eman ta zabal zazu

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BILBOKO INGENIARITZA ESKOLA

DOKTOREGO TESIA

ENVIRONMENTAL, SOCIAL AND GOVERNANCE (E.S.G.) ENPRESA INBERTSIO EREDUAREN OSAGAI SOZIALAREN AZTERKETA

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ESKER ONAK

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Bide pertsonal honi ekin nionean, eta nora eramango ninduen ez nekielarik, ez nekien bidaide onak aukeratzeak zer nolako garrantzia izango zukeen. Bidea luzea izan da, bere malda eta lautadekin. Ibilbidean zehar oztopoak gaindituz joan naiz eta baita oztopo bakoitzarekin zerbait ikasten. Ibileraren zati bat ere atzera egin behar izan dut, eta estropezuen ondoren behin baino gehiagotan altxatu. Baina batez ere egindako aurrerapen bakoitzarekin eta lortutako etapa bakoitzarekin gozatu egin dut. Orain, behin bidea amaituta, nire bidelagunei eskerrak eman nahi dizkiet eskainitako laguntzagatik, haiek gabe ez bainuen sekulan lortuko.

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Eta eskerrik asko Ibon, Mikel eta Joaneri. Zuek izan zarete eta izango zarete beti bidea jarraitzeko nire motibazio nagusia.

Oztoporik gabeko bidea aurkitzen baduzu ez zaitez fidatu.
Agian ez zaitu inora eramango (C. Vigil konstantzioa)

AURKIBIDEA

IRUDIEN AURKIBIDEA

GLOSARIOA

Bibliometria: Zientziometriaren atala non, zientzia-literatura osoari eta hura sortzen duten egileei metodo matematikoak eta estatistikoak aplikatzen dizkien, jarduera zientifikoa ikasi eta aztertzeko helburuarekin.

CPC *(Cooperative Patent Clasification*): Patenteen Europako Bulegoaren (EPO) eta Ameriketako Estatu Batuetako Patenteen eta Marken Bulegoaren (USPTO) arteko baterako proiektua, patenteen argitalpenak sailkatzeko sistema komun bat garatzeko. Bi bulego horiek patenteak emateko prozedura erabiliko dute.

Datu-meatzaritza: estatistikaren eta konputazio-zientzien eremua, datu-multzoen bolumen handietan patroiak aurkitu nahi dituen prozesuari buruzkoa. Adimen artifizialaren, ikaskuntza automatikoaren, estatistikaren eta datu-base sistemen metodoak erabiltzen ditu.

ESG *(Environmental, Social and Governance*): Enpresa batean inbertitzeko orduan kontuan hartzen diren ingurumen, gizarte eta gobernu korporatiboko faktoreei buruzkoak dira ESG irizpideak.

Eurostoxx50: Burtsaren kapitalizazioari dagokionez, euroguneko 50 enpresa handienak ordezkatzen dituen burtsa-indizea.

Gephi: Kode irekiko eta doako softwarea, grafoak eta sareak bistaratu eta miatzeko erabiltzen dena.

GEK (Gizarte-Erantzukizun Korporatiboa): erakunde bakoitzak bere ingurunearekin eta bere gizartearekin duen erantzukizuna

GJH (Garapen Jasangarriko Helburuak): Garapen Jasangarriko 17 Helburuak (GJH), Helburu Global izenez ere ezagutzen direnak, Nazio Batuek 2015ean hartu zituzten deialdi unibertsal gisa, pobreziari amaiera emateko, planeta babesteko eta 2030erako pertsona guztiek bakea eta oparotasuna izango dituztela bermatzeko.

Hu Liu: Datuen sentimenduen analisiaren alorrean erabilitako lexiko garrantzitsuenetako eta ezagunenetako bat.

I+G(+b) (Ikerketa eta Garapena eta berrikuntza): Korporazioek edo gobernuek produktu eta zerbitzu berriak garatzeko edo hobetzeko hartzen dituzten jarduerak.

LCA (*Life Cycle Assesment*) / BZA (Bizi-Zikloaren Analisia): Produktu edo jarduera baten bizi-ziklo osoko ingurumen-alderdiak eta eragin potentzialak kalkulatzen dituen azterketa mota. Beraz, prozesuaren etaparik edo elementurik kritikoenak non dauden jakiteko aukera ematen du, eta, horrela, horietan fokatzeko eta irtenbide alternatiboak bilatzeko. Bizi-

zikloaren analisiak ekoizpen iraunkorragoa sustatzen laguntzen du, ingurumenaren ikuspegitik.

LCC *(Life Cycle Costing*) / BZK (Bizi-Zikloaren Kostuaren Kalkulua): Produktu edo zerbitzu bati esleitu dakizkiokeen kostu guztiak aztertzea, ideia sortzen hasten denetik bizitza baliagarriaren amaierara arte, haren bizitzaren faseekin lotutako edozein eragilek edo eragilerentzat.

LCSA (*Life Cycle Sustainability Assessment* / BZJA (Bizi-Zikloaren Jasangarritasunaren Analisia): Bizi-zikloaren jasangarritasunaren analisia edo ebaluazioa, produktu eta zerbitzu jasangarriak bizi-ziklo osoan zehar garatzeko erabakiak hartzeko prozesuetan ingurumenean, gizartean eta ekonomian izango diren inpaktu eta onura guztien ebaluazioari dagokio.

NLP (*Natural Languaje Processing*) / HNP (Hizkuntza Naturalaren Prozesamendua): Ordenagailuek giza hizkuntza ulertzeko, interpretatzeko eta prozesatzeko duten modua aztertzen duen eremua. Eremu konplexua da, eta hainbat diziplina sartzen dira jokoan: adimen Artifiziala (IA), *big data* edo linguistikoa.

OI (*Open Innovation*): Berrikuntza irekia, mundu konplexu batean kanpo-lankidetza gero eta gehiago onartzeari buruzko termino bat da. Horrek esan nahi du barne-ezagutza kanpoko ezagutzarekin konbinatzea estrategia- eta I+G proiektuak aurrera ateratzeko helburuarekin. Testuinguru horretan, unibertsitateek eta ikerketa-zentroek garrantzi berezia hartzen dute erakundea erlazionatzen den eragileen ekosisteman.

***Orange Data Mining*:** Datu-meatzaritza eta analisi prediktiboa egiteko programa informatikoa, Ljubljanako Unibertsitateko informatika fakultateak garatua. Datu-meatzaritzako algoritmoak eta datuen aurreprozesamenduko eta irudikapen grafikoko eragiketak inplementatzen dituzten C++ sisteman garatutako osagai batzuk ditu. Orangeren osagaiak Phytonen garatutako programetatik edo ingurune grafiko baten bidez manipula daitezke.

Patseer: Patenteak ikertzeko plataforma, adimen artifizialak bultzatua, analisi integratuekin, proiektuen lan-fluxuekin eta lankidetza-gaitasunekin. 150 milioi patente baino gehiago biltzen ditu 108 herrialde baino gehiagotan, eta zehaztasunean zentratzen da. Informazio prozesagarria sortzeko iragazkiak, grafikoak eta tresna analitikoak ditu.

Power BI: Hodeian (*cloud*) oinarritutako enpresa-analisiaren soluzioa, hainbat datu-iturri batu, aztertu eta txostenen eta panelen bidez datu-iturri horien azterketa aurkezteko aukera ematen duena.

SA (*Sentiment Analysis*): Sentimenduen Analisia. Baliabideetatik informazio subjektiboa identifikatzeko eta ateratzeko hizkuntza

naturalaren prozesamendua, testu-analisia eta hizkuntzalaritza konputazionala erabiltzeari dagokio. Idazki bat positiboa, negatiboa edo neutroa den "konputazionalki" zehazteko prozesua da.

Sareen analisia: Emaitza grafikoak eta zenbakizkoak ematen dituen estatistika-prozedura. Sareko grafikoei "mapa" deitzen zaie, sarean agertzen diren aktoreak nola dauden lotuta erakusten dutelako.

Scopus: Elsevierren jabetzakoak diren aldizkari zientifikoetako artikuluen laburpen eta aipuen datu-base bibliografikoa, 2004an kaleratua.

sLCA (*Social Life Cycle Assessment*) / BZSA (Bizi-Ziklo Sozialaren Analisia): Bizi-Ziklo Sozialaren azterketa ebaluazio-tresna bat da, produktu batek bere bizi-ziklo osoan izan ditzakeen ondorio positiboak edo negatiboak alderdi sozialean baloratzeko erabiltzen dena, lehengaiak erauzteko prozesua, ekoizpena, banaketa, aplikazioa, berrerabilera, mantentzea, birziklatzea eta azken ezabatzea barne.

VADER (*Valence Aware Dictionary and Sentiment Reasoner*): Sentimenduak aztertzeko tresna, lexiko eta arauetan oinarritua, gizarte-inguruneetan adierazitako sentimenduetara berariaz egokitzen dena.

VP (*Vantage Point*): Maila profesionaleko idazmahaiko testu-meatzaritzaren aplikazioa, analistei informazio zientifikoa, teknikoa, merkatuari buruzkoa eta patenteei buruzkoa emateko txostenak findu, aztertu eta egiteko tresna indartsuak eskaintzen dizkiena.

WOS (*Word of Science*): *Clarivate Analytics* enpresaren jabetzakoa, 1900. urtetik gaur egunera informazioa biltzen duten erreferentzia bibliografikoen eta aldizkako argitalpenen aipamenen datu-baseen bilduma da.

1. ATALA

1. SARRERA

Azken hamarkadetan, berrikuntza-eredu itxi batetik ireki batera igaro gara. Horrek esan nahi du enpresek pixkanaka aldatu dutela beren ikerketan inbertitzeko modua lankidetza-metodo batera (Smart et al., 2019). Berrikuntza-eredu itxi batean, enpresek beren I+G sailean inbertitzen zuten, eta, horrela, ideia berriak ez ezik, haien ezagutza osoa, tazitua eta esplizitua ere eduki zezaketen. Baina, gero eta lehiakorragoa den ingurune batean, ideiak garatzen laguntzeko beharra sortzen da, produktu hobeak, aurreratuagoak eta I+Gn inbertsio handiagoa eskatzen dutenak lortzeko (Hoffmann et al., 2007), (Kratzer et al., 2017). Testuinguru dinamiko eta global honetan, Berrikuntza Irekiaren edo *Open Innovation-aren* (OI) paradigma berrikuntza itxiaren aurreko paradigma ordezkatuz agertzen da, eta ikuspegi berri bat adierazten du berrikuntzaren kudeaketa eredu itxi batetik ireki batera aldatzeko (H. Chesbrough, 2004). OIren eredua erakundeek berrikuntzaren praktika elkarrekin nola lantzen duten azaltzeko erabiltzen da, bereziki ezagutzaren sarrera- eta irteera-fluxuekin berrikuntza-prozesuan, edo produktu berriak garatzeko (Anderson & Hardwick, 2017b). Enpresek, zentro teknologikoek eta unibertsitateek osatutako sistema da, non lankidetza-proiektuak eusten diren (Noviaristanti, 2019).

Berrikuntza ezinbestekoa da enpresentzat, langileen berrikuntza ezinbestekoa den moduan. Hau ezagutzaren trukeari esker lortu daiteke (Haack, 1997) (Ya Pian et al., n.d.). Ritalaren et al.-aren arabera (Ritala et al., 2015), ezagutzaren lorpen eta partekatzeak berrikuntza dakar. Hala ere ezagutza lortzea ez da prozedura erreza, eta antolaketen arteko ezagutza transferentzia prozedura honek daukan alde inplizitua da (Anderson & Hardwick, 2017a). Trukearen bitartez ezagutza eraldatzeko ahalmenaren arabera, berrikuntza maila bate do beste bat lortuko da (Dasgupta et al., 2009). Ezagutzen truke hau antolaketara bideratzen bada, pertsonari bideratu beharrean, berrikuntza joera handiagoa izango da (Ya Pian et al., n.d.). Baina antolakuntza barruko truke eta transferentziek daukaten konplexutasun handiaz gain, antolakuntza mota desberdinen arteko ezagutza truke batera ari dira eraldatzen. Honen adibide unibertsitate eta enpresen arteko erlazioak dira (Becker & Eube, 2018) (Perkmann & Walsh, 2007). Hau guztia dela eta ezinbestekoa gertatzen da ezagutzaren kudeaketa sistema eraginkor bat izatea. Sistema honek ezagutzen bereganatzea erraztu behar du, bai antolakuntzen barnean gertatzen diren ezagutza trukeetatik datorrena, bai antolakuntza desberdinen artetik datorrena ere (emaitis, 2014). OI ikuspuntuan oinarritzen diren antolaketa inguruneek, ezagutzaren truke eta transferentziei zabaltzen diete atea. Alderantziz ere, berrikuntza prozesurako ematen den ezagutzen fluxuak, OIn oinarritutako

antolaketa ikuspuntu estrategikoarekiko konpromisoa suspertzen du (A. P. V. B. V. Lopes & de Carvalho, 2018). OI-ko berrikuntza jasangarria, enpresa ugaritako negozio ereduentzako funtsezko zatia bihurtu da (C. M. Lopes et al., 2017), egungo enpresa-ingurunean ingurumen-abantaila lehiakorrak lortzeko, ezinbestekoa bait da ezagutzak partekatzea (García-Álvarez, 2015). Izan ere, jasangarritasun-gaiek konplexutasun handia dutenez, enpresak beste enpresa batzuen ezagutza eta berrikuntzen mendeko bihurtzen dira (Andersen & Foxon, 2009). Hori dela eta, enpresa askok kanpoko ezagutza-iturrietara jotzen dute, beste erakunde batzuekin elkarteak ezartzen dituzte eta beren I+G+b indartzen dute. Horrela, berrikuntza iraunkorren bitartez, enpresa-mozkinak handitzea lortzen dute (De Marchi, 2012a). Izan ere, iraunkortasunean gehien berritzen duten enpresak, berrikuntza horiek garatzeko beste enpresa batzuekin lankidetzan aritzen direnak izaten dira, baita ingurumen-inpaktu gehien eragiten dutenak ere (C. M. Lopes et al., 2017). Iraunkortasuna gizarteko partaideek, enpresak barne, biodibertsitateari kalterik egin ez diezaioten bermatzeko modu bat da , berrikuntza jasangarriei buruzko politika egokiak aplikatuz (De Marchi, 2012b), (Faisal, 2010). Gainera, enpresek kontuan izan behar dute kontsumitzaileek gero eta kezka handiagoa dutela bai ingurumen-inpaktua bai bere ingurumen-aztarna murrizteko. Halaber, ezin da ahaztu ingurumen-inpaktu hori zigortzen duten politikak gero eta murriztaileagoak direla (Clarke, 2006). Beraz, enpresak jasangarritasuna enpresa-kudeaketako estrategian txertatzen badu, negozio-eredu iraunkorra lortuko da, bai eta gizarte-garapen orekatua ere (McPhee, 2014). Erronka global berriei aurre egin behar dien mundu honetan, hala nola baliabide naturalen agortzea eta berotze globala, ingurumena eta pertsonen balioak gero eta askotarikoagoak eta konplexuagoak dira (Fukuyama, 2018). Testuinguru horretan, 2015eko irailean, Nazio Batuek Garapen Jasangarriaren Helburuen 2030 Agenda (GJH) hartu zuten gune gisa (UNESCO Moving Forward the 2030 Agenda for Sustainable Development - UNESCO Biblioteca Digital, n.d.).

Beraz, globalizazio eta ezagutza-truke baten testuinguruan aurkitzen gara, non enpresak ingurumenean sortzen dituen inpaktuak gero eta garrantzitsuagoak diren. Horregatik, beharrezkoa da produktuek eta enpresen prozesuek gizartean eragiten dituzten inpaktuak neurtu ahal izatea, iraunkortasuna sustatzeko helburuarekin (Norris & Reveret, 2015). Behin enpresek egiten duten ezagutza-trukea eta enpresek gizartean eragiten dituzten inpaktuak aztertuta, garrantzitsua da, halaber, ekintza horiek gizartean sortzen duten irudia ezagutzea, haien erreputazioa neurtu ahal izateko. Irudi on batek enpresaren ospea edo erreputazioa hobetuko du, baina irudi txar batek okerrera egingo du, eta enpresek ezin dute haien ospea ahaztu, kontsumitzailearen gogobetetzeari eragiten baitio, besteak beste

(Chun, 2005). Raithelen arabera, ospe korporatiboa bi adierazleren bidez neur daiteke: enpresarekiko sentitzen den sinpatia eta enpresaren konpetentzia (Raithel et al., 2010). Kontsumitzaileek, enpresa baten ospeari buruz erabakitzean, ahoz ahoko datuetan, berrietan, publizitatean eta abarretan oinarritzen dira (Kossovsky, 2012). Beraz, enpresarekiko begikotasun hori neurtzeko modu bat korporazio horiei buruz argitaratzen diren albisteen bidez izan daiteke. Kontsumitzaileak ikusten badu albisteek tonu positiboa dutela enpresei buruz, haiekiko sinpatia handiagoa izango du, eta enpresaren ospea handitu egingo da. Gauza bera gertatuko da, bestela, albisteetan enpresei buruzko tonu negatiboak haiekiko irudi txarra ekarriko du, eta salmentak baldintzatuko ditu.

2. ESPARRU TEORIKOA

Enpresek beren ingurunearekin duten aldebiko harremanaren barruan kokatzen dira enpresen ezagutzaren transferentzia Berrikuntza Irekiaren edo *Open Innovation*-eko (OI) testuinguru batean, produktuaren bizi-zikloaren eragin soziala eta enpresei buruz argitaratzen diren berriak.

Ezagutzaren transferentzi

a 1985ean sartu zen lehen aldiz prozesu berritzailean, Klinen ereduari esker. Eredu horretan prozesu berritzailearen konplexutasuna islatzen da, eta berrikuntza bat garatzeko artearen egoera kontsultatzeko beharra formalizatzen da (Mäntylä et al., 2018) (Hackenhaar et al., 2019). Baina OI berrikuntzaren kontzeptua ez da 2003ra arte agertuko, Henry Chesbroughek termino hori sortu zuen urtea izanik. OI berrikuntza-estrategia bat da, zeinaren bidez enpresak beren mugetatik haratago doazen, eta kanpoko erakunde edo profesionalekin lankidetza garatzen duten, hala nola unibertsitateekin eta zentro teknologikoekin (H. W. Chesbrough, 2003).

Jakintzaren sarrera eta irteera intentzionalak gertatzen direnean enpresa batean euren berrikuntzak sustatzeko helburuarekin eta bide batez merkatuak zabaltzen direnean kanpotik berrizteko, OIko egoera batean gaudela esan dezakegu. Definizioaren arabera, erakundeak gai dira enpresa barruko eta kanpoko informazioa eta prozedurak erabiltzeko, eta horrela izan behar du teknologikoki aurrera egin nahi badute (Bagherzadeh et al., 2019). Berrikuntza irekiaren paradigma (OI) berrikuntza itxiaren aurreko paradigmaren ordez agertzen da, eta berrikuntzaren kudeaketaren ikuspegi berri bat adierazten du, eredu itxi batetik ireki batera igarotzen dena (H. Chesbrough, 2004) (H. W. Chesbrough, 2016). Erakundeek nola laguntzen duten berrikuntzaren praktikan adierazteko erabiltzen da OIren eredua, bereziki ezagutzaren sarrera- eta irteera-fluxuek berrikuntza-prozesuan edo produktu berrien garapenean duten garrantzia (Anderson & Hardwick, 2017a).

Enpresaren eta gizartearen arteko aldebiko harremanean eragina duen beste faktore bat produktuaren bizi-zikloa da, gizartean eragina baitu, eta eragin hori irudi edo ospe gisa itzultzen da enpresara. Nazio Batuen Ingurumenerako Programaren (PNUMA) arabera (About UN Environment Programme | UNEP - UN Environment Programme, n.d.), sLCA erakundeen, produktuen eta zerbitzuen bizi-zikloaren iraunkortasuna ebaluatzeko garatu diren hiru metodologietako bat da, bizi-zikloaren ingurumen-inpaktua (LCA) eta bizi-zikloaren kostearen (LCC) kalkuluarekin batera. LCA, LCC eta sLCA-ren konbinazioak, iraunkortasunaren hiru zutabeen kontzeptuan oinarrituta, Bizi Zikloaren Iraunkortasunaren Ebaluazioa

(LCSA) dakar. LCSAren tresna hauek batera erabiltzean, "Produktu bat beste bat baino jasangarriagoa zenbateraino den" zehaztu daiteke (Jungmeier et al., 2015). Hiru zutabe horien definizioari begiratuta agerian geratzen da alderdi soziala berez ez dela nahikoa iraunkortasuna ebaluatzeko: iraunkortasunaren jatorrizko definizioak hiru osagai edo zutabe hartzen ditu: ingurumena, ekonomia eta alderdi sozialak. Produktu bat diseinatzerakoan, jasangarritasunaren hiru "zutabe" horiek modu orekatuan ebaluatu eta osatu behar dira beraz (Kloepffer, 2008). *Horizon 2022* (European Commission; Directorate General for Research and Innovation, 2018),lanean, bizi-zikloaren ingurumen-inpaktuaren kalkulua (LCA) eta bizi-zikloaren kostuaren kalkuluak (LCC) nahitaezko zeregina dira produkzio-lerroak eta/edo produktuak optimizatzeko. Ondorioz, LCSAren azterketa osoak ez du sLCA aipatzen, hau da, alderdi soziala. Bizitza zikloaren giza-ebaluazioa (sLCA) metodologia bat da non produktuen bizi-zikloekin lotutako inpaktu sozialak, positibo eta negatiboak, errealak edo potentzialei buruzko erabakiak hartzen laguntzen duen (Jørgensen, 2013; UNEP SETAC Life Cycle Initiative, 2009). 2009an, PNUMAren eta Toxikologia eta Ingurumen Kimikako Elkartearen (SETAC) bizi-zikloari buruzko ekimen bateratu batek metodologia hori jarraitzeko jarraibideak argitaratu zituen (UNEP SETAC Life Cycle Initiative, 2009). Kontuan hartuta sLCAren aplikazio nagusia enpresen produktu, prozesu edo zerbitzuetan dagoela oinarrituta (Walker et al., 2021), enpresak izango dira metodologia hori aplikatzearen arduradun nagusiak. Beraz, hori aplikatzea funtsezko faktore estrategikoa da enpresentzat. Horrela, enpresek beren prozesuetan sLCA metodologiak aplikatzea erabakitzen badute, gai horren inguruan dagoen informazio zientifikoa balio handikoa izango da haientzat, zientziaren erakunde egileengana jo ahal izango baitute, baita lankidetza-sareetan sartu ere. Garrantzitsua da, halaber, sLCAn ikertzen duten enpresa pribatuak identifikatzea, eta horietako zeinek aplikatzen duten beren kudeaketa-ereduetan ikustea, beste enpresa batzuek aplikatu ahal izateko, erreferentzia gisa.

Prentsa idatzian enpresei buruz argitaratzen diren albisteek enpresa horietan bertan sortutako eta gertatutako praktika eta gertakarietan dute jatorria, eta, aldi berean, albiste horiek eragina izango dute enpresa horien irudian. Beraz, enpresa-praktikek gizartean eragiten dute albisteetan horiei buruz esaten denaren bidez, eta, aldi berean, gizarteak berengan eragina izatea eragiten dute, haiei buruz proiektatzen den irudiaren bidez. Gainera, egungo gizarteak gero eta erantzukizun sozial handiagoa eskatzen die enpresei, eta beren ekintzen ondorio sozialen berri ematen ere eskatzen die. Ondorioz, Gizarte Erantzukizun Korporatiboa (GEK) beharrezko praktika bihurtu da enpresetan. Baina ez Gizarte Erantzukizuna da ulertu behar

enpresek nahitaez egin behar duten eta inongo, onurarik ematen ez duen zerbait bezala, GEK Berrikuntzaren eta lehiarako abantailaren iturri handia bihur baitaiteke (Porter & Kramer, 2006). Gainera, globalizazioaren eta interneten erabileraren ondorioz, gero eta albiste gehiago sortzen dira edozein gairi buruz, eta, ondorioz, gero eta zailagoa da albiste-bolumen hori guztiori kontrolatzea eta aztertzea. Informazio hori modu tradizionalean aztertu ezin denez, ezinbestekoa da adimen artifiziala eta datu-meatzaritza erabiltzea (Agarwal, 2020).

Testuinguru honetan, sentimenduen analisia edo *Sentiment Analysis* (SA), datu-meatzaritzaren eta semantika konputazionalaren barruan dagoen azpidiziplina bat da. Beraz, albisteek proiektatzen duten ospe edo irudia neurtzeko modu bat, sentimenduen analisia (SA) izango da. Gilbert eta Huttoren arabera (Hutto & Gilbert, 2014), sentimenduen analisia edo iritziaren meatzaritza, Hizkuntza Naturalaren Prozesamenduaren (NLP) arloko ikerketa-arlo aktiboa da, eta pertsonen iritziak, sentimenduak, ebaluazioak, jarrerak eta emozioak aztertzen ditu, testuan subjektibotasuna konputazionalki prozesatuz.

Sentimenduetan aberatsak diren iturrietatik (albisteak, gizarte-komunikabideetako guneak, aipamenak, etab.) lortutako datuak ulertzeaz ari da sentimenduen analisia (Agarwal, 2020). Beraz, sentimenduen analisia testutik sentimendua, iritziak eta emozioak ateratzeaz arduratzen da (Ravi & Ravi, 2015a) eta eremu askotan ditu aplikazioak, bezeroaren gogobetetzetik hasi eta iritzi politikoetaraino (Medhat et al., 2014) (Mäntylä et al., 2018) (Ravi & Ravi, 2015b). Sentimenduen kategorizazio automatikorako oinarrizko bi ikuspegi daude: ikaskuntza automatikoaren ikuspegia eta lexikoan oinarritutako ikuspegia. Ikaskuntza automatikoko metodoek "hitz-poltsa" ikuspegia erabili ohi dute corpusean hitzak (normalean lematizatuak edo sustraituak) ezaugarri independente gisa erabiltzen dituena dokumentuak irudikatzeko ezaugarri bektore batean (Khoo & Johnkhan, 2018). Bigarren ikuspegiak existitzen den lexiko bat erabiltzen du hitzekin edo hainbat hitzetako terminoekin, positiboak, negatiboak edo neutroak bezala etiketatuta (batzuetan sentimenduaren indarra edo intentsitatea islatzen duen balio batekin) (Khoo & Johnkhan, 2018).

Beraz, enpresen praktikek eragina izan dezakete gizartean, besteak beste, ezagutzaren kudeaketaren, produktu eta prozesuen bizi-zikloaren gizarte-inpaktuen eta/edo gizarte-komunikabideen kudeaketaren bidez. Praktika horiek enpresetan izan ditzaketen gizarte- eta ingurumen-ondorio horiek neurtzeko modu bat *Environmental, Social and Governance* (ESG) inbertsio-irizpideak dira.

ESG irizpide horiek enpresa baten portaerarako arau multzo bat dira, eta azterketa-tresna gisa erabiltzen dira, enpresek beren Gizarte Erantzukizun Korporatiboa (GEK) neurtzen saiatzeko, hau da, enpresak gizartearekin duen erantzukizun-maila neurtzeko. Enpresen ESG irizpideak enpresa batean inbertitzeko garaian kontuan har daitezkeen ingurumen, gizarte eta gobernu korporatiboko faktoreei buruzkoak dira (Initiative, 2005), enpresan irudi korporatibo moduan eragiten baitute.

Beraz, enpresaren ingurumen- eta gizarte-politikak aztertzeko tresna bat da, enpresaren finantzetan eragina izango dutenak, ospe eta irudi moduan (ona edo txarra). Egile askok aztertu dute ESG irizpideen aplikazioaren eta finantza-emaitzen arteko lotura hori. Horrela, Friede et al (Friede et al., 2015) -ek, berrikuspen sakon baten bidez, enpresetan ESG irizpideak aplikatuz, enpresek finantza-emaitza hobeak lortzen dituztela frogatzen dute. Amir eta Serafeimen arabera, enpresek ingurumenari, gizarteari eta gobernantzari buruzko informazioa erabiltzeko duten garrantziaren araberako motibazio nagusiak honako hauek dira: inbertsioaren errendimendua, bezeroen eskaria, produktuaren estrategia eta, azkenik, gogoeta etikoak (Amir & Serafeim, 2018). Brooksek eta Oikonomouk ESG irizpideen eta finantza-errendimenduaren arteko erlazioa jorratzen dute ere. Autore horiek lotura positiboa, estatistikoki esanguratsua baina ekonomikoki apala aurkitzen dute, ESG irizpideen eta enpresa-mailako finantza-errendimenduaren artean. Haren artikuluaren arabera, asimetria bat dago ESGaren finantza-inpaktuetan, eta, beraz, enpresen gizarte-arduragabekeriaren finantza-ondorio negatiboak indartsuagoak dira enpresen gizarte-erantzukizunaren finantza-ondorio positiboak baino (Brooks & Oikonomou, 2018). Fatemi et al.-ek (Fatemi et al., 2018) beren ikerketan ondorioztatzen dute ESG irizpideen indarguneek enpresaren balioa handitzen dutela eta ESGen inguruko kezkek, murrizten dutela. Azkenik, Lee et al.-ek (Lee et al., 2016) erlazio positibo esanguratsua aurkitzen dute ingurumen-erantzukizunaren eta enpresa-mailako finantza-errendimenduaren artean, eta ingurumen-erantzukizunaren eta enpresa-mailako errendimendu operatiboaren artean.

ESG irizpide horien neurketari buruz dagoen literatura aztertu ondoren, egiaztatu da ESG irizpideak kalifikatzen dituzten enpresak dauden arren, beharrezkoa dela enpresen ESG irizpideak neurtzeko moduak estandarizatzea. Horretarako, irizpide horiek modu estandarizatuan neurtuko lituzkeen eredu bat sortu beharko litzateke. Bloombergs, Kinder, Lydenberg, Domini Research & Analytics (KLD) bezalako kalifikazio-enpresa erabilienek ESG neurketa-kontzeptuen konbergentzia falta nabarmena dute (Chatterji et al., 2009). Kalifikazioak ez datoz bat, eta, beraz, ez dago enpresetan ESG irizpideak neurtzeko eredu estandarizaturik (Dorfleitner,

2015). Gainera, enpresa kalifikatzaile horien estandarizazio faltaz gain, informazioaren sinesgarritasun falta, alborapena, konpentsazioak, gardentasun falta eta independentzia falta daude (Windolph, 2013). Beste egile batzuek ere nabarmentzen dute ESG informazioa erabiltzeko oztopo garrantzitsu bat informazio-araurik eza dela (Amir & Serafeim, 2018).

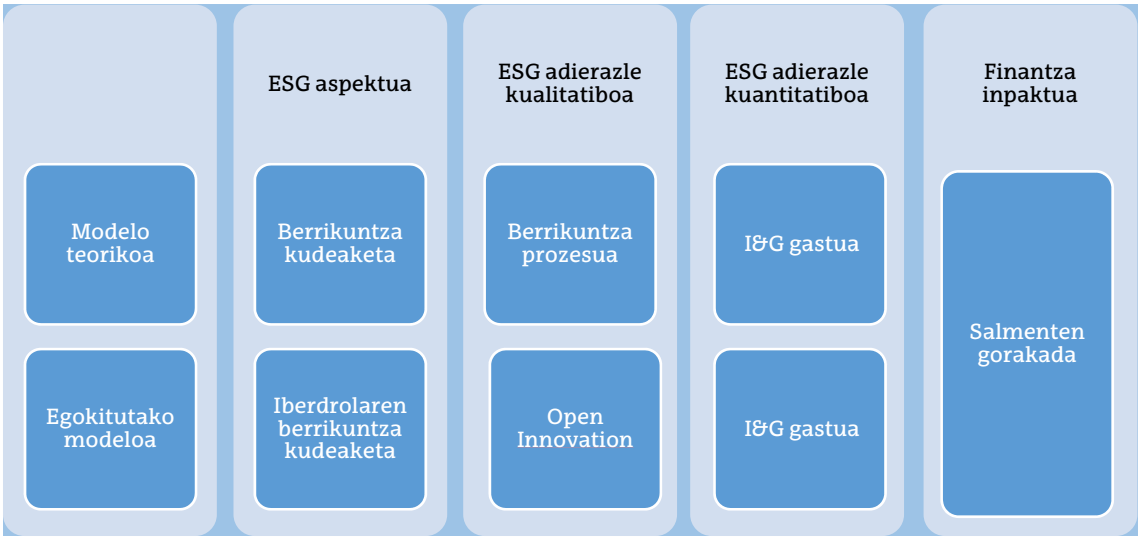
ESG inbertsio-irizpideak neurtu ahal izateko eredu estandarizaturik ez dagoela egiaztatuta, beharrezkoa da eredu hori sortzen laguntzea; beraz, tesi honen azken helburua gizarte-adierazleetan oinarritutako ESG inbertsio-negozio eredu bat definitzea izango da. Helburu hori lortzeko erabili den metodologiak hiru ikuspegi ditu, 1. irudian ikus daitekeen bezala.

Irudia 1: ESG inbertso-negozio eredua

2.1- LEHEN IKUSPEGIA. *OPEN INNOVATION*, I+G+b ARLOKO ERAKUNDE-LANKIDETZAREN OINARRIZKO FAKTORE GISA

Eredu horren lehen ikuspegia OI-an zentratzen da, I+G+b arloko erakunde-lankidetzaren funtsezko faktore gisa. Lehenik eta behin, datu meatzaritza eta sareen analisien tekniken bidez, erakundeetan OI ingurune batean ezagutza transferitzeak eta partekatzeak duen garrantzia identifikatzen da (Alvarez-Meaza et al., 2020a). Hortik sortzen da enpresa jakin baten kasua aztertzeko beharra, enpresa horren berrikuntzaren kudeaketa-ereduan OI praktika sartuta dagoelarik; kasu honetan Iberdrola S.A. aukeratu da. (Alvarez-Meaza et al., 2020b). Fase honetan, Iberdrola SAk beste erakunde

batzuekin lankidetzan egindako garapen zientifikoa aztertzen da, datu-meatzaritzako eta sareetako teknikak erabiliz. OI praktikek erakundean duten eragina neurtzen duen adierazle bat definitzeko, ESG eredua erabiltzen da (2. irudia).



