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Building bridges to overcome organisational distance in the supply network: an exploratory study of exchanges opening industrial boundaries and their facilitation for a circular economy

Bâtir des ponts pour franchir la distance organisationnelle au sein du réseau
d'approvisionnement : une étude exploratoire des échanges dépassant les frontières
industrielles et de leur facilitation pour une économie circulaire

Thèse de Doctorat présentée en vue de l'obtention
du grade de docteur ès Sciences de gestion et du Management
par

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dirigée par

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Soutenance le 6 décembre 2023

Devant un jury composé de :

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L'Université n'entend donner aucune approbation ou improbation aux opinions émises dans les thèses. Ces opinions doivent être considérées comme propres à leurs auteurs.

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Résumé de la thèse en français

Le déploiement à grande échelle du modèle économique circulaire nécessite l'activation d'un certain nombre de leviers. L'un d'entre eux est la mise en œuvre d'opérations systémiques, collaboratives, et qui dépassent les frontières cloisonnant habituellement les filières industrielles (De Angelis, Howard, and Miemczyk 2018; Tate et al. 2019; Domenech et al. 2019; Jensen 2016; Ashton 2008). L'objet de cette thèse est l'étude de ces opérations.

Cette recherche s'attache à explorer la tension suivante : les échanges entre entreprises appartenant à des secteurs industriels différents présentent un potentiel prometteur dans l'établissement de nouveaux flux circulaires de ressources, or, ces échanges pourraient se révéler difficiles à mettre en jeu du fait des divergences existant entre les filières. Nous avons donc développé une étude exploratoire des opérations collaboratives à des fins de circularité impliquant plusieurs secteurs industriels, afin de comprendre leur facilitation, leur opérationnalisation et de saisir les opportunités qu'elles offrent pour le modèle économique circulaire.

Pour ce faire, nous avons articulé notre raisonnement en trois articles. Le premier est consacré à une formulation conceptuelle de ces collaborations circulaires inter-industrielles (chapitre 2). Le deuxième est dédié aux acteurs qui assurent la facilitation des collaborations circulaires au sein du réseau d'approvisionnement (chapitre 3). Le troisième est une étude de quatre exemples de ces collaborations afin de comprendre leurs conditions d'émergence et leur fonctionnement (chapitre 4). Les paragraphes suivants résument les principales conclusions des trois études, en montrant leur interconnexion et la manière dont les articles dans leur ensemble contribuent à dialoguer avec la littérature antérieure et à apporter des réponses à notre énoncé de recherche initial.

Afin de poursuivre l'objectif précédemment énoncé de cette thèse, la première étape a consisté en une réflexion permettant de disposer d'une vision claire de notre sujet de recherche i.e. répondre à la question "Qu'est-ce que je cherche ?" (Allard-Poesi and Marechal 2014) p48. L'objectif de cette première réflexion est de déterminer les contours du phénomène empirique que l'on souhaite étudier,

"l'objet concret", avant de formuler une construction théorique "l'objet de recherche", qui permette de l'étudier (Davallon 2004) p32. Il s'agit donc de l'objectif du premier article de la thèse, qui consiste en une revue de la littérature permettant de situer "la frontière entre savoir et non-savoir" (Dumez 2011) p17 : faire un état des lieux de ce qui est connu du sujet de recherche et de ce qui reste à découvrir, permettant ainsi de mettre en évidence une lacune de la littérature et ainsi donner une perspective originale à la thèse. Dans cette partie de la recherche, nous avons répondu à la question suivante :

RQ1a : Que savons-nous des collaborations entre supply chains inter-industrielles circulaires?

Des travaux récents menés dans les disciplines de la supply chain et du management ont mis en exergue que l'un des piliers sur lequel repose le modèle économique circulaire est la collaboration (Hofmann 2019; Farooque et al. 2019; Bressanelli, Perona, and Sacconi 2019; Mishra, Chiwenga, and Ali 2019; Lahane, Kant, and Shankar 2020; Bressanelli, Visintin, and Sacconi 2022). Suite à la recommandation de conduire des études complémentaires sur le phénomène, deux revues systématiques de la littérature portant sur les pratiques collaboratives au sein des chaînes d'approvisionnement circulaires ont été publiées en 2022 (Sudusinghe and Seuring 2022; Danvers, Robertson, and Zutshi 2023). Ces publications ont permis de dresser un état des lieux exhaustif et actualisé des connaissances récemment générées sur le sujet et nous avons constaté que les collaborations circulaires inter-industrielles, contrairement à d'autres pratiques de collaboration spécifiques au modèle circulaire, n'avaient pas encore fait l'objet d'études. Ayant constaté ces lacunes dans le domaine spécifique de la gestion de la chaîne d'approvisionnement concernant ce type de collaboration, nous avons proposé un résumé de ce que les sciences du management en général avait produit sur le sujet des collaborations inter-industrielles. Cette revue de la littérature a permis d'appréhender les premières dynamiques relatives au fonctionnement des collaborations industrielles dans le cadre du management de l'innovation (Kotabe and Scott Swan 1995; Gattringer et al. 2021; Enkel and Gassmann 2010), en particulier celles relatives aux aspects cognitifs (Enkel and Heil 2014; Hilda Bø Lyng and Brun 2018; Hilda B. Lyng and Brun 2019; Enkel and Bader 2016) et au lien social (Dingler and Enkel 2016) entre

les individus impliqués dans ces collaborations. Malgré ces premiers éléments de réflexion, il est apparu que l'ensemble des connaissances disponibles ne permettait pas de comprendre les enjeux liés à la circularité pour deux raisons principales. En premier lieu, les analyses menées ne se situent pas au niveau du réseau organisationnel, ce qui est indispensable pour saisir la dimension systémique du modèle circulaire (De Angelis 2021). Ensuite, les échanges étudiés sont principalement de nature immatérielle, alors que le modèle circulaire se caractérise notamment par la circulation de flux physiques (Marques and Manzanares 2022). Cela étant établi, et en poursuivant l'idée qu'un objet de recherche consiste en un concept formulé par le chercheur, la suite de l'article 1 vise à répondre à la deuxième question de recherche :

RQ1b : Quelles nouvelles perspectives théoriques peuvent être utilisées pour étudier les collaborations circulaires inter-industrielles au sein du réseau d'approvisionnement ?

