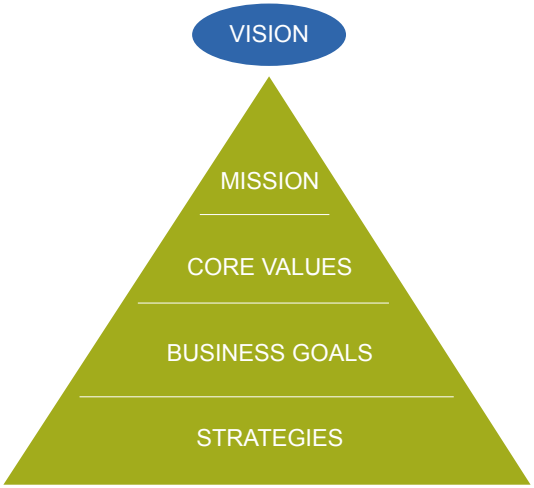

Figure 3. Elements of the strategic plan.
Source: own elaboration.

Figure 3 shows the main elements of the strategic plan; at the top of the pyramid are the general features such as the mission and vision of the organization, while at the base of the pyramid are the more specific elements such as values, objectives, and strategies. These elements of the strategic plan can be extracted from the organization's strategic plan (Alfaro *et al.*, 2020).

3.2. DEFINITION OF THE BSC PERSPECTIVES

The perspectives that will group the strategic objectives or indicators proposed in the strategic plan are defined.

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3.3. PREPARATION OF THE STRATEGY MAP

The strategy map is drawn up considering the cause-effect relationships identified between the strategic objectives or indicators. Microsoft Visio or similar software can be used.

3.4. DATABASE IMPLEMENTATION

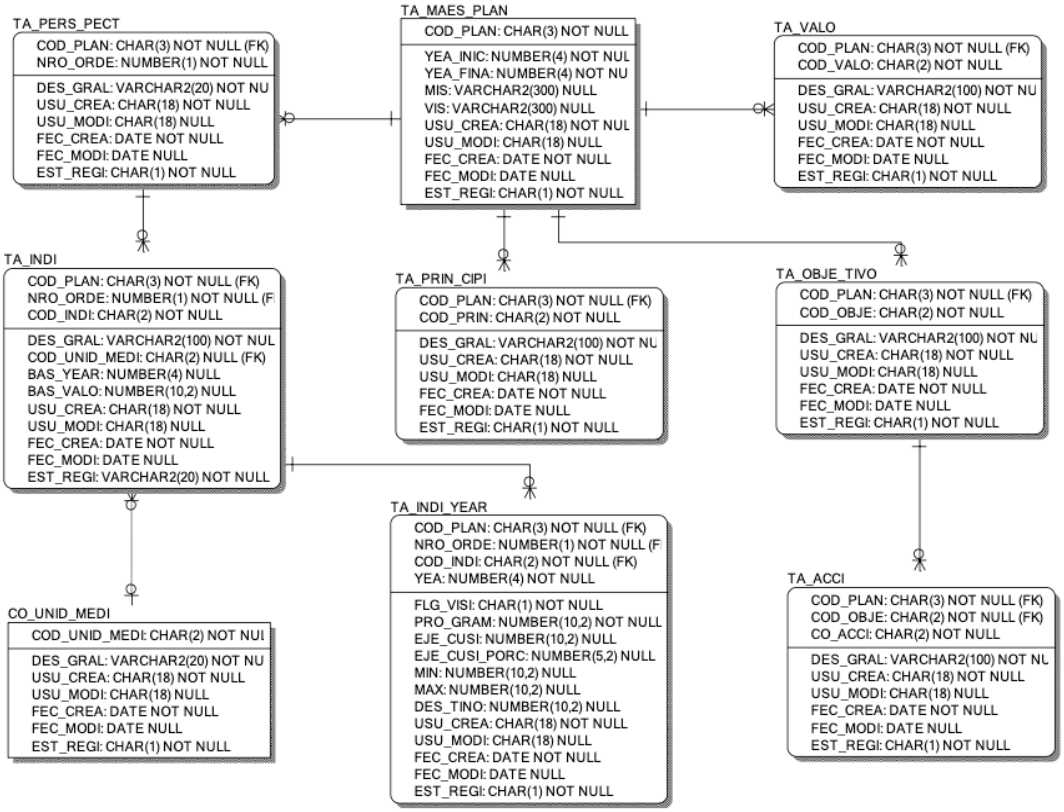

Figure 4. Data model of the BSC-based solution.
Source: own elaboration.