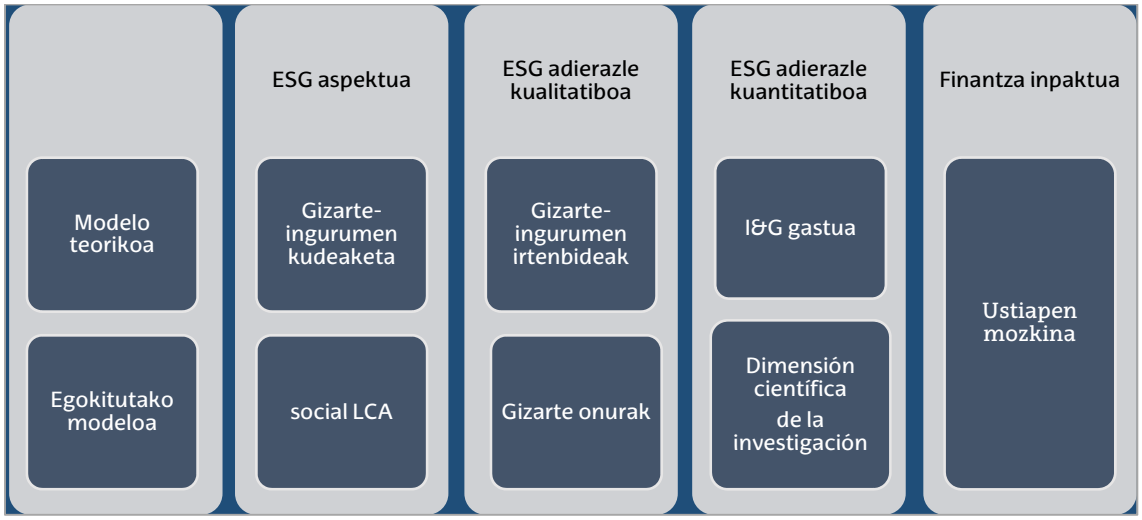
Irudia 2. Informazio kualitatiboaren eta kuantitatiboaren finantza-inpaktua, ESG aspektua berrikuntzaren kudeaketa denean

Schoenmaker eta Schramaderen (Schoenmaker & Schramade, 2019) enpresen eredu teorikoaren arabera, aztertuko diren ESG gaien ebaluazio kualitatibo eta kuantitatibo batek aukera emango du sortzen duen finantza-inpaktua ezagutzeko. 2. irudian ikus daitekeen bezala, ESGren inguruko informazio kualitatiboak eta kuantitatiboak duen finantza-inpaktua, enpresaren salmenten hazkundearen bidez neur daiteke. Berrikuntzaren kudeaketaren kasuan (ESG gai gisa), ezartzen den adierazle kualitatiboa berrikuntza-prozesua da, eta adierazle kuantitatiboak, I+Gan egiten den gastua neurtzen du. Bi alderdi hauek (berrikuntzaren kudeaketa eta I+Gko gastua) eragiten duten finantza-inpaktua salmenten gehikuntza kalkulatuz kuantifikatuko da. Iberdrola S.A. enpresari begiratzen badiogu, ikusten dugu berrikuntzaren kudeaketaren epe luzerako balioa sortzea, OIren ikuspegian zentratzen dela kualitatiboki.

Iberdrola S.A. enpresaren kasuan, eredu teorikoa kasu zehatz honetara egokitu da. «ESG business model» delakoak berrikuntzaren kudeaketan jartzen du arreta, eta Iberdrola SAren kasuan, OIko praktiken bidez neurtzen da, berrikuntzaren kudeaketa gisa, eta I+Gko gastua adierazle kuantitatiboa izango da, salmentetan duen eragin positiboa egiaztatuz.

2.2- BIGARREN IKUSPEGIA: sLCA GARAPEN SOZIALAREN FAKTORE GISA

Bigarren ikuspegiak sLCA du ardatz, gizarte-jardunaren funtsezko faktorea baita. *Social Life Cycle Assessment* (sLCA)-aren inguruan ikertzen duten enpresak identifikatzeko, ikerketa-arlo horri lotutako literatura zientifikoaren analisi bibliometrikoa egiten da (Delgado, 2021). Aurkezten diren emaitzen arabera, hiru enpresa handi, Basf, BMW Group eta Brødrene Hartmann, dira aktiboenak arlo horretan. Ondorioz, hiru enpresa horiek aztertzen dira, beren praktiketan ebaluazio sozialaren metodologia hori aplikatzen duten identifikatzeko, eta hala dela egiaztatzen da. Horregatik guztiagatik, sLCA praktikek erakundeetan duten eragina neurtuko duen adierazle bat definitu nahi da, eta, horretarako, ESG eredura jotzen da berriro.



Irudia 3. Informazio kualitatiboaren eta kuantitatiboaren finantza-inpaktua, ESG aspektua sLCA denean

3. irudiak Schoenmaker eta Schramade eredutik (Schoenmaker & Schramade, 2019) egokitutako eredu bat erakusten du, bai eta informazio kualitatiboak eta kuantitatiboak sLCAn duten finantza-inpaktua ere. Enpresaren gizarte- eta ingurumen-kudeaketa bi ikuspegitatik ebaluatzea da helburua: kualitatiboa eta kuantitatiboa. Kasu zehatz honetan, gizartearen eta ingurumenaren arloko kudeaketa hori enpresen sLCA izango da. Ikuspegi kuantitatiboa neurtzeko, enpresak argitaratutako sLCArekin lotutako artikuluen kopurua hartzen da kontuan. Eredu honetan ikuspegi kualitatiboa ebaluatzeko adierazlea, sLCA ezartzeak alderdi interesdunentzat sortzen dituen onura sozialak izango dira. Bi adierazle horiek eragin positiboa dute enpresaren ospean, ospe horrek salmentak

handitzea eragiten du, eta salmenten handitzeak, ustiapen mozkina handitzea dakar. Enpresa baten ospea ukiezina den arren, eta, beraz, eredu horren arabera neurtzen zaila den arren, salmenten hazkundea enpresa baten ospearen adierazle ona izan daiteke.

2.3.- HIRUGARREN IKUSPEGIA. ALBISTEAK, GIZARTE-KOMUNIKABIDEAK. SENTIMENDUEN BALIOA NEGOZIOETAN.

Hirugarren eta azken ikuspegian, prentsan idatzitako albisteak dira ESG inbertsio-ereduaren osagai sozial gisa aztertu beharreko funtsezko faktorea. Prentsako albisteek negozioetan duten eragina identifikatzeko, sentimenduen analisia (SA) egitea erabaki da. Horretarako, Schoenmaker eta Scharamederen eredu teorikora jotzen da beste behin (Schoenmaker & Schramade, 2019), eta, beraz, adierazle kualitatibo eta kuantitatiboekin neurtutako ESG alderdi batez ere osatuko da. Hirugarren ikuspegi horretan, lehenik eta behin, 2020an dibidendu bidezko errentagarritasun handiena duten Eurostoxx 50ean kotizatutako enpresak hautatzen dira. Jarraian, 2016-2020 aldian enpresa horiei lotutako berriak identifikatzen dira, eta sentimenduen analisia egiten zaie, gizarte-komunikabideen bidez negozioek enpresaren finantza-portaeran, zehazki prentsako albisteetan, sortzen duten eragina neurtzeko adierazle bat ezartzeko. Datu-meatzaritzako teknikak erabiltzen dira datuak garbitzeko, eta *Natural Language Processing*-ekoak (NLP) sentimenduak aztertzeko, VADER eta Hu Liu sentimenduak aztertzeko tresnetan oinarrituta. Adierazle hori albisteen finantza-inpaktua aztertzea helburu duen ESG ereduaren irizpide kuantitatibo bihurtzen da.

Irudia 4. Informazio kualitatibo eta kuantitatiboaren finantza-inpaktua, ESG aspektua gizarte-komunikabideak direnean.

Gainera, ereduaren alderdi kualitatiboa ospearen bidez neurtzen da, zeina, aldi berean, sentimenduen analisiaren (negozioarekiko sinpatia) eta ustiapenaren emaitzaren (sendotasun finantzarioa) aldi baterako analisi korrelazionalaren emaitza den.

3. HELBURU OROKOR ETA ESPEZIFIKOAK

Tesi honen helburu nagusia gizarte-adierazleetan oinarritutako ESG inbertsio-negozioaren eredua definitzea da.

Helburu nagusi honetatik honako helburu espezifiko hauek ateratzen dira, hartutako ikuspegietan oinarrituta:

LEHEN IKUSPEGIA: *OPEN INNOVATION*, I+G+b ko ANTOLAKETA-LANKIDETZAREN OINARRIZKO FAKTORE GISA (1. eta 2. artikuluak)

1. helburu espezifikoa: OIak enpresako adierazle sozial baten osagai gisa duen garrantzia aztertzea, eta ESG inbertsio-negozioaren eredu batean baliozkotzea.

BIGARREN IKUSPEGIA: sLCA GIZA JARDUNAREN FAKTORE GISA (3. artikulua)

2. helburu espezifikoa: sLCAren garrantzia aztertzea, enpresako adierazle sozial baten osagai gisa, eta ESG inbertsio-negozioaren eredu batean baliozkotzea.

HIRUGARREN IKUSPEGIA: ALBISTEAK, GIZA-KOMUNIKABIDEAK. SENTIMENDUEN BALIOA NEGOZIOETAN (4. artikulua)

3. helburu espezifikoa: giza komunikabideak enpresako gizarte-adierazle baten osagaitzat hartzea, eta ESG inbertsio-negozioaren eredu batean baliozkotzea.

3.1- TESIAREN EGITURA

Doktorego-tesi hau artikuluen bilduma gisa aurkezten da. Tesia hiru ikuspegitan egituratzen da, gizarte-adierazleetan oinarritutako ESG inbertsio-negozio eredua definitzen lagunduko dutenak. Hiru ikuspegien helburuak Helburu Nagusiarekin bat datozenez, argitalpen guztiek helduko diote helburu horri.

Lehen argitalpenean, datuen meatzaritzako tekniken eta sareen analisiko tekniken bidez, erakundeetan OI ingurune batean ezagutza transferitzeak eta partekatzeak duen garrantzia identifikatzen da, hau da, enpresaren elkarlaneko praktika zientifikoaren analisia egiten da, eredu korporatibo iraunkor baterantz. Beraz, 1. Helburu Espezifikoaren zati bat jorratzen da; «*OIk zer garrantzi duen enpresako adierazle sozial baten osagai gisa aztertzea*». Berrikuntza Irekiko ingurune batean ezagutzaren transferentzia aztertu ondoren, bigarren argitalpenerako, azterketa-kasua enpresa jakin batean aztertzeko beharra sortzen da, enpresa horren berrikuntzaren kudeaketa-ereduan OI praktika sartuta badago. Kasu honetan Iberdrola S.A.

enpresa aukeratu da. Fase honetan, Iberdrola S.A.k beste erakunde batzuekin lankidetzan egindako garapen zientifikoa aztertzen da, datu-meatzaritzako teknikak eta sareak erabiliz. OI praktikek erakundean duten eragina neurtzen duen adierazle bat definitzeko, ESG eredura jotzen da. Iberdrola S.A.ren kasuan, «*ESG business model*» delakoak berrikuntzaren kudeaketan jartzen du arreta, eta OIko praktiken eta I+Gko gastuaren bidez neurtzen da, salmentetan duen eragin positiboa egiaztatuz. Horrela, 1. Helburu Espezifikoaren bigarren zatia betetzen da, hau da, "... *ESG inbertsio-negozio-eredu batean adierazle sozialak baliozkotzea"*. Lehenengo bi argitalpen horiek tesiaren lehen ikuspegiari dagozkio: *Open Innovation, I+G+b arloko erakunde-lankidetzaren funtsezko faktore gisa*.

Lehen ikuspegia osatu ondoren, bigarren ikuspegia aztertuko da, *sLCA gizarte-jardunaren funtsezko faktore gisa*. Ikuspegi hau landuko da bere osotasunean hirugarren argitalpenean. Artikulu honetan, lehenik eta behin, enpresak SLCA esparruan egiten duen praktika zientifikoaren azterketa egiten da. Ondoren, enpresek sLCA praktikak aplikatzeari buruzko azterketa bat egiten da, sLCA praktikek erakundeetan duten eragina neurtuko duen adierazle bat definitzeko. Kasu honetan, «ESG business model» delakoak sLCA praktikan jartzen du arreta, eta sortutako onura sozialen eta I+Gko garapenean duen inplikazioaren bidez neurtzen da, ustiapen-mozkinan duen eragin positiboa eta enpresaren irudian duen eragina egiaztatuz. Horrela, 2. Helburu Espezifikoa ere betetzen da.

Azkenik, laugarren argitalpenarekin hirugarren ikuspegia aztertuko da, enpresei buruzko albisteen sentimenduen balioa azaltzen duena, ESG enpresa-inbertsioaren ereduaren osagai soziala konfiguratzeko ikuspegi gisa. Artikuluaren amaieran, enpresari buruzko albisteek sortzen dituzten sentimenduen balioaren eta finantza-portaeraren arteko erlazioa azaltzen da, ESG enpresa-inbertsioaren ereduaren bidez, eta, horrela, 3. Helburu Espezifikoari heltzen zaio.

4. LABURPENA ETA EZTABAIDA.

1. kapitulua. *Knowledge sharing and transfer in an Open Innovation context: mapping scientific evolution*

Kapitulu hau lehen argitalpen zientifikoari buruzkoa da, 1. helburu zehatzaren lehen zatia ardatz duena. Ezagutzaren transferentziaren eta/edo partekatzearen kontzeptuaren garapen zientifikoa aztertu nahi da, *Open Innovation (OI)* testuinguru batean. OI konplexua da, eta, gainera, prozesu dinamiko bat da, zeina gaur egungo mundu teknologikoa islatzen duten elementu dinamikoak dituzten estrategien eraginpean baitago (Lopes & de Carvalho, 2018), (Appleyard & Chesbrough, 2017). Hortaz, praktikoagoa da OIren paradigma haren ezagutza-fluxuaren ikuspegira mugatzea. OI ereduen bidez azaltzen da nola sartzen diren ezagutza-fluxu horiek enpresetako berrikuntza-prozesuetan, baita nola ateratzen diren ere. (Anderson & Hardwick, 2017). Etorkizuneko ikerketetarako ikuspegi orokor bat eskaintzeko, artikulu honen xedea da OIren eta ezagutzen transferentziaren edo ezagutzen trukearen kontzeptuen arteko harremana ikertzea ikuspegi zientifiko batetik. Ikerketak analisi bibliometriko bat egiten du testuinguru zientifikoarekin lotura duten adierazle nagusiak identifikatzeko eta aztertzeko. Halaber, sareen analisi bat egiten du eragile nagusien eta kontzeptu-esparruaren arteko harreman nagusi indartsuenak identifikatzeko, eta ikerketak etorkizunean izan ditzakeen joerak aurrez ikusteko. Bi analisi horiei esker, artikuluaren helburua lortu ahal da: eremuaren bilakaera, ekoizle nagusiak eta lankidetzarako dituzten ereduak, zabalkunde-iturri nagusia, kontzeptu-esparrua eta ezagutzaren iturri nagusiak identifikatzea. Aurrekoa lagungarria izan daiteke komunitate zientifikoarentzat eta haren inguru zientifikoarentzat, ikerketarako bide berriak planteatu eta diseinatzen dituztenean, etorkizunean intereseko arloei funts zientifikoak esleitzean eta, aldi berean, lankidetza-talde berriak bilatzeko lanetan, lankidetza-bide berriak zabaltzeko, bai nazionalak, bai nazioartekoak.

Helburua lortzeko erabilitako metodologiak literatura zientifikoaren analisi kuantitatiboa izan du ardatz, eta teknika bibliometrikoak, datu-meatzaritza eta sareen analisia baliatu dira. Ildo horretan, lehenik eta behin aztertutako datu-multzoa (*dataset*) definitu behar da. Datu-base espezifiko hori *Web of Science (WoS)* bildumako *Core Collection* datu-base zientifikoko argitalpenetatik abiatuta sortu da, argitalpen horien informazio eta erreferentzia guztiak baititu, eta, horri esker, datuak sakonago aztertu ahal dira. *Dataset*a behar bezala garatzeko funtsezko elementu bat da datu-base zientifikoan bilaketak egiteko «*query*» deritzon elementuaren definizioa.

Definizio horretan, eztabaidagai dira bilaketaren zehaztasuna, azterlanaren xedeari dagokionez, eta lortutako argitalpenen kopurua («*recall*» ere esaten zaio). Ezinbestekoa da bien arteko oreka bat mantentzea helburuan proposatutako emaitza hoberenak lortu ahal izateko. Datuen analisi kuantitatiboa datu-meatzaritzako tekniken bitartez egingo da, Vantage Point (VP) softwarea erabilita (Search Technology, 2022). Software horrek aukera ematen digu datuak zenbait eremutan sailkatzeko eta datuen garbiketa egiteko *fuzzy matching* teknikak baliatuta. Jarraian, eragiketa estatistikoen konbinazio baten bidez, emaitzak kuantifikatu ahal izango dira, eta bibliometriaren ikuspuntutik aztertu. Horrez gainera, analisia sendoagoa izan dadin, sareak sortzen dira, aztertutako zenbait eremuren aldi bereko agerraldien matrizea oinarri hartuta, VP eta Gephi software tresnen bidez (Bastian et al., 2009). Sortutako sareek aukera eman dute herrialdeen, erakundeen, autoreen eta ikerketa-eremuen arteko lankidetzarako patroiak aztertzeko eta identifikatzeko.

OI kontzeptuaren eta ezagutzen transferentziaren edo trukearen arteko harremanarekin lotutako ekoizpen zientifikoa astiro hazi da azken 10 urteetan. Baina dokumentu zientifiko horien aipamena gehiago hazi da. Aipamenak gehiagotan agertzea argitalpenen kalitatearen adierazle ona da (Liñán & Fayolle, 2015), eta, aldi berean, ikerketaren zabalkundearen adierazle garrantzitsu bat da. Gainera, ikerketa-artikulu bati buruzko aipamenen kopurua ere adierazle garrantzitsua da ezagutza-iturri nagusiak identifikatzeko eta argitalpen horrek etorkizun hurbilean izango duen balioa neurtzeko (Shibata et al., 2007). Kasu honetan, gehien aipatutako artikuluak unibertsitatea-enpresa harremanei eta berrikuntza irekiari buruz eztabaidatzen du, eta ikerketarako agenda bat zehazten du. Gehien aipatutako argitalpen horietan, hitz gakoa «estrategia» da. Inguruabar horrek argi erakusten du zein garrantzitsua den ezagutzaren transferentzia berrikuntza irekiaren ingurunean oinarritutako ingurune zientifiko-enpresarialean.

Garapen zientifikoaren jokaera akademikoari dagokionez, ekoizle garrantzitsuenak identifikatu dira, bai herrialdeei dagokionez, bai erakundeei dagokienez. Ikerketa ekoizten duten herrialdeei dagokienez, Erresuma Batua da unibertsitate-laguntza duen herrialde garrantzitsuena; atzetik datoz Italia, Errumania eta Espainia. Lankidetza-sarearen arabera, Europako herrialdeak erdigunean daude kooperazioaren arloan, agian Europar Batasunak sustatutako ikerketaren finantzaketari esker. Izan ere, finantzaketa horrek Batasuneko kide diren herrialdeen artean ikerketaren arloko lankidetzak gora egitea ekarri du (Ferligoj et al., 2015). Gainera, informazioaren teknologien garapenak eta ikertzaileen mugikortasunak gora egiteak nazioarteko lankidetza areagotzeko aukera ekarri dute.

Herrialdeen arteko lankidetza zientifikorako sareak nukleoa-periferia egitura du, Europako herrialde garrantzitsuenek (Erresuma Batua, Frantzia, Alemania eta Italia) eta Estatu Batuek osatuta. Nabarmendu behar da Estatu Batuak eta Erresuma Batua direla bitartekari gisa zeregin nagusia betetzen dutenak, eta beste herrialde batzuen gainean eragin handiena dutenak. Bestalde, Suitzak ekoizpen txikia du, baina lankidetzarako jarrera serioa. Hala ere, OI paradigma da nazioarteko lankidetza zientifikorako arrazoietako bat, bide garrantzitsua baita kanpoko ezagutza erakartzeko eta herrialdearen maila zientifikoa hobetzeko (Gui et al., 2019; Roper, A. T.; Cunningham, S.W.; Porter, A.L.; Mason, T.W.; Rossini, F.A.; Banks, 2011). Erakundeei dagokienez, aktiboena Erresuma Batukoak dira, batez ere Exeterreko Unibertsitatea, zeinaren emaitzak lagungarriak baitira komunitate zientifikoan eragina duten ikerlanak garatzeko. Emaitza horiek A.T. Alexander doktoreak zuzentzen ditu nagusiki, K. Miller eta R. McAdamekin (biak Belfasteko Queen's Unibertsitatekoak) ikerketa-taldea osatuta. Orokorrean, ikerlana ikerketa-talde txiki isolatuetan egiten da (hau da, ez dute lankidetzan lan egiten). Europako unibertsitateak dira aktiboenak, baina, lankidetzari dagokionez, Adelaidako Unibertsitatea (Australia) eta Ikerketarako Unibertsitate Nazionala (Errusia) dira zerrendako lehenak.

Jokabide akademikoa aztertu eta horri buruz eztabaidan aritu ondoren, ikerketak kontzeptu-esparruaren definizioari ekiten dio, OI testuinguruan ezagutzaren transferentziari lotutako ikerketa-item nagusiak zehaztu ahal izateko. Termino berriak edo urtero definitutako hitz gako berriak ateratzeak eta aztertzeak aukera ematen du ondorioztatzeko azterlanaren eremuari lotutako ikerketa heltze garaian dagoela, hazkunde-kurbaren metodoaren bidez zenbatetsita. Horrenbestez, planteatzen den kontzeptu-mapa, batetik, zentratuta dago *Open Innovation* terminoan, zeinak lankidetzaren bideagatik eta nodo bitartekari gisa duten jokabideagatik garrantzitsuenak diren terminoak biltzen baititu: 'ezagutzaren transferentzia', 'ETE', 'unibertsitatea-enpresak lankidetza' eta 'berrikuntza'. Eta, beste alde batetik, «ezagutzaren transferentzia» terminoan, 'baterako sorkuntza', 'I+Gren arloko lankidetza', 'produktu berrien garapena' eta, bitxia bada ere, 'automobilgintzaren' sektore bat aztergai dituen ingurune zientifikoarekin elkartzen da.

Ezagutzaren kudeaketa jardun-eremu berriak esploratzen ari da gaur egungo testuinguru dinamikoaren ondorioz, eta bide berritzaile berriak bilatu behar ditu enpresen munduan, hala nola berrikuntza irekian oinarritutako kudeaketa-ereduak. Ikerlanaren emaitzek I+Gren arloko lankidetzek (lotura estua dute unibertsitatea-enpresa lankidetzarekin) OIren testuinguruan duten garrantzia nabarmentzen dute. Beraz, interesgarria

izango litzateke ezagutzak trukatzeko osatzen diren sareak aztertzea, baita etekin industrialean eta garapen teknologikoan duten eragina aztertzea ere, OI ikuspegian oinarritutako antolaketa-ikusmolde baten garrantzi estrategikoa justifikatzeko. Horretarako, enpresa-antolakunde baten garapen zientifikoan dagoen elkarlaneko jokabidea azter genezake, sare zientifikoen, teknologikoen eta sozialen analisiaren bidez, berrikuntza irekia haren kudeaketa-ereduaren input gisa neurtzeko.

2. kapitulua. *Sustainable Business Model Based on Open Innovation: Case Study of Iberdrola*

Enpresa-antolakunde baten garapen zientifikoan dagoen elkarlaneko jokabidea aztertzeko beharra hauteman ondoren, Iberdrola SA enpresa aukeratu da bigarren artikuluan jasotzeko. Iberdrola SAren erakunde-eredua OIn integratuta dago (Tejedor-Escobar & Martínez-Cid, 2009), eta, gainera, Iberdrola SAren negozio jasangarrirako ereduaren gauzatze berritzailea ingurumenaren, gizartearen eta gobernantzaren arloko metrikak (ESG) etengabe hobetzeko eskaeraren ondorioa da. Eredu ekonomiko jasangarri baten epe luzerako balioaren sorrera ESG irizpideen bidez neurtu ahal da. Irizpide horiek enpresak etorkizunean izango dituen finantza-emaitzak eta ospea hobeto zehazten laguntzen dute (Chun, 2005), (Schoenmaker & Schramade, 2019). Hala, Iberdrola SAri dagokionez, haren ospea zuzenean lotuta dago jasangarritasunarekin, eta jasangarritasun-indize nagusietan argi islatzen da hori (van Nunen et al., 2018). Proiektu berritzaileak eta jarraitzaileak ikertzeko, Iberdrola SAk OI du bere jardunaren ardatz, eta, ondorioz, lankidetzan aritu behar da unibertsitateekin, zentro teknologikoekin eta beste enpresa batzuekin, I+G eredu ireki bat ezarrita (*Open Innovation and Partnerships - Iberdrola*, n.d.).

Bada, artikulu honen helburua da zehaztea nola oinarritzen duen Iberdrola SA enpresak zientzia eta teknologia garatzeko eta zabaltzeko bere estrategia OIn oinarritutako ingurune batean, funts horren jasangarritasuna bideratuta. Horrez gainera, enpresaren finantza-eragina aztertzen da, berrikuntzaren –zehazki, OIn oinarritutakoa– kudeaketarekin lotutako ESG inbertsiorako irizpideen azterketaren bidez. Horretarako, teknika bibliometrikoei eta sareen analisiari esker, zientziaren zein teknologiaren arloko lankidetza garrantzitsuenak sortu eta identifikatu ahal ditugu, eta, aldi berean, «jasangarritasunaren» trazabilitatea identifikatu ahal dugu ingurune zientifiko eta teknologiko horretan. Aurreko guztiak aukera emango dio komunitate zientifikoari eta teknologikoari enpresa hartzen ari den bideak ezagutzeko eta lankidetzak areagotzeko, enpresa-estrategiatzat OI oinarri duen erakunde-inguruneari balioa emateko.

Iberdrola SAren lankidetza-sarea eratzeko, Iberdrola SAren argitalpen zientifikoen datuak atera dira *Wos* eta *Scopus*en datu-baseetatik, «Iberdrola» *query*a erabilita. Halaber, Iberdrola SA lagapen-hartzaile eta titular duten patenteen datuak atera dira *Patseer* datu-basetik. Testu- eta datu-meatzaritzako teknikak erabilita, bi datu-multzoak garbitu dira Vantage Point (VP) softwarea erabilita (*Text Analytics Software from Search Technology - The VantagePoint*, n.d.), eta Iberdrola SAren lankidetza

zientifiko-teknologikoaren nodo garrantzitsuenak eta jarduketa-eremuak identifikatzeko aukera emango duten lankidetza-sareak sortu dira.

Sareen analisiari esker, ikerketarako bazkide nagusiak identifikatu ahal dira eta ikerketa-eremu batzuen jokabidea (hala nola, jasangarritasuna, OI edo kudeaketa estrategikorako beste eredu batzuk) aztertu ahal da. Halaber, Iberdrola SAk eremu jakin batean teknologia garatzeko dituen aliatu nagusiak identifikatu dira (adibidez Patenteen Sailkapen Kooperatiboak (CPC) definitutako Y02 klasea, klima-aldaketa arinduko duten teknologia berrien garapenari buruzkoa). Horrez gainera, Iberdrola SAk ikerketa zientifiko eta teknologikoaren eremu berrien garapenean izan duen bilakaera aztertu da, patenteen sailkapenaren arloko hitz gakoen eta kodeen analisiaren bidez, VP eta Power BI erabilita. Iberdrola SAren profil zientifikoa eta teknologikoa zehaztu ondoren, berrikuntzaren kudeaketaren finantza-eragina aztertu da, ESG enpresa-inbertsioaren irizpidearen bitartez.

Emaitzen arabera, Iberdrola SA enpresak beti eman dio balioa garapen zientifikoa sustatzeari, eta, beraz, komunitate zientifikoarekin duen harremana sustatzeari; jarraitu beharreko ildo estrategiko oso garrantzitsua izan da 2005etik aurrera. Bere ibilbide teknologikoan bezala, 2000ko hamarkadaren hasieran geldiune bat izan ondoren, 2008tik aurrera enpresak aukera izan zuen bere asmakizunak berreskuratzeko eta bere jarduketa-eremuak dibertsifikatzeko.

Iberdrola SAren jasangarritasunari buruzko lehen txostena 2004an idatzi zen (Iberdrola, 2020b), eta orduan hasi zen hazkunde jasangarriaren eta ingurumenarekiko errespetuzkoaren ereduaren aldeko apustua; bere profila aldatu zuen, gizarte-erantzukizun korporatiboa duen energia-enpresa izateko. Horrez gainera, 2013tik aurrera, Iberdrola SAk indartu egin du ildo hori, kudeaketa jasangarrirako politikak ezarrita (*Open Innovation and Partnerships - Iberdrola*, n.d.), klima-aldaketarekin eta ingurumenarekin lotutako lehenagoko beste politika batzuen osagarri gisa (Iberdrola, 2020a). Azterlanaren emaitzetan, ikertutako terminoen analisiak erakusten du 2009an agertzen dela lehen aldiz OI terminoa Iberdrola SAren argitalpen zientifikoetan. Urte horretan eman zioten ezagutzera komunitate zientifikoari Tejedor-Escobar eta Martínez-Cid autoreek(Tejedor-Escobar & Martínez-Cid, 2009), beren argitalpenaren bidez, Iberdrola SAk ezagutzaren kultura garatu eta sustatzeko abian jarritako I+G eta berrikuntza eta lankidetza kudeatzeko sistema berria: berrikuntza-sarea. Urte horretatik aurrera, gora egin zuen Iberdrola SArekin batera egindako argitalpenen kopuruak; konstante mantendu da gaur arte eta kudeaketarekin lotutako zenbait arlo (informazioaren kudeaketa, negozio-eskolak eta jasangarritasuna) ikertu dira. Horren bidez, Iberdrola SA enpresak bere berrikuntza-politikak indartu zituen eta OI ardatz estrategiko bihurtu zuen

proiektu berritzaile eta jasangarriak gauzatzeko unibertsitateekin eta beste erakunde batzuekin elkarlanean (*Open Innovation and Partnerships - Iberdrola*, n.d.). Azterlan honetan egindako sareen analisiak berretsi egin du inguruabar hori. Iberdrola SAk sare sendoa du beste erakunde batzuekin elkarlanean aritzeko, eta haren bitartekari garrantzitsuenak dira Espainiako unibertsitateak eta ikerketa-zentroak; era berean, lankidetza indartsu bera du nazioarteko unibertsitate eta ikerketa-zentroetako nazioarteko atalekin, eta Amerikan, Asian eta Europan nodoak dituen sare bat du eratuta. Horrez gainera, nabarmendu behar da bai enpresa nazionalek bai nazioartekoek elkarlaneko garapen zientifikora bideratzen dituztela beren ahaleginak; inguruabar horrek berrikuntza ireki eta elkarlanekoaren enpresa-kudeaketan aurrerapauso bat eman dela islatzen du.

Patenteei dagokienez, 2000tik 2006ra moteldu egin zen asmakizunen kopurua, eta pentsa daiteke enpresaren ikuspegi estrategikoaren aldaketa baten ondorioa izan zela, eta indarra galdu zuela berrikuntza teknologikoen garapenak. Hala ere, 2007an eta 2008an, Iberdrola SAk berriro sustatu zuen garapen teknologikoa; eremu tekniko ezberdinetan sartu zen eta, beraz, lankidetzen sarea sustatu zuen. Garapen zientifikoarekin ez bezala, lankidetzen sare hau patenteen jabetza eta etorkizuneko merkataritza-garapena Iberdrola SArekin partekatzen duten enpresek osatzen dute nagusiki. Aurreko guztiak justifikatzen du elkarlaneko lana berrikuntza-sistema hobetzeko tresna gisa balioesten duten politika estrategikoen ezarpen egokia. Jasangarritasunaren ikuspegiari dagokionez, CPC kodeen definizioari esker, klima-aldaketa arintzen duten berrikuntzak edo garapen teknologikoak identifikatu ahal dira, besteak beste Y02 delakoa (*About CPC | Cooperative Patent Classification*, n.d.), (Veefkind et al., 2012). Hortaz, arlo tekniko honetan sailkatutako patenteen kopuruari lotutako emaitzek baliozkotu egiten dute Iberdrola SA 2004tik aurrera sustatzen ari den kudeaketa eta garapen jasangarriaren ikuspegia.

Ikerketa-lan honek berretsi egiten du Iberdrola SAk kudeaketan ezarritako aldaketa estrategikoak –enpresa-kudeaketa OIn oinarritutako ikuspegi berri batean zentratuta– aukera eman diola kokapen on bat lortzeko garapen zientifikoari eta teknologikoari egin dien ekarpenean, berrikuntza jasangarri eta irekiaren alde dauden unibertsitate, ikerketa-zentro eta enpresekin duen elkarlanari esker. Ikuspegi honek enpresa jasangarri gisa duen ospea areagotzea ekarri du. Horrenbestez, negozio jasangarriaren eredua lortzeko ikuspegi estrategikoak beste erakunde batzuekin elkarlanean aritzeko aukera ematen duten prozesu berritzaileak ezartzea sustatzen du, eta horrek finantza-eragin positiboa du enpresan.