Prenant en compte les limites du corpus actuel de connaissances sur les collaborations inter-industrielles (à savoir le besoin d'une perspective systémique et le besoin d'une vision holistique des échanges entre organisations, i.e. faisant état des échanges de ressources tangibles et intangibles qui ont lieu au cours des opérations circulaires), nous proposons une contribution théorique prenant la forme d'une *combinaison de perspectives théoriques* (Okhuysen and Bonardi 2011). Cette approche de construction théorique appartient à la forme générale du *bricolage théorique* (Boxenbaum and Rouleau 2011) ou des *emprunts et mélanges théoriques* (Whetten, Felin, and King 2009). Afin de satisfaire aux critères concrets d'une combinaison de perspectives théoriques admissible tels que décrits par Okhuysen et Bonardi, nous avons démontré la compatibilité et la proximité des hypothèses soutenues par les deux perspectives choisies, la théorie des réseaux pour la vision systémique d'une part (Granovetter 1983; Burt 2009) et le cadre de la proximité inter-organisationnelle (Boschma 2005) pour l'examen des échanges matériels et immatériels entre les parties à la collaboration d'autre part (Okhuysen and Bonardi 2011). A notre connaissance, bien qu'il ait déjà été mentionné que les deux perspectives présentaient "[des] idées plus ou moins alignées" (Boschma 2005) p15, cette opération de combinaison n'avait pas encore été soutenue ou formalisée avant la proposition faite dans cet article, et constitue

donc une contribution théorique. Dans cette combinaison théorique, les apports de la théorie des réseaux expliquent les mécanismes de connexion et la dynamique régissant la circulation des ressources entre les nœuds d'un réseau d'approvisionnement, tandis que le cadre de la proximité inter-organisationnelle explique les facteurs d'alignement géographiques, organisationnels, cognitifs, sociaux et institutionnels qui expliquent l'émergence et le fonctionnement de ces collaborations.

Après avoir passé en revue les connaissances produites sur les collaborations circulaires d'une part, et les collaborations inter-industrielles d'autre part, et après avoir formulé une conceptualisation des collaborations circulaires inter-industrielles, le deuxième article de la thèse se concentre sur les acteurs susceptibles de réunir des organisations appartenant à des secteurs industriels différents souhaitant établir des opérations circulaires conjointes. Il est ainsi dédié à la compréhension des rôles des acteurs facilitateurs de l'économie circulaire dans le réseau d'approvisionnement.

Contrairement aux définitions précédentes des réseaux d'approvisionnement qui se limitaient à la cartographie des flux physiques entre les membres du réseau (Choi and Hong 2002), il a été établi que d'autres flux, immatériels (tels que les flux financiers ou d'information), s'y superposent. Cela sous-tend que les agents entre lesquels circulent ces flux immatériels sont également à considérer comme des parties intégrantes des réseaux d'approvisionnement. L'inclusion de ces organisations et la reconnaissance de leur valeur ajoutée à la bonne exécution des opérations permet une compréhension plus précise et plus complète du réseau d'approvisionnement. Suivant cette logique, la chaîne d'approvisionnement circulaire est faite "non seulement [d]es collaborations amont-aval, mais aussi [d]es collaborations aval-amont impliquant des acteurs internes et externes de la chaîne d'approvisionnement" (Batista et al. 2023) p 8.

La théorie des réseaux nomme *brokers* les organisations qui créent des ponts entre les membres du réseau, également appelés *nœuds*, et permettent ainsi aux flux de ressources de circuler (Obstfeld 2005). Dans le contexte de la chaîne d'approvisionnement circulaire, ces brokers portent le nom spécifique de *brokers de circularité*, et leur fonction est définie comme "la mise en relation d'acteurs

ayant des produits ou des matériaux sans valeur pour eux, d'une part, avec d'autres acteurs qui peuvent utiliser ces produits ou matériaux pour leur propre consommation ou comme intrants pour leurs activités, d'autre part. Le broker de circularité peut réunir des parties précédemment déconnectées ou relier des acteurs qui sont déjà connectés les uns aux autres pour certaines activités de la chaîne d'approvisionnement, mais qui sont déconnectés pour le transfert des déchets" (Ciulli, Kolk, and Boe-Lillegraven 2019) p6. Cette étude fournit une première définition de ces agents qui facilitent l'échange de matières premières secondaires. D'autres études s'intéressent également à d'autres facettes des facilitateurs circulaires, comme ceux dont l'activité est dédiée à une région géographique particulière (Patricio et al. 2018), ou qui adoptent spécifiquement un modèle d'entreprise de plateforme numérique (Berg and Wilts 2019; Schwanholz and Leipold 2020; Pizzi, Leopizzi, and Caputo 2021). Le point de départ de notre deuxième article est le suivant : les activités d'économie circulaire ne se limitent pas à la transformation des déchets en ressources (i.e. recyclage), mais comprennent également d'autres types d'activités telles que la revente, la réutilisation, la réparation, le reconditionnement ou la récupération de l'eau et de l'énergie (Reike, Vermeulen, and Witjes 2018). La prise en compte de ces autres activités constitutives du modèle circulaire conduit donc à compléter la définition initiale des brokers de circularité afin d'esquisser les contours généraux des fonctions de ces acteurs émergents. Pour ce faire, nous avons formulé une première question de recherche :

RQ2a : Pourquoi les organisations qui souhaitent circulariser leurs chaînes d'approvisionnement font-elles appel aux services de brokers de circularité ?