Figure 4 shows the data model of the proposed solution elaborated with CA Erwin software; this model must be implemented in a relational database.

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3.5. ELABORATION OF THE USER INTERFACE

To display all information obtained from the previous activities, use Microsoft Power BI software or similar.

GREEN	YELLOW	RED
> = 90%	< 90% > = 50%	< 50%

Figure 5. Color scale.
Source: own elaboration.

Figure 5 shows the proposed color scale for the graphical indicator of the percentage of execution. Green indicates that it is possible to meet the goal, yellow warns us that the plan may not be met, and red indicates that we are far from meeting the goal.

4. RESULTS

The prototype of the BSC-based solution was implemented on the institutional strategic plan of the public entity, applying the proposed methodology. The following activities were carried out:

4.1. IDENTIFICATION OF THE ELEMENTS OF THE STRATEGIC PLAN

Table 1. Matrix of Strategic Objectives, Indicators, and Targets.

Strategic Objective	Indicator	Baseline		Goals			
		Value	Year	2019	2020	2021	2022
OEI.01: Increase access to and reliability of registry services for citizens.	Percentage of people who receive registry services directly.	36.85	2017	39	40	41	42
	Percentage of citizens with the perception of security concerning the public entity	68	2017	70	71	72	73
	Percentage increase in the number of properties registered with the public entity	3.46	2017	4	4	4	4
OEI.02: Modernize institutional management for citizen satisfaction.	Percentage of citizens with the satisfactory perception of a public entity	75.8	2016	77	78	79	80

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OEI.03: Implement disaster risk management in the public entity.	Percentage of disaster risk management actions programmed and executed.	60	2018	80	85	90	95

Source: (Superintendencia Nacional de los Registros Públicos (SUNARP), 2020).

Table 1 shows the strategic objectives, indicators, and goals established in the institution's strategic plan.

Table 2. Strategic Route.

Priority	Strategic objective	PGG Vinculation	Priority	Strategic Actions
1	OEI.01: Increase access to and reliability of registry services for citizens.	EJE 3 POL 3.2	1	AEI 01.01: accessible, timely, and predictable registry registration services for citizens
			2	AEI 01.02: accessible, timely, and predictable registry publicity services for citizens.
			3	AEI 01.03: effective registry inclusion programs to promote the formalization of the country's most remote and informal populations.
			4	AEI 01.04: Improve the physical and technological infrastructure of the institution.
2	OEI.02: Modernize institutional management for citizen satisfaction.	EJE 3 POL 3.2	1	AEI 02.01: simple and efficient administrative and operational processes to improve institutional management.
			2	AEI 02.02: permanent capacity building for the institution's staff.
			3	AEI 02.03: optimized registry services processes for the benefit of citizens
3	OEI.03: Implement disaster risk management in the institution.	EJE 3 POL 3.2	1	AEI 03.01: effective disaster risk prevention and reduction in the entity AEI 03.02: training for the institution's staff
			2	AEI 03.02: comprehensive training to respond effectively to emergencies and disasters in the entity AEI 03.02: training to respond effectively to emergencies and disasters in the entity

Source: (Superintendencia Nacional de los Registros Públicos (SUNARP), 2020).

Table 2 shows the strategic path established in the institution's strategic plan.

4.2. DEFINITION OF THE BSC PERSPECTIVES

The indicators established in the strategic plan were grouped into three perspectives:

- Learning and growth.
- Internal processes.
- Citizenship.

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4.3. ELABORATION OF THE STRATEGIC MAP