Azkenik, berrikuntzaren kudeaketa aztertu da neurtu beharreko ESG alderdi gisa. Batetik, kualitatiboki neurtu da, OI ikuspegi batetik, enpresaren

garapen zientifikoan oinarritutako adierazle baten bitartez. Eta, bestetik, kuantitatiboki, I+G arloko gastuaren bitartez. Abiarazitako ekintzaren finantza-eraginaren emaitza enpresaren salmentek islatzen dute, eta OI jardunaren, I+G arloko gastuaren eta salmenten gorakadaren artean kausa-efektu erlazioa dagoela erakusten dute. Beraz, OI ikuspegia ezartzea funtsezko gakotzat jo daiteke Iberdrola SAren berrikuntza-sisteman. Haren barruan, harremanak sustatu ditu unibertsitateen eta erakundeen artean, besteak beste, eta eragin positiboa izan du konpainiaren salmenten emaitzetan.

3. kapitulua: *Mapping social life cycle assessment: Science toward industrial involvement*

OIk enpresan adierazle sozial baten osagai gisa duen garrantzia aztertu ondoren, eta adierazle hori Iberdrola SA enpresan baliozkotu ondoren, erabaki da adierazle hori hobetzea hirugarren artikuluan. Horretarako, bigarren ikuspegia aukeratu da, hau da, sLCA ardatz duena enpresaren jarduera sozialaren gako gisa. Bizi-ziklo sozialaren ebaluazioa (sLCA) produktuen bizi-zikloekin lotutako inpaktu sozial positibo eta negatiboen gaineko erabakiak hartzeko laguntza ematen duen metodologia da. Nazio Batuen Ingurumen Programaren (NBIP) arabera, erakundeen, produktuen eta zerbitzuen bizi-zikloaren jasangarritasuna ebaluatzeko garatu diren hiru metodologietako bat da sLCA. Hala ere, alderdi soziala, bera bakarrik, ez da nahikoa jasangarritasuna ebaluatzeko. Jasangarritasunaren jatorriko definizioak hiru osagai edo zutabe ditu: ingurumena, ekonomia eta alderdi sozialak. Produktua diseinatzean, jasangarritasunaren hiru «zutabe» horiek ebaluatu behar dira, eta elkarren osagarri izan behar dute modu orekatuan (Kloepffer & Renner, 2009). Beste bi metodologiak dira bizi-zikloaren ebaluazioa (LCA) eta bizi-zikloaren kostuaren kalkulua (LCC). LCA, LCC eta sLCAren konbinazioak, hiru zutabeko jasangarritasunean oinarrituta, bizi-zikloaren jasangarritasunaren ebaluazioa (LCSA) dakar. LCSA tresnen konbinatu hori erabilita zehaztu ahal da «zein neurritan den produktu bat beste bat baino jasangarriagoa» (Jungmeier et al., 2015).
sLCA jarduera sozialean funtsezko alderdi gisa aztertzeko, sLCAren inguruko zientziaren analisi bat egin da, eta, horretarako, teknika bibliometrikoak eta sareen analisia erabili dira. Hala, lan honen helburuak izango dira, batetik, argitalpenen kopuruaren bilakaera aztertzea, denboran zehar izan duten garrantzia egiaztatzeko, eta, bestetik, herrialdeekin eta erakundeekin lotutako errendimendu akademikoa aztertzea, ikerketa non egin den eta nork egin duen identifikatuta. Horri esker, hurrengo helburua planteatu ahal izango da: ESG irizpideak erabiltzea aurreko helburuan identifikatutako sLCA eredua garatzen eta aplikatzen duten enpresen ospea aztertzeko. Jarraian, sLCA aplikatzeak enpresaren finantza-etekina handitzea dakarren aztertuko da.

Hala, enpresek beren prozesuetan sLCA metodologiak aplikatzea erabakiz gero, informazio zientifiko hau baliagarria izango zaie, erakunde horiengana jo ahal izango baitute, baita lankidetza-sareetan sartu ere. Hala ere, garrantzitsua da, halaber, sLCAri buruz ikertzen ari diren enpresa pribatuak identifikatzea, eta jakitea haietako zeinek aplikatzen duten beren kudeaketa-ereduetan. Horregatik, merezi du ezagutzea zer ondorio dituen metodologia horiek ikertzen eta aplikatzen dituzten enpresen ospean,

finantza-emaitzak neurtuta. Horretarako, ingurumena, gizartea eta gobernantza ardatz dituen ereduak (ESG) baldintza egokiak ditu.

Helburu horiek lortzeko, sLCAri buruzko argitalpen zientifikoen datu-base bat sortu da, Scopus eta WOSetik ateratako datuekin. Bi datu-base horietan garbiketa egin ondoren Vantage Point (VP) erabilita, sLCAren profil zientifikoa sortuko da eta sareen analisia egingo da. Profil zientifiko horrek argitalpenen joerak eta errendimendu akademikoa zehaztuko ditu. Sareen analisia VP eta Gephi softwareen bidez egingo da. Sareen analisiak eta errendimendu akademikoak aukera emango digute sLCA ikertzen duten enpresa pribatuak identifikatzeko, baita haien negozio-ereduetan ezartzen duten ala ez aztertzeko ere. Azkenik, enpresa horien ospe korporatiboa eta finantza-emaitzak aztertuko dira ESG irizpideak erabilita.

sLCAren helburua da produktuaren bizi-zikloaren inpaktu sozialak neurtzea; beraz, haren aplikazio-eremua enpresek osatzen dute nagusiki. BMW taldea, BASF eta Brødrene Hartmann dira sLCAren inguruan gehien ikertzen ari diren enpresa pribatuak. Horrez gainera, enpresa horiek sLCA metodologia aplikatzen dute beren produktuen bizi-zikloan. BMW Group taldearen kasuan, ibilgailu motordunak dira produktua; BASF enpresan, produktu kimikoak, eta Brødrene Hartmannen, ontziak.

Lortutako datuetatik ondorioztatu ahal da sLCA ikerketa-arlo aktibo bihurtu dela azken urteetan, enpresen inpaktu sozialak neurtzeko metodologia gisa. Gainera, garapen zientifikoa Europan, Asian eta Amerikan dauden herrialdeetan gauzatzen da, eta horrek ikerketa geografikoki kontzentratuta ez egotea justifikatzen du. Ekonomikoki indartsuak diren herrialdeak daude ikerketaren buruan, eta, aldi berean, elkarlanean aritzen dira ekonomikoki hain garrantzitsuak ez diren herrialdeekin, eta, ondorioz, sLCAri buruzko ikerketan parte hartzeko aukera ematen zaie.

Erakundeei dagokienez, arlo akademikoa –unibertsitatea, adibidez– da liderra ikerketaren garapenean. Inguruabar horrek agerian uzten du Europako unibertsitateek ikerketan duten garrantzia. Horrez gainera, beren kudeaketa-ereduan sLCA ezarri duten enpresa pribatu batzuk daude, unibertsitateekin elkarlanean ari direnak garapen zientifikoaren arloan. Enpresa pribatu horiek kontuan hartuta, ondoriozta dezakegu sLCAri buruzko ikerketak eta enpresa horien produktu edo prozesuetan aplikatzeak haien ospea hobetzen dutela, Schoenmaker eta Schramadek definitutako ESG ereduaren arabera (Schoenmaker & Schramade, 2019). Hori dela eta, sLCAren aplikazioari eta ikerketari esker, enpresek beren finantza-emaitzak hobetzen dituzte. Horren adibidea da salmentek gora egitea.

4. kapitulua: *News versus Corporate Reputation: Measuring through Sentiment and financial analysis*

Tesiaren laugarren artikuluan, hirugarren ikuspegi bat gehitu zaio ESG ereduaren adierazle sozialari, zeinak OI eta sLCA baititu dagoeneko. Hirugarren ikuspegi hori komunikabide sozialek osatzen dute, enpresei buruzko irudi bat sortzen baitute. Raithelen arabera (Raithel et al., 2010), irudi edo ospe korporatibo hori 2 adierazleren bidez neurtu ahal da: enpresak eragiten duen sinpatia eta enpresa horren gaitasuna. Enpresa baten ospea zehazteko, ahoz aho jasotako datuak hartzen dituzte oinarritzat kontsumitzaileek, edo berriak, publizitatea, etab. (Kossovsky, 2012). Horrenbestez, enpresarekiko sinpatia hori neurtzeko modu bat izan daiteke korporazio horiei buruzko berriek sortzen duten sentimendua aztertzea. Kontsumitzaileak uste badu berriek enpresei buruzko tonu positiboa dutela, enpresa horiek sinpatia gehiago eragingo diote eta gora egingo du enpresen ospeak. Komunikabideek sortzen duten sentimendu hori neurtzeko tresna bat sentimenduen analisia da. Horregatik, ikerlan honetan, sentimenduak aztertzeko, dagoen lexikoa erabiliko da, hau da, enpresei buruz prentsan idatzi diren berriak, eta hitz batzuk edo hitz batzuez osatutako terminoak etiketatuko dira: positiboak, negatiboak edo neutroak (Khoo & Johnkhan, 2018). Datu-multzo beraren kodetze automatikorako tresna ezberdinak erabiltzea funtsezkoa da emaitzen sendotasuna ebaluatzeko tresnen artean (Mayor & Bietti, 2021). Kasu honetan bi tresna erabiliko dira. Lehenengoa, Pythonen tresna, VADER (*Valence Aware Dictionary and Sentiment Reasoner*), sentimendua aztertzeko esparru bat, zeinak lexikoan oinarritutako ikuspegia erabiltzen baitu esaldi baten sentimendu-balioak zehazteko. Bigarren tresna Hu & Liu da, zeina bezeroen iritzien sentimendua aztertzeko garatu baitzen. Hortaz, artikuluaren helburua da enpresei buruzko berrien sentimenduaren analisiaren eta haien ospearen artean egon daitekeen korrelazioa aztertzea.

Horretarako, erabaki da, 2021eko maiatza erreferentziatzat hartuta, Eurostoxx50 indizean dibidenduko errentagarritasun handiena zuten 10 enpresei buruzko berriek eragindako sentimendua aztertzea. Hauek dira enpresak: Axa, Eni, Total Energies, Intesa Sanpaolo, ING, Engie, BNP Paribas, Basf, Allianz eta Daimler. Enpresa eta urte bakoitzeko, komunikabide nagusietan 2016tik 2020ra bitartean argitaratu diren 500 berri garrantzitsuenak deskargatu dira. 2016., 2017., 2018., 2019. eta 2020.urteak aztertzea erabaki zen. Orange erabiliko dugu. Ikaste automatikoko eta datu-meatzaritako suite bat da, datu-analisia Pythoneko scripten bidez egiten duena(Demar et al., 2013), eta berri bakoitzaren sentimendua VADER eta Hu Liu tresnen bidez aztertzeko erabiliko da. Azkenik, VADER eta Hu Liu

tresnekin egindako sentimenduaren analisiak islatutako joeren eta enpresa bakoitzaren ustiapenaren emaitzen artean egon daitekeen korrelazioa aztertu da.

Lortutako emaitzetan, ikusten da, batetik, VADER eta Hu Liu tresnen datuek bat egiten dutela joerari dagokionez, kasu guztietan. Hau da, VADER tresnarekin neurtutako enpresa bati buruzko berrien sentimenduen balorazioak denboran aurrera egin ahala behera egiten duenean, gauza bera gertatzen da Hu & Liu tresnarekin. Datu horiek isla dezakete bi tresnek bat egiten dutela sentimenduaren analisiaren neurketetan. Sentimenduaren analisiaren joera horiek denbora berean izandako emaitza operatiboen joerarekin alderatuz gero, ikusten dugu ia kasu guztietan bat egiten dutela ere. Hau da, berrien sentimenduaren analisian joera positiboa izan duten enpresek hobetu egin dituzte beren emaitza operatiboak, eta alderantziz. Sentimenduaren analisiaren eta emaitza operatiboen arteko korrelazioa positiboa da kasuen % 78tan. Beraz, sentimenduaren analisiak joera positiboa duenean, gora egiten dute ustiapenaren emaitzek, hau da, gora egiten dute produktu horren salmentek. Joera negatiboa denean, salmentek behera egiten dute.

Lortutako datuak kontuan hartuta, ondoriozta daiteke hasierako tesia zuzena dela. Enpresen ospearen joera neurtzeko, bi faktore hartu behar dira kontuan eta elkarren artean korrelazioa dute: enpresa horiek sortzen duten sinpatia eta haien finantza-sendotasuna (Raithel et al., 2010). Sinpatia hori neurtzeko modu bat izan daiteke prentsa-oharren sentimenduaren analisia egitea. Sentimenduaren analisi horiek hobera egiten badute, hobetu egingo da enpresaren ospea. Aurrekoaren ondorioz, hobetu egingo dira salmentak, eta, beraz, hobetu egingo da etekin operatiboa. Eta finantza-emaitzen hobekuntzak enpresen ospea hobetzea ekarriko du, eta, hala, zikloa osatu egingo da. Beraz, berriek sortzen dituzten sentimenduak baliozkotu dira ESG ereduaren osagai sozial gisa, eta eragina dute enpresen finantza-emaitzetan.

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2. ATALA

ONDORIOAK

Tesi honen helburu nagusia gizarte-adierazleetan oinarritutako ESG inbertsio-negozio eredu bat definitzea da. Helburu hori lortzeko definitu den negozio-eredua hiru gizarte-adierazletan oinarritzen da, hiru ikuspegiren bidez, hurrenez hurren.

Lehen ikuspegia, *Open Innovation I+G+b arloko erakunde-lankidetzaren funtsezko faktore gisa* da, eta 1. eta 2. artikuluetan jorratzen da. Horretarako, erakundeak OI ingurune batean daudenean, ezagutza transferitzeak eta partekatzeak duen garrantzia aztertu da. Hau da, enpresaren lankidetzako praktika zientifikoa (OI) aztertu da, eredu korporatibo iraunkor baterantz. Lortutako datuek erakusten dute ezagutzaren kudeaketak enpresan duen garrantzia eta OIn oinarritutako ereduetarantz dagoen joera. OIren testuinguru horien barruan, I+G+b arloko lankidetzek garrantzi berezia hartzen dute, batez ere unibertsitatearen eta enpresaren arteko lankidetzan. Ondoriozta daiteke OIa funtsezko faktorea dela I+G+b arloan antolatzeko lankidetzan, eta, beraz, enpresako adierazle sozial baten osagaitzat har daitekeela.

Erakunde arteko lankidetzetan OIk duen garrantzia egiaztatu ondoren, eredua, ESG inbertsio-negozio eredu gisa baliozkotu da. Horretarako, sortzen diren ezagutza truke sareak aztertzea erabakitzen da (zientifikoak, teknologikoak eta sozialak), baita enpresa jakin baten errendimendu industrialean eta garapen teknologikoan duten eragina ere. Eredua baliozkotzeko aukeratu den enpresa Iberdrola S.A. izan da. Enpresa horren berrikuntzaren kudeaketa-ereduan, OIren praktika eta iraunkortasuna integratzen dira. Iberdrola S.A. enpresaren kasuan, bere berrikuntzaren kudeaketak salmentetan eragin positiboa duela egiaztatu da. Eragin hori OIren praktiken eta I+G+bko gastuaren bidez neurtzen da. Beraz, Iberdrola S.A.ren kasuan, OI baliozkotu da I+G+b arloko erakunde-lankidetzaren funtsezko faktore gisa.

Behin enpresa jakin batean lehen ikuspegiaren baliozkotasuna egiaztatuta, hirugarren artikuluan, bigarren ikuspegia jorratzen da; *sLCA, gizarte-jardunaren funtsezko faktore gisa.* Horretarako, lehenengo urratsa sLCAk enpresan adierazle sozial baten osagai gisa duen garrantzia aztertzea da. Lehenik eta behin, enpresak sLCAren esparruan egiten duen ikerketaren eta lankidetza zientifikoaren azterketa egiten da.

Lortutako datuetatik abiatuta, ondoriozta daiteke sLCA, enpresen gizarte-inpaktuak neurtzeko metodologia gisa, ikerketa-arlo aktibo garrantzitsu bihurtu dela azken urteotan. Ondoren, enpresen sLCA praktikak aplikatzeari

buruzko analisi bat egiten da, sLCA beren prozesuetan ikertzen eta aplikatzen duten enpresa nagusiak identifikatzeko asmoz. Enpresa horiek Basf, Brodrenne Hartman eta BMW Group dira, eta sLCA praktikek erakundeetan duten eragina neurtuko duen adierazle bat definitzeko aztertzen dira. Kasu honetan, «*ESG business model*» delakoak enpresa horien sLCA praktikan jartzen du arreta, eta sortzen dituzten onura sozialen bidez neurtzen da, baita I+G+b garapenean duten inplikazioaren bidez ere. Lortutako datuekin ustiapen-mozkinean duen eragin positiboa egiaztatzen da eta enpresaren irudian duen eragina. Beraz, hiru enpresa horien kasuan, sLCA adierazle sozial gisa baliozkotu da, ESG inbertsio-negozioetan.

Azkenik, laugarren argitalpenean, hirugarren ikuspegia jorratu da: *albisteak, gizarte-komunikabideak, sentimenduek negozioetan duten balioa*. Artikulu honetan gizarte-komunikabideak enpresako gizarte-adierazle baten osagaitzat hartzen dira. Enpresei buruzko albisteen sentimenduen balioa azaltzen da, ESG enpresa-inbertsioaren ereduaren osagai soziala konfiguratzeko ikuspegi gisa. Horretarako, Eurostoxx 50eko finantza-garrantzi handiko 10 enpresatako berriak deskargatzen dira, eta sentimenduen analisia egiten zaie. Lortutako datuetatik abiatuta, ondoriozta daiteke sentimenduen analisi horien datuen hobetzeak enpresaren ospea hobetzea ekarriko duela. Horrek salmentak eta, beraz, mozkin operatiboak hobetzea ekarriko du. Era berean, finantza-emaitzak hobetuz gero, enpresaren ospea hobetuko da, zikloa osatuz. Beraz, albisteek sortzen dituzten sentimenduak baliozkotzen dira enpresen finantza-emaitzetan eragina duten ESG ereduaren osagai sozial gisa.

Hortaz, oro har, tesi honetan definitutako ESG inbertsio-negozioaren eredua baliozkoa dela ondoriozta daiteke, proposatutako gizarte-ikuspegi bakoitzean lortutako datuek hori bermatzen baitute. Lortutako emaitzek proposatutako eredua baliozkotu dutela kontuan hartuta, etorkizunerako lan-ildo gisa, eredua zabaltzea proposatzen da, ESG enpresa-inbertsioko eredu baten adierazle gisa txertatuko diren gizarte-ikuspegi berriak txertatuz. Era berean, ikuspegi berriak baliozkotuta joan beharko lirateke hainbat enpresatako datuekin, erabilitako prozedurari jarraituz. Horrela, eredu berria erreferentea izan liteke ESG inbertsio-irizpideak erabili nahi lituzketen enpresentzat.

3.ATALA

ERANSKINAK I. Argitalpenen kalitateari buruzko txostena

Ondoren, tesi honetan aurkezten diren argitalpenen kalitate txostena aurkezten da:

Argitalpen 1:

Titulua: *Knowledge sharing and transfer in an Open Innovation context: mapping scientific evolution*

Autoreak: Izaskun Alvarez Meaza, Naiara Pikatza Gorrotxategi, Rosa María Rio Belver

Aldizkaria: *Journal of Open Innovation: Technology, Market and Complexity.* 6(4), 186 (2020)

ISSN:2199-8531

Egoera: Argitaratuta

Onarpen-data: 2020/12/09

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Inpaktu-faktorea: SJR(2020): 0.459 Kuartil 2 (Q2):kategoria: *ECONOMICS, ECONOMETRICS AND FINANCE (MISCELLANEOUS)* 102(433)

Aipamenak:11 (Google Scholar)

Argitalpen 2

Titulua: *Sustainable Business Model Based on Open Innovation: Case Study of Iberdrola*

Autoreak: Izaskun Alvarez Meaza, Naiara Pikatza Gorrotxategi, Rosa María Rio Belver

Aldizkaria: *Sustainability.* 12(24), 10645 (2020)

ISSN:2071-1050

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Onarpen-data: 2020/12/16

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Inpaktu-faktorea: JCR(2020): 3.251 Kuartil 2 (Q2): kategoria: *ENVIRONMENTAL SCIENCE* 59(125)

Aipamenak:8 (Google Scholar)

Argitalpen 3

Titulua: *Mapping social life cycle assessment: Science toward industrial involvement*

Autoreak: Naiara Pikatza Gorrotxategi, Izaskun Alvarez Meaza, Rosa María Rio Belver, Enara Zarrabeitia Bilbao

Aldizkaria: DYNA (2021)

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Argitalpen4: Liburua kapitulua (Konferentzia aktak)

Titulua: *News versus Corporate Reputation: Measuring through Sentiment and financial analysis*

Autoreak: Naiara Pikatza Gorrotxategi, Izaskun Alvarez Meaza, Rosa María Rio Belver, Enara Zarrabeitia Bilbao

Liburu kapitulua:KONFERENTZIA AKTAK: *4th International Conference on Advanced Research Methods and Analytics (CARMA2022)*

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ERANSKINAK II. Argitalpenak

Journal of Open Innovation: Technology, Market, and Complexity

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Article

Knowledge Sharing and Transfer in an Open Innovation Context: Mapping Scientific Evolution

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Abstract: The essence of innovation lies in knowledge, which is why open innovation opens the door to knowledge transfer with agents outside the organization. In order to comprehend the joint scientific trajectory of these two areas of knowledge, the aim of this study is to identify and analyze the main indicators of scientific behavior involved in the research field related to the link between open innovation and knowledge transfer or knowledge sharing concepts through bibliometric and network analysis. The results show clear European leadership in scientific production developed in universities. In addition, the high quality of the main sources of diffusion infers publications of good scientific quality. The most recognized source of knowledge used in new research is directed towards university-company relationships in an open innovation environment. Network analysis related to keywords has allowed us to define the most interesting, relevant fields of research, highlighting the importance acquired by topics such as 'communication', 'inter-organizational context' and 'education', to better focus on future research of the scientific community. It can be concluded that the scientific development of both concepts is an active field in the academic community, and also, that new key terms appear, opening new paths of research.

Keywords: open innovation; knowledge transfer; knowledge sharing; bibliometric analysis; network analysis

1. Introduction

In the last decades, we have passed through a closed innovation model to an open one. This means that companies have gradually reversed their ways of investing in their research toward a collaborative method [1]. In a closed innovation model, companies used to invest in their own R&D department and so not only were they able to keep new ideas under control but also all their knowledge, tacit and explicit. However, now this closed, static model has become highly difficult to manage; resources are constantly flowing, moving, changing and increasing in complexity. As employees start changing from one company to another, so does information, making it very difficult for the firm to contain ideas [2,3]. In this dynamic context, the open innovation (OI) paradigm appears, replacing the previous closed innovation paradigm, and it represents a new approach into the innovation management shift from a closed to an open model [4]. The OI model is used to indicate how organizations work together with innovation praxis, particularly the relevance of input and output flows of knowledge in the innovation process or for developing new products [5]. We can understand OI as the use of intentional incomes and outcomes of knowledge to further a firm's innovation and to extend markets to innovate externally.

The definition perceives organizations as able to use information and procedures from inside and outside the firm, and this is the way it has to be if they wish to progress technologically [6].

Innovation is critical for enterprises, and employee innovation is needed as a basic unit of innovation; this can be promoted by knowledge sharing [7–10]. According to Ritala et al. [11], sharing and obtaining knowledge commonly induces innovation. However, obtaining knowledge is not an easy procedure, and transferring knowledge among organizations is an implicit part of this procedure [5]. The ability to transform knowledge through sharing will lead to one level of innovation or another [12]. Moreover, according to Pian et al. [10], organization-oriented knowledge sharing impacts innovative behavior more than individual-oriented knowledge sharing. In addition to the complexity of knowledge sharing and transfer within organizations, this is evolving towards a sharing of knowledge between organizations, such as university-business relations [13,14]. It is necessary to have an effective knowledge management system that facilitates the absorption of knowledge arising from knowledge sharing within and among organizations [15].

The importance of research profiling opens the doors to bibliometric techniques. Based on a significant amount of academic literature, the bibliometric method makes quantitative analysis of information [16] possible. Bibliometric analysis allows the identification of research priorities, new applications, geographic location of development and research networks, among others [17,18]. Therefore, it becomes a fundamental tool in the science-related decision-making process, and its results can be considered an important aid to facilitate the allocation of funding by the relevant agencies [19]. In addition, network analysis makes it possible to visualize the constantly evolving dynamic connections that occur in science [20–22]. This technique will allow the identification and quantification of collaboration patterns among authors, organizations and countries, also known as Social Network Analysis [23], as well as to pinpoint and group the main research topics [24]. In addition, the basic measurements of graph theory, such as degree centrality, betweenness centrality and closeness centrality will allow us to quantify the behavior of the network, identifying the main relationships between countries, organizations and authors, and identifying the research topics hubs that enable prediction of future research trends [25,26].

Organizational environments based on an OI perspective open the doors to knowledge transfer and sharing; and vice versa, the importance of knowledge flow for the innovation process stimulates commitment to a strategic organizational approach based on OI. This link is reinforced by the results of the bibliometric analyses carried out by Randhawa et al. [27] and Gao et al. [28] that present knowledge as an important research topic within science that analyzes the OI paradigm.

Within the scientific environment linked to OI, several authors have opted for different bibliometric techniques to study the OI concept from different approaches, such as Kovàcs et al. [29], Randhawa et al. [27], de Paulo et al. [30], Ebrahim and Bong [31], Lopes and de Carvalho [32], Le et al. [33], Aziz et al. [34] and Gao et al. [28]. However, these techniques have also been used to analyze the OI environment from other perspectives, such as small and medium-sized enterprises by Odriozola-Fernández et al. [35], large firms by Noviaristanti [36], absorptive capacity by Segui-Mas et al. [37], sustainable tourism by Della Corte et al. [38] and its relationship with solar energy technologies by Paulo and Porto [23]. Regarding the research carried out in the field of knowledge transfer or sharing using bibliometric techniques, Naushad Ali et al. [39] present a bibliometric analysis about knowledge sharing in general from 1990 to 2016, offering an overview of trending publications, journals, countries and organizations. Considering that technology transfer and entrepreneurship are related to knowledge transfer, Skute et al. [40] depicts the bibliometric analysis to conduct an interpretation based on the clustering of the main terms. Concerning knowledge management, a bibliometric mapping overview has been conducted by Kokol et al. [41], identifying the research trends. In addition, the study by Aman [42] measures the knowledge transfer related to scientist mobility. With regard to absorptive capacity, Apriliyanti and Alon [43] have conducted a bibliometric analysis and, as a result, knowledge transfer is among the main research streams in absorptive capacity. As for the development of bibliometric studies of OI from a knowledge transfer perspective, they have

not been identified. The closest approximation is presented by the work carried out by Agostini et al. [44] in which bibliometric techniques are used to study the evolution of scientific literature in knowledge management within an inter-organizational context, which is similar but not equal to the term OI.

A review of the scientific literature linked to the OI paradigm has identified the flow of knowledge as a fundamental cornerstone on which this new organizational approach is based, as well as various research works based on scientific literature reviews through bibliometric methods that ratify the field of knowledge as a relevant topic, among others. OI is complex, moreover, it is a dynamic process influenced by strategies incorporating dynamic elements that reflect the current technological world, making it difficult to investigate [32,45]. Therefore, it is more practical to limit the OI paradigm to its knowledge flow approach. Consequently, this study contributes to filling the literary gap in the analysis of scientific research related to the relationship between the OI paradigm and the process of knowledge transfer.

To offer an overview for future research, this article aims to investigate the relation between OI and knowledge transfer or knowledge sharing concepts from a scientific perspective. The research conducts a bibliometric analysis to identify and analyze the key indicators related to scientific context and a network analysis to identify the strongest major relationships between main actors and a conceptual framework and prediction of future research tendencies. The combination of both allows us to achieve the aim of the article: identifying the evolution of the field, the main producers and their cooperation patterns, the main sources of dissemination, the conceptual framework, as well as the main sources of knowledge. This may help the scientific community and its scientific environment in the approach and design of new research paths, the allocation of scientific funding to areas of interest in future scenarios and, in turn, the search for new collaborative groups, which will open up new paths for both national and international collaboration.

2. Methods

Various methods or techniques can be used to review the scientific literature [46]. In this case, a bibliometric and network analysis is chosen to achieve the objective of the work: to analyze the OI paradigm from a knowledge transfer or knowledge sharing perspective. These techniques are of value to assess the current state, identify strategic relationships and predict development trends [28,35]. To this end, the proposed methodology consists of three phases described below (see Figure 1). These phases will make it possible to identify and quantify, on the one hand, academic performance (trends, authors, countries, organizations...) along with the main research subareas and, on the other hand, the main collaboration networks and the conceptual framework of topics, thus satisfying the established objective. However, the aim of this research practice is that it can be applied to any type of emerging field of scientific research.

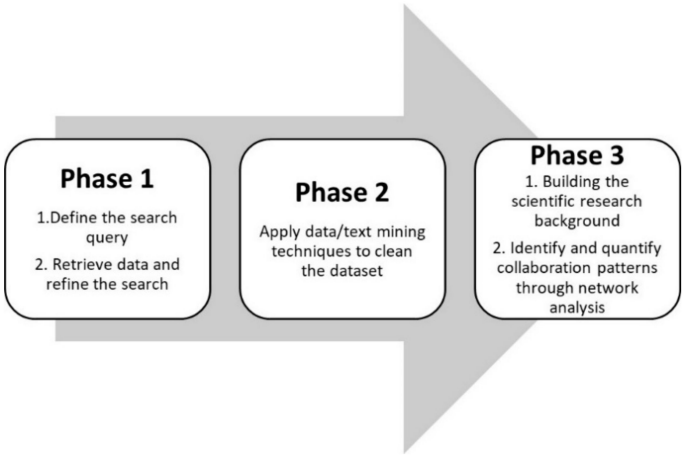

Figure 1. Phases of the research work.

In order to build the scientific profile of the research area, the following three phases are carried out. In the first phase, the search query is defined, making it possible to obtain the dataset formed by scientific publications related to the emerging research field being analyzed. In the case of knowledge sharing or transfer in OI, the specific database is generated from the Core Collection of Web of Science (WoS) scientific database. WoS Core Collection database is chosen for two reasons; the first is that the rest of WoS accessible databases contain hardly any publications in the field of study, and the second reason is that the Core Collection provides higher quality data, since it contains all information and cited references of the publications, which allows more extensive analysis [32]. WoS has been from the three most important scientific databases (Scopus, WoS and Google Scholar (GS)) because it is the one that produces more results. However, as presented by different studies [47–49] the best results would be obtained by using all three databases. Nevertheless, in this case, the three databases complement each other and the WoS database presents the most complete search result. Since burgeoning research fields cover different approaches, the definition of the query is an essential process, since a query with a wide recall makes the search less precise. Therefore, a balance has to be established between call and precision, which usually have an inverse relationship [50,51]. Although bibliometric studies related to OI have used different terms as synonyms for OI in their queries [28,30], in this research we have chosen to limit the study to the term defined by Chesbrough [52] in order to focus the study on the OI paradigm as established in the objective. Therefore, the query was built using "open innovation" and "knowledge transfer" or "knowledge sharing" as author keywords (47 documents), obtaining a highly precise query, but not enough to conduct a bibliometric analysis. In addition, to accomplish greater recall, the search for the same terms based on title-abstract-keywords (TS) is added to the query (see Table 1). In order to analyze all the articles that cover the field of research, the search period has not been limited. As the first document is from 2007, the time span of the dataset was established between 2007 and actually (November 2020). The final dataset is composed by a total of 272 articles, conference proceedings, books and book series for the defined time span.

Table 1. Search query for Knowledge sharing/transfer in OI adapted to WoS database.

Search Query
TS = ("open innovation*") AND TS = ("knowledge sharing" OR "knowledge transfer")

In the second phase, the dataset obtained in phase 1 is cleaned up using data and text mining tools. The scientific dataset was imported into Vantage PointR (VP) software [53], text mining software that allows us to classify the raw data, and clean the data of specific fields (authors, author's keywords, ...) by using fuzzy matching techniques in order to group words that have the same meaning. Once these two steps are completed, a combination of statistical operations will allow us to show and quantify the results based on the dataset of scientific publications.

In the last and third phase, the profile of the scientific literature described in the results is built, identifying the trend of publications and their citations, the main producers and their location, the main sources of dissemination, the main research subareas and their evolution and the most cited publications that represent the main sources of knowledge. In addition, the study is completed through a network analysis, making it possible to identify and analyze the patterns of collaboration between countries, organizations and authors, and the conceptual network based on research topics. To do this, starting from co-occurrence matrices created in the VP software, the networks are generated and visualized through Gephi software [54].

3. Results

3.1. Research Trends: Publications and Citations

The progress of publications and citations is represented in Figure 2. Since 2010, the number of publications has remained constant, with an average of 21 articles per year; the year 2016 prominent for

having 41 publications. It is true that the first publication identified is from the year 2007, having only five records, and the topic loses interest in the next two years, but in 2010 it is again of interest to the scientific community. However, the number of citations per year rapidly augmented from 2010, and by 2020 (751) this was over twelve times higher than in 2012 (62). Hence, the science research community is focusing its attention on concepts related to the approach of knowledge management in the OI model.