Nous avons opté pour une méthodologie qualitative qui repose sur l'analyse d'entretiens semi-dirigés de 16 brokers de circularité. En choisissant un large échantillon, nous avons pu recueillir une grande variété d'obstacles rencontrés par les organisations les amenant à faire appel aux services des facilitateurs de l'économie circulaire. Il s'agit notamment de barrières se situant au niveau micro ou organisationnel (de part et d'autre du pont créé par les brokers entre les membres d'une collaboration circulaire), telle par exemple qu'une vision exclusivement axée sur la création de valeur financière et à court terme. Au niveau méso (celui des partenariats entre organisations), d'autres difficultés

interviennent comme celles liées au partage de la valeur créée par la collaboration circulaire, ou le manque de partenaires potentiels pour créer des opérations circulaires communes. Enfin, il existe des obstacles au niveau macro (ceux qui existent au niveau d'un secteur industriel ou au niveau sociétal), tels que le manque de maturité des solutions techniques circulaires relatives aux matériaux ou aux procédés industriels, ou encore le manque de dispositions légales encourageant les initiatives entrepreneuriales circulaires. La présence de ces obstacles à tous les niveaux d'analyse fait écho à de nombreuses publications qui postulent que seul un changement global et intégré, impliquant tous les acteurs de la société et à tous les niveaux d'analyse, peut conduire à l'adoption générale du modèle circulaire (Kirchherr, Reike, and Hekkert 2017; Korhonen et al. 2018; Prieto-Sandoval, Jaca, and Ormazabal 2018; Suárez-Eiroa et al. 2019; Velenturf and Purnell 2021; Miemczyk, Carbone, and Howard 2022). Cet inventaire des obstacles s'opposant à la circularité se situant à tous les niveaux d'analyse nous amène à la deuxième question de recherche de l'article :

RQ2b: Comment les brokers de circularité contribuent-ils à la circularité du réseau d'approvisionnement ?

Nous avons constaté que les brokers de circularité fournissent un soutien aux organisations et plus largement aux réseaux d'approvisionnement en mettant en jeu des activités impliquant des compétences techniques, méthodologiques et relationnelles. Les activités techniques rapportées sont par exemple l'expertise en innovation circulaire en matière de matériaux ou de conception, le conseil en législation relative à l'économie circulaire ou les services de data-mining dédiés à l'inventaire des gisements de matières premières secondaires. Les activités méthodologiques couvrent l'utilisation d'approches adaptées aux questions de circularité, telles que la gestion du cycle de vie ou la conception et la mise en œuvre de solutions logistiques partagées. Enfin, les brokers de circularité sont également impliqués dans des activités relationnelles, telles que les services de mise en relation qui réunissent des organisations susceptibles d'avoir un intérêt commun dans l'échange de matériaux. Nous soulignons que la valeur ajoutée des brokers de circularité est souvent basée sur une combinaison de ces trois familles d'activité. Par exemple, une mission de lobbying implique une composante technique ou méthodologique circulaire qui confère au broker sa légitimité,

combinée à des compétences relationnelles relatives à une mobilisation appropriée de son réseau et à la vulgarisation du message à délivrer, ce qui augmente in fine les chances de convaincre les décideurs. Les auteurs de l'étude qui pose la définition du concept de brokers de circularité ont proposé six rôles que ceux-ci assument dans le cadre de leur tâche de transfert des déchets entre les nœuds de réseau. Ces six rôles sont la *connexion*, *l'information*, *la protection*, *la mobilisation*, *l'intégration* et *la mesure* (Ciulli, Kolk, and Boe-Lillegraven 2019). Notre postulat de départ est que l'économie circulaire n'est pas strictement limitée aux activités de recyclage (Reike, Vermeulen, and Witjes 2018), et que le soutien à la chaîne d'approvisionnement circulaire repose sur la facilitation de flux autres que ceux strictement matériels (Carter, Rogers, and Choi 2015). Nous avons donc opté pour un échantillon qui couvre une plus grande variété de brokers en circularité que ceux précédemment considérés dans la littérature. Cet élargissement d'échantillon a résulté en deux nouveaux rôles assumés par les brokers en circularité, en plus des six décrits précédemment. Ces deux nouveaux rôles sont le *soutien* (dans l'adoption de mesures circulaires) et *l'équipement* (avec une solution circulaire, telle qu'une innovation circulaire ou un logiciel). Nous avons complété cette étude des compétences des brokers en nous appuyant sur le fait que la position occupée par le broker dans le réseau conditionne de manière déterminante leurs dispositions à remplir leur mission (Obstfeld 2005; Galunic, Ertug, and Gargiulo 2012). Nous avons donc formulé la troisième question de cet article :

RQ2c : Comment les brokers se positionnent-ils dans le réseau des entreprises qui font appel à leurs services, et comment les échanges qui en résultent affectent-ils les missions qu'ils fournissent ?

Dans le contexte de la chaîne d'approvisionnement durable, une typologie conceptuelle de brokers basée sur les interfaces qu'ils présentent avec leur réseau a été proposée (Saunders et al. 2019). Cinq interfaces théoriques ont été décrites, chacune résultant en des aptitudes plus ou moins développées des brokers dans la réalisation de différentes missions de *brokerage* relatives à la durabilité de leur réseau. Notre article soutient ces propositions théoriques en fournissant des preuves empiriques qui sont cohérentes avec les hypothèses formulées en établissant un lien entre *le degré d'encastrement* des brokers dans leur réseau et

le succès dans les missions de facilitation qu'ils entreprennent. Dans notre article, nous formulons l'hypothèse qu'un broker ayant un degré d'encastrement très faible, de type *consultant*, est plus susceptible d'introduire une solution circulaire qui était auparavant inconnue du réseau pour lequel il opère afin de l'*équiper*. A l'inverse, un broker très fortement encastéré dans son réseau, de type *coordinateur*, est susceptible de disposer une excellente connaissance de ses membres, lui permettant de comprendre leurs besoins, ainsi que d'une légitimité auprès d'eux dont il peut faire usage pour les convaincre d'adopter une solution circulaire ou de les *soutenir* dans sa mise en œuvre via une mission d'accompagnement. Enfin, un broker de type *liaison*, formant un pont entre deux réseaux d'approvisionnement distincts, est probablement le type d'acteur le mieux à même de remplir un rôle de *connexion*.

Le deuxième article de cette thèse est donc consacré aux acteurs qui soutiennent les échanges matériels de la chaîne d'approvisionnement via des flux immatériels (Carter, Rogers, and Choi 2015; Rosca et al. 2022). Le dernier article se concentre sur les acteurs entre lesquels les flux physiques de ressources sont établis, et plus particulièrement les flux qui circulent entre organisations appartenant à des secteurs industriels différents.