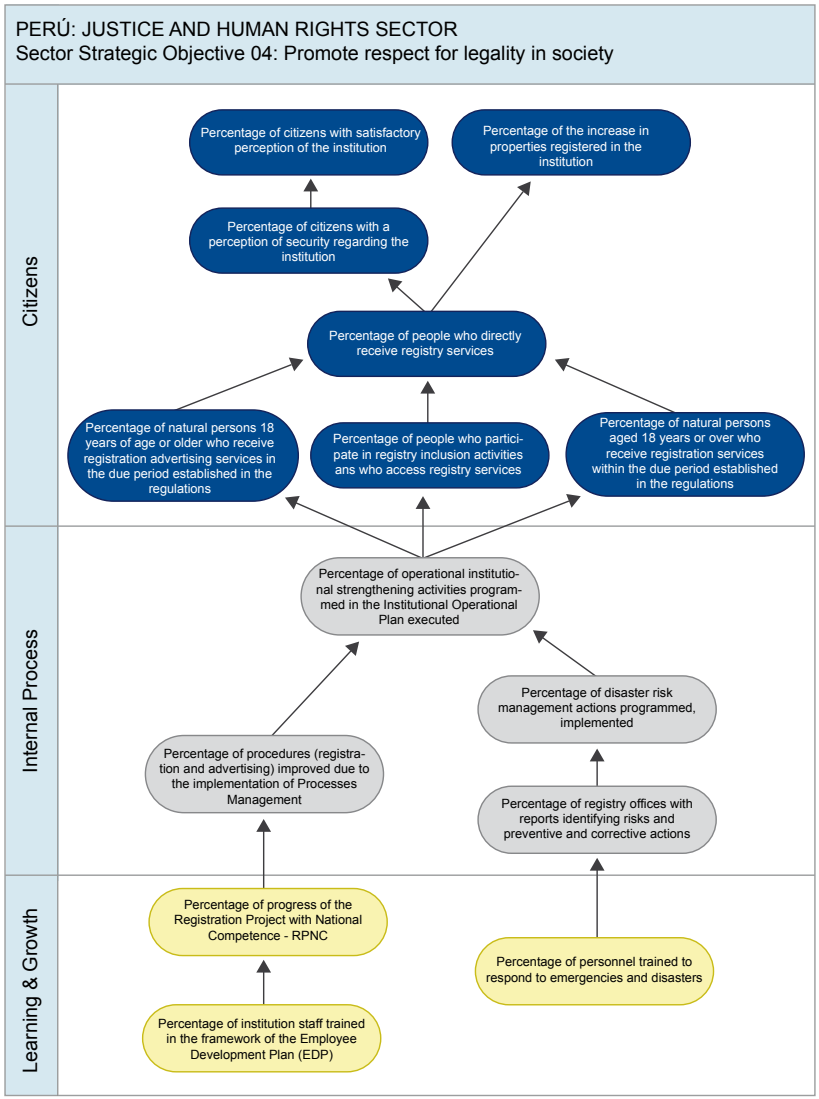

Figure 6. Strategy map of the public entity.
Source: own elaboration.

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Figure 6 shows the institution's strategy map, which represents the indicators and the cause-effect relationships between them. This map allows explaining the results to be achieved and why they will be achieved.

4.4. DATABASE IMPLEMENTATION

The proposed data model was implemented in an Oracle database of the Institution; all the necessary information for implementing the BSC-based solution was loaded into this database.

4.5. DEVELOPMENT OF THE USER INTERFACE

The solution based on BSC was built using Microsoft Power BI software; in this interface, it is possible to visualize the execution percentage at the following levels:

- At the level of the vision of the institution (the whole BSC).
- At the level of one of the three perspectives.
- At the status of an indicator.

This solution shows the colors proposed in the methodology.

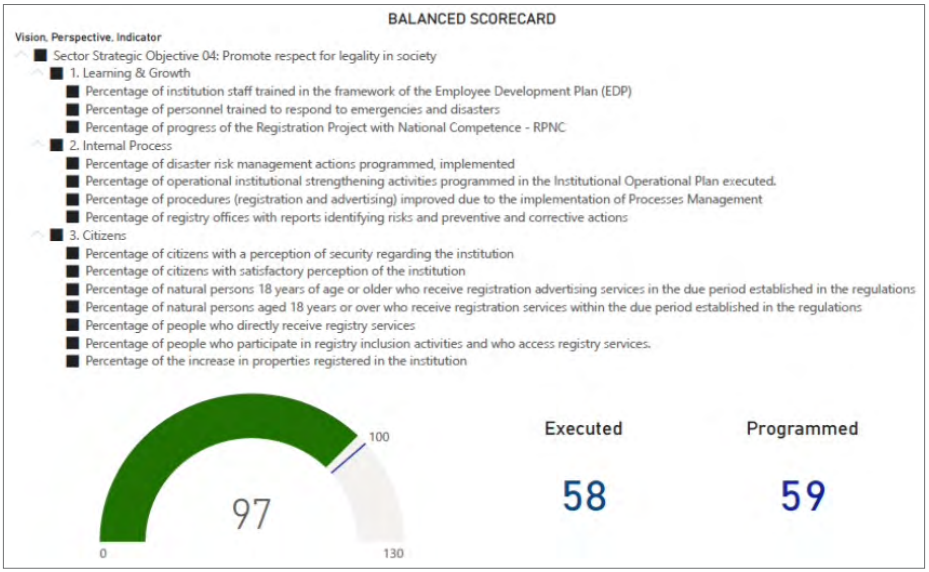

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Figure 7. BSC: Average execution percentage for 2019.
Source: own elaboration.