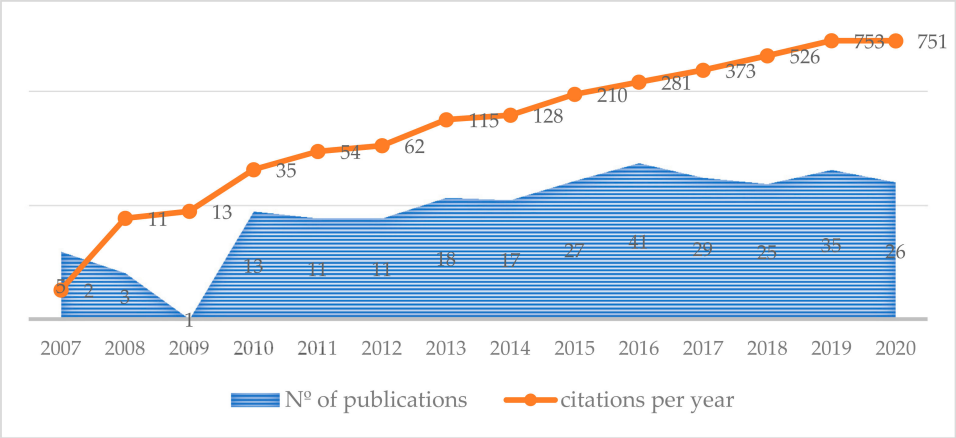

Figure 2. Number of publications and citations from 2007 to 2020.

3.2. Main Producers in Research

One of the purposes of a bibliometric analysis is to ascertain the geographical location of scientific development, which allows the generation of an indicator that measures the excellence and the concentration of scientific research carried out by both countries and organizations. The most prolific countries in terms of knowledge sharing/transfer in OI publishing (see Figure 3) are mainly geographically concentrated in Europe but are also located in China and USA. The countries with the highest number of publications are from Europe: UK (52), Italy (46) and Germany (26), representing almost half of the publications. In general, Europe is the main driving force behind this area of research.

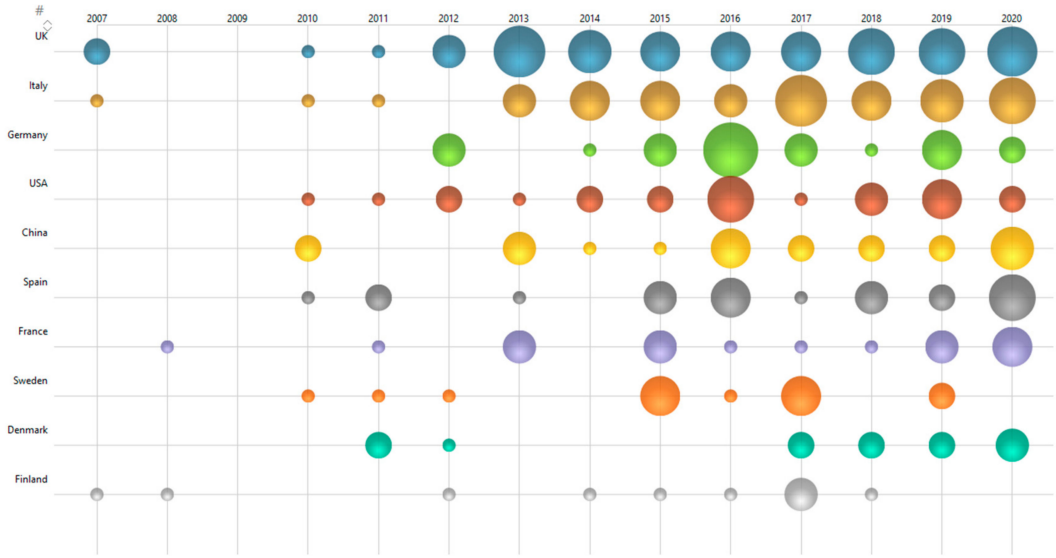

Figure 3. Evolution of number of publications by country according to publication year, from 2007 to 2020.

In addition, the UK, Italy and Finland are highlighted as pioneers in scientific research (with regards to the 2007 start date). With the exception of Finland, they have developed steady scientific production, and they have grown progressively over time. Production in China and the USA, despite being the fourth and fifth countries with most publications, began to be relevant in 2010 but without constant growth in recent years.

A network analysis has made it possible to identify and quantify the collaborative activities between the different countries. Gephi software has modeled the co-occurrence network created in VP, mapping the countries that have at least one collaboration (see Figure 4). In addition, the node size represents the weighted degree, which indicates the number of connections (edges) that a node has with other nodes, but weighted by the thickness of each edge. Consequently, the country most active in academic collaborations in the research field is the UK. In the cluster led by the UK, mainly European countries are collaborating, including Russia and New Zealand. The second cluster is led by France, Spain and Belgium, with collaborations grouped with Argentina, Lebanon, Canada and Algeria (Asia and America). As far as the USA-related cluster is concerned, collaboration is mainly with Germany, Netherlands, Switzerland and Portugal. China, as the main node, forms another cluster, mainly with Asian countries, such as South Korea, Singapore and Pakistan.

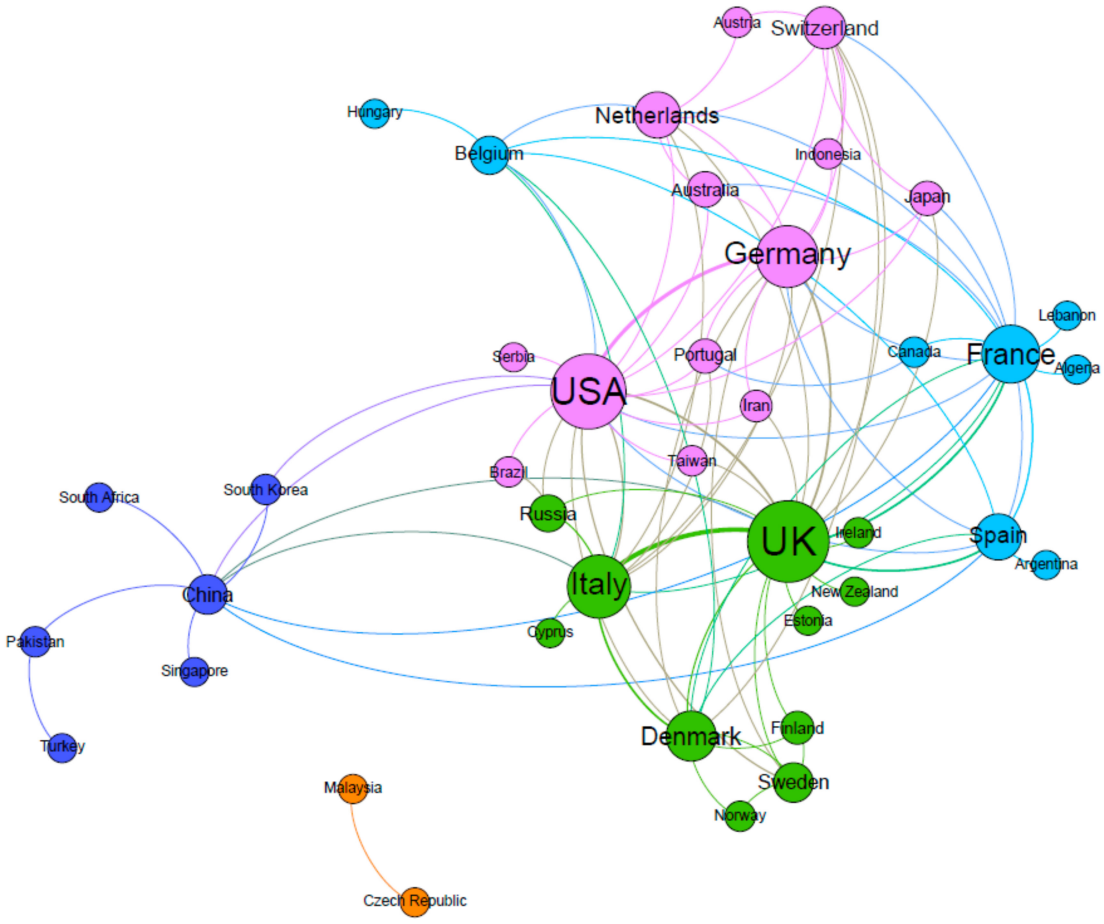

Figure 4. Research collaboration among countries.

The size of the node represents the level of collaboration, and in order to quantify and analyze the countries' cooperation pattern, Table 2 shows the ranking of the most productive and collaborative countries, intermediary countries and influential countries. The United Kingdom remains in first place as the most productive and collaborative, however, countries such as France, the United States, Sweden, Belgium and China improve their ranking in terms of collaboration, unlike Germany and Finland.

In general, the collaboration patterns are very similar in science, with the leading countries being in the central positions, followed by emerging countries, whose affinity is possibly defined by language, colonial links and proximate economies, among others [55,56]. In this case, Switzerland develops little, however, the little it does develop is done cooperatively, whereas China, considered a science powerhouse, collaborates less than it produces. Another interesting fact that the network provides is the betweenness centrality field, i.e., the role of intermediary that the country plays. In this case, the USA, UK, China and France are the countries that most help countries without direct contact to collaborate. In addition, the countries with the greatest influence on others are quantified in the network through the closeness centrality indicator. The results indicate that USA, UK, France and Italy are the most influential, and China drops in the ranking, even though it continues to be among the ten most influential. In general, European countries are the most influential over other countries.

Regarding organizations, Table 3 describes the 10 most productive organizations, including the number of documents, their affiliated countries, and their average citations per publication. The most productive organization is University of Exeter (UK) with eight publications, but there is hardly any difference in the number of publications in the top 10. In the scientific development of the research topic (272 publications), 388 organizations form part of it, which means that scientific production is widely distributed and not very concentrated in just a few nodes. If we analyze average citations per publication in order to analyze the impact on the scientific context, University of Exeter, Queens University of Belfast, University of Turin and University of London, besides being the most productive (all of them very similar), are also the ones that transfer more knowledge to the scientific community (they have the highest average). However, University of Naples Federico II, Scuola Super Sant Anna and Ramon Llull University- ESADE have low average of citations to guarantee that these publications become sources of knowledge for other research works.

The network analysis will allow us to determine, among other characteristics of the network, the degree of collaboration between organizations. The results obtained show a network with a high level of modularity (0.935), which indicates that there are dense connections between the nodes of the same module but few connections with other nodes of other modules, resulting in the formation of many clusters (see Figure 5).

Table 4 shows the results of the network analysis, identifying the most collaborative organizations (Weighted Degree), and at the same time, those that play an important role as intermediaries of other organizations that have no direct connection (Betweenness Centrality) and their influence (Closeness Centrality). Except for the University St. Gallen (Switzerland) (2 publications), the results indicate that the most productive countries are the ones that collaborate the most. However, if we analyze the organizations that play an important role as intermediaries for other organizations that do not have direct contact with each other, the results change. Figure 5 shows where the main intermediary organizations are located in the network. Copenhagen Business School (three publications) is the one with the highest betweenness centrality, providing the most help for contact between non-linked organizations, but a medium-low influence on other organizations, according to its value of closeness centrality (0.3838). The University of Turin, besides being a productive and collaborative organization, plays an important role as an intermediary, with influence on other universities. The University of Adelaide, despite being very collaborative, does not play a significant role as an intermediary, suggesting that everything it has developed has been done with the same research group (as far as organizations are concerned). The University of Birmingham and the University of Naples Parthenope, although not very productive, do play an important role as intermediaries.

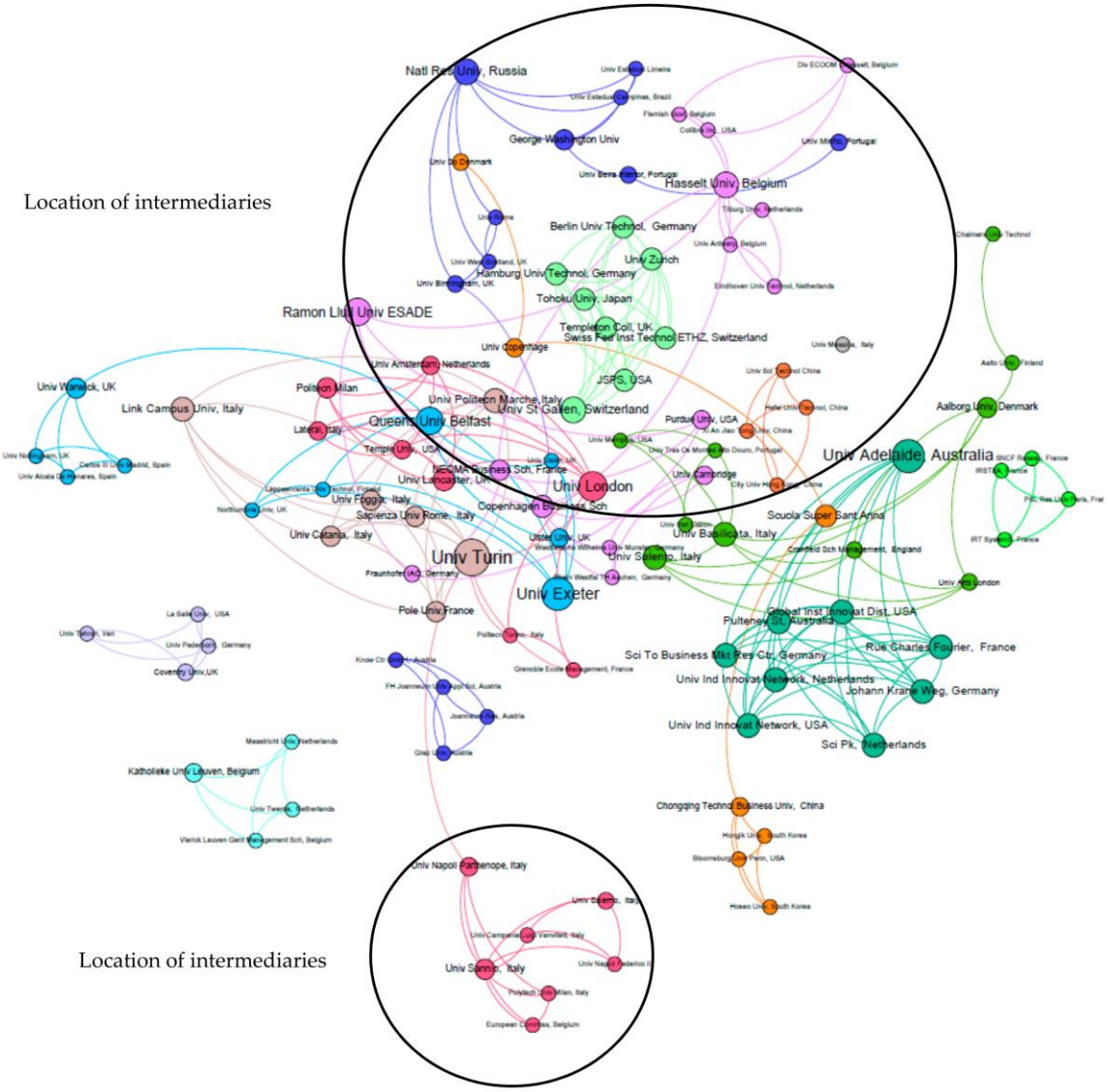

Figure 5. Research collaboration among organizations.

Table 2. Ranking of the most productive, collaborative, intermediary and influential countries.

Ranked	Countries Most Productive	Number of Publications	Countries Most Collaborative	Weighted Degree	Intermediary Countries	Betweenness Centrality	Influential Countries	Closeness Centrality
1	UK	52	UK	21	USA	171.47	USA	0.6727
2	Italy	46	USA	14	UK	169.88	UK	0.6379
3	Germany	26	Italy	13	China	143.65	France	0.6065
4	USA	25	Germany	9	France	119.33	Italy	0.5781
5	China	23	France	8	Italy	62.88	Germany	0.5606
6	Spain	23	Denmark	7	Spain	47.35	Spain	0.5441
7	France	18	Netherlands	7	Germany	45.42	Denmark	0.5441
8	Sweden	14	Spain	6	Denmark	41.63	China	0.5362
9	Denmark	12	Switzerland	6	Belgium	37.4	Switzerland	0.5211
10	Finland	10	China	5	Pakistan	36	Netherlands	0.5138

Table 3. The main producers: organizations.

Organization	Publications	Country	Average Citations per Publication
University of Exeter	8	UK	20.88
Queens University of Belfast	5	UK	21.40
University of Turin	5	Italy	35.4
Polytechnic University of Timisoara	5	Romania	4.80
Ramon Llull University-ESADE	5	Spain	2
Scuola Super Sant Anna	5	Italy	2.20
University of London	5	UK	23
University of Napoli Federico II	5	Italy	0
University of Oradea	5	Romania	4.80
Chalmers University of Technology	4	Sweden	6.25

Table 4. Ranking of the most collaborative and intermediary organizations.

Ranked	Organizations Most Collaborative	Weighted Degree	Intermediary Organizations	Betweenness Centrality	Closeness Centrality
1	Univ Turin (5)	15.0	Copenhagen Business Sch (3)	437.0	0.3838
2	Univ Exeter (8)	13.0	Univ Turin (5)	387.5	0.5230
3	Univ Adelaide, Australia (4)	13.0	Univ Birmingham, UK (2)	345.0	0.3584
4	Univ London (5)	11.0	National Research Univ, Russia (4)	332.0	0.3247
5	Queens Univ Belfast (5)	10.0	Univ London (5)	293.0	0.4722
6	Ramon Llull Univ ESADE (5)	10.0	George Washington Univ (3)	217.0	0.2753
7	National Research Univ, Russia (4)	9.0	Hasselt Univ, Belgium (3)	201.0	0.3333
8	Hasselt Univ Belgium (3)	9	Univ Napoli Parthenope, Italy (2)	189.0	0.4096
9	Univ St Gallen, Switzerland (2)	9	Ramon Llull Univ ESADE (5)	179.5	0.3392
10	Univ Salento, Italy (4)	8	Univ Beira Interior, Portugal (3)	169.0	0.2317

() number of publications.

The analysis of the most productive authors (see Table 5) reveals Allen T. Alexander (University of Exeter Business School, UK) as the most published researcher in the field. The other nine top authors have between three and five publications, however, if we evaluate their citation average per publication, Marcel Bogers differs from the rest of the top authors by having the highest average citations per publication (30.33). Only the authors Allen T Alexander (20.88) and Kristel Miller (19) follow, which indicates that their research work is transcendent for other investigations. In general, the top authors publish their research mainly in research areas related to Business Economics, Engineering, Operation Research Management Science and Information Science Library Science, based on the categorization stipulated by Web of Science [57], which has a total of 252 subject categories in science, social sciences, arts and humanities.

Table 5. The main producers: authors.

Authors	Organization [a]	Country	Counts	Average Citations per Publication
Alexander, Allen T	University of Exeter Business School	UK	8	20.88
Miller, Kristel	Queens University of Belfast	UK	5	19
Baban, Calin Florin	University of Oradea	Romania	5	4.80
Draghici, Anca	Polytechnic University of Timisoara	Romania	5	4.80
Di Minin, Alberto	Scuola Super Sant Anna	Italy	4	1.5
Rumanti, Augustina Asih	Institute Technology of Bandung	Indonesia	4	1
Wiratmadja, Iwan Inrawan	Institute Technology of Bandung	Indonesia	4	1
Bogers, Marcel	University of Copenhagen	Denmark	3	30.33
Bonacci, Isabella	University of Naples Federico II	Italy	3	0
Ivascu, Larisa Victoria	Polytechnic University of Timisoara	Romania	3	7.67

[a] The organization with which they publish the documents.

An interesting method to gauge scientific collaboration is the analysis of co-authorship networks. Based on the matrix of authors' co-occurrences, the layout of the network is generated and mapped using Gephi software. Figure 6 shows the most collaborative research groups. The network has a high modularity (0.988) which indicates that many clusters are formed and, in this case, there is no collaboration between the different research groups (each group forms a cluster). The most collaborative authors according to the calculation of their weighted degree are Alexander, A.T. (17), Miller, K. (16) and Di Minin, A. (15) and the research groups formed by Draghici and Baban (15 and 13) and Rumanti and Wiratmadja (12). It should be noted that Di Minin, A. is the author who has the strongest role as an intermediary (betweenness centrality: 62.33), and Ramos Castro, J. who, despite having only two publications, is a collaborative author and intermediary over other actors.

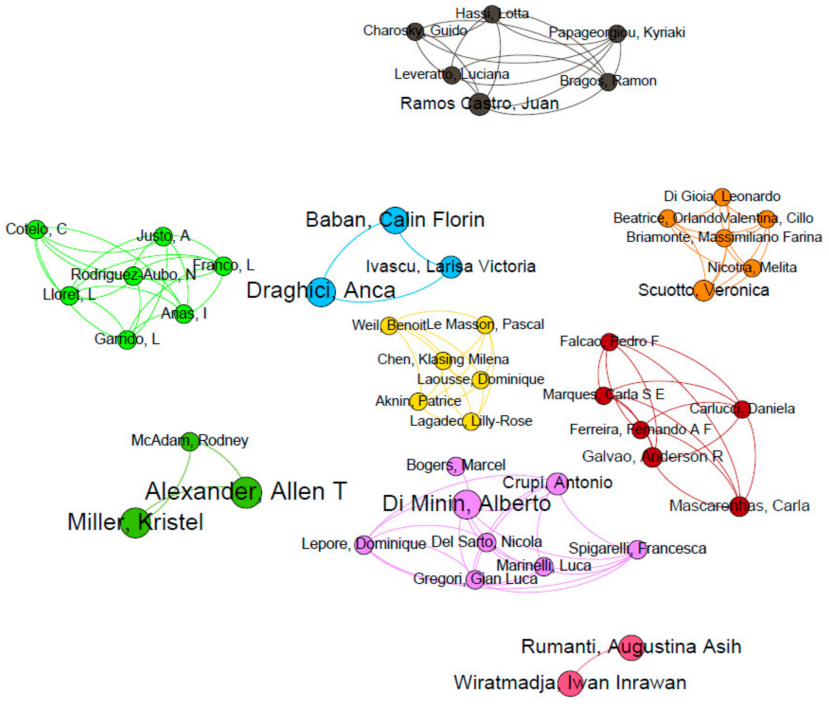

Figure 6. Co-authorship network.

3.3. Sources of Diffusion

Analyzing the sources of diffusion of publications makes it possible to identify the journals most related to the subject important for the producer (authors), and at the same time, allow the publishers to determine relevant information to guide their positioning strategy. The search has been done in Journals, Conference proceedings and Books, with 66% of publications published in Journals and 30% in Conference Proceedings. According to Journals, the most important sources of diffusion are linked to areas of innovation and management. The 272 documents were published in 170 different sources; therefore, there are many sources of diffusion. The main journals are 'Journal of Knowledge Management', 'Technology Forecasting and Social Change', 'R&D Management', 'International Journal of Innovation Management' and 'Technovation', all having more than six articles (15.5%) (see Figure 7).

Figure 7. The top sources of diffusion.

Among the top 10 sources is the conference 'IFKAD 2014: 9th International Forum on Knowledge Asset Dynamics: Knowledge and Management Models for Sustainable Growth' with five publications. If we analyze the quality of the sources, both the Journal Citation Report (JCR) and the Scimago Journal Rank (SJR) indexing, the sources with the highest number of documents are located in high quartiles. Table 6 presents a description of the quality of the five sources with the greatest number of documents according to the JCR and SJR indicators, and the average number of citations of the articles of the study published in them. Except for the International Journal of Innovation Management that is indexed in a high quartile according to the SJR index, all sources are indexed in the upper quartile according to JCR and SJR, 'Management' being the field of research common to all of them. It should be noted that the articles published in the journals with the highest quality (quartile 1) are those with the most average citations; therefore, their research becomes a source of knowledge for other research. It also denotes quality in the research carried out. However, the IFKAD2014 Conference publications have not been cited or been the basis of other research work.

3.4. Research Topics

Author keywords analysis provides an insight into research trends, helping to identify areas of interest to the scientific community related to knowledge sharing or transfer in an open innovation context. Using VP software, 655 author keywords were obtained from 272 publications. In addition, the analysis of the first year in which a keyword in an obtained dataset appears allows the maturity level of the research field to be measured. In this case, as shown in Figure 8, there are two phases in its scientific evolution. On the one hand, the initial development phase is identified between the years 2007–2009, during which hardly any new knowledge terms are generated. On the other hand, between 2010 and 2019 new terms are generated above the scientific production, producing a science growth phase. The year 2020 has not been considered in this analysis because it may not be truly representative or objective as the year has not ended.

Table 6. Main sources of publications (with more than six publications).

Sources	Type of Source	Average of Citations per Publications	JCR			SJR			Publisher
			Field of Research	Quartile	Impact Factor 2019	Field of Research	Quartile	Impact Factor 2019	
Journal of Knowledge Management	Journal	18.27	Information Science & Library Science/Management	Q1	4.745	Management Technology and Innovation/Strategy and Management	Q1	1.75	Emerald
Technological Forecasting and Social Change	Journal	20.56	Business/Regional &Urban Planning	Q1	5.846	Management of Technology and Innovation/Business and International Management/Applied Psychology	Q1	1.82	Elsevier
R&D Management	Journal	26.13	Business/Management	Q2	2.908	Business and International Management/Management of Technology and Innovation/Strategy and Management	Q1	1.25	Wiley
International Journal of Innovation Management	Journal	5.86				Business and International Management	Q2	0.49	World Scientific Publishing
Technovation	Journal	46.43	Industrial Engineering/ Management/Operation Research and Management Science	Q1	5.729	Engineering/Management of Technology and Innovation	Q1	2.8	Elsevier

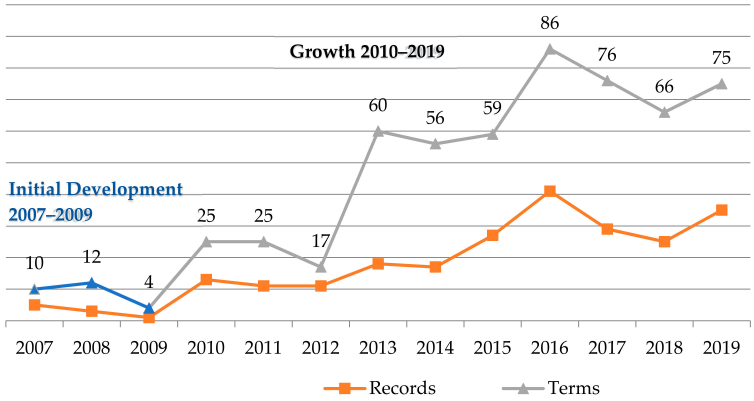

Figure 8. Number of new author keywords any year vs. the number of records for that year.

The network of author keywords, based on a matrix of co-occurrences and generated by Gephi, makes it possible to monitor the relational structure of the main research topics for the period 2007–2020, revealing areas of research interest. In order to reduce any possible disparity in research focus produced by single-used keywords and to make it readable, the network of author keywords (see Figure 9) presents terms with a high number of connections (>10). The network has an average modularity (0.503) which indicates that the terms are grouped in many clusters (32) but there are 9 robust clusters that group from 22 to 171 elements, as is the cluster led by 'Open Innovation', which include themes related to SMEs, University-Industry collaboration, Knowledge transfer, Technology transfer, Innovation, network, crowdsourcing, collaborative innovation, technology innovation, innovation ecosystems and healthcare. 'Knowledge sharing' as topic leader of the second biggest cluster (92 elements) relates to co-creation, R&D cooperation, new product development, automobile industry, innovation management and social media. And the third cluster with more terms (62) is led by 'Absorptive Capability' and linked to process innovation, dynamic capabilities, inbound Open Innovation, external knowledge open innovation practices and social networks.

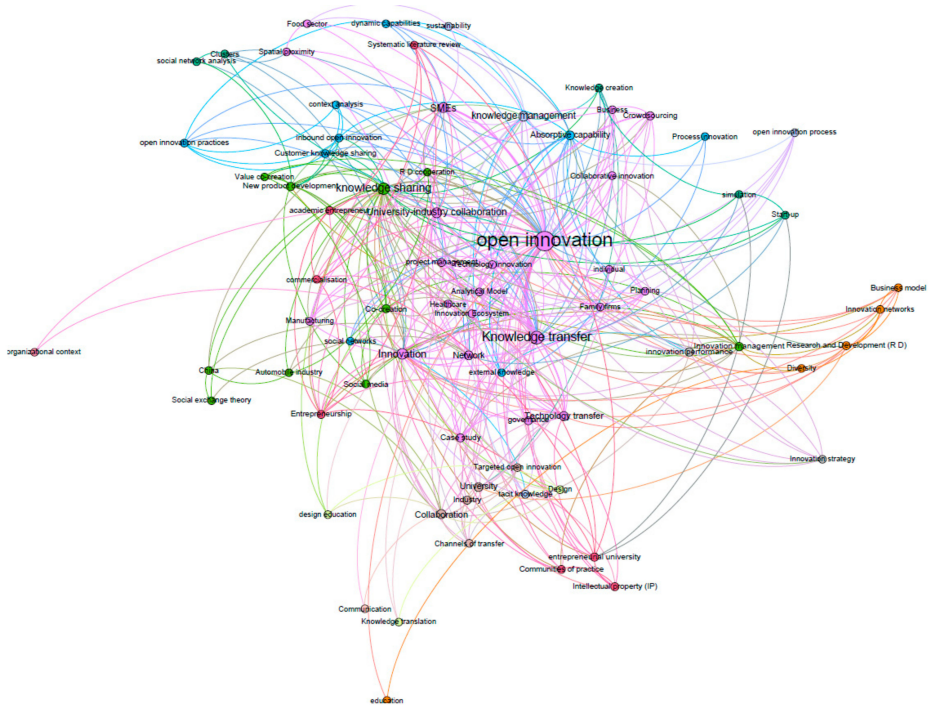

Figure 9. Author's keyword co-occurrence networks: clustering by modularity.

In order to quantify the co-occurrences of author keywords, their weighted degree is described in Table 7. The weighted degree is represented by the size of the node, and describes the number of links that the author keyword has with other terms. Therefore, a high value indicates that the research topics are closely related to other topics, and will be important reference nodes for future research.

Table 7. Author's keywords ranked by weighted degree.

Ranked	Keywords	Weighted Degree	Ranked	Keywords	Weighted Degree
1	Open Innovation	453.0	16	Crowdsourcing	35.0
2	Knowledge transfer	203.0	17	Entrepreneurial university	34.0
3	Knowledge sharing	155.0	18	Co-creation	31.0
4	Innovation	120.0	19	Case study	30.0
5	University-industry collaboration	96.0	20	Intellectual property (IP)	27.0
6	SMEs	93.0	21	Research and Development (R&D)	25.0
7	knowledge management	82.0	22	Industry	24.0
8	Collaboration	66.0	23	Entrepreneurship	24.0
9	Technology transfer	61.0	24	Tacit knowledge	22.0
10	Network	54.0	25	Communities of practice	21.0
11	Absorptive capability	50.0	26	Collaborative innovation	20.0
12	University	49.0	27	Social media	20.0
13	Innovation management	41.0	28	Governance	20.0
14	Innovation performance	39.0	29	Academic entrepreneur	19.0
15	New product development	36.0	30	Clusters	19.0

In network analysis the most significant basic measures of graphs for predicting emerging research are degree centrality (number of connections), betweenness centrality (bridge nodes) and closeness centrality (closeness to the entire network or influence); in fact, in the study by Shibata et al. [25] the betweenness centrality metric turns out to be the best indicator for predicting the number of future citations of an article as a function of its number of citations. Although no work has been identified that demonstrates this, if we take this study as a similar or referent for the analysis of research topics, the nodes with a high measure of betweenness centrality behave as good intermediaries on other research topics, which makes these nodes research topics of interest for other topics not so related to each other, both now and in the future. In addition, any node of the network presents a high connectivity with other terms (high degree centrality); therefore all the terms have their representativeness within the area of study. However, those terms that have a higher value of betweenness centrality will be considered. Those that play a more important role as a link, therefore, are considered to play an important role in the future. Figure 10 shows the author's keyword co-occurrences network but its nodes have been characterized based on the measure of betweenness centrality, the degree of dark color being the one with the highest measure. It should be noted that in general most of the terms with a higher degree of relationship also have an important role as an intermediary. However, there are several research topics that despite being less collaborative turn out to be good intermediaries, making them more relevant future researchers than others that have a lower degree of betweenness centrality.

Figure 10. Author's keyword co-occurrence networks: betweenness centrality.

To better evaluate the network, quantification of author's keyword values is represented in Table 8 based on their betweenness centrality measure. Its analysis and comparison with Table 7 allows us to observe that terms such as "Communication", "Inter-organizational context", "Open innovation practices", "education", "Innovation strategy", "Start-up", "Process innovation", "Sustainability" and "Knowledge creation" gain relevance and become important bridge nodes. However, "Tacit knowledge", "Governance" and "Industry" lose relevance, but are still important research topics.

Table 8. Author's keywords ranked by betweenness centrality.