L'hypothèse que nous exploitons repose sur l'idée que les flux constitutifs d'un pont entre différentes industries donnent lieu à la circulation de ressources jusqu'alors cloisonnées au sein de leur chaîne d'approvisionnement d'origine, permettant ainsi la création de nouvelles boucles circulaires. Ce dernier article vise donc à comprendre comment fonctionnent les collaborations circulaires inter-industrielles. Il prend la forme de quatre études de cas de collaborations inter-industrielles circulaires. La première question de recherche de ce dernier article est donc la suivante :

RQ3a : Comment les collaborations circulaires inter-industrielles émergent-elles et fonctionnent-elles ?

Nous avons étudié les collaborations circulaires inter-industrielles en utilisant une approche de cycle de vie, ce qui nous a conduit à définir trois phases successives par lesquelles passent les collaborations réussies. Nous avons d'abord défini une

phase préalable à toute formalisation de la collaboration, au cours de laquelle l'idée d'une collaboration inter-industrielle émerge. Nous avons trouvé trois types de déclencheurs qui interviennent dans cette phase, à savoir l'attente d'un gain financier, comme la recherche d'un dispositif permettant de protéger l'organisation des fluctuations du prix des matières premières et de l'énergie, la vision durable des entrepreneurs initiateurs de la collaboration, ou encore l'impulsion donnée par le secteur public, à travers un appel à projets par exemple. Ces trois types de déclencheurs ont déjà été décrits dans la littérature sur l'adoption de mesures circulaires au sein des chaînes d'approvisionnement en général (Govindan and Hasanagic 2018) et nous en avons étendu la validité concernant les chaînes d'approvisionnement présentant des collaborations circulaires inter-industrielles.

La deuxième étape de la collaboration correspond à la phase de convergence entre les organisations collaboratrices. Il s'agit d'une étape au cours de laquelle les organisations mettent activement en œuvre des actions de brokering destinées à garantir la viabilité économique de la collaboration afin de déterminer un juste partage de la valeur entre les parties afin et ainsi assurer la pérennité du partenariat établi. Le deuxième objectif de ces actions de brokering est de faire converger les processus des organisations, par exemple en créant des procédés industriels communs ou des pratiques logistiques partagées. Enfin, les organisations mettent en place des actions de convergence des connaissances. Il s'agit de créer ou de renforcer la base des savoirs communs nécessaire au bon fonctionnement de la collaboration. Cela se fait par le biais d'actions conjointes de R&D ou par l'embauche d'employés ayant une bonne connaissance des deux secteurs industriels engagés dans la collaboration. Ces initiatives ont déjà été rapportées dans la littérature sur les pratiques génériques de collaboration au sein des chaînes d'approvisionnement circulaires (Sudusinghe and Seuring 2022). Parallèlement à ces actions de brokering, qui sont activement mises en œuvre par les parties à la collaboration, un certain nombre de facteurs contextuels présentent des impacts positifs ou négatifs qui facilitent ou entravent ces collaborations. Ces facteurs contextuels comprennent par exemple la tendance générale favorisant les chaînes d'approvisionnement durables et locales (Ashby 2016; Tseng et al. 2019), qui encouragent indirectement les collaborations

circulaires inter-industrielles. De même, les avancées techniques en matière d'innovation circulaire qui conduisent à la standardisation des matériaux et des processus (Suchek et al. 2021) facilitent également la circulation des matériaux d'une industrie à une autre.

Enfin, la troisième et dernière étape de ces collaborations correspond à une phase opérationnelle, qui intervient une fois le travail de convergence achevé. Cette première lecture empirique de notre objet de recherche est complétée par une lecture théorique, basée sur le cadre de la proximité inter-organisationnelle. La deuxième question de recherche de ce dernier article est donc :

RQ3b: Comment les différentes dimensions de la proximité inter-organisationnelle contribuent-elles aux collaborations circulaires inter-industrielles et comment peuvent-elles être ajustées pour aboutir à une meilleure circularité ?

Nous soutenons que la succession des trois étapes, idée, initiation et fonctionnement des collaborations circulaires inter-industrielles correspond à trois états distincts des cinq dimensions de la proximité inter-organisationnelle mises en jeu entre les parties à la collaboration. Ces trois étapes avaient déjà été décrites dans des études consacrées à la proximité cognitive dans les projets *d'open innovation* qui suivaient les étapes de découverte des connaissances, de transit des connaissances et d'intégration des connaissances entre des entreprises appartenant à des secteurs différents (Hilda Bø Lyng and Brun 2018; Hilda B. Lyng and Brun 2019). Notre étude vient étendre la compréhension des dynamiques en jeu en prenant en compte les cinq dimensions de la proximité inter-organisationnelle et en considérant non plus seulement un flux intangible (celui de connaissances) mais également d'autres flux.

Nous proposons qu'au premier stade, seuls deux types de proximité préexistent, ce qui explique que les collaborations circulaires inter-industrielles soient peu observées malgré les opportunités qu'elles présentent pour la diffusion du modèle circulaire, et encore peu décrites dans la littérature. Leur caractère "accidentel" tient au fait qu'elles émergent dans des conditions spécifiques, qui sont celles d'une proximité sociale importante (les initiateurs sont liés par des

liens familiaux ou amicaux) ou d'une proximité institutionnelle importante (les initiateurs partagent un ensemble de valeurs communes orientées vers le développement durable, ce qui les amène à partager les mêmes réseaux professionnels et à fréquenter les mêmes événements spécialisés). Les proximités engagées à ce stade n'étant pas celles qui sont habituellement présentes dans la mise en place d'autres types de collaborations, cela explique leur caractère novateur et le potentiel encore irréalisé que représentent ces nouveaux ponts dans la diffusion du modèle circulaire.