Figure 7 shows that the institution has achieved an average of 97% execution of the goals programmed for 2019.

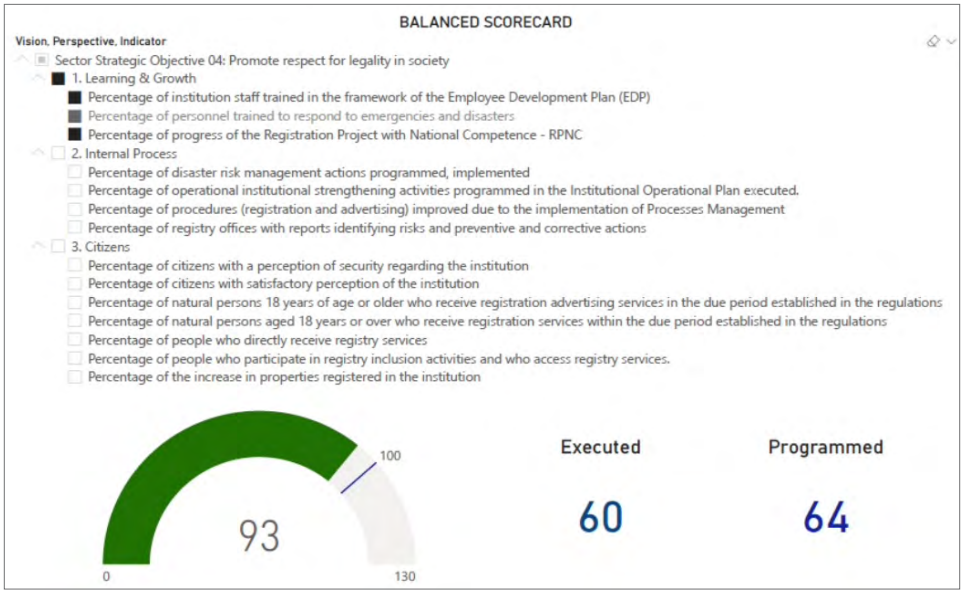

Figure 8. BSC: Average percentage of execution of the learning and growth perspective in 2019.
Source: own elaboration.

Figure 8 shows that the institution has achieved an average of 93% execution of the programmed goals of the learning and growth perspective for the year 2019.

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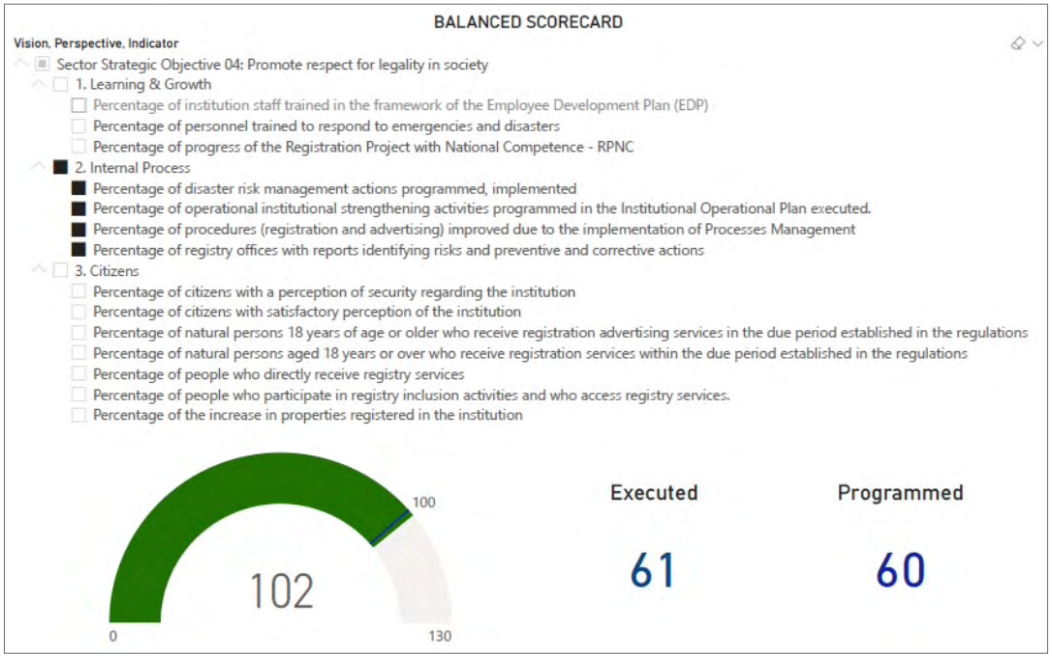