Ranked	Keywords	Betweenness Centrality	Ranked	Keywords	Betweenness Centrality
1	Open innovation	104.580	16	Open innovation practices	4011
2	Knowledge transfer	31.700	17	Technology transfer	3783
3	Knowledge sharing	28.142	18	Education	3720
4	Innovation	17.602	19	New product development	3165
5	University-industry collaboration	17.456	20	Crowdsourcing	3160
6	SMEs	11.373	21	Innovation strategy	3105
7	Knowledge management	11.202	22	Start-up	2894
8	Absorptive capability	7782	23	Clusters	2686
9	Collaboration	5687	24	University	2507
10	entrepreneurial university	5604	25	Academic entrepreneur	2420
11	Communication	5573	26	Case study	2368
12	Network	4380	27	Communities of practice	2282
13	Innovation performance	4355	28	Research and Development (R D)	2179
14	Inter-organizational context	4333	29	Intellectual property (IP)	2079
15	Innovation management	4182	30	Co-creation	2021

3.5. Where Knowledge Comes from

The importance of knowing the origin of the most influential knowledge sets in motion the process of identifying the five most cited articles (See Table 9). In addition, according to the results of the study conducted by Shibata et al. [25] the times an article is cited is a good indicator of the times cited in the near future. The results show that the most cited article presents almost four times more citations than the second most cited, which shows that it is a key reference. The article "University-industry relationships and open innovation: Towards a research agenda" thoroughly analyzes the university-business relations and defines a research agenda in an OI context, which makes it highly appreciated as a historical and practical reference to justify a new field of research. European Countries, such as the UK, Italy, Netherlands, Belgium and Finland are leading countries, collaborating with the USA and Russia, and the producing organizations are universities. Among the keywords, the most represented is strategy, so these articles focus their research on something relevant or conclusive to that end. As far as journals are concerned, the most cited journal is 'International Journal Of Management Reviews', one of the top journals in the field of business and management according to the Journal Citation Report 2019. The fourth most frequently cited article is relatively up-to-date from 2017. The next most cited articles are published in journals related to innovation and knowledge management such as the 'Research Policy', 'European Journal of Innovation Management', 'Journal of Knowledge Management' and 'Technovation'.

Table 9. Where knowledge comes from.

Times Cited	Title	Publication Year	Authors	Affiliations	Country	Source title	Author Keywords
610	University-industry relationships and open innovation: Towards a research agenda [14]	2007	Perkman, M. Walsh, K.	Loughborough Univ	UK	International Journal of Management Reviews	Strategic research partnership Technology-transfer Academic research
175	Closed or open innovation? Problem solving and the governance choice [58]	2014	Felin, T. Zenger, T.	Univ Oxford Washington Univ	UK USA	Research Policy	Strategy Governance choice Open and closed innovation
121	Technological Activities and Their Impact on the Financial Performance of the Firm: Exploitation and Exploration within and between Firms [59]	2010	Belderbos, R. Faems, D. Leten, B. Van Looy, B.	Maastricht Univ Katholieke Univ Leuven Univ Twente Vlerick Leuven Gent Management Sch	Netherlands Belgium Netherlands Belgium	Journal of Product Innovation Management	Strategic alliances Interorganizational collaboration Knowledge transfer
110	How MNC's subsidiaries may improve their innovative performance? The role of external sources and knowledge management capabilities [60]	2017	Ferraris, A. Santoro, G. Dezi, L.	Univ Turin Ural Fed Univ Univ Napoli Parthenope	Italy Russia	Journal of Knowledge Management	Open innovation Innovative performance External R&D Knowledge management
89	The Janus face of the appropriability regime in the protection of innovations: Theoretical re-appraisal and empirical analysis [61]	2007	Hurmelinna, P. Kylaeheiko, K. Jauhiainen, T.	Lappeenranta Univ Technol	Finland	Technovation	Open innovation Tacit knowledge Appropriability regime Intellectual property

4. Discussion

Scientific production related to the relation between OI concept and knowledge transfer or knowledge sharing has grown slowly over the last 10 years. However, the citation of these scientific documents has grown more. This increase in frequency of citations is a good indicator of the quality of the publications [62] and, at the same time, an important exponent or indicator of dissemination of the research.

Moreover, the most influential publications that should be regarded as important transporters of knowledge are detected by a citation analysis [63]. In addition, the times a publication is cited is a good indicator of its value in the near future [25]. In this case, the most cited publication discussions on university-industry relationships and OI, defining a research agenda, published in 'International Journal of Management Reviews' and developed by Perkman and Walsh from Loughborough University (UK). It becomes a key article, both as a historical reference and as a justification for future scientific actions based on the established research agenda. The main sources of knowledge originate in Europe and from universities, and it should be noted that three of them are international collaborative works between two countries, UK with USA, Belgium with Netherlands and Italy with Russia. As far as the conceptual approach is concerned, the most acclaimed keyword, being the most cited, is 'strategy', which indicates the focus of this research and where it is conceptually oriented.

Regarding the research producers, the UK is the leading University-supported country (Exeter University, Queen's University Belfast, among others), followed by Italy, Romania and Spain. According to the collaboration network, European countries hold the central positions in cooperation, perhaps due to the research funding promoted by the European Union, which has led to an increase in research collaboration between member countries [64]. In addition, the development of information technologies and increased mobility of researchers has made it possible to increase international cooperation. According to [65] "the fourth age of research" has led to the definition of international collaboration as key for organizations. The scientific collaboration network among countries has a core-periphery structure formed by Main European countries (UK, France, Germany and Italy) and the USA, emphasizing that the USA and UK are the countries with a stronger role as intermediaries and influencers on other countries, and highlighting Switzerland as a country that has low production but a serious attitude towards collaboration. Nevertheless, OI paradigm is one of the reasons for international scientific collaboration, as an important way to attract external knowledge and improve the scientific level of the country [66,67].

The most active organizations are from the UK, most notably the University of Exeter, whose results, led mainly by A.T. Alexander, forming a research group with K. Miller and R. McAdam (both from Queens University of Belfast), collaborate in the development of research work with an impact on the scientific community. In general, research is carried out in small, isolated research groups (i.e., they do not collaborate with each other). The most prominent author in terms of his role as an intermediary is Alberto Di Minin, whose collaborative environment is the most extensive, however, the impact of his results is not high. Therefore, in this case the author's collaborative attitude cannot be linked to a direct positive relationship with the impact of his work on the scientific community or that the work becomes the basis of future research. European universities are the most active, but in terms of collaboration the University of Adelaide (Australia) and the National Research University (Russia) are at the top. Even so, the University of Turin has a relevant role in terms of collaboration, emphasizing its capacity to intermediate and influence other organizations. However, Copenhagen Business School and University of Birmingham are two important bridge nodes of collaboration.

The main sources do not differ much in terms of number of publications, and they are linked to the research area of Management and Innovation. However, in terms of impact, the publications of journals located in higher quartiles have greater impact, whereas documents from Conference Proceedings have hardly any impact. According to the relation between journal impact factor and publication citation, results indicate a positive correlation. Consequently, the high quality of the main sources of diffusion infers publications of good scientific quality.

The level of maturity of a technology could be estimated using a growth curve method [67]. In this case, the extraction of the new terms by year allows the maturity level of the curve to be analyzed, concluding that research into the relationship between OI and knowledge transfer and knowledge sharing concept has been growing since 2010. The network is focused around the term 'Open Innovation', establishing a research environment that brings together terms with more weight by way of collaboration and in terms of their behavior as intermediary nodes, such as 'Knowledge transfer', 'SMEs', 'University-Industry collaboration' and 'Innovation'. The other term of interest for the 'Knowledge sharing' study is grouped with a scientific environment that studies 'Co-creation', 'R&D cooperation', 'New product development' and, curiously, an 'Automobile industry' sector. These nodes will define a near future in terms of research paths related to knowledge transfer in OI context. The study also shows that new research nodes, less conventional than previous ones, are opening the way to become study references, such as 'Communication', 'Inter-organizational context', 'Open innovation practices', 'Education', 'Innovation strategy, 'Start-up', 'Process innovation', 'Sustainability' and 'Knowledge creation'.

5. Conclusions

Knowledge management is exploring new fields of action due to the current dynamic context and the need to search for new innovative paths in industry, such as OI models. Therefore, the bibliometric and network analysis provides a picture of the trajectory followed by science, identifying the geographical location of research, producers and their collaborative networks, research priorities, which will help researchers and their environment both to locate working groups and forecast new research items, as well as to assist in decision making. Europe stands out as the main continent in research into OI linked to knowledge transfer, and its research teams are small and isolated, usually belonging to the same organization. Despite the fact that its scientific production has been constant over the last ten years, there has been an important generation of new study topics related to this field of research. Therefore, it can be concluded that research is still active and evolving. It is very important for the scientific community to know both the current state of evolution and what the most researched fields of research are. This will allow them to better focus their future research, as well as to identify the foremost sources of knowledge as the main sources of publication. Among the identified fields of research, two that differ from the subject of study stand out: university-industry collaboration and SMEs. Future research frameworks related to these items and others identified as key for the near future may be proposed, providing the scientific community with research guidelines. Considering the importance of R&D collaborations (closely related to both university-industry collaboration) in an OI context, it would be interesting to analyze the networks for knowledge sharing that are formed and the influence they have on industrial performance and technological development in order to justify the strategic importance of an organizational approach based on an OI perspective. To this end, we could study the behavior of scientific, technological and social networks within a specific organization.

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Sustainable Business Model Based on Open Innovation: Case Study of Iberdrola

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Abstract: The change in business management towards a vision based on open innovation has opened the doors to knowledge transfer between organizations, promoting scientific–technological collaborations resulting in new research that opens the way to new technological innovations. Therefore, the objective of this study is to see how the company Iberdrola has oriented its management strategy towards an open innovation approach, analyzing both its scientific and technological development through a bibliometric and network analysis. The results highlight that Iberdrola has always considered scientific and technological development to be part of its strategic approach as a means of disseminating and transferring knowledge. Furthermore, it can be concluded that the implementation of strategic axes related to sustainable development in an open innovation environment has improved the results of its scientific and technical production, and also the company's financial results.

Keywords: Iberdrola; open innovation; sustainability; bibliometric analysis; network analysis

1. Introduction

In recent decades, the business innovation model has evolved from a closed to an open approach to the environment [1]. In the closed model, innovations were generated by means of investments in R&D (push system), circumscribed by the limits of the company itself; in contrast, in an open model, innovations are generated through interactions with external agents of the R&D system, increasing their social value [2]. In the former innovation model, the knowledge and technology required for production, distribution, and marketing were developed and remained within the company [3]; there was very little interaction with external entities so they were able to keep not only new ideas under control but also all their knowledge [2].

In an increasingly globalized market, resources are constantly flowing, moving, changing, and increasing in complexity. As employees start moving from one company to another, so does information and technology, making it very difficult for the firm to contain ideas [4,5]. However, this transition to an open innovation model is not entirely natural; companies are also an active agent in this process [6]. The exploration of resource complementarity and economies of scale attempts at easier entry into markets, the minimization of costs and risks, tacit collusion, and obtaining know-how all promote collaboration between different economic agents [7]. As a result, companies have gradually reversed their ways of investing in their research toward a collaborative method.

In this dynamic context, open innovation (OI) has appeared in recent decades. As Chesbrough describes [1], OI represents an innovation paradigm shift from a closed to an open model. OI can be understood as the intentional utilization of incoming and outgoing knowledge to further a firm's innovation and to extend markets to innovate externally. The definition perceives organizations as being able to use information and procedures from inside and outside the firm, and this is the way it has to be if they wish to progress technologically [8]. When a company is part of a collaborative structure and shares innovation and knowledge, it will be more effective in achieving its goals. Therefore, companies working in an OI environment are more likely to improve their results [9,10]. Within this open environment, partnerships aimed at achieving sustainable innovation processes are becoming increasingly important compared to other innovations [11].

Sustainable innovation within OI has become an essential part of many companies' business models [12]. To achieve competitive environmental advantages in today's business environment, it is essential to share knowledge [13]. This is because the complexity that sustainability issues can have makes companies more dependent on the knowledge and innovations of other companies [14]. This is why many companies use external sources of knowledge, enter into partnerships, and strengthen their R&D. Thus, through their sustainable innovations, they increase their business benefits [15].

In fact, it is the companies that innovate more in sustainability that collaborate more with other companies to develop these innovations and are usually the ones that produce the most environmental impacts [12]. Sustainability is a way to ensure that members of society, including companies, do not harm biodiversity, implementing appropriate policies on sustainable innovations [15,16]. Companies have to take into account growing consumer concern about reducing environmental impact and their environmental footprint and that the policies that penalize this environmental impact are increasingly restrictive [17]. Therefore, if the company integrates sustainability into its business management strategy, a sustainable business model will be achieved, as well as balanced social development [18].

In a world facing new global challenges, such as the depletion of natural resources and global warming, the environment and people's values are becoming increasingly diverse and complex [19]. In this context, in September 2015, the United Nations adopted the 2030 Agenda for Sustainable Development Goals (SDG) as its core [20]. In 2016 an initiative called "Society 5.0" was proposed by the Japanese Cabinet in its 5th Science and Technology Basic Plan [21]. This is a new super-smart society that aims to make people live healthier and more comfortably [22]. Society 5.0 focuses on achieving SDGs such as "conscientious consumption and production", "sustainable cities and towns", "industrialization, innovations and infrastructure", and "cheap and low-cost energy", among others [23].

An example of a company that integrates OI and sustainability in its organizational model is Iberdrola [24], a Spanish energy company with over 170 years of history. It is the world's energy leader as well as the largest producer of wind energy [25]. Iberdrola is the only Spanish electricity company among the 100 most sustainable companies in the world and incorporated the SDGs approved by the UN in September 2015 into its business strategy [26]. In addition, the innovative execution of Iberdrola's sustainable business model responds to the demand for continuous improvement in environmental, social, and governance (ESG) metrics, combined with 20 years of outstanding financial performance [27]. The long-term value creation of a sustainable economic model can be measured through ESG issues, which better help to determine future company financial performance and reputation [28,29]. Therefore, for Iberdrola its reputation is strongly linked to sustainability, clearly manifested in the main sustainability indexes [30]. In order to carry out research into innovative and sustainable projects, Iberdrola has established OI as the mainstay of its activities, which means collaborating with universities, technology centers, and other companies by implementing an open R&D model [27].

Bibliometric techniques establish a method that allows the analysis of a large amount of academic literature, facilitating the identification and quantification of research results in a given field of interest or organization [30]. Therefore, bibliometric analysis becomes a tool that enables the geographic location of research, the main drivers, collaborative networks, and research hubs, among others [31].

Likewise, bibliometrics is an analytics tool used to process information obtained in patent databases. In addition, another analytics tool is network analysis that makes it possible to identify and quantify collaboration patterns between organizations, authors, and countries, including ascertaining the main topics of research [32,33]. The use of these techniques allows large amounts of data to be analyzed and, therefore, their results allow new research projects, new collaborations, or even funding of technological research areas to be channeled along an optimal path [34].

A review of the literature identified several works related to OI, but none that analyzes the impact of implementing strategic lines of innovation management based on an OI vision of scientific and technological development. As far as OI is concerned, Medeiros et al. [35] carried out a bibliometric analysis of OI in the agrifood chain. Lopes and Carvalho [36] analyzed how OI can affect organization and innovation performance using a systematic literature review based on bibliometric analysis. De Paulo et al. [37] provided a bibliometric analysis of OI in developed and emerging countries between the years 2000 and 2014. Furthermore, in another study carried out by de Paulo et al. [38], the conclusions lead to a direct relationship between the improvement of business competitiveness and the implementation of OI practices. The research conducted by Della Corte et al. [39] carried out bibliometric analysis of sustainable tourism in the field of OI to analyze the state of the art of sustainable tourism in the digital era. Finally, Chaurasia et al. [40], through a review of literature, considered the main aspects of OI for sustainability, thus establishing their interrelationships.

Therefore, the aim of this work is to determine how the company Iberdrola bases its strategy of development and dissemination of science and technology in an environment based on OI, channeling sustainability in that background. In addition, the financial impact of the company is evaluated by analyzing the ESG issue related to innovation management, specifically based on OI. For this, the use of bibliometric techniques and network analysis allows us to generate and identify the main collaborations, both in science and technology, and in turn, identify the traceability of "sustainability" in this scientific and technological environment. All this will give the scientific and technological community an opportunity to see the paths that the company is taking and thus increase collaborations, adding value to the organizational environment based on OI as a business strategy.

2. Materials and Methods

To achieve the objective, the methodology followed employs three important phases before analyzing the results (see Figure 1). These three phases facilitate the identification of scientific collaborations of Iberdrola, both in a general area of development and based on a specification of terms relating to management and sustainability, and the identification of collaborations in the development of patents based on a particular technological field determined by the Cooperative Patent Classification (CPC): Y (general tagging of new technological developments). This method can be applied to any other organization whose strategic approach is based on an OI model. This could give rise to future research whose results will be used for feedback and improvement of strategic know-how.

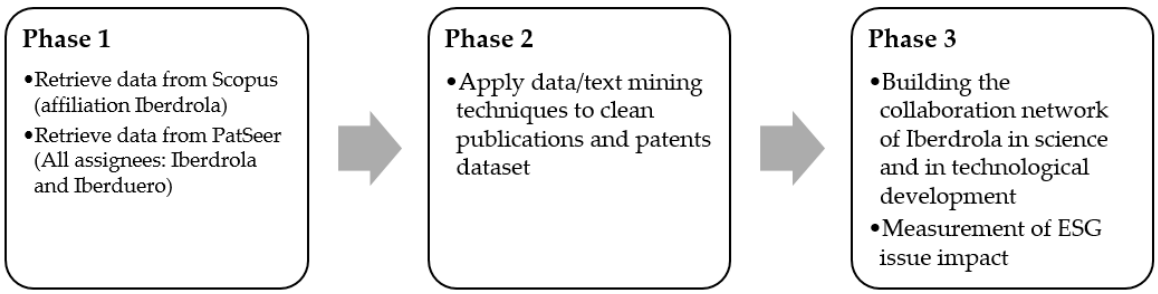

Figure 1. Methodological process phase by phase.

In order to build Iberdrola's collaboration network, the first step was focused on obtaining the data from Iberdrola's scientific publications and the data from the patents whose assignee and owner was

Iberdrola. To choose the scientific reference database, a search for "Iberdrola" in the field of affiliation or address in the two scientific publication databases Web of Science (WoS) and Scopus was performed, obtaining better results in Scopus (474 versus 278 in WoS). The Iberdrola scientific publications dataset is thus created from the documents identified in Scopus [41]. The search in Google Scholar is also interesting, since several studies have shown that the results are improved if the three databases are used [42]. However, in this case it distorts the analysis, given that up to 26,000 publications are obtained in which "Iberdrola" as a term appears, because Google Scholar lacks certain functionalities to do the required bibliometric search [43,44]. Regarding the patents dataset, this was generated using PatSeer [45], a comprehensive global full-text patent database. The search was performed in all possible assignee fields (Normalized Assignee, Assignee Original, Current Assignee, Assignee Non Latin, and All Assignees in US Reassignment History) based on "Iberdrola" and "Iberduero" (the name of the company before it was named Iberdrola). A total of 126 patent families were obtained whose priority year, or year they were invented, was between 1930 and 2019.

In the second phase, the use of text and data mining techniques allowed the two datasets to be cleaned. For this purpose, the two datasets obtained in the first phase were imported to VantagePoint (VP) software [46], through which the raw data could be classified and the data cleaned thanks to the use of fuzzy matching techniques, grouping the terms that had the same meaning.

Once the cleaning was done, phase three of the research began, generating the collaboration networks that would allow us to identify the main nodes of scientific–technological collaboration of Iberdrola and its fields of action. To do this, we used both VP, which allowed us to create the co-occurrence matrices of the fields to study, and Gephi software [47], which allowed us to generate and visualize the collaboration networks based on these matrices. The network analysis allowed us to identify the main research partners and analyze the behavior of certain research fields (such as sustainability, OI, or other strategic management models). Subsequently, the network analysis identified Iberdrola's main allies in the development of technology in a particular field (such as that defined by Cooperative Patent Classification (CPC) Y02, relating to the development of new technologies that mitigate climate change). In addition, the evolution of Iberdrola was analyzed both in the development of new scientific and technological research fields through the analysis of keywords and patent classification codes, using VP and Power BI.

Once the scientific and technological profile of Iberdrola was determined, the impact of the innovation process was analyzed through the quantification of the cause and effect of an ESG issue.

3. Results

The purpose of this study was to identify and analyze the scientific–technological development carried out by the company Iberdrola, which in turn became a very important output indicator to measure the company's OI practices.

3.1. Iberdrola's Scientific Collaboration Network

After further investigating and updating the study by Naiara et al. [48], the company Iberdrola began to develop its scientific activity during its diffusion phase in 1992, collaborating on three articles. In addition, the company has collaborated on an average of 19 publications per year in the last 15 years, with 2009 being the most productive year with 33 publications, as shown in Figure 2 (on a logarithmic basis). However, the most remarkable thing was the significant growth in the number of citations received for these articles, which means that they were of great interest to new developments within the scientific and technological community.

In total, Iberdrola published articles with authors from 29 different countries. In this case, we were interested in ascertaining Iberdrola's level of collaboration, both nationally and internationally, in order to identify with which institutions and countries it is most likely to carry out its scientific research and to identify the geographical location of the scientific production. In addition, the main countries of scientific collaboration were the UK, USA, France, and Germany.

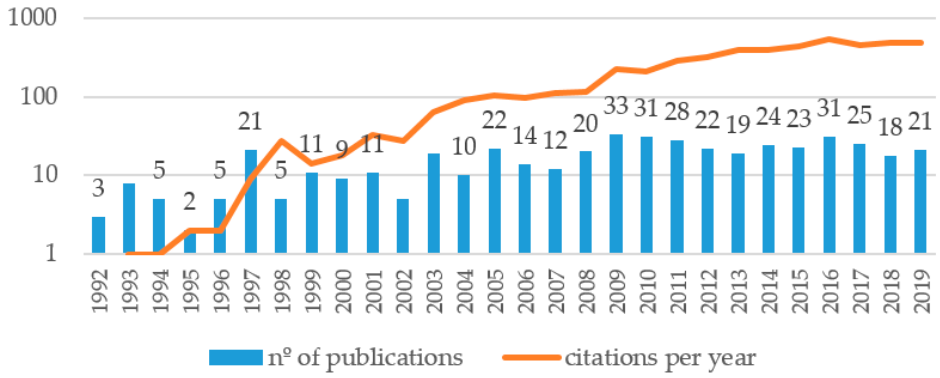

Figure 2. Number of publications and citations per year.

In terms of production by country, as shown in Table 1, the country with the most publications was Spain (430), followed by the UK (36), the USA (29), and France with 27 documents. In general, Europe countries were the main driving force behind Iberdrola's scientific development. Nonetheless, if the map of collaborations between countries is generated and the degree of the relationship quantified using the software Gephi (see Figure 3), it is observed that it was mainly the European countries with the highest levels of collaboration. Some authors believe that this may be due to funding of projects by the European Commission, which promotes collaboration between European countries. With the exception of the USA, whose level of collaboration was lower than the productive one, it was still ranked among the best positions, and Qatar, whose level of collaboration was lower than the top 10.

Table 1. Ranking of most productive and collaborative countries.

Ranked	Countries	Number of Publications	Most Collaborative Countries	Weighted Degree
1	Spain	430.0	Spain	189.0
2	United Kingdom	36.0	France	85.0
3	United States	29.0	United Kingdom	77.0
4	France	27.0	Italy	75.0
5	Germany	26.0	Germany	69.0
6	Italy	26.0	United States	45.0
7	Qatar	16.0	Switzerland	40.0
8	Switzerland	15.0	Sweden	34.0
9	Denmark	10.0	Denmark	26.0
10	Sweden	10.0	Austria	20.0

In general, there was greater activity in countries where Iberdrola had significant representation, such as Europe and America. Collaborations in the Asian market were less common in countries such as South Korea, Malaysia, Australia, Qatar, and Japan, which represent markets that are only beginning to develop.

As far as affiliations were concerned, in the clean-up phase the main sections of Iberdrola—Iberdrola, Iberdrola Distribution, Iberdrola Engineering and Construction, Iberdrola Engineering and Consulting, Iberdrola Renewables, Iberdrola Generation, Iberdrola Nuclear Generation, and Global Smart Grids Iberdrola—plus Iberdrola Internacional (depending on the country), were defined as independent affiliations. In order to identify Iberdrola's scientific collaboration activities, an effective method was a network analysis. The network was generated through a matrix of co-occurrences and plotted using Gephi (see Figure 4). As indicated in Figure 4, the isolated groups are small collaboration groups linked to Iberdrola Internacional, such as Iberdrola renewables US, which collaborates with NASA, the US Department of Energy, University of Washington, Santa Clara University, and the National Renewable Energy Laboratory, among others, and Iberdrola Portugal, which collaborates with companies in that country.

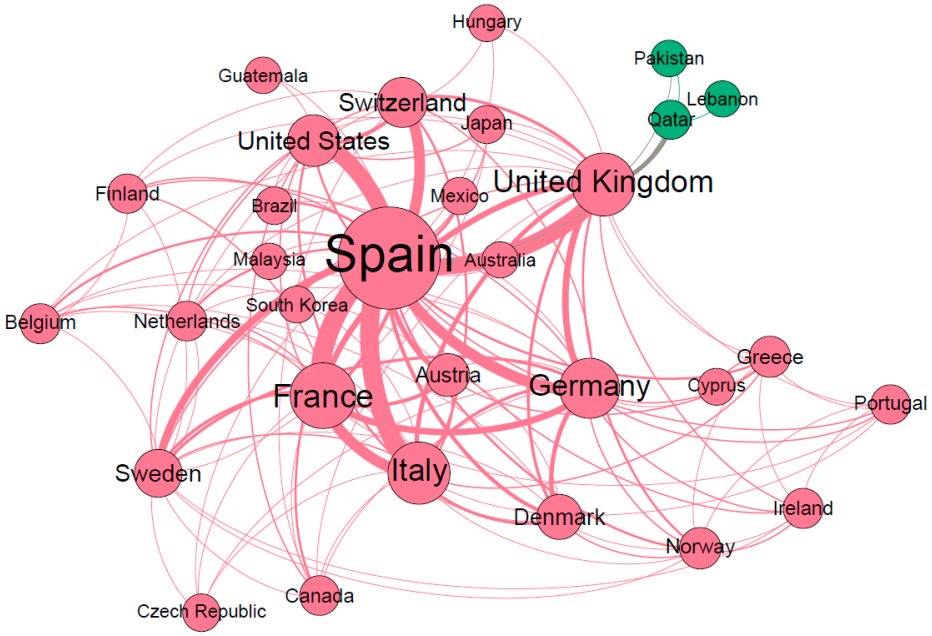

Figure 3. Iberdrola's scientific network: countries.

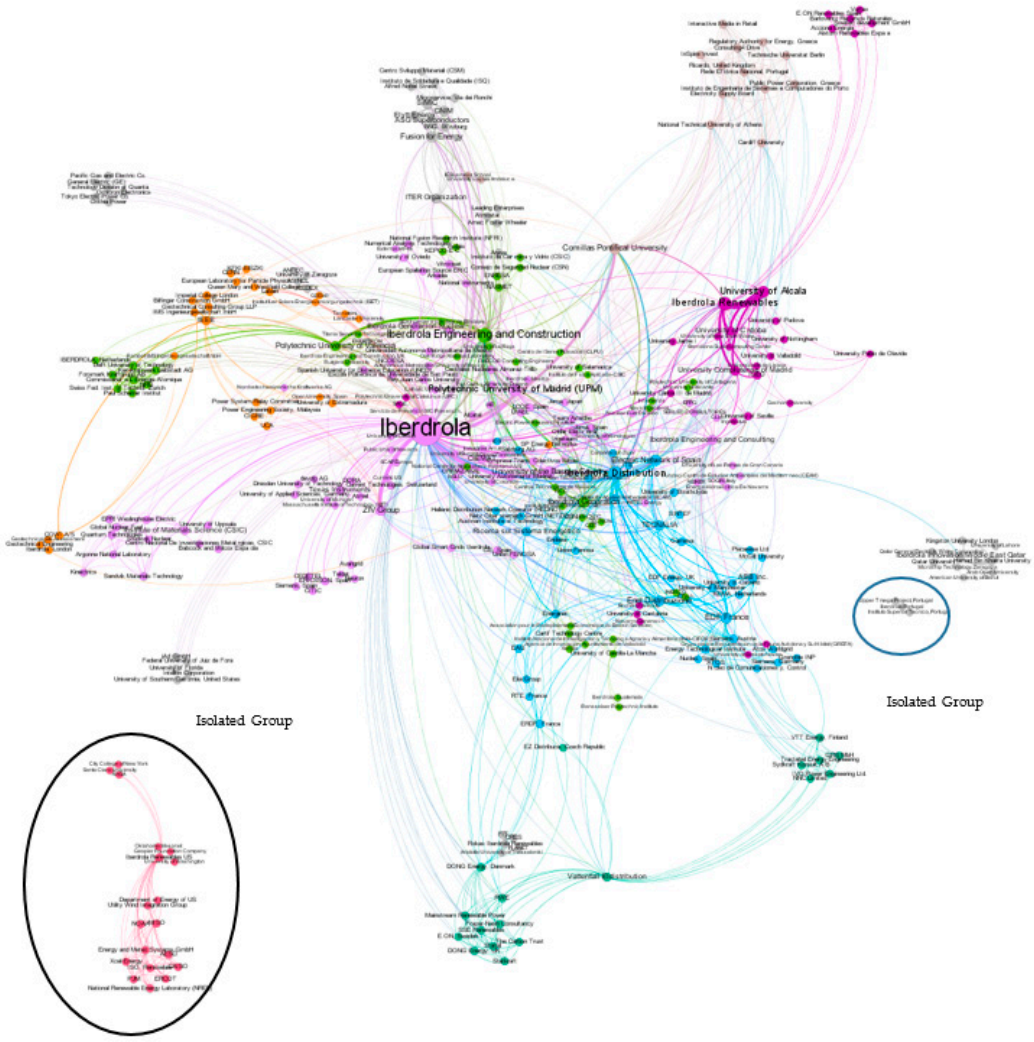

Figure 4. Iberdrola's scientific collaboration: organizations.

Iberdrola Spain was the central nucleus of the network, and collaborated with all national sections. It had a wide range of collaborations with universities (National: University of the Basque Country, Comillas Pontifical University, Polytechnic University of Madrid, Autonomous University of Madrid, University of Oviedo, and University of Burgos; International: University of Strathclyde, University of Michigan, University of Colorado, Lancaster University, University of Applied Science, and Dresden University), companies (ZIV, Texas Instruments, Team Arteche, Spanish Electrical Network (REE), Siemens, Jema Energy, Ormazabal, Current, General Electric, Gamesa, and DONG Energy—mainly companies from the electricity sector), and research centers (Massachusetts Institute of Technology (MIT), the European Organization for Nuclear Research (CERN), Tecnalia, Basque Center for Applied Mathematics (BCAM), and the European Laboratory for Particle Physics) (See Figure 5). Iberdrola Spain collaborated with all main sections except Iberdrola Nuclear Generation.

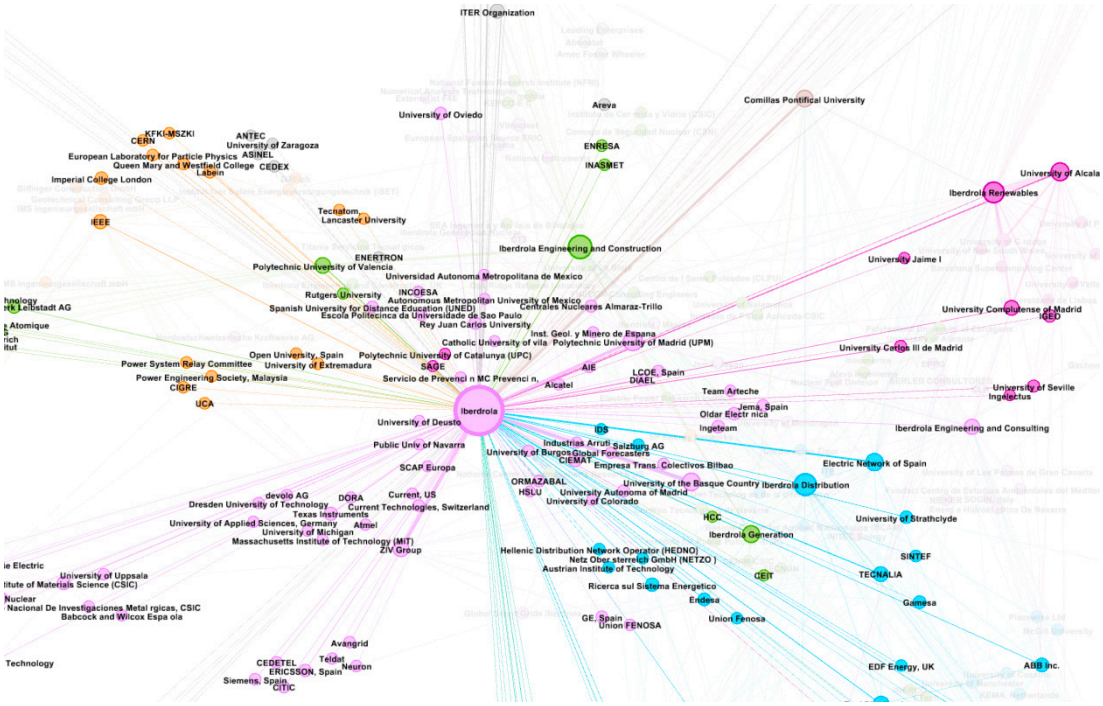

Figure 5. Iberdrola's scientific collaboration: Node Iberdrola.

In the case of Iberdrola Distribution, regarding universities, it collaborated mainly with Spanish universities such as Comillas Pontifical University, Polytechnic University of Madrid, University of the Basque Country, University of Salamanca, and University of Mondragon, and international ones such as University of Manchester and University of Cassino (see Figure 6). As far as other types of collaborations were concerned, the main companies with which it collaborated were the international companies EDF France, Enel Distribuzione, Siemens (Austria and Germany), and the national companies Team Arteche, Corporacion Zigor, Jema, and Ingeteam, among others. It also collaborated with research centers such as the Basque Center for Applied Mathematics (BCAM), the Energy Technological Institute, and the Austrian Institute of Technology.