Nous proposons que la deuxième phase, celle de l'initiation, correspond à l'étape où les actions de brokering décrites ci-dessus et les facteurs contextuels ayant des effets modérateurs sur la collaboration font converger les autres dimensions de la proximité inter-organisationnelle entre les parties. A la lumière des actions de brokering et des facteurs modérateurs rapportés, nous interprétons que dans le cas des collaborations circulaires inter-industrielles, ce sont les proximités géographiques, organisationnelles et cognitives qui sont plus particulièrement travaillées au cours de cette phase. Ainsi, par exemple, nous postulons que l'introduction de pratiques logistiques partagées correspond à la convergence géographique, et que les avancées en matière d'innovation circulaire qui rendent les matériaux utilisables indifféremment d'une industrie à l'autre correspondent à la convergence cognitive et organisationnelle. Il découle de cette interprétation l'hypothèse que les dimensions de proximité mises en jeu sont spécifiques à chaque collaboration et aux organisations qui en font partie. En effet, nous pensons que c'est le caractère circulaire des collaborations étudiées qui donne autant de force à la proximité institutionnelle (qui correspond à un socle commun de valeurs durables) ou à la proximité géographique (qui est une condition nécessaire à la mise en place de flux de récupération d'eau et d'énergie, par exemple). Nous formulons donc la proposition que tout type de collaboration suit ces trois étapes successives de convergence et de gestion des proximités, mais que les proximités qui représentent un enjeu particulier varient selon les participants et les objectifs de la collaboration.

Enfin, nous proposons que la dernière phase correspond au stade où les cinq dimensions de la proximité inter-organisationnelle ont atteint un niveau de convergence suffisant et que le travail de gestion des proximités à effectuer par

les brokers consiste uniquement à maintenir ces dimensions à une intensité suffisante pour assurer le fonctionnement de la collaboration inter-industrielle, qui correspond alors à une " nouvelle normalité ", où travailler avec un partenaire d'une autre industrie n'est pas plus difficile que de travailler avec un partenaire issu de la même filière.

Comme expliqué dans la partie relative aux fondations motivationnelles de cette recherche, cette étude vise à contribuer au corpus de connaissances destiné à aider les organisations à réaliser leur transition vers le modèle économique circulaire.

Cette recherche a des implications au niveau macro, pour les décideurs politiques. Nous avons vu dans l'article 2 que l'une des motivations des entreprises ayant recours aux facilitateurs de l'économie circulaire est de rester en conformité avec de nouvelles mesures législatives ou fiscales. De même, l'article 3 a montré qu'un des déclencheurs des collaborations circulaires inter-industrielles était l'impulsion donnée par les pouvoirs publics, qu'il s'agisse de l'opportunité représentée par la création de nouveaux marchés, par exemple avec un pourcentage plancher d'équipements dans les commandes publiques qui doivent être reconditionnés ou fabriqués à partir de matériaux recyclés (la loi AGEC -Anti-Gaspillage Economie Circulaire- a été citée par certains de nos répondants) ou par la mise en place de mesures visant à atteindre une plus grande circularité dans les territoires. Cela peut prendre la forme, par exemple, de programmes de circularité inter-filières coordonnés par des agences nationales (comme l'Agence de l'Environnement et de la Maîtrise de l'Energie par exemple), d'appels à projets circulaires inter-filières, de renforcement des programmes de standardisation des matières premières secondaires, ou encore d'une réflexion globale sur la réutilisation des flux au sein des territoires. Nous avons également vu dans l'article 3 que plusieurs de nos cas étaient basés sur des activités conjointes de R&D impliquant des institutions publiques telles que des universités ou des laboratoires de recherche. On peut donc imaginer que l'Agence Nationale de la Recherche puisse impulser des programmes de R&D inter-industriels, par exemple en organisant des regroupements d'établissements d'enseignement supérieur dédiés à des industries spécifiques pour des programmes conjoints de développement de l'innovation et en partenariat avec le secteur privé.

Le même type d'impulsion pourrait être donné au niveau meso via les conseils économiques, sociaux et environnementaux régionaux, en partenariat avec la fonction publique territoriale et les Chambres du Commerce et de l'Industrie. Parallèlement, et toujours au niveau régional ou local, cette recherche peut profiter aux Pôles de Compétitivité, acteurs institutionnels au sein desquels interagissent entreprises, universités et laboratoires qui développent de nouveaux systèmes de relations, parfois au-delà de la filière à laquelle ils appartiennent, en vue de création d'innovations ou d'opportunités entrepreneuriales (de Géry, Glaser, and Laviolette 2021).

Au niveau de leurs réseaux d'intervention, les facilitateurs de l'économie circulaire peuvent également tirer profit de cette étude en améliorant leurs chances de succès, par exemple en ciblant des entreprises qui ne font pas encore partie de leur réseau s'ils appartiennent au type consultant, ou en choisissant d'élargir leur réseau à des entreprises issues d'industries avec lesquelles ils n'ont pas encore de lien afin de construire de nouvelles passerelles s'ils appartiennent au type liaison. De même, un parc industriel ou un territoire souhaitant augmenter son niveau de circularité peut décider de s'appuyer sur une organisation facilitatrice bien établie en son sein pour profiter de sa bonne connaissance des membres du réseau et ainsi coordonner l'adoption de mesures de circularité partagées. Dans la même optique, le cadre conceptuel proposé pour l'utilisation de la facilitation circulaire peut être utilisé comme une première approche diagnostique d'un réseau d'organisations et visualiser où se situent les lacunes en matière de circularité, afin d'initier des actions ou avoir un recours efficace à la facilitation.

Au niveau micro, celui de l'organisation ou des individus, cette recherche a également des implications pour les praticiens en fournissant des éléments pour guider leur processus de prise de décision dans la sélection et la gestion de leurs relations avec leurs partenaires. Elle suggère des approches pour la sélection de partenaires adéquats avec lesquels collaborer, ainsi que des organisations facilitatrices. Cette étude propose également une analyse des facteurs tangibles et intangibles en jeu dans les collaborations circulaires inter-industrielles. En fournissant des exemples de pratiques de rapprochement, elle suggère l'activation de leviers opérationnels cognitifs, sociaux, organisationnels, institutionnels et géographiques pour optimiser les opérations et leur

performance. Enfin, les connaissances créées sur le brokering circulaire et les collaborations circulaires inter-industrielles pourraient améliorer leur potentiel de réussite et contribuer à une diffusion plus large du modèle économique circulaire.