Figure 9. BSC: Average percentage of execution of the internal process perspective in 2019.
Source: Own elaboration.

Figure 9 shows that the institution has achieved an average of 102% execution of the programmed goals of the internal processes perspective for the year 2019. In this perspective it has exceeded the expectations for that year.

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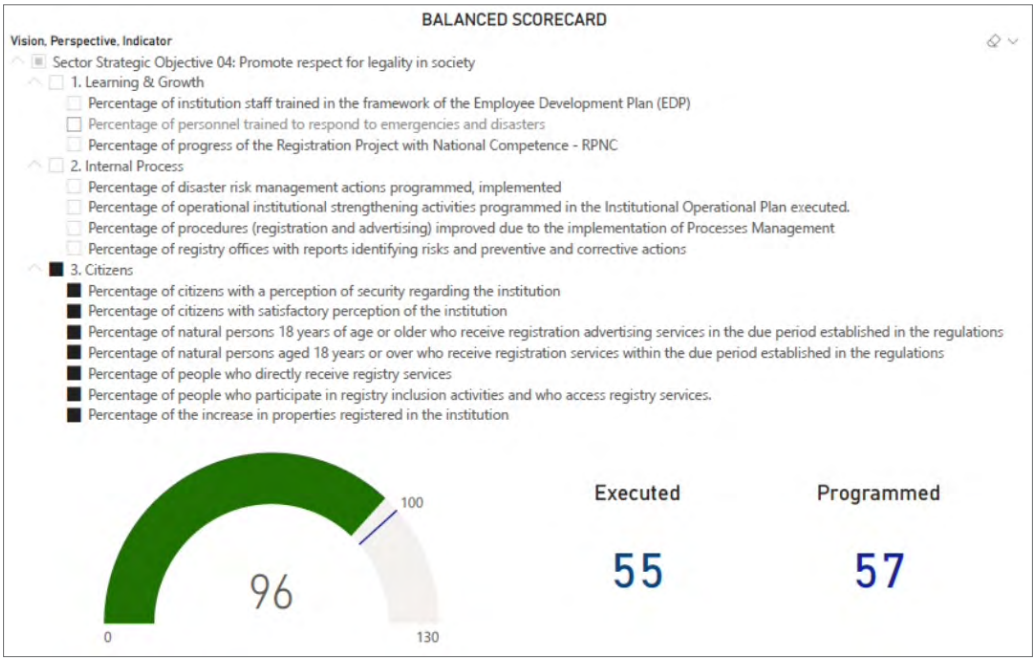

Figure 10. BSC: Average percentage of the citizens' perspective in 2019.
Source: own elaboration.

Figure 10 shows that the institution has achieved an average of 96% execution of the programmed goals of the citizens' perspective for the year 2019.