As far as Iberdrola Engineering and Construction was concerned, it collaborated with various sections, namely, Iberdrola Nuclear Generation, Iberdrola Generation, Iberdrola Distribution, and Iberdrola Renewables. In addition, it collaborated mainly with research centers and companies, both Spanish and international, such as the National Fusion Research Institute (South Korea), mobiis (South Korea), Vitrociset (Italy), the Research Applications Laboratory (USA), Oak Ridge National Laboratory (USA), ASG Superconductors (Italy), International Thermonuclear Experimental Reactor ITER organization, Fusion for Energy (EU), Jema (Japan), and National Instruments (USA),

among others. In this case, collaboration with universities (University of la Rioja, Polytechnic University of Madrid and Valencia, and University of Salamanca) did occur but with less intensity than in other sections of Iberdrola (see Figure 7).

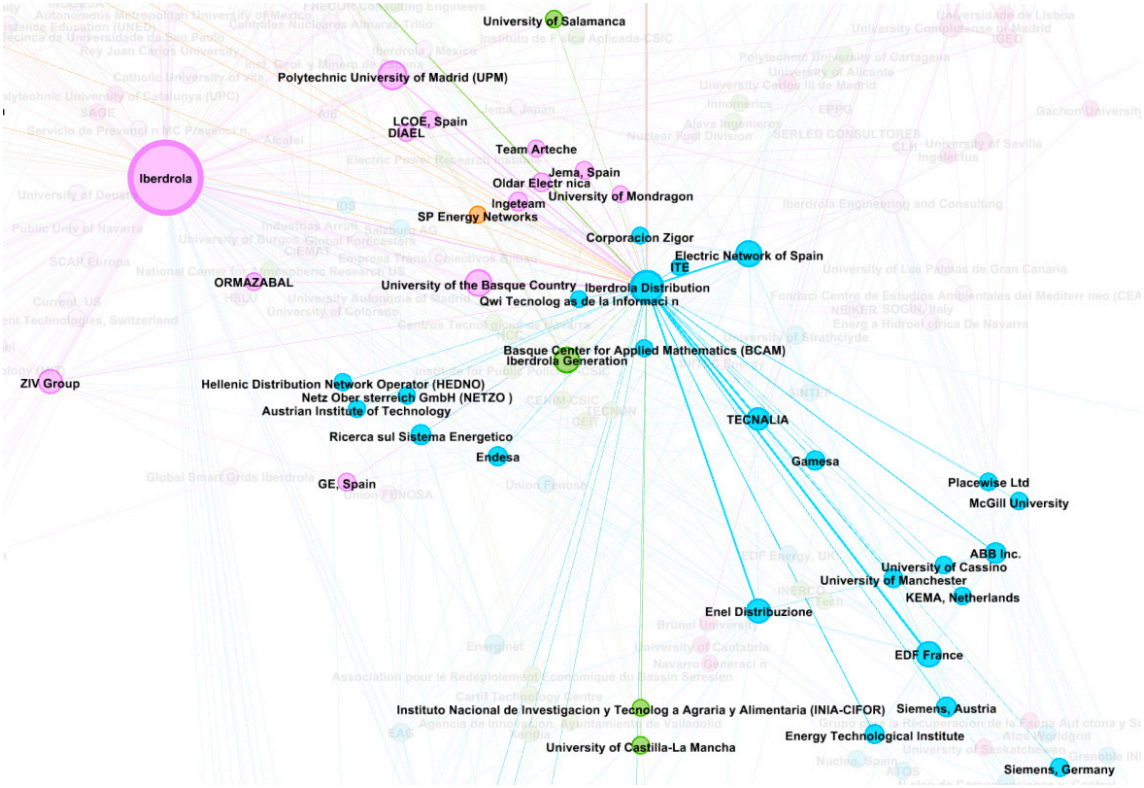

Figure 6. Iberdrola's scientific collaboration: Node Iberdrola Distribution.

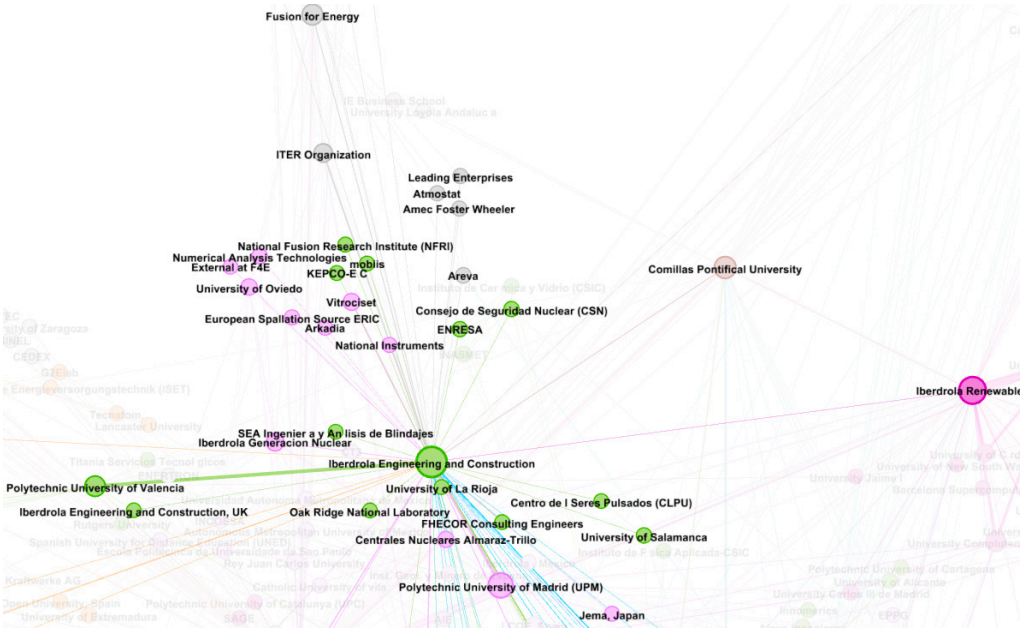

Figure 7. Iberdrola's scientific collaboration: Node Iberdrola Engineering and Construction.

Regarding Iberdrola Engineering and Consulting (see Figure 8), its main collaborators were Spanish universities (University Complutense of Madrid, University of the Basque Country,

Polytechnic University of Madrid, and University of Las Palmas de Gran Canaria), research centers (NEIKER, CIEMAT, and the Foundation Center for Environmental Studies of the Mediterranean (CEAM)), consulting enterprises (EPPG/EBSCO and Serled Consultores) and international companies (CLH, VTT Energy Finland, and EDF France), as well as with nuclear organizations such as nuclear power plants and the Nuclear Safety Council (CSN).

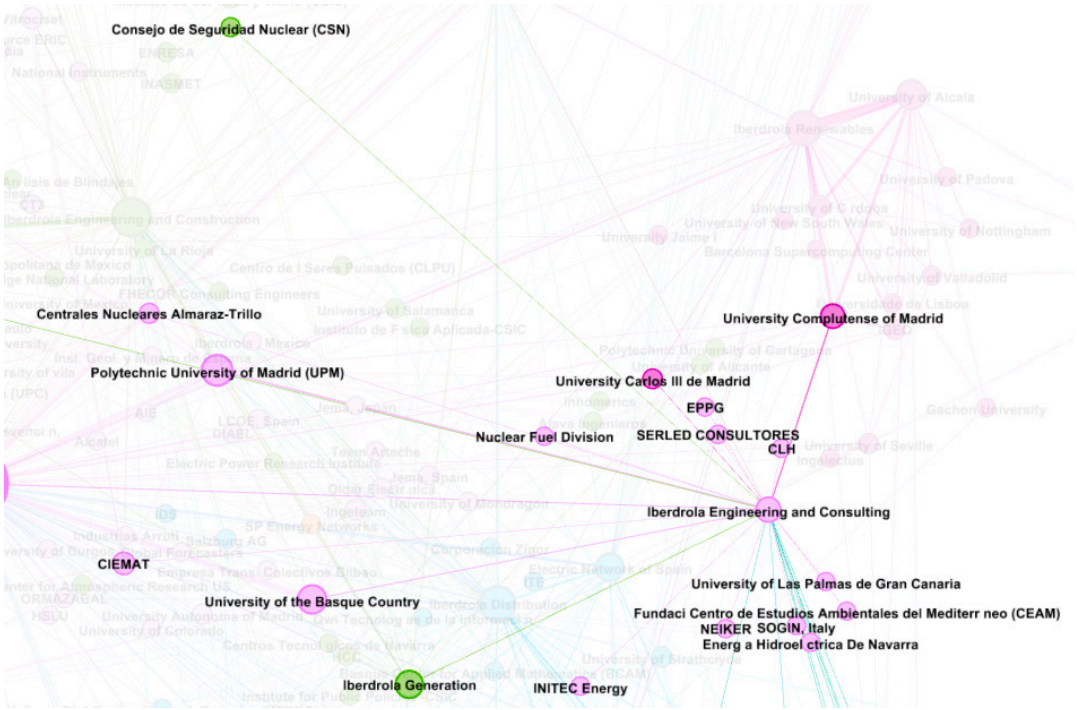

Figure 8. Iberdrola's scientific collaboration: Node Iberdrola Engineering and Consulting.

As far as Iberdrola Renewables was concerned (see Figure 9), its main collaborators were Spanish and international universities (University of Alcala, University Complutense of Madrid, University of Córdoba, University of Lisbon, University of Nottingham, and University of South Wales, among others). It also collaborated with companies and organizations such as Barcelona Supercomputing Center, Almston Renewables, Acciona Energia, and EON Spain, among others.

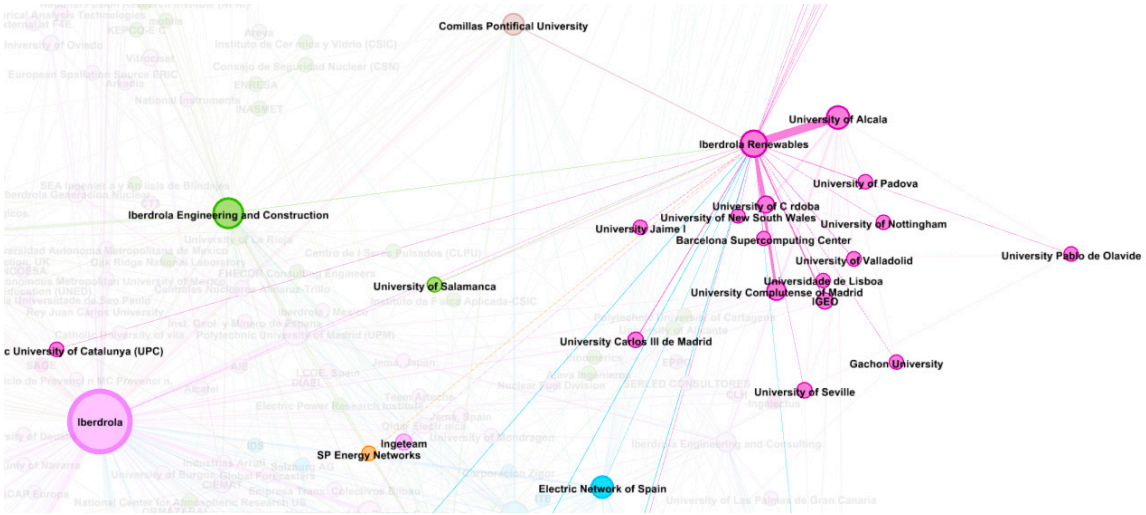

Figure 9. Iberdrola's scientific collaboration: Node Iberdrola Renewables.

Iberdrola Generation collaborated mainly with Spanish universities (Polytechnic University of Madrid, Autonomous University of Madrid, University of the Basque Country, Tecnun, Polytechnic University of Cartagena, University of Seville, Tecnun, and University of Salamanca, among others) and with Spanish research centers (Superior Council of Scientific Research (CSIC), Center for Technical Studies and Research (CEIT), the Electric Power Research Institute, and the Technological Centers of Navarra, among others). As regards Iberdrola Nuclear Generation, it collaborated with different sections of Iberdrola, some universities (Polytechnic University of Madrid and Valencia, University of Oviedo, Comillas Pontifical University, and Autonomous Metropolitan University of Mexico) and with Spanish engineering companies linked to the nuclear energy sector (SEA and CT3), as well as German companies related to the electricity sector (Nordostschweizerische Kraftwerke AG) (see Figure 10). It also collaborated with Fusion for Energy, the European Union organization handling Europe's contribution to the ITER project.

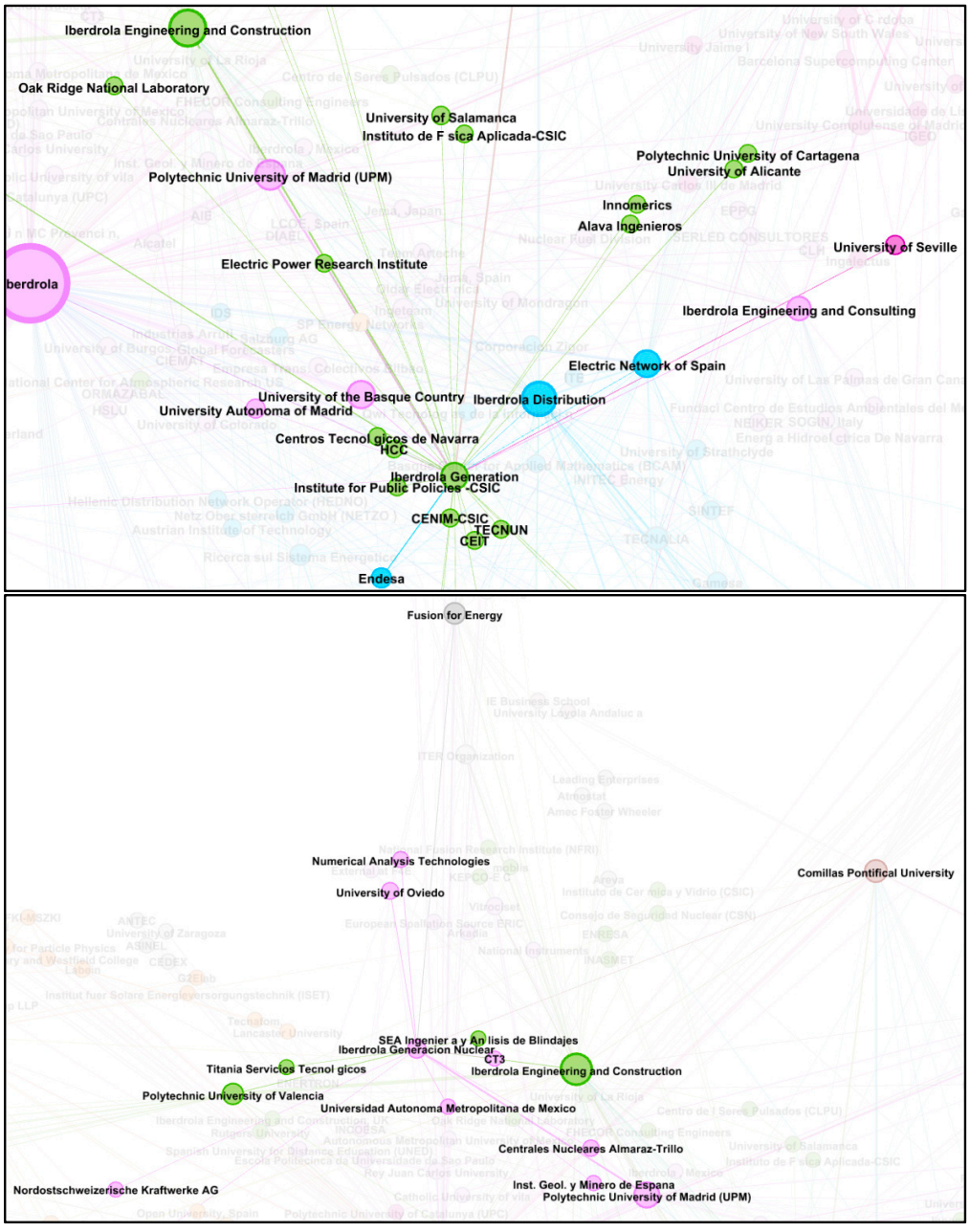

Figure 10. Iberdrola's scientific collaboration: Node Iberdrola Generation and Iberdrola Nuclear Generation.

Iberdrola's international sections, in general, played an important role when searching for allies in the corresponding country, creating geographically located working groups. With regard to Iberdrola's newest section, Global Smart Grids, Iberdrola collaborated with the University of the Basque Country, Tecnalia, CIEMAT, Neuron, and the ZIV group (see Figure 11).

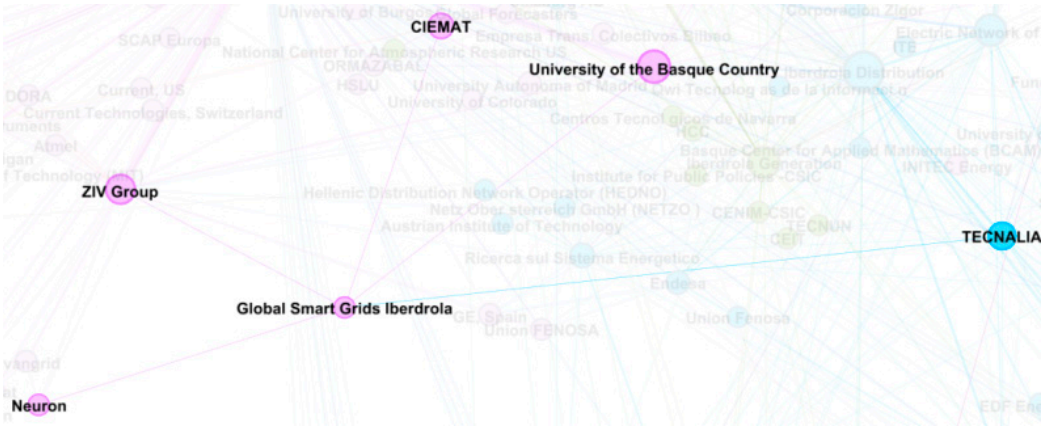

Figure 11. Iberdrola's scientific collaboration: Node Global Smart Grids Iberdrola.

In addition, the analysis of keywords or new terms generated over the years allowed us to identify the company's progress when researching new fields of scientific development. As indicated in Figure 12, the number of new terms grew as the number of publications increased, which indicated the company's interest in embracing a greater scientific dimension and expanding its scientific domains.

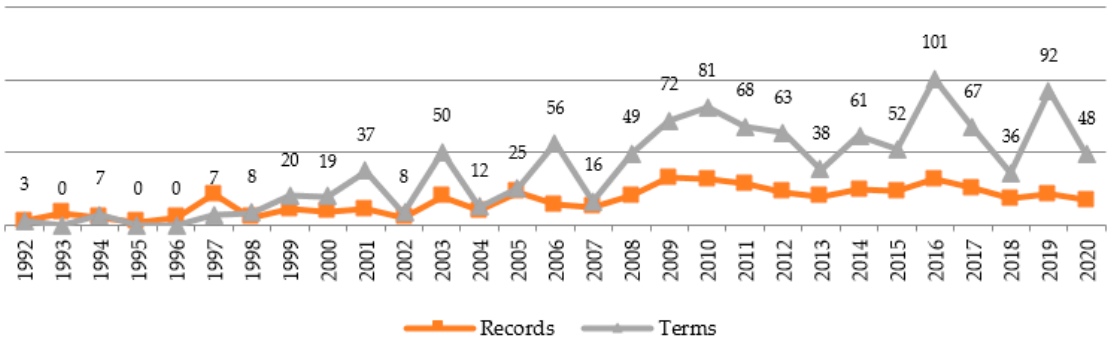

Figure 12. Evolution of scientific domains: new terms by year.

Iberdrola, apart from collaborating in the scientific development of its main area of business interest, namely energy, also collaborated in research areas related to business management, such as open innovation (the first year the term appeared was 2009), business (2000), technological innovation management (2002), knowledge management (2009), energy management (2009), risk management (2009), management of information (2010), strategy (2014), business schools (2020), sustainability (2020), and management (2020). Figure 13 shows the organizations involved in joint research with Iberdrola in these knowledge areas linked to business management.

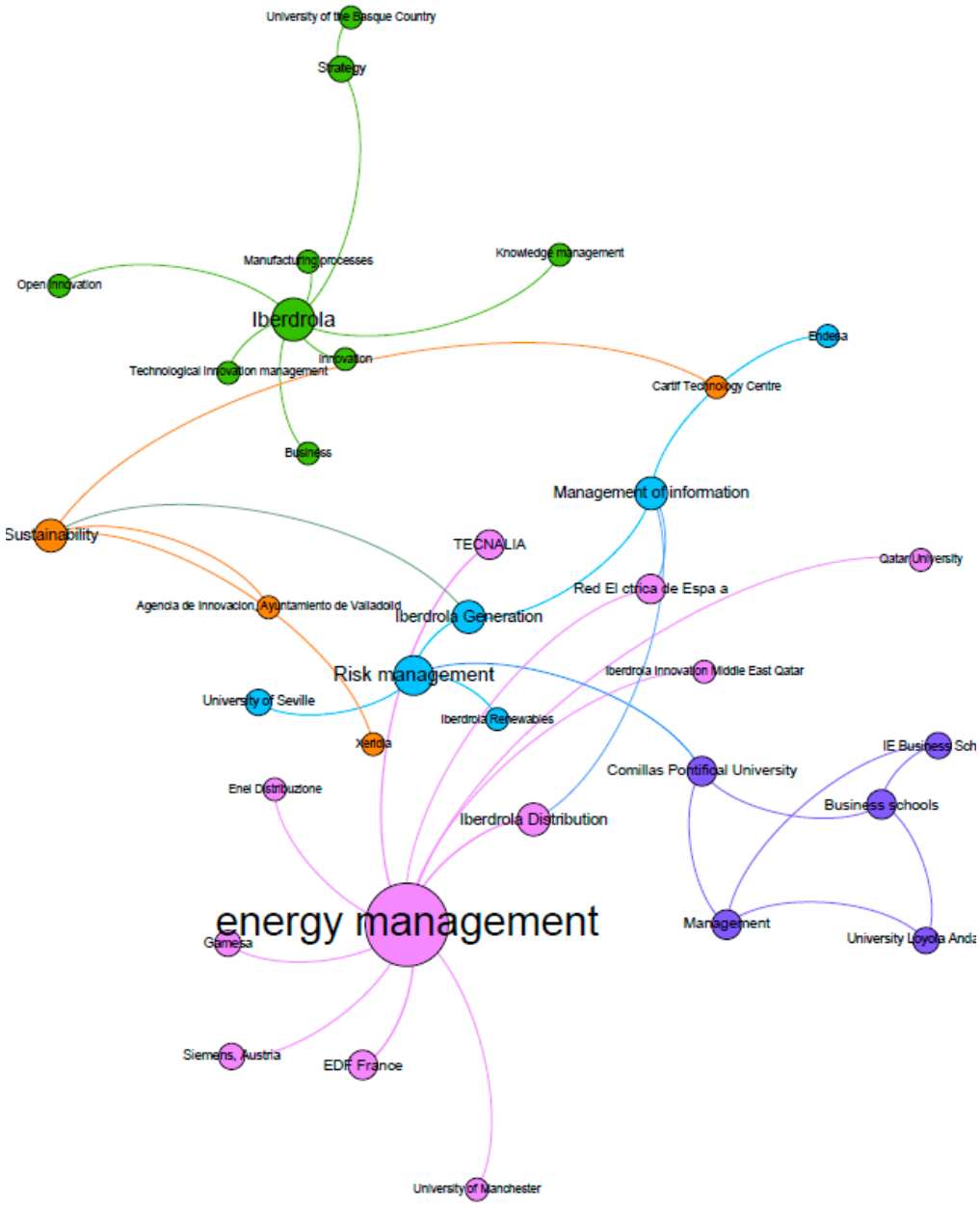

Figure 13. Scientific areas of business management and research organizations.

3.2. Iberdrola's Collaboration Network in Technological Developments

The analysis of the technological development carried out by Iberdrola was directed, on the one hand, to study the path that inventions have followed and the collaborative relations between the assignees of the patents, updating and extending the study carried out by Pikatza et al. [48] and, on the other hand, to identify collaborations in the technological field relative to the development of new sustainable technologies.

As indicated in Figure 14, the evolution of inventions evolved in such a way that there were periods that were more productive than others. For this reason, we analyzed the year in which the invention was created, also known as the priority year. The period between 1990 and 1996 stood out as the most productive. In addition, another interesting period, with variability in the number of inventions, was between 2008 and 2016.

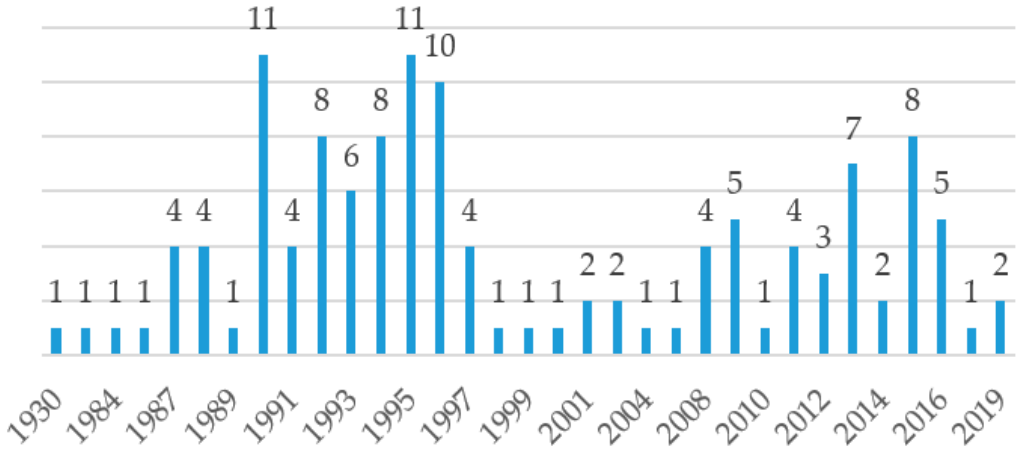

Figure 14. Evolution of patents by priority year.

With regard to the assignees, also called applicants or owners, according to the patent office, as indicated in Table 2, the beneficiaries with the largest number of patents, apart from Iberdrola and Iberduero and its affiliated companies Iberdrola Engineering and Construction and Iberdrola Generation, were companies from the electronic and communications sector (Angel Iglesias SA), energy suppliers (New York State Electric and Gas, Energetix, and Rochester Gas and Electric Corp), and renewable energies (Enertron and Avangrid).

Table 2. Ranking of most productive and collaborative assignees.

Ranked	Top Assignee	Number of Patent Families	Most Collaborative Assignee	Weighted Degree
1	Iberdrola	92.0	Iberdrola	108.0
2	Iberduero	20.0	Angel Iglesias SA	31.0
3	Angel Iglesias SA	19.0	Iberduero	30.0
4	New York State Electric Gas	13.0	Energetix Gmbh	17.0
5	Energetix Gmbh	12.0	New York State Electric and Gas	16.0
6	Iberdrola Engineering and Construction	12.0	Rochester Gas and Electric Corp	12.0
7	Iberdrola Generation	8.0	Es Inc	8.0
8	Rochester Gas and Electric Corp	7.0	University of The Basque Country	8.0
9	Enertron	5.0	Nasa	7.0
10	Avangrid	4.0	Electronica Arteche Hermanos	6.0

As for the collaborative relationships between the different assignees, the network generated allowed us to identify the collaborative groups with at least one patent. Two assignees that did not participate in their patents were identified with other assignees, namely Iberdrola Nuclear Generation and Iberdrola Engineering and Consulting. Figure 15 shows the different cooperation groups, with two isolated groups: Iberdrola Generation and Polytechnic University of Madrid, and the one headed by Iberdrola Renewables Spain and Iberdrola Engineering and Construction that collaborated mainly with universities. The main group, whose most important node was Iberdrola, had the largest number of collaborations. The degrees of the top relationships were quantified (see Table 2), and the level of collaboration that Iberdrola had with the University of the Basque Country, NASA, and with Electronica Arteche Hermanos stood out.

The technical domain of patent analysis allowed us to identify the main fields of technological development (see Figure 16). This classification of the patent based on the technical domain was specified by the technical expert of the patent office [49]. The main domains were apparatus, electrical machinery, energy, measurement, engines, pumps, turbines, and telecommunications, among the 26 different domains that the patents presented.

Figure 15. Collaboration network between assignees.

In addition, it is of interest to see the technical domains of the assignees; to do this, a network that relates the assignees with their technical domains was generated (see Figure 17). The network identified work groups based on technical domains.

For better comprehension, the three most important parts of the network were zoomed in on. As shown in Figure 18, the main technical domains of Iberdrola Nuclear Generation, Iberdrola Generation, Iberdrola Engineering and Construction, Iberdrola Renewables, Nac Uranio; Polytechnic University of Madrid (UPM), and University of La Coruña were related to engines, pumps, and turbines, among others, highlighting the link between Iberdrola Generation, UPM, University of

Salamanca, CLPU, and environmental technology. The biotechnology domain also appeared as an isolated area linked to Iberdrola Engineering and Construction.

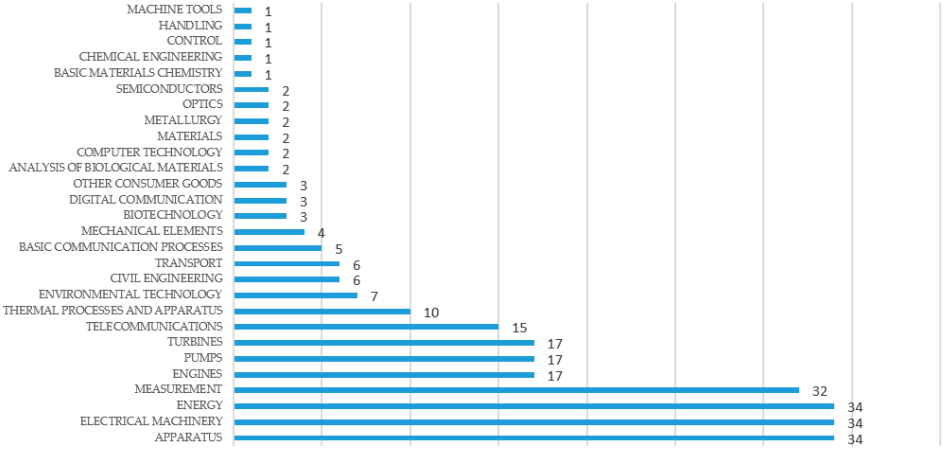

Figure 16. Technical domains of patents.

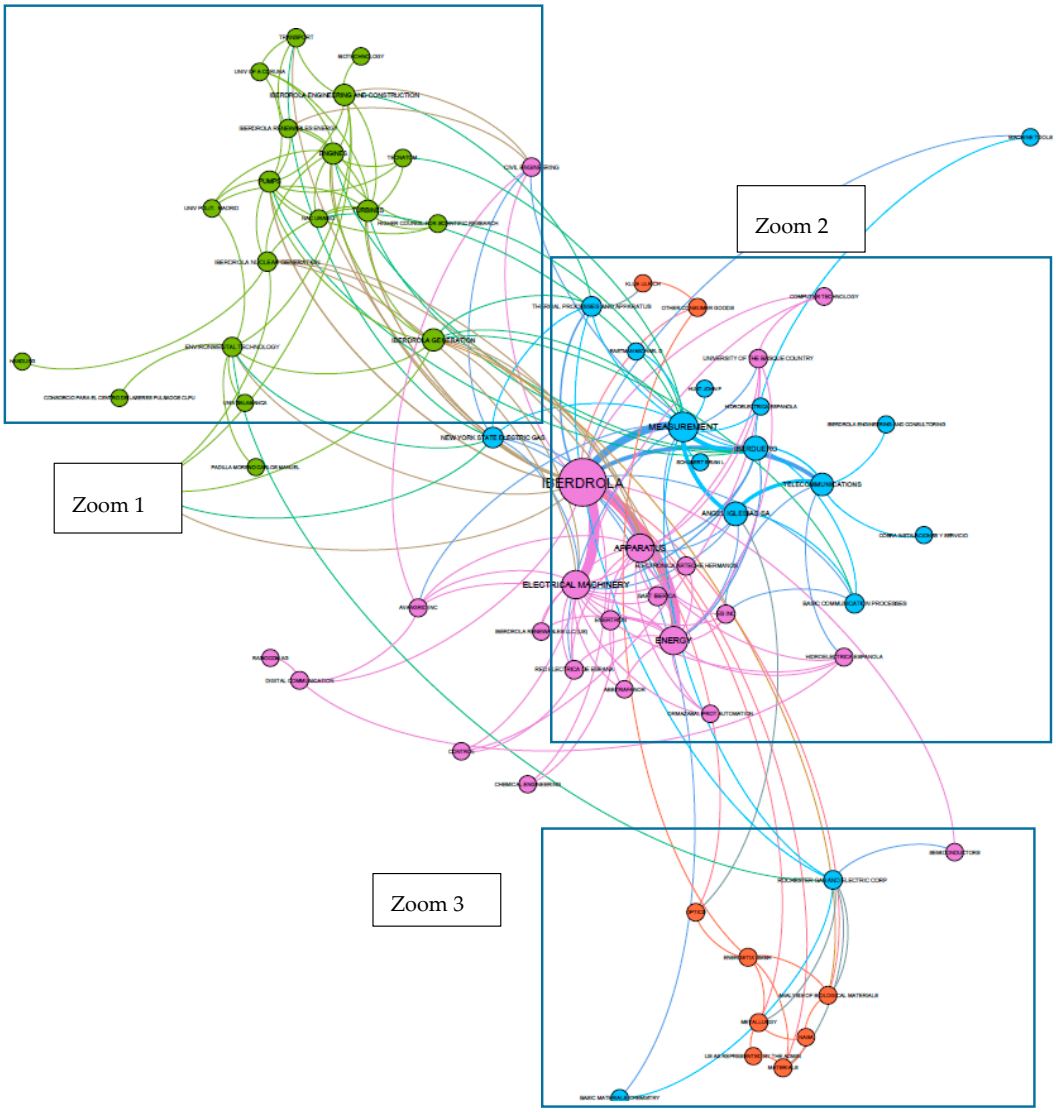

Figure 17. Network linking assignees and technical domains.