Une limite importante de notre étude sur les brokers de circularité est que nous n'avons pas trouvé de broker dont le principal type d'échange appartienne à la catégorie *gatekeeper* ou *représentant*. Nous avons déjà exposé dans l'article que nous pensons que ces formes d'échange sont avant tout conceptuelles et difficiles à observer sous une forme " pure " dans la pratique. Cependant, il n'est pas exclu qu'une sélection a priori des organisations à interviewer, avec une attention particulière portée à la position spécifique qu'occupent les brokers dans leur réseau, aurait pu nous permettre de développer des conclusions sur ce type d'échange. Une autre limite de cette étude est que seul le point de vue des brokers est étudié. Nous avons veillé à la cohérence avec la perspective du réseau en choisissant des brokers qui sont intégrés dans un réseau d'au moins trois nœuds dans le cadre de leur mission de facilitation. Toutefois, il aurait aussi été pertinent de recueillir le point de vue des entreprises qui ont bénéficié de leurs services.

La limite la plus importante de l'étude consacrée à la collaboration circulaire inter-industrielle est le fait que notre échantillon de cas ne présente pas de récits de tentatives de collaboration qui ont échoué. De plus, un des quatre cas développés est relativement immature. La raison de cette faiblesse dans la sélection des cas est la difficulté que nous avons eue à accéder au terrain. Nous avons contacté un grand nombre d'organisations à partir des bases de données et des listes présentées dans la section méthodologie de l'article 3, et un nombre relativement important d'organisations ont répondu positivement à nos demandes d'entretien. Cependant, la perspective la plus pertinente pour l'étude de ces collaborations est celle du réseau, et pour assurer une cohérence méthodologique avec cette approche, nous avons établi comme critère de sélection des cas le fait de pouvoir interviewer au moins trois organisations membres de la collaboration étudiée. Nous n'avons ainsi pas pu inclure plusieurs cas dans notre article car nous n'avons pas pu satisfaire ce dernier critère car nous nous sommes heurtés au fait que de nombreuses organisations impliquées dans ces collaborations n'ont pas manifesté d'intérêt à participer à l'étude, ce qui nous a empêché d'obtenir des

interviews de trois nœuds d'un même réseau. Nous pensons qu'il aurait été pertinent de compléter notre échantillon de réussites par des tentatives infructueuses qui nous auraient permis de détecter les menaces et les pièges de ces collaborations.

L'angle que nous avons choisi pour cette recherche sur un phénomène émergent est interprétatif et exploratoire. Afin de maintenir une cohérence entre l'ontologie et la méthodologie, nous avons respecté certaines recommandations, telles que le nombre limité de cas et d'entretiens réalisés (Darby, Fugate, and Murray 2019). Cette recherche doit donc être complétée par des études supplémentaires adoptant une perspective épistémologique différente. Par exemple, les résultats des articles 2 et 3 de la thèse pourraient être complétés par des études relevant d'un paradigme épistémologique différent, où l'objectif est d'atteindre la saturation théorique. Dans ce cas, il sera nécessaire d'avoir plus d'un individu répondant par organisation afin d'obtenir des données couvrant plusieurs points de vue permettant ainsi une meilleure compréhension du phénomène des collaborations circulaires inter-industrielles ou de leur facilitation. Dans le cas de grandes organisations, par exemple, il s'agirait d'interroger à la fois les décideurs au niveau de la direction et les personnes directement impliquées dans la réalisation des opérations sur le terrain. D'autres travaux pourraient prendre la forme d'études de cas approfondies, comme celle d'une collaboration circulaire inter-industrielle mature ou d'un facilitateur de l'économie circulaire, idéalement en s'appuyant sur la proposition théorique décrite dans l'article 1. Les articles 2 et 3 décrivent les difficultés qui font obstacle à l'adoption du modèle circulaire dans un contexte inter-industriel : ces constats pourraient donner lieu à des études dédiées à ces difficultés spécifiques, en vue d'identifier des leviers d'action concrets.

Cette recherche pourrait également être complétée par des études reposant sur des bases théoriques différentes. Les perspectives *resourced-based-view* ou *natural-resource-based-view* sont souvent utilisées dans le domaine des chaînes d'approvisionnement durables et circulaires. De même, nous avons vu que les perspectives de la *capacité d'absorption* ou des *capacités dynamiques* permettent d'appréhender les mécanismes de transfert de connaissances d'un secteur industriel à un autre. Nous proposons également que des recherches

basées sur la *théorie institutionnelle* puissent aider à comprendre les mécanismes de convergence des valeurs et des pratiques. De même, *l'agency theory* ou la *transaction costs theory* pourrait aider à définir les meilleures stratégies d'alignement pour le partage de la valeur créée entre les organisations participant à une collaboration circulaire inter-industrielle. Enfin, la *relational-exchange view* pourrait être une perspective théorique pertinente pour comprendre les mécanismes de rapprochement social ou de construction de la confiance qui correspondent à la dimension sociale de la proximité inter-organisationnelle que nous avons développée dans cette étude.

Enfin, l'économie circulaire étant par nature systémique, l'une des limites de cette recherche est qu'elle est principalement ancrée dans un seul domaine, celui de la chaîne d'approvisionnement, alors que d'autres perspectives auraient apporté des éclairages complémentaires. Bien que certains articles issus de la littérature d'autres champs aient été lus, cette étude pourrait être complétée par une approche plus transdisciplinaire. Jusqu'à présent, l'étude des collaborations inter-industrielles relevait du domaine du management de l'innovation. Nous avons adopté une approche plus axée sur la chaîne d'approvisionnement. Nous suggérons davantage de recherches issues de l'intersection de ces domaines avec les champs de la théorie des organisations, par exemple. Des recherches établissant également un pont avec la littérature sur l'administration pourraient développer le rôle des acteurs publics. De la même manière, des travaux issus des études régionales ou de la gestion territoriale pourraient également être utilisés, notamment ceux relatifs aux symbioses industrielles. Plus ambitieuses car plus lointaines, des collaborations avec des disciplines hors du champ des sciences sociales, comme l'ingénierie ou l'agronomie, pourraient s'intéresser aux compatibilités possibles entre industries et secteurs pour l'économie circulaire en explorant les possibilités offertes par la standardisation des matériaux, ce qui permettrait de trouver de nouveaux domaines de coopération entre les cycles biologiques et techniques décrits dans le *diagramme papillon* de la fondation Ellen Macarthur.