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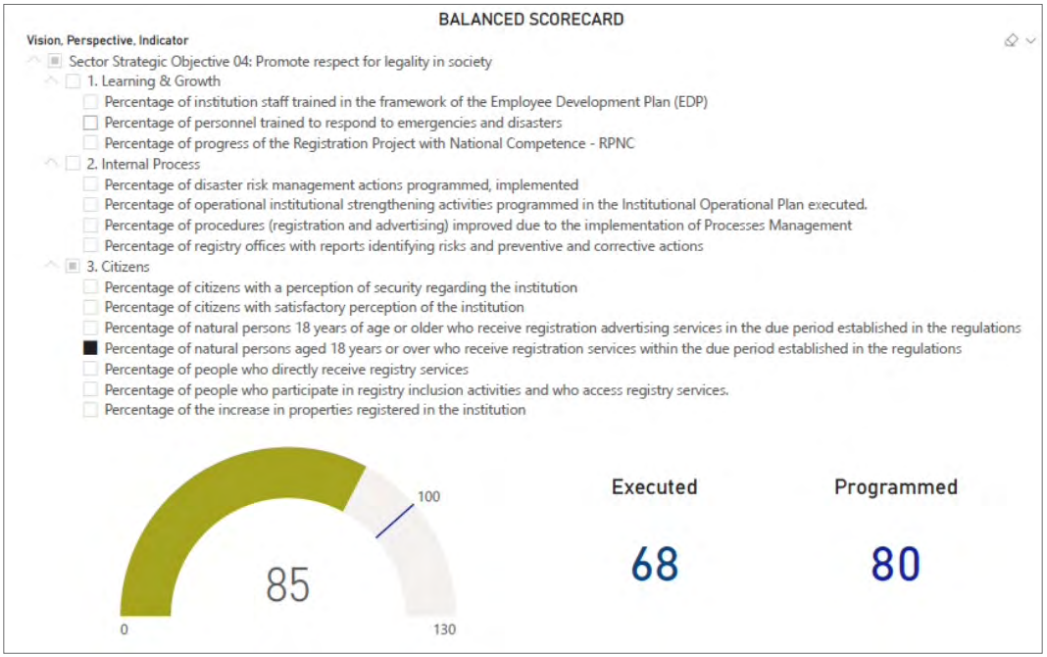

Figure 11. CSB: Percentage of natural persons aged 18 years and older who receive registry registration services within the due date established in the regulations in 2019.

Source: own elaboration.

Figure 11 shows that the institution has reached 85% execution of the programmed goal of the percentage of natural persons aged 18 years and older who receive registry registration services in the due time established in the regulations for the year 2019. This is the only result shown in yellow.

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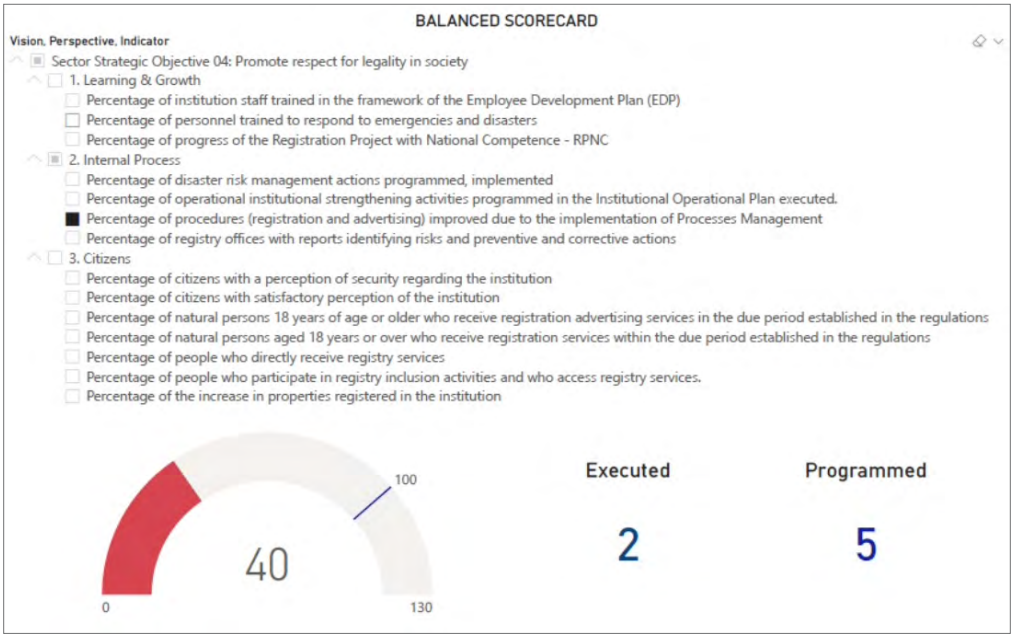

Figure 12. BSC: Percentage of procedures (registration and publicity) improved as part of the implementation of process management in 2019.

Source: own elaboration.