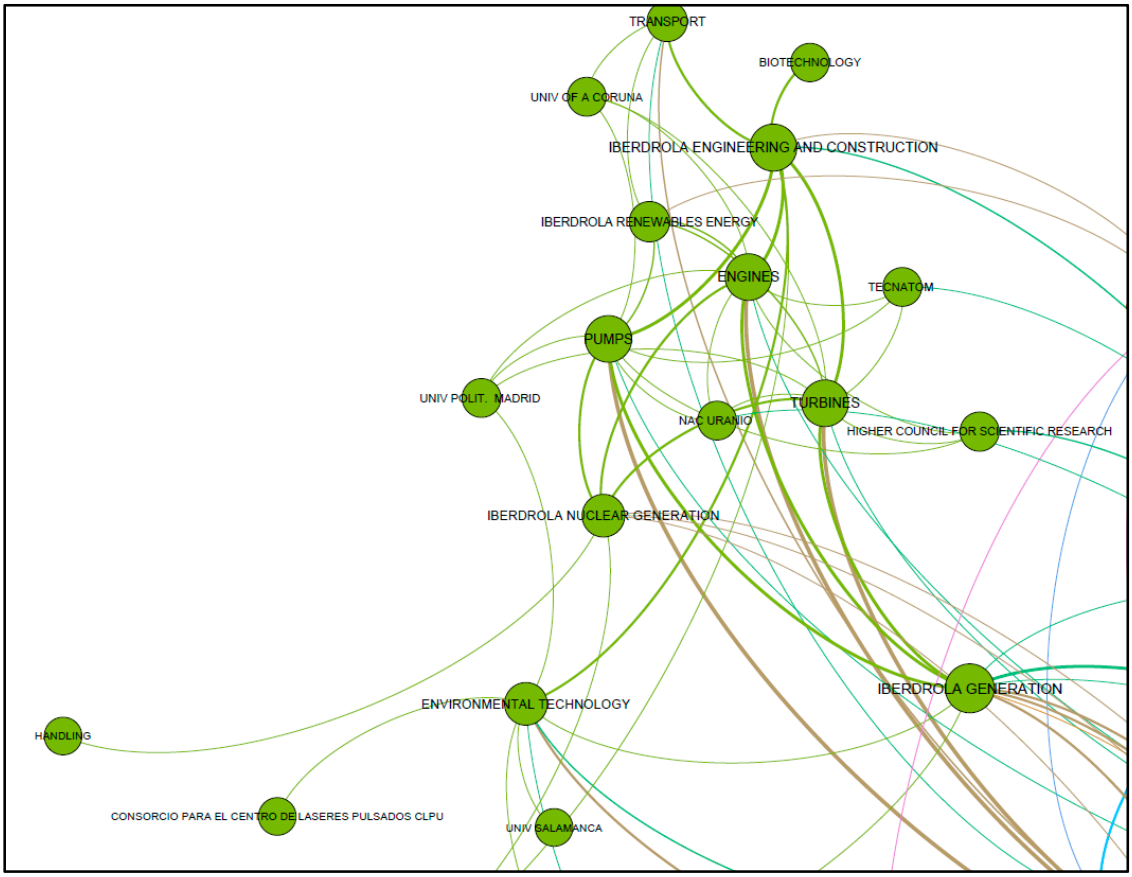

Figure 18. Zoom 1 of the network linking assignees and technical domains.

With regard to Iberdrola as the main company, in zoom 2 (Figure 19) we can see a greater diversification in domains. Nevertheless, they were mainly grouped in two clusters. In the first place were those linked to domains related to apparatus, energy, and electrical machinery, together with the companies Enertron, Electronica Arteche Hermanos, Red Electrica de España, Saft Iberica, Avangrid, and the University of the Basque Country, among others. In addition, Avangrid was also linked to digital communication and civil engineering, and the University of the Basque Country with computer technology. Second the blue cluster, with companies such as Angel Iglesias, Iberduero, New York State Electric and Gas, and Rochester Gas and Electric Corp focused on domains linked to measurement, telecommunications, thermal processes and apparatus, and basic communication processes.

Regarding another important cluster (orange), zoom 3, linked companies such as NASA, Energetix, and the US Administration with technical domains related to metallurgy, materials, optics, and analysis of biological materials (See Figure 20).

In order to deepen the technological development, patents were analyzed based on the Cooperative Patent Classification (CPC). More specifically, patents classified as Y02 (General Tagging of New Technological Developments: Technologies or Applications for Mitigation or Adaptation Against Climate Change) were analyzed in order to identify Iberdrola's collaborations with other assignees in the field of technological development for purposes based on sustainability. However, in order to clarify the meaning of the CPC codes offered by the patents, a network had to be made to link the technical domains with the CPC classifications (see Figure 21). The most common classification in all groupings was Y02E, which represents, reduction of greenhouse gas emissions related to energy generation, transmission, or distribution, or related to turbines, engines, pumps, transport, mechanical elements, biotechnology, thermal processes and apparatus, semiconductors, electrical machinery, energy, apparatus, and basic materials chemistry. In addition, there were other relationships such as metallurgy and materials

with Y02P (climate change mitigation technologies in the production or processing of goods), environmental technology with Y02C (capture, storage, sequestration or, disposal of greenhouse gases), and civil engineering with Y02A (technologies for adaptation to climate change).

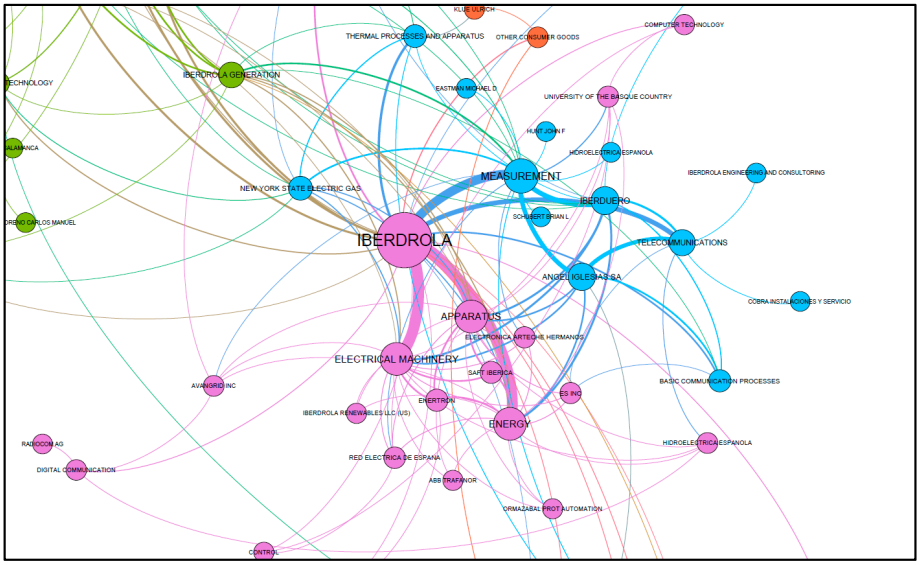

Figure 19. Zoom 2 of the network linking assignees and technical domains.

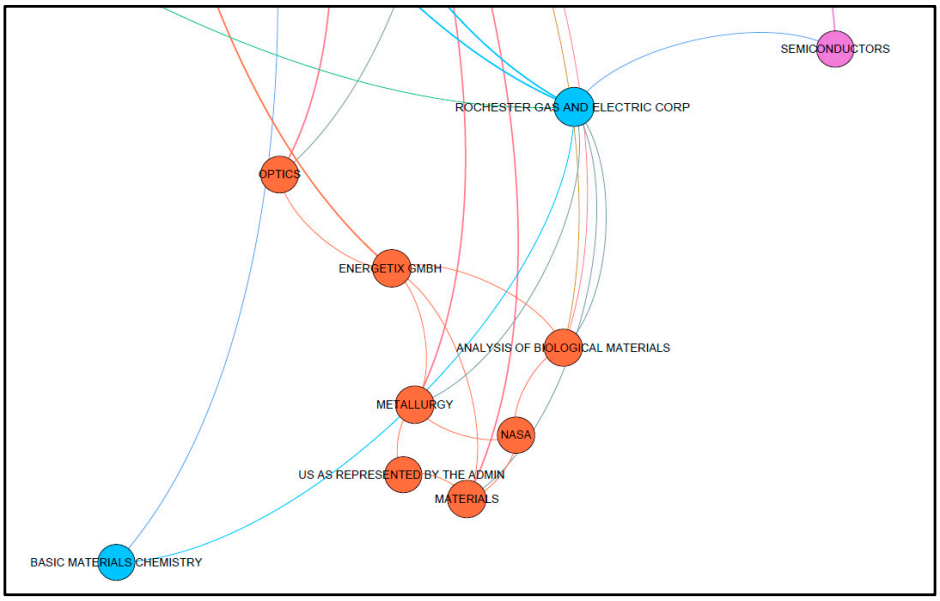

Figure 20. Zoom 3 of the network linking assignees and technical domains.

In order to identify collaborations between assignees within a technological development framework based on sustainability criteria, such as technological developments that aim to mitigate climate change, the network of relationships between assignees and CPCs (Y02) was carried out (see Figure 22). Six clusters were defined, and in the biggest one Iberdrola shared ownership of patents with Rochester Gas and Electric, Energetix, Nac Uranio, Tecnaton, the Higher Council of Scientific Research, and Iberdrola Nuclear Generation. A second cluster was led by Iberdrola Engineering and Construction and related to Iberdrola Renewables Spain and Carlos Manuel Padilla. Iberdrola Generation formed the third cluster together with the Polytechnic University of Madrid. The other three small clusters linked Iberdrola with Saft Iberica, New York State Gas and Electric, and Iberduero.

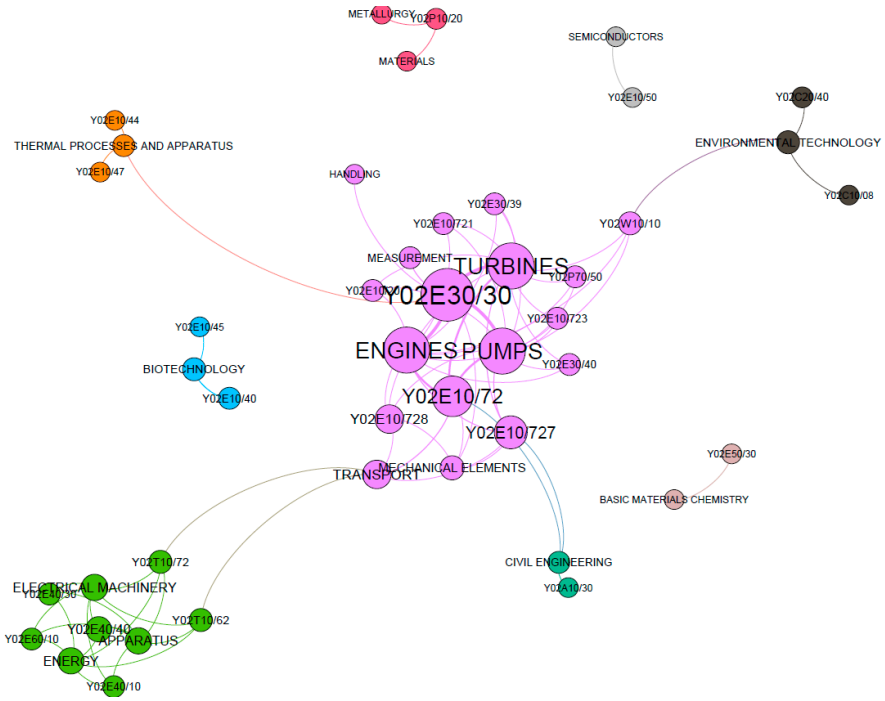

Figure 21. Network linking technical domains with Y02 code.

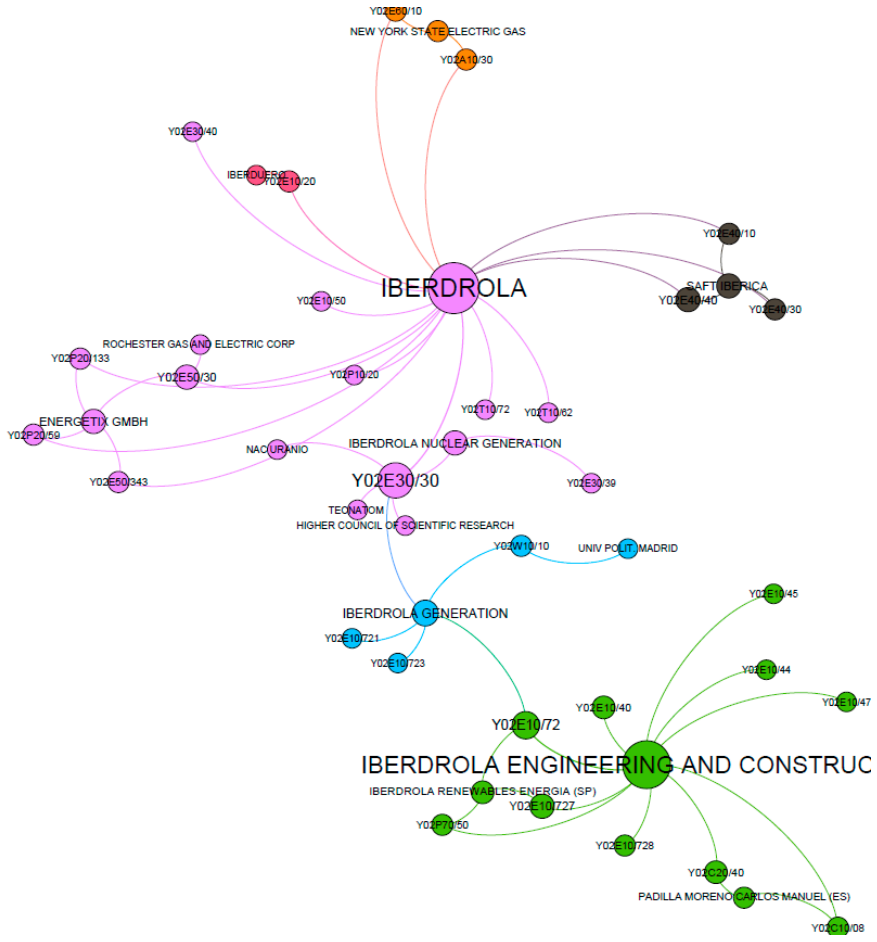

Figure 22. Network linking Assignees with Y02 code.

Once Iberdrola's collaborative relationships for its technological development in different technical domains were analyzed and identified, it was important to determine how the company had evolved in its technical work areas. To this end, the profile of the patents was analyzed by priority year and CPC code. As shown in Figure 23, the number of patents in which Iberdrola participated started to regain importance (after some relatively unproductive years at the beginning of the decade) from the year 2007–2008, emphasizing its wide technical diversification, especially in the year 2015, which implied greater collaborative diversification, and the year 2012, as a more productive year but with a greater concentration of technological fields. Regarding CPC Y02, it is important to highlight the importance it acquired in the last 10 years, directing innovative efforts towards technologies that prevent climate change.

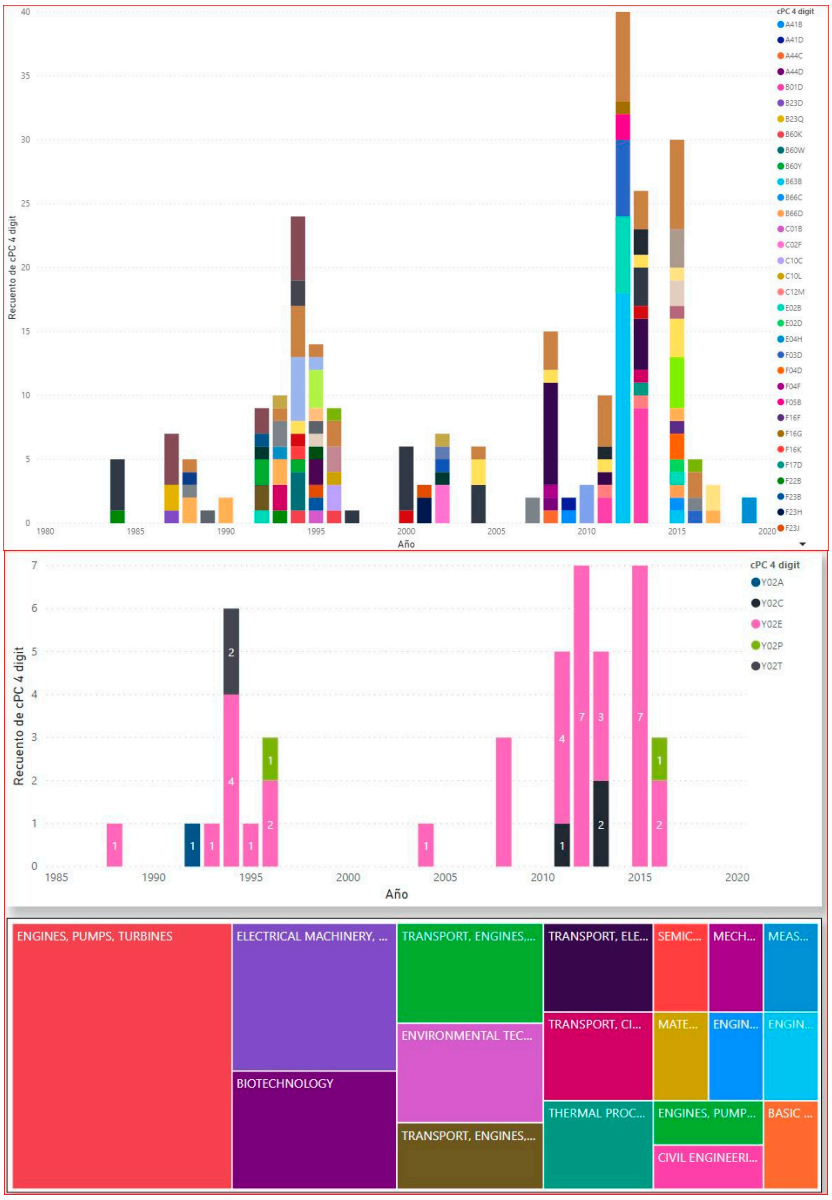

Figure 23. Iberdrola's patents profile by priority year and CPC code.

3.3. A Sustainable Business Model Innovation

The change in direction of Iberdrola's strategy towards an innovation management model based on the OI paradigm denoted a significant increase in its research, and technological development resulted

in a collaborative way, as this research work shows. However, could it be said that this strategic change had an effect on the company's reputation? A company's reputation, being intangible, is very difficult to quantify. Nonetheless, there are various ways to measure it. One of the most established measures of reputation is ranking by media, such as Fortune, which is widely used by the scientific community to measure the link between reputation and other strategic variables [28]. One of the attributes used by Fortune [50] is long-term value creation that integrates financial, social, and environmental values to establish a sustainable business model. In addition, different studies confirm that companies with good performance in environmental, social, and governance (ESG) issues boast superior financial performance [29,51]. According to Schoenmaker and Schramade [29], a qualitative and quantitative evaluation of the ESG issues to be analyzed makes it possible to ascertain the financial impact it produces. As Figure 24 shows, the financial impact of the qualitative and quantitative information on ESG is measured through sales growth. In the case of innovation management (as an ESG issue), qualitative information about the innovation process is established and the quantitative information measures the expenditure in R&D, and consequently the financial impact indicator is established in the increase of sales. If we turn to the company Iberdrola, the creation of long-term value of innovation management is qualitatively focused on the OI perspective.

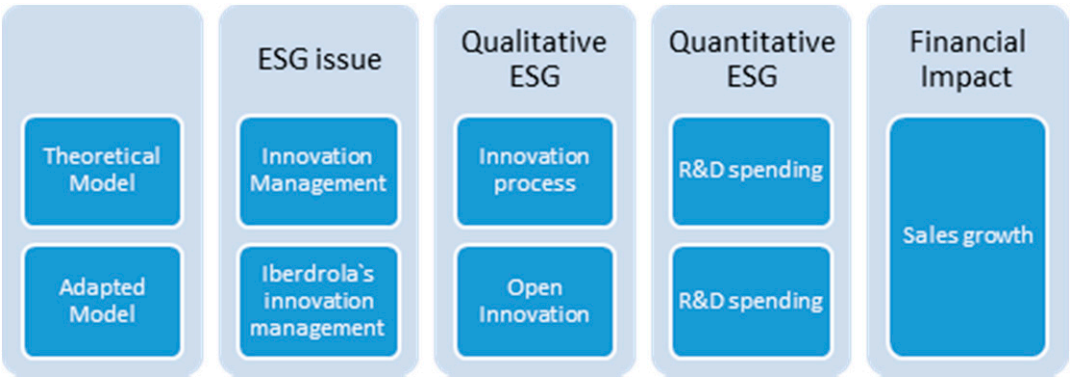

Figure 24. The financial impact of the qualitative and quantitative information about ESG issues. Adapted from Schoenmaker and Schramade [29].

Therefore, if we consider long-term value creation as an attribute that allows us to measure the reputation of the company Iberdrola and, in turn, innovation management as the material ESG issue to measure, then the measurement is carried out qualitatively through an OI perspective analyzed through the indicator based on the company's scientific development and quantitatively through R&D expenditure. The financial impact of the action taken was measured through the company's sales (as shown in Figure 24). This cause–effect relationship is represented graphically in Figure 25, from 2010 when the company Iberdrola received certification in R&D management systems. Iberdrola's scientific development generated an average of 23 publications per year in the last 10 years and, as a result of the study carried out, the development approach was collaborative, mainly with universities and research centers. In addition, R&D expenses increased in recent years. The financial impact of both are reflected in sales, which indicate an increase in sales of about EUR 6 billion between 2010 and 2019. Therefore, the implementation of the OI perspective can be considered a key element in Iberdrola's innovation system, boosting relations between universities and institutions, among others, and having a positive impact on the company's sales results. In addition, within the Fortune Global 500 [52], Iberdrola ranks at number 303.

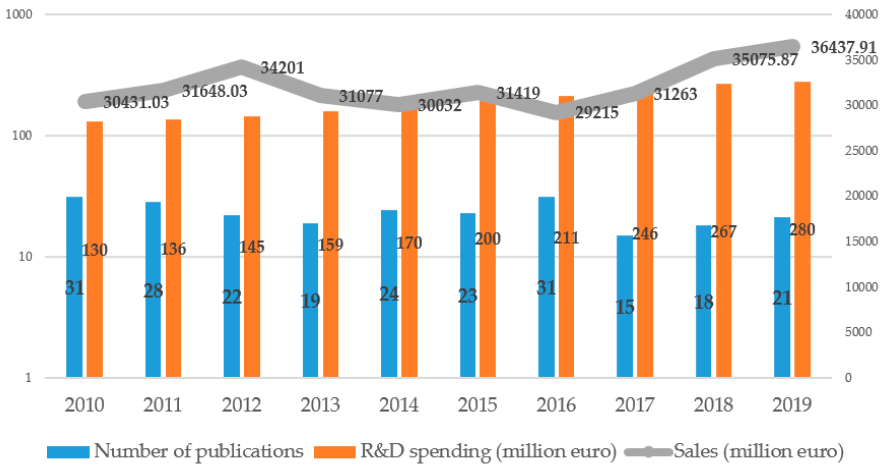

Figure 25. Number of publications, R&D spending, and sales of Iberdrola (2010–2019). Data on R&D spending and sales obtained from Iberdrola's annual reports [53].

4. Discussion and Conclusions

The results show that the company Iberdrola has always valued the promotion of scientific development and, therefore, its relationship with the scientific community, becoming a strategic line to follow and with further importance since 2005. As with its technological path, after a halt in the early 2000s, the company was able to recover its inventions and diversify its fields of action after 2008.

Iberdrola's first sustainability report was written in 2004 [54], and with it, the beginning of its commitment to a model of sustainable growth and respect for the environment, changing its profile to that of an energy company with corporate social responsibility. In addition, since 2013 Iberdrola has reinforced this line by implementing sustainable management policies [55], complementing other previous policies associated with climate change and the environment [56,57]. In the results of the study, the analysis of the research terms establishes 2009 as the first time that the term "OI" appears in Iberdrola's scientific publications. This was the year in which Tejedor-Escobar and Martinez-Cid [24], through their publication, introduced the scientific community to the new system of R&D management and innovation and collaboration management, known as innovation network, which Iberdrola launched in order to develop and promote a culture of knowledge. From that year onward, the number of publications in co-authorship with Iberdrola increased, remaining constant until now and investigating certain areas related to management (management of information, business schools, and sustainability). With this, the company Iberdrola chose to strengthen its innovation policies, making OI a strategic axis to carry out innovative and sustainable projects through collaboration with universities and other institutions [27]. This is corroborated by the network analysis carried out in the study. Iberdrola has a solid, sound network of scientific collaboration with other institutions, its main links being universities and research centers in Spain, while also maintaining the same strength of collaboration with international sections of universities and international research centers, creating a network that has nodes in America, Asia, and Europe. Moreover, it should be noted that both national and international companies direct their efforts towards collaborative scientific development, indicating an advancement in business management of open and collaborative innovation.

With regard to patents, between the years 2000 and 2006 there was a slowdown in the number of inventions, suggesting that this may be due to a change in the company's strategic approach, with the development of technological innovations losing strength. However, from 2007 to 2008 Iberdrola once again promoted technological development, becoming involved in different technical domains and, therefore, promoting the network of collaborations. Contrary to what happens in scientific development, this network of collaborations is mainly formed by companies that share the ownership and future commercial development of the patent with Iberdrola. All this justifies the correct implementation of strategic policies that value collaborative work as an improvement of the

innovation system. As for the sustainability approach, the definition of the CPC codes makes it possible to identify innovations or technological developments that mitigate climate change, such as Y02 [58,59]. Therefore, the results related to the number of patents classified in this technical area validate the approach to management and sustainable development that Iberdrola has been promoting since 2004.

This research study confirms that the strategic change of management set by Iberdrola, focusing its business management on a new approach based on OI, has enabled it to attain a good situation in its contribution to both scientific and technological development, thanks to collaborations with various universities, research centers, and companies that are committed to sustainable and open innovation. This approach has resulted in an increase in its reputation as a sustainable company. Therefore, the strategic approach towards a sustainable business model promotes the implementation of innovative processes open to collaboration with other entities, which produce a positive financial impact on the company.

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Mapeo de la evaluación del ciclo de vida social: la ciencia hacia la participación industrial

Mapping social life cycle assessment: science toward industrial involvement

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1. INTRODUCCIÓN

La evaluación del ciclo de vida social (sLCA) es una metodología para apoyar la toma de decisiones sobre los impactos sociales positivos y negativos relacionados con los ciclos de vida de los productos. En 2009, una iniciativa conjunta del Programa de las Naciones Unidas para el Medio Ambiente (*PNUMA)* y la Sociedad de Toxicología y Química Ambiental (*SETAC*) sobre el ciclo de vida publicó unas directrices para seguir esta metodología.

Según el PNUMA, el sLCA es una de las tres metodologías que se han desarrollado para evaluar la sostenibilidad del ciclo de vida de las organizaciones, los productos y los servicios. Sin embargo, el aspecto social por sí solo no es suficiente para evaluar la sostenibilidad. La definición original de sostenibilidad abarca tres componentes o pilares: el medio ambiente, la economía y los aspectos sociales. A la hora de diseñar un producto, estos tres "pilares" de la sostenibilidad deben evaluarse y complementarse de forma equilibrada [1]. Las otras dos metodologías son la evaluación del ciclo de vida (LCA) y el cálculo del coste del ciclo de vida (LCC). La combinación de LCA, LCC y sLCA basada en el concepto de sostenibilidad de los tres pilares da como resultado una Evaluación de la Sostenibilidad del Ciclo de Vida (LCSA). Con este uso combinado de las herramientas LCSA es posible determinar "hasta qué punto un producto es más sostenible que otro" [2].

En Horizonte 2022 [3] el cálculo del impacto ambiental (LCA) y del coste (LCC) es una tarea obligatoria para optimizar las líneas de producción y/o los productos. En consecuencia, el análisis completo del LCC omite el sLCA. Una forma de comprobar su relevancia en la comunidad científica es empleando técnicas bibliométricas para analizar la evolución de las publicaciones sobre este tema; identificando los países y organizaciones que investigan y sus redes de colaboración. Teniendo en cuenta que la principal aplicación del sLCA reside en los productos, procesos o servicios de las empresas [4], las empresas serán las principales responsables de la aplicación de esta metodología. Se trata, por tanto, de un factor estratégico clave para las empresas. Así, en el caso de que las empresas decidan aplicar metodologías sLCA en sus procesos, esta información científica les resultará muy valiosa, ya que podrán remitirse a estas organizaciones e incluso entrar en redes de colaboración. Sin embargo, también es importante identificar aquellas empresas privadas que investigan sobre sLCA y cuáles de ellas lo aplican en sus modelos de gestión. Por todo ello, merece la pena conocer las consecuencias sobre la reputación de estas empresas que investigan y aplican estas metodologías, midiendo los resultados financieros. Para ello, el modelo medioambiental, social y de gobierno (ESG) cumple con los requisitos adecuados. Los criterios ESG son un conjunto de normas para el comportamiento de una empresa.

Tras realizar una búsqueda en diferentes bases de datos científicas, se ha encontrado que este tipo de análisis no se ha realizado previamente. Ramos Huarachi et al., además de distinguir cuatro etapas en la investigación para el período 1996 a 2019, analizan las tendencias de investigación en sLCA y concluyen que la mayoría de los casos de aplicación son análisis. Las tendencias de investigación muestran el uso de la Base de Datos de Puntos Calientes Sociales como base de datos, y el uso del Método de Evaluación de Subcategorías como marco de investigación [5]. También se realiza un estudio bibliométrico para el período 2003 a 2018 por Huertas-Valdivia et al. [6]. Detectan lagunas en los métodos de investigación, marcos utilizados, paradigmas e indicadores. Otro análisis bibliométrico es el realizado por Petti et al. [7], donde se revisan las diferentes aplicaciones. Dubois-Iorgulescu et al. también revisan los métodos utilizados. Distinguen dos enfoques en los estudios de casos: el enfoque técnico, centrado en los procesos, y el enfoque socioeconómico, que considera las organizaciones como unidades del sistema [8]. El objetivo del artículo de Pollok et al. es identificar los desarrollos pasados y las barreras metodológicas del sLCA, desde 2015 hasta 2020 [9]. Esas barreras que obstaculizan la aplicación del sLCA son el gran número de categorías y subcategorías de impacto, la no integración de los Objetivos de Desarrollo Sostenible (ODS) y la dificultad de vincular y supervisar el LCA con los impactos sociales. Finalmente, en su artículo, Mesa Álvarez y Ligthart presentan las metodologías actuales que se han desarrollado para realizar un sLCA, además de mostrar las principales diferencias entre ellas [10]. Concluyen que la comunidad científica utiliza mayoritariamente la metodología del PNUMA/SETAC, sin embargo, la Mesa Redonda de Métricas Sociales de Producto (PSIA) propone un enfoque más orientado a la industria para responder a la demanda de las empresas manufactureras.

Todas estas revisiones bibliométricas analizan las diferentes metodologías y/o aplicaciones utilizadas en sLCA pero no desde un punto de vista de red, es decir, vinculando la investigación entre diferentes países o instituciones. Además, no existen investigaciones que analicen el impacto reputacional de las empresas que investigan y aplican modelos sLCA. Por ello, los objetivos de este trabajo son analizar la evolución del número de publicaciones para comprobar su relevancia a lo largo del tiempo, y analizar el rendimiento académico relacionado con los países y las organizaciones, identificando dónde y quién realiza la investigación. Esto nos permite plantear el siguiente objetivo que es utilizar los criterios ESG para analizar la

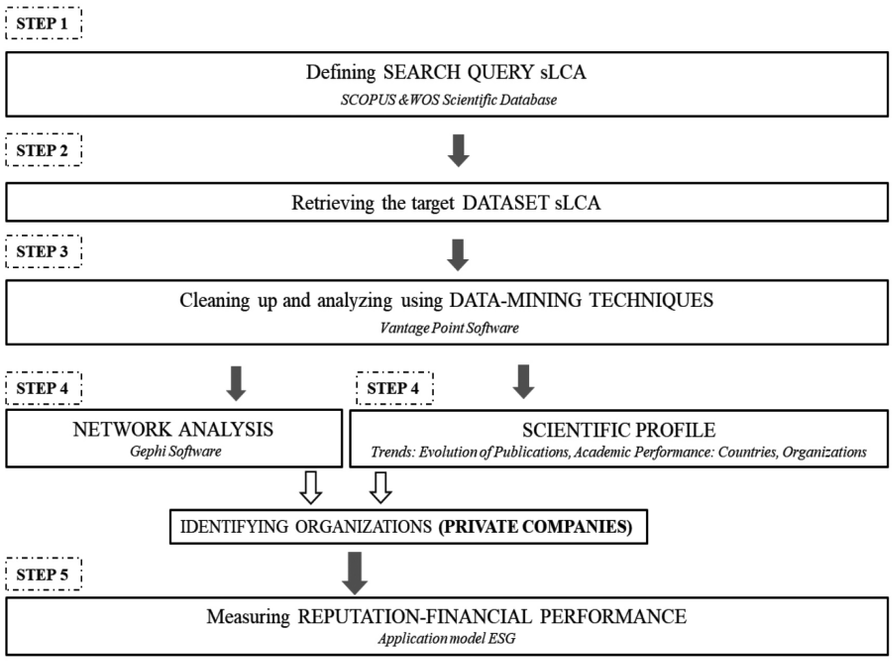

Fig. 1. Proceso metodológico

reputación de las empresas que desarrollan y aplican el modelo sLCA identificado en el objetivo anterior. A continuación, analizaremos si la aplicación del sLCA beneficia aún más a la empresa en términos de rendimiento financiero.