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1. Introduction

1.1 Motivational background

This section provides context to the thesis by describing the motivations and personal background that led to this research project.

We belong to a generation that has been made aware of environmental issues since primary school, at a stage where geopolitics, macroeconomics and the necessary trade-offs between economic performance and social and environmental impacts remain largely unintelligible and are obviously not part of the educational curriculum. One of our earliest school memories is related to the explanation of animal species extinction in relation to environmental degradation. The approach was simplistic, but we recall the importance of school and education in general in raising awareness of the ecological crisis. Over the following decade, the contours of the problem became less blurred, and awareness of the risks increased. However, we were still a long way from fully recognising the links between the dominant economic model and episodes of drought and flooding, mass extinctions of species in all areas of life, the development of zoonoses or the submersion of islands and coastal towns, to name but a few. We knew that the people of Madagascar, where part of our family come from, are among the most vulnerable to climate change (vulnerability that materialised during the PhD years with the first global famine directly linked to it ('Madagascar: Severe Drought Could Spur World's First Climate Change Famine | UN News' 2021)), and even if this awareness significantly shaped our daily actions and our ecological convictions, the trigger leading us to a systemic vision of the subject was not yet made. At the time when we were old enough to vote, the ecological doxa was still based on the adoption of individual eco gestures or on the opportunity represented by renewable energies in the pursuit of green growth, and the global questioning of the civilisational system in which we were evolving belonged to a marginal field of thought (or at least a marginal one in the environment to which we were exposed at that time), and we do not remember feeling any mistrust towards the public authorities in dealing with environmental degradation, nor do we remember seriously envisioning a less promising future than what we had known up to that point. It is in this state of mind that, in 2013, we carried out our end-of-study professional master thesis at the Toulouse

Business School, in the business department of an engineering company that financed our studies. The problematic of our company was the following: the sector had suffered a loss of business due to the reduction in the number of projects caused by the financial crisis of 2008. In Toulouse region, whose economic heart is the aeronautics sector, this has resulted in a reduction in the number of major avionics design programmes. The preferred innovation in the sector became incremental and the need for outsourced design engineers was decreasing. Our company was gradually losing many contracts and the revenue stream was declining. A strategic direction for my business unit was decided, we needed to redirect our engineers to new industries. The purpose of our mission concerned the compatibility and transfer of skills between different industrial sectors. Our *alternance* period was therefore devoted to a study dedicated to mapping and analysing the skills held within our teams in order to find new compatible markets and local clients. We spent a year doing this internal skills audit, interviewing our technical experts and consulting white papers to determine the new industries that our team would be looking at for new revenue streams. At the end of this process, we decided to focus our commercial efforts on three sectors that we felt had the potential: medical, agriculture and environmental technologies.

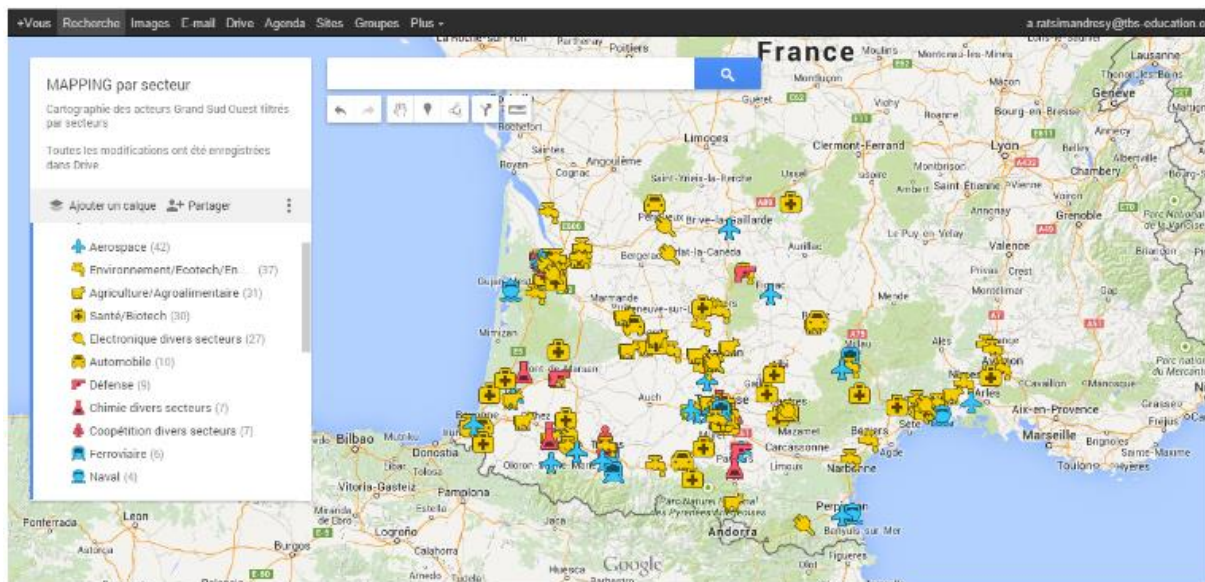


Figure 1. Overview of the potential cross-industrial transfers in the author's previous company

Source: Author's master's professional thesis

This intellectually rich professional experience was our first as an employee. Above all, it was the breeding ground for many reflections on the professional world and the interdependencies between organisations in business ecosystems. A few years later, once the “systemic perspective” switch had been made, we came to the uncomfortable realisation that there was an incompatibility between the economic health of our native region, which is largely dependent on the aeronautics industry, and the safeguarding of global ecological interests. A dilemma that still preoccupies us today regarding the impact that the sustainable reorientations that are indisputably necessary will have on many of our relatives.

In 2018 we changed our professional orientation and joined a social economy company (*entreprise de l'économie sociale et solidaire* in French) for a year, which trains and employs migrant workers in recycling activities. The company developed from the waste sector and successively extended its activities to the professional furniture and construction sectors with activities of reuse, reconditioning, and remanufacturing. We realised the vast entrepreneurial opportunity that the environmental transition represents, which can be accompanied by positive social impact. The combination of these two professional experiences has given us a glimpse of the interconnections that exist between industrial sectors and of the opportunities represented by the activities of secondary raw materials valorisation, which act as pivots for the redistribution of these resources to new players.