Figure 12 shows that the institution has reached 40% execution of the programmed goal of the percentage of procedures improved in the framework of implementing the management by processes for the year 2019. This is one of the two results shown in red.

https://doi.org/10.17993/3cemp.2021.100448.127-147

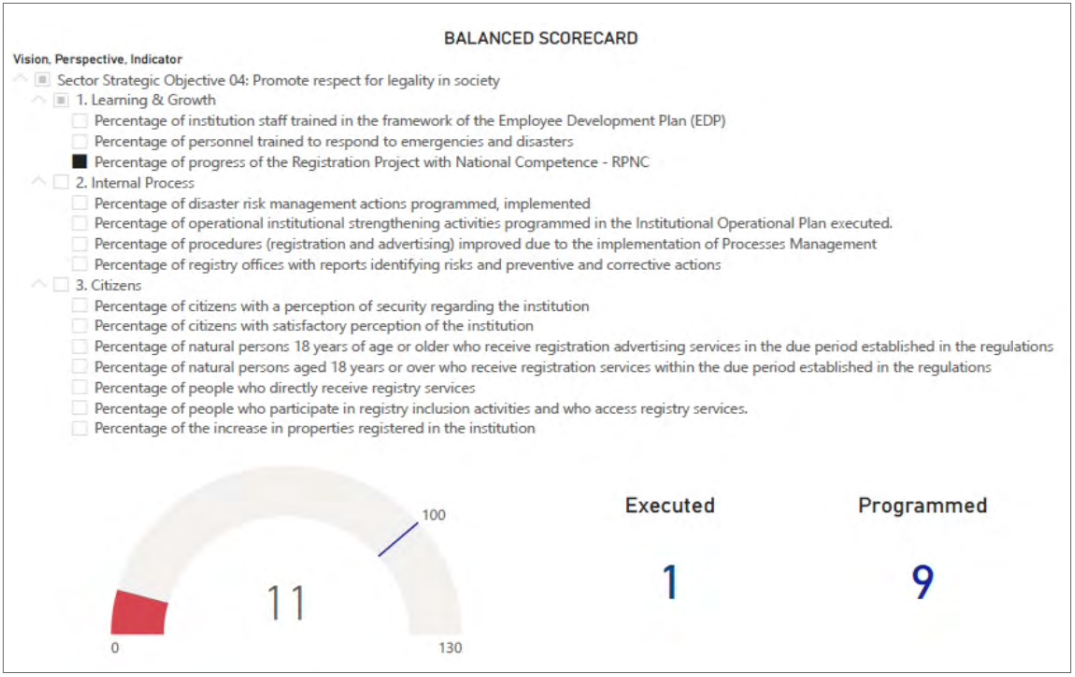

Figure 13. BSC: Percentage of the progress of the Registration Project with National Competence - IRCN in 2019.
Source: own elaboration.

Figure 13 shows that the institution has reached 11% of the execution of the programmed goal of the percentage of progress of the Registration Registration Project with National Competence - IRCN for the year 2019. This is one of the two results shown in red.

5. CONCLUSIONS

The prototype of the BSC-based solution was implemented on the institutional strategic plan of the public entity, applying the proposed methodology.

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The achievement of the objectives corresponding to the learning and growth and internal processes perspectives has a significant impact on the service that the institution provides to the citizen; this is reflected in the strategic map of the public entity.

At the level of the whole year 2019, according to the last report of the public entity, the institution has achieved an average of 97% of execution of the goals programmed for that year. The BSC shows this result in green.

At the level of the perspectives defined in the BSC, the percentage of execution of the goals programmed for 2019 was as follows: the learning and growth perspective reached an average of 93% execution. The internal processes perspective reached an average of 102% execution; this perspective exceeded the expectations for that year. The citizenship perspective achieved an average of 96% execution. The three views are shown in the BSC in green (Ubalde *et al.*, 2020).

At the indicator level, 85% of the programmed target for the percentage of individuals 18 years of age and older who receive registry registration services due to time established in the regulations was reached. This is the only result shown in yellow in 2019. It is also noted that 40% execution of the programmed goal of the percentage of procedures improved in the framework of the implementation of process management was achieved; the BSC shows this result in red color. It is also observed that 11% of the programmed goal of the percentage of progress of the Registry Registration Project with National Competence - IRCN was achieved, the BSC shows this result also in red color (Alfaro *et al.*, 2020).

The proposed model provides the relevant information of the strategic plan. Therefore it should be taken into account when strategic decisions are to be made in an organization, allowing the fulfillment of the objectives set out in the plan.

The model proposed in this research work can be taken as a basis for a similar implementation in any public or private organization.

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