2. MATERIALES Y MÉTODOS

Tras analizar diferentes procesos de investigación publicados, se ha adaptado el proceso realizado por Álvarez-Meaza et al. [11]. Este proceso consta de cinco pasos:

Paso 1: Definir la consulta de búsqueda. El objetivo de este paso es definir la búsqueda para generar una base de datos sobre la que empezar a trabajar. Para ello, se ha decidido obtener datos de dos bases de datos de publicaciones científicas que ofrecen herramientas sólidas para medir la ciencia, a saber, Scopus y WOS. En consecuencia, se ha definido una consulta para cada una de las bases de datos.

La consulta de búsqueda de sLCA adaptada a la base de datos Scopus, es la siguiente:

TITLE-ABS-KEY ("soci* life* cycle* assessment*" OR "soci*life*-cycle* assessment*" OR "soci* life*analys*" OR "soci*life*_cycle*analys*") OR AUTHKEY ("sLCA" OR "s_LCA") AND (EXCLUDE (EXACTKEYWORD, "XML" OR "Algorithms" OR, "XMLData" OR "XMLKeywordSearch") AND (LANGUAGE, "German" OR "French" OR "Japanese" OR "Spanish").

La consulta de búsqueda de sLCA, adaptada a la base de datos WOS, es la siguiente:

(TS= (("soci* life* cycle* assessment*) OR ("soci* life* -cycle* assessment*") OR ("soci* life* cycle* analys*") OR ("soci* life*- cycle* analys*")) OR AK="s-LCA*") AND IDIOM: (English) Refined by: [excluyendo] CATEGORÍAS DE LA WEB DE LA CIENCIA: (ANESTESIOLOGÍA)

Paso 2: Recuperación de datos: Tras introducir las consultas en las dos bases de datos, se realizó la búsqueda y se obtuvo y exportó un conjunto de datos de 882 publicaciones, 492 de la base de datos Scopus y 390 de la base de datos WOS.

Paso 3: Limpiar la base de datos refinada: Mediante el uso de Vantage Point (VP), software de minería de datos y textos utilizado para la limpieza y normalización de datos bibliográficos en bruto [12], se limpiaron los datos obtenidos de las dos bases de datos, eliminando los artículos duplicados y aplicando algoritmos de lógica difusa para limpiar los campos de datos. El conjunto de datos resultante, de 575 artículos, estaba listo para el análisis estadístico mediante VP.

Paso 4: Generar el perfil científico sLCA y el análisis de redes. Este perfil científico definirá las tendencias de publicación y el rendimiento académico, y el análisis de la red se llevará a cabo a través del software VP y Gephi. Gephi se utiliza para mapear la ciencia, analizando gráficamente las principales relaciones de los temas de investigación. Tanto el análisis de redes como el rendimiento académico nos permiten identificar las empresas privadas que investigan en sLCA y estudiar si también lo implementan en sus modelos de negocio.

Paso 5: Análisis de la reputación corporativa y de los resultados financieros de estas empresas a través de criterios SG. Tomando como referencia el modelo ESG de Schoenmaker y Schramade [13], se mide el impacto que la investigación y la aplicación de sLCA puede tener en la reputación de la empresa. sLCA se considera como el input del modelo y el comportamiento financiero como el output.

3. RESULTADOS

3.1. EVOLUCIÓN DE LAS PUBLICACIONES

El número de artículos publicados sobre un tema y su evolución son buenos indicadores de la relevancia de la investigación. Se ha analizado el número de artículos publicados sobre sLCA desde una perspectiva temporal, (Figura 2). La tendencia al alza es evidente, especialmente en 2018 y 2019 (hay que tener en cuenta que en 2021 faltan 2 meses, ya que el análisis se realizó en octubre de 2021).

3.2. RENDIMIENTO ACADÉMICO: PAÍSES

Otra perspectiva del análisis bibliométrico es el estudio de la investigación por países, lo que permite identificar la ubicación geográfica de la investigación realizada. Esto responde a la pregunta de dónde se está investigando. El país con mayor número de publicaciones es Ale-

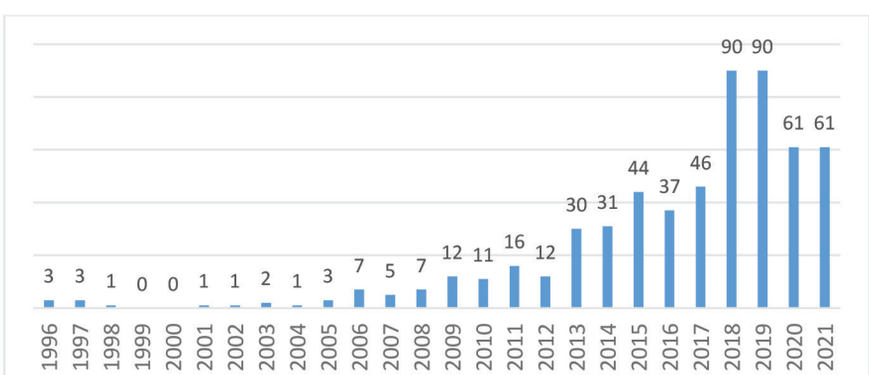

Fig. 2. Evolución de las publicaciones sobre sLCA

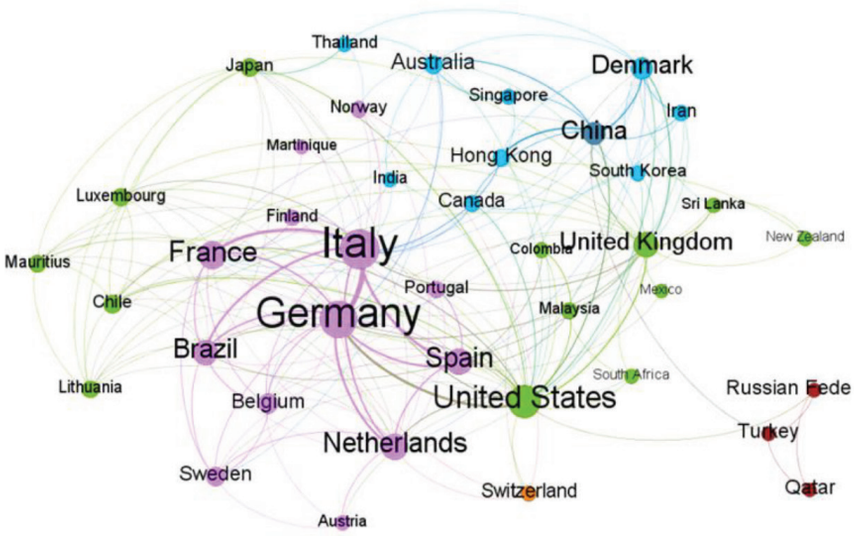

Fig. 3. Colaboración en la investigación por países

mania, con 103 publicaciones, seguido de Italia, con 83, y Estados Unidos, con 59. Para establecer el grado de colaboración entre países a partir de una matriz de co-ocurrencia, se genera la red y se visualiza a través del software Gephi (ver Figura 3).

Esta red muestra los países que han colaborado al menos dos veces. La modularidad de la red permite analizar el nivel de agrupación por afinidad que se produce en las colaboraciones. En este caso, teniendo en cuenta que los valores de modularidad están entre 0 y 1, la modularidad es baja (0,244), lo que indica que se generan pocos clusters, es decir, pocos grupos de trabajo y algunos bastante grandes. En el caso del clúster 1 (púrpura), liderado por Alemania, el grupo de colaboración está liderado por países europeos junto con América. El cluster 2 (verde), liderado por EEUU donde se observa la afinidad de colaboración con países europeos, americanos, africanos y asiáticos, y el tercer cluster más importante (azul) liderado por China, colaborando con Asia, América y Europa.

El análisis de la red identifica el grado de colaboración entre los diferentes países, identificando los países más colaboradores, los más intermediarios y los más influyentes en el desarrollo de la investigación sobre sLCA, como se muestra en la Tabla 1. Destaca que Italia, a pesar de ser menos productiva que Alemania, tiene un enfoque más colaborativo de la investigación y a su vez influye en otros países. Estados Unidos comparte esta característica, siendo el país más influyente e intermediario para el trabajo cooperativo entre países. Este nivel de colaboración demuestra que el desarrollo de la investigación en el área de las sLCA no está concentrado geográficamente. Además, las colaboraciones lideradas por estas potencias económicas permiten a otros países menos competitivos participar en grupos de investigación internacionales.

3.3. RENDIMIENTO ACADÉMICO: ORGANIZACIONES

En cuanto a las instituciones que han publicado sobre sLCA, las universidades dominan claramente. De hecho, las 10 primeras instituciones que publican sobre este tema de investigación son todas universidades. La Universidad Técnica de Berlín ocupa el primer lugar, con 29 publicaciones, seguida de la Universidad Técnica de Dinamarca, con 22. Le siguen la Universidad Rhein Westfal TH Aachen (RWTH) con 17 publicaciones, la Universidad Federal de Tecnología-Paraná con 15 y la Universidad Politécnica de Hong Kong también con 15. A estas instituciones les siguen la Universidad Gabriele d'Annunzio de Pescara, la Universidad Mediterránea de Reggio Calabria, la Universidad Tecnológica de Chalmers, la Universidad New Earth y la Universidad de Utrecht, por este orden. También cabe destacar que, de estas 10 universidades, siete son europeas.

Rango	La mayoría de los países colaboradores	Grado ponderado	País intermediario	Centralidad de la interinidad	Países de influencia	Centralidad de proximidad
1	Italia	73	EE.UU.	298.03609	EE.UU.	0.684932
2	Alemania	68	Reino Unido	147.884835	Alemania	0.617284
3	EE.UU.	53	Italia	139.259687	Italia	0.609756
4	Francia	41	Francia	129.34325	Francia	0.609756
5	España	36	Alemania	124.119029	Reino Unido	0.609756
6	Países Bajos	36	España	97.668891	Países Bajos	0.581395
7	Brasil	33	China	71.125098	España	0.549451
8	Reino Unido	33	Brasil	56.696999	Brasil	0.549451
9	China	26	Países Bajos	41.59795	China	0.515464
10	Canadá	9	Canadá	4.695725	Canadá	0.46729

Tabla 1. Países más colaboradores, intermediarios e influyentes

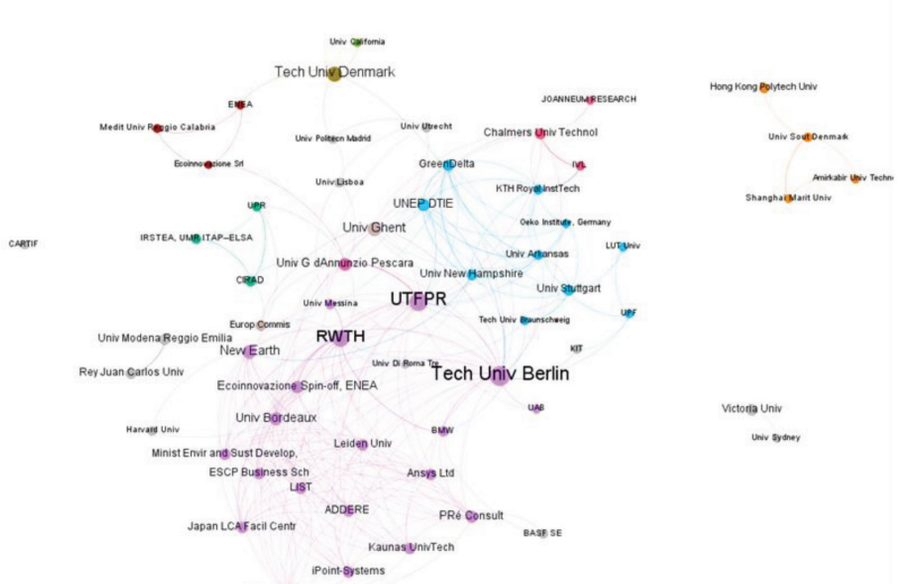

Fig. 4. Rendimiento científico. Instituciones

Para identificar los principales grupos de investigación, se hace una red a partir de una matriz de co-ocurrencias, como se muestra en la Figura 4.

La red tiene una alta modularidad (0,805), lo que indica que hay muchos clusters o grupos de colaboración. En esta red, el cluster púrpura es el principal, liderado por la Universidad Técnica de Berlín, seguida por la Universidad Federal de Tecnología-Paraná (UTPFR), la Universidad Rhein Westfal TH Aachen (RWTH) y la Universidad New Earth. Además de otras universidades, aparecen en este clúster otras instituciones, concretamente consultorías y empresas como BMW y BASF. El segundo clúster (azul) está dirigido por la División de Tecnología, Industria y Economía del Programa de las Naciones Unidas para el Medio Ambiente (UNEP DTIE). La consultora Green Delta y varias universidades también forman parte de esta red. La Universidad Técnica de Dinamarca y la Universidad de Gante dirigen pequeños grupos de investigación y se encuentran entre las instituciones que más colaboran. Además, tanto el análisis de la red como los datos estadísticos obtenidos en VP permiten identificar a las empresas privadas que colaboran en el desarrollo de la investigación científica.

3.4. ORGANIZACIONES PRIVADAS

Teniendo en cuenta que el objetivo final de sLCA es su aplicabilidad en el ámbito empresarial, es importante determinar si alguna de las organizaciones que desarrollan ciencia relacionada con el tema procede del mundo empresarial. En este análisis se han identificado empresas del sector del automóvil (BMW, Daimler, Volkswagen, Goodyear...), del sector químico (BASF, Avantium...), del sector energético (EDEF, GDF, JPS, Rina...), del sector del acero (Arcelor Mittal, Mahindra Sanyio...), del sector informático (Dell...) y de la consultoría (Ernst&Young, KPMG...).

3.4.1. Publicaciones

Se han identificado las empresas privadas que más han investigado sobre el sLCA. BMW, con ocho publicaciones, seguida de BASF y Brødrene Hartmann con cuatro cada una, son las empresas más implicadas en el desarrollo científico de esta área de conocimiento. Les siguen Ceramiche Gresmalt, con tres publicaciones, y Ansys y Daimler, con dos cada una. Al igual que en el caso de las instituciones públicas, los países líderes son Alemania y Dinamarca, con un claro dominio de los países europeos.

La empresa líder en investigación en el campo de la sLCA es el Grupo BMW, una importante multinacional alemana del sector del automóvil. Como parte de su estrategia corporativa, BMW crea valor en términos económicos, ecológicos y sociales. Los esfuerzos de responsabilidad social de BMW se centran en tres pilares: productos y servicios, producción y creación de valor, y empleados y sociedad [14].

BASF, la segunda empresa líder en investigación, es una multinacional química alemana y el mayor productor de productos químicos del mundo. En 1996, la corporación BASF desarrolló una metodología de análisis de ecoeficiencia para evaluar tanto el impacto económico como el ambiental de las sustancias químicas, los procesos y los productos durante su ciclo de vida [15]. Ha continuado investigando normas para las metodologías que se aplican al sLCA, y ha desarrollado la metodología SEEbalance®. De hecho, esta metodología para evaluar la sostenibilidad de diferentes alternativas de productos y procesos se mejoró y perfeccionó en 2019 y se ajusta a los procedimientos de sLCA [16].

La tercera empresa por número de publicaciones después de BASF es Brødrene Hartmann, una empresa danesa y el mayor fabricante mundial de tecnología para la producción de envases de fibra moldeada. Según el informe de sostenibilidad de Hartmann, sus cartones de huevos sostenibles consisten exclusivamente en fibra moldeada hecha de papel reciclable. Esta fibra moldeada es biodegradable y puede reciclarse de nuevo después de su uso. Las aguas residuales y las emisiones de las instalaciones de producción se controlan estrictamente [17].

3.4.2. sLCA y su impacto financiero en las empresas

El objetivo de sLCA es medir los impactos sociales del ciclo de vida del producto, por lo que su ámbito de aplicación se encuentra principalmente en las empresas. El Grupo BMW, BASF y Brødrene Hartmann, las empresas privadas que más investigan sobre sLCA, pretenden aplicar esta metodología en el ciclo de vida de sus productos. En el caso de BMW, los vehículos de motor; BASF, los productos químicos y Brødrene Hartmann, los envases.

Los beneficios sociales generados por la investigación y la aplicación de la metodología sLCA tienen un impacto directo en la sociedad, es decir, en las diferentes partes interesadas. Sin embargo, ¿cómo se pueden medir estos beneficios sociales y qué influencia pueden tener estos beneficios en las empresas? Una forma de medir estos impactos sociales de las inversiones realizadas por las empresas es a través de los criterios ESG. Estos criterios ayudan a conocer los futuros resultados financieros de las empresas [18]. Diferentes estudios confirman que las empresas con un buen desempeño en cuestiones ambientales, sociales y de gobernanza (ESG) obtienen un rendimiento financiero superior al aumentar su reputación [19]. La figura 5 muestra un modelo adaptado del modelo de Schoenmaker y Schramade [13]y el impacto financiero de la información cualitativa y cuantitativa en el sLCA. Se trata de evaluar la cuestión material, sLCA, desde 2 perspectivas, cualitativa y cuantitativa.

La perspectiva cuantitativa se mide contando el número de artículos relacionados con el sLCA publicados por la empresa. El indicador para evaluar la perspectiva cualitativa en este modelo son los beneficios sociales que la implantación de sLCA genera para las distintas partes interesadas. Estos dos indicadores tienen un impacto positivo en la reputación de la empresa, lo que genera un aumento de las ventas. Aunque la reputación de una empresa es un intangible y, por tanto, difícil de medir, según este modelo, el crecimiento de las ventas puede ser un buen indicador de la reputación de una empresa. La tabla 2 muestra cómo BMW, BASF y Brødrene Hartmann han aumentado sus ventas entre 2016 y 2020. En el caso de BMW este incremento de ventas ha sido del 5% en este periodo, BASF del 2,76% y Brødrene Hartmannn del 22,13%.

La reputación también puede medirse a través de los diferentes rankings de empresas líderes que publica anualmente la revista Fortune. Según estos rankings de Fortune, BMW ocupa el puesto 54º en el Global 500 2021 y BASF, el 134º (las empresas con mayor facturación). En el ranking de las empresas más admiradas del mundo 2021, BMW ocupa el puesto 35º [20].

4. CONCLUSIONES

A partir de los datos obtenidos, se puede concluir que el sLCA, como metodología para medir los impactos sociales de las empresas, se ha convertido en un área activa de investigación en los últimos años. Además, el desarrollo científico se lleva a cabo en países situados en Europa, Asia y América, lo que justifica la no concentración geográfica de la investigación. La investigación está liderada por países económicamente poderosos que, a su vez, colaboran con otros países de me-

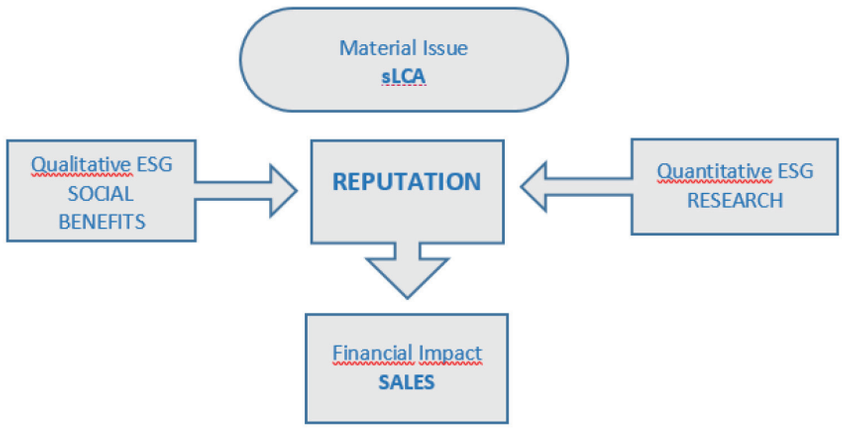

Fig. 5. El impacto financiero de la información cualitativa y cuantitativa sobre cuestiones ASG, adaptado del modelo de Schoenmaker y Schramade

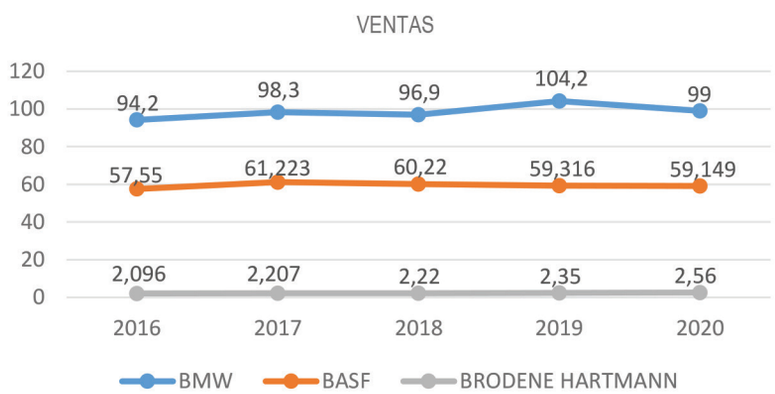

Tabla 2. Ventas de BMW, BASF y Brødrene Hartmann en millones de euros

nor relevancia económica, lo que facilita la participación de estos países en la investigación sobre sLCA.

En cuanto a las organizaciones, el mundo académico, como la universidad, es líder en el desarrollo de la investigación, lo que pone de manifiesto la relevancia de las universidades europeas en la investigación. Además, existen algunas empresas privadas que han implementado el sLCA dentro de su modelo de gestión y que a su vez colaboran con las universidades en su desarrollo científico. Centrándonos en estas empresas privadas, podemos concluir que la investigación y aplicación de sLCA en los productos o procesos de estas empresas mejora su reputación, según el modelo ESG definido por Schoenmaker y Schramade. En consecuencia, la aplicación e investigación en sLCA da lugar a que las empresas mejoren sus resultados financieros, como en el caso del aumento de las ventas.

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News versus Corporate Reputation: Measuring through Sentiment and financial analysis

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Abstract

Today's companies cannot overlook their reputation if they want to continue to survive. One way to measure that reputation is through two factors: sentiment analysis of news stories in the press about those companies and the financial data of those companies. In this research, the sentiment analysis of news stories about several Euro Stoxx 50 companies for the years 2016 and 2019 has been carried out. For this purpose, the lexicon-based tools VADER and Hu Liu have been used. Then the trends of the results obtained for this four-year period have been analyzed and compared with the trends in their operating results in the same time period. The results obtained indicate that there is a high correlation between the sentiments reflected in the news and their operating results, i.e., when news sentiment about a company improves, its reputation also improves, and this causes its sales to increase. The same is true in the opposite direction.

Keywords: *Sentiment Analysis; Corporate Reputation; VADER SA tool, Hu Liu SA tool*

1. Introduction

In today's society, companies have increasingly more data at their disposal. This data may contain strategic information for companies, however, it is so voluminous that it is not easy to analyse it in the traditional way, making the use of artificial intelligence and data mining indispensable (Agarwal, 2020). In this context, sentiment analysis is a sub-discipline that falls under the umbrella of data mining and computational semantics. According to Gilbert and Hutto (Hutto & Gilbert, 2014), sentiment analysis, or opinion mining, is an active area of study in the field of Natural Language Processing (NLP) that analyses people's opinions, feelings, evaluations, attitudes and emotions by computationally processing subjectivity in text. It refers to the understanding of collected data obtained from sentiment-rich sources such as news, social media sites, reviews, etc. (Agarwal, 2020). Therefore sentiment analysis is concerned with extracting sentiment, opinions and emotions from text (Ravi & Ravi, 2015) and has applications in a wide range of domains, from customer satisfaction to political opinions (Medhat et al., 2014) (Mäntylä et al., 2018) (Ravi & Ravi, 2015).

Another aspect that companies cannot overlook is their reputation, as it affects, among other factors, consumer satisfaction. (Chun, 2005). According to Raithel in his article "The value-relevance of corporate reputation during the financial crisis" (Raithel et al., 2010), corporate reputation can be measured through 2 indicators: the sympathy felt towards the company, and the competence of that company. Consumers, when deciding on a company's reputation, rely on data received through word of mouth, news, advertising, etc. (Kossovsky, 2012). Therefore, one way to measure this sympathy for the company can be through sentiment analysis of news stories about those corporations. If the consumer perceives that the news has a positive tone about the companies, they will have more sympathy towards them and the company's reputation will increase.

The Python tool, VADER (Valence Aware Dictionary and Sentiment Reasoner), a sentiment analysis framework, uses a lexicon-based approach to determine the sentiment values of a sentence. This is used in conjunction with sentiment values explicitly assigned to keywords commonly found among news headlines, or in individual emails (Agarwal, 2020) (Borg & Boldt, 2020). This sentiment extraction typically results in a score that can be translated into positive, neutral or negative (Hutto & Gilbert, 2014). Another frequently used instrument, the Hu & Liu lexicon, was developed for sentiment analysis of customer reviews. The resulting categories (lexicon-based) are Sentiment (an overall measure of positivity), Positive and Negative (good classification metrics in machine learning tasks). This tool has been chosen because it has almost exclusively been used in studies that do not focus on textual production in the social media. (Mayor & Bietti, 2021)
A substantial number of sentiment analysis approaches rely greatly on an underlying sentiment (or opinion) lexicon. A sentiment lexicon is a list of lexical features (e.g., words) which are generally labeled according to their semantic orientation as either positive or

negative (B. Liu, 2010). With Hu Liu, words are categorized into binary classes (i.e., either positive or negative) according to their context free semantic orientation. (Hutto & Gilbert, 2014). Hu and Liu present a natural language-based approach for providing feature-based summaries of customer reviews. The approach uses a part-of-speech tagger to divide words into lexical categories, as only the semantic orientation of adjectives is considered by the algorithm. The use of different instruments for the automatic coding of the same dataset is essential to assess the robustness of results across tools (Mayor & Bietti, 2021). As there are 2 suitable tools, this research will measure the reputation of companies through sentiment analysis, measured with VADER and Hu Liu. Therefore the aim of the article is to analyse the possible correlation between the sentiment analysis of news about companies and their reputation.

2. Methodology

The methodology followed to obtain and analyze the data was as follows:

STEP 1.- Choice of database: The objective is to carry out a sentiment analysis of the news on the 10 highest dividend yielding companies in the Euro Stoxx 50 as of May 2021. This database was chosen because of consistent data for these companies. These companies are: Axa, Eni, Total Energies, Intesa Sanpaolo, ING, Engie, BNP Paribas, Basf, Allianz and Daimler (*El 26% Del Euro Stoxx 50 Paga Una Rentabilidad Por Dividendo Superior Al 4% | Mercados | Cinco Días*, n.d.).

STEP 2.- Data extraction: having selected the companies, their most relevant news items according to different databases were downloaded. To do so, we went to the original source and downloaded the 500 most relevant news items by company and year from the main media. It was decided to analyse the years 2016 and 2019. In the event that a company did not reach 500 news items per year, all of them were downloaded. The total number of news items per company per year is as follows:

Table 1. Extracted news items per year.

Year	2016	2019	TOTAL
News Items	3,994	3,838	**7,832**

For each of the selected companies 1,000 news items (500 per year) have been extracted, with 3 exceptions: *Intesa San Paolo* had only 482 news items in total, ING 250 news items in total, and Total Energies, due to its numerous name changes over the years, produced very little news, so it is not counted. Therefore the total number of news items is 7,832.

STEP 3.- Cleaning and classification of extracted data for SA: Having downloaded all of the news items in txt format, they are imported into the data mining software Vantage Point (W. Liu & Liao, 2017), through which the raw data can be structured for subsequent export in xlx-csv format.

STEP 4.- Conducting Sentiment Analysis: The news items are ready to be exported to Orange, a machine learning and data mining suite for data analysis through Python scripting (Demšar et al., 2013). Now the sentiment analysis of each of the news items will be carried out using the VADER and Hu Liu tools.

STEP 5.- Analyzing the correlation between the Sentiment Analysis of the news and the operating results, by company: The possible correlation between the trend between the Sentiment Analysis with VADER and Hu Liu and the operating profits of each company is analyzed.

3. Results

Once the Sentiment Analysis of the extracted news has been carried out, the results obtained, classified by company and tool used, are as follows:

Table 2. Results of the Sentiment Analysis of the news

	VADER		**HU LIU**	
	2016	**2019**	**2016**	**2019**
AXA	0.5534	0.6067	0.5560	0.9739
ENI	0.4778	0.2920	0.0806	0.0826
INTESA SANPAOLO	0.2188	0.2491	-0.6068	-0.0290
ING	0.7067	0.4582	0.0721	-0.0911
ENGIE	0.6582	0.668075	0.4966	1.063754
BNP Paribas	0.2944	0.226955	-0.2662	-0.5982
BASF	0.7113	0.4003	0.3850	0.1311
ALLIANZ	0.5568	0.5682	0.07709	0.1541
DAIMLER	0.7358	0.5607	1.3256	1.03161

One way to study the data is to analyze their trend over time, and see whether they are improving or worsening. In this way it will be possible to check the trend of the sentiments and opinions reflected in the news about each company, and, since the evolution of sympathy towards these companies is being measured, to analyze whether its reputation could improve or not. An improvement in a company's reputation will, in principle, lead to an increase in sales. Consequently, the evolution in the sentiment analysis has been compared with the evolution in the operating result of each company. The data obtained are as follows in Table 3:

Table 3. Comparison of trends in news Sentiment Analysis and operating profit, by company

	VADER	HU LIU	PROFIT		VADER	HU LIU	PROFIT
AXA				**ENI**			
2016	0.5534	0.5560	7,641		0.4778	0.0806	2,315
2019	0.6067	0.9739	8,427		0.2920	0.0802	8,597
TREND	UP	UP	UP		DOWN	DOWN	UP
INTESA				**ING**			
2016	0.2188	-0.606	8,273		0.7067	0.0721	5,903
2019	0.24914	-0.029	8,760		0.4582	-0.0911	6,834
TREND	UP	UP	UP		DOWN	DOWN	UP
ENGIE				**BNP**			
2016	0.6582	0.4966	9,491		0.2944	-0.2662	10,771
2019	0.6680	1.0637	10,366		0.2269	-0.5982	10,057
TREND	UP	UP	UP		DOWN	DOWN	DOWN
BASF				**ALLIANZ**			
2016	0.7113	0.3851	5,330		0.5568	0.0770	11,056
2019	0.4003	0.1311	4,631		0.5682	0.1541	11,855
TREND	DOWN	DOWN	DOWN		UP	UP	UP
DAIMLER							
2016	0.7358	1.3256	31,963				
2019	0.5607	1.0316	29,165				
TREND	DOWN	DOWN	DOWN				

**Operating profit is shown in millions of euros*

Having obtained the data on the sympathy generated by the companies, it is time to measure the reputation of these companies. In order to measure the reputation trend of companies, two factors should be taken into account, which are also intercorrelated; the likeability that these companies induce and their financial consistency (Raithel et al., 2010). One way to measure this sympathy can be through sentiment analysis of press releases. If those sentiment analyses improve, that will mean an improvement in the company's reputation. This will lead to an improvement in sales and therefore in the operating profit. In turn, an improvement in its financial results will cause the company's reputation to improve, completing the cycle. Figure 1 shows this correlation between the trend in sympathy towards the company and the trend in operating income.

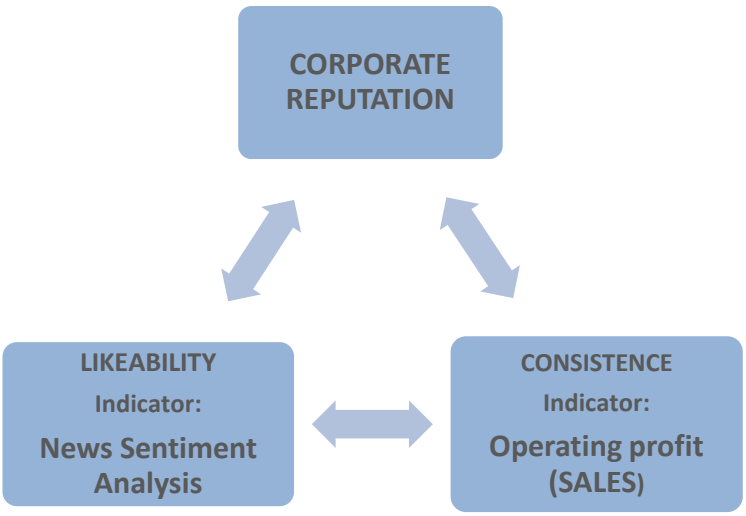

Figure 1: Corporate reputation trend measurement model

4. Conclusions

Based on the obtained data, it can be concluded that the initial thesis is correct. On the one hand, it can be seen that the VADER and Hu Liu data coincide in terms of trend. If we analyze the trend between 2016 and 2019, the trends between these two tools coincide in all cases. In 4 of the cases the trend in the sentiment analysis of the 2 tools is upward with both VADER and Hu Liu (Axa, Intesa, Engie and Allianz), and in the other 5 companies the trend is downward (Eni, ING, Bnp, Basf and Daimler). This data may be an indicator that the 2 tools coincide in their sentiment analysis measurements. If we compare these sentiment analysis trends with the trend in operating results over the same time period, we

can see that they also coincide in almost all cases, i.e., companies that have had a positive trend in their news sentiment analysis increase their operating results and vice versa. This occurs in all cases except for Eni and ING, which increase their profits within that period but lower their scores in news sentiment analysis. The reason for this discordance in the data in the case of ING may be the low number of news items analyzed with respect to the other companies (250 news items in the case of ING, and 1,000 news items in the others). In any case, the correlation between sentiment analysis and operating results is positive in 78% of the cases. Therefore, when sentiment analysis shows a positive trend, operating results increase, i.e., sales of that product increase. When the trend is negative, sales decrease.

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