Despite the moral alignment that working in a company with a social and environmental impact gave us, we lacked the time and mental space to fully understand what we were experiencing professionally. A few years before embarking on our management studies, we had taken great pleasure in studying languages, literature, and law, developing a diverse knowledge base and building bridges between the different disciplines. The idea of devoting more time to reasoning, formalising ideas and transmitting knowledge was attractive and we considered the idea of extending our training with a doctorate in management sciences, which presented the advantage of being an action-oriented discipline. We enquired about the ESCP doctoral programme and contacted Professor Joe Miemczyk. We discussed and the idea emerged of a research project on the circular economy at the crossroads of several industries.

1.2 Overview of the conceptual background

This chapter summarises the main concepts that are the background of this study. The first section recalls the well-known context of sustainable development, which can be considered from different approaches, and which here adopts the angle of business activity, with the context of industrial ecology. A second section briefly explains the circular economy, a model that partly responds to the principles of industrial ecology, with a particular focus on the circular supply chain. The third section provides a quick overview of the circular and collaborative supply chain that are the subject of our study. The last section explains the approach of the thesis which chooses the circular network perspective rather than the linear supply chain perspective.

1.2.1 Sustainable development and industrial ecology

At the time of writing this manuscript, human activities are having a lasting impact on the planet on a geological scale and have given rise to the proposed Anthropocene epoch (Waters et al. 2016). This translates into the transgression of six of the nine planetary boundaries that are essential processes to maintaining the stability and resilience of Earth system, suggesting that our planet is now well beyond the safe operating space for humanity (Rockström et al. 2009; Richardson et al. 2023).

To contain the deleterious effects of the human systems, the United Nations called for putting the safeguarding of the planet at the centre of countries' policies over 30 years ago (Brundtland 1987). Building on the Meadows report, which warned that our economic paradigm based on unlimited growth is incompatible with a resource-constrained world (Meadows et al. 1972), the Brundtland Commission set out a definition of sustainable development that is probably the most widely shared : « *a development that meets the needs of the present without compromising the ability of future generations to meet their*

own needs. » (Brundtland 1987) p1. This definition was then translated into a three-dimensional model which is founded on the assumption that profit should no longer be made at the expense of people (the social dimension) or the planet (the environmental dimension) and known as the Triple-Bottom-Line of sustainable development (Elkington 1998).

The transition must be comprehensive and involve all actors in society in a complementary and coordinated manner. This research is part of the field of management sciences, and therefore focuses more specifically on the responsibility incumbent on companies in achieving this sustainable transition. *Corporate societal responsibility* is a widely used concept, sometimes criticised because there is no consensus on its understanding, and because its application translates into actions of varying scope and significance (Matten and Moon 2008). The approaches differ, and their ambition varies from simply limiting the negative externalities of activities to a complete rethinking of organisations (Pagell and Shevchenko 2014; Markman and Krause 2016).

One example of the latter approach is the proposal that companies, similarly to all other human organisational systems, should be inspired by natural ways of functioning (Benyus 1997). This vision is called *Industrial Ecology* (Graedel 1996), in which industries function according to an ecosystem model: « *In such a system the consumption of energy and materials is optimized, waste generation is minimised and the effluents of one process [...] serve as the raw material for another process.* » (Frosch and Gallopoulos 1989) p2.

Applying ecosystem functioning to industry is based on a number of principles, two of which are particularly relevant to this study: The first one is the move away from the concept of *inputs* and *outputs* to that of *roundputs*, where matter, water and energy are used in cycles and cascades. The second is the engagement of diversity: diversity of both players and industries which are de facto interdependent and must therefore act in cooperation (Korhonen 2001).

1.2.2 Circular economy and the circular supply chain

One of the expressions of industrial ecology is the circular economy model, for which more than a hundred of definitions have been proposed (Kirchherr, Reike, and Hekkert 2017), but all of which share the common denominator of proposing a systemic production and consumption model that reduces pollution and waste through processes that ensure that all or most of the products produced and consumed can be reintegrated into the economy (Pearce and Turner 1989; McDonough and Braungart 2010; Tukker 2015; Haas et al. 2015; Ghisellini, Cialani, and Ulgiati 2016; Prieto-Sandoval, Jaca, and Ormazabal 2018; Geissdoerfer et al. 2017). A central aspect of the model is its multi-scale nature : it must be applied at the micro level, that of organisations and consumers, at the meso level, that of organisational networks, and at the macro level, that of societies, nations and regions (Ghisellini, Cialani, and Ulgiati 2016).

One of the most recent and comprehensive definitions, which highlights the systemic and multi-level aspect of the circular economy, is the following:

« The circular economy is a transformational and systemic vision for a more ecologically effective economic system that works within planetary limits, and thereby maintains and rebuilds natural capital. It is enabled by multiple, cooperative and simultaneous innovations at different scales in the wider socio-economic context involving regulation, policy and production and consumption systems. Companies in a circular economy can attain a sustained competitive advantage through innovative business models wherein circular principles in offerings and relationships enable the creation, delivery and capture of economic value, whilst ecological and social value are accrued by nature and society. » (De Angelis 2021) p17.

At the scale of organisations, and from a business model point of view, this translates into slowing, closing, and narrowing loops of energy and resources (Bocken et al. 2016), ultimately resulting in the extension of the life of products through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling (Geissdoerfer et al. 2017). Operationally, one approach

for companies is to engage in the circular economy through the adoption of circular supply chains (Genovese et al. 2017).

Following the multi-scale reasoning, the circular supply chain archetype (Batista et al. 2018) sets out a number of rules that apply to the end product of the supply chain, to the activities that make up the supply chain and finally to the industry level in which it is embedded.

- The final product of the circular supply chain must be modular, repairable, upgradable and recyclable.
- The circular supply chain must integrate activities of reuse, repairing, reconditioning, refurbishing, remanufacturing and recycling.
- Finally, the industry to which the circular supply chain belongs must organise resource sharing activities, infrastructure, as well as symbioses from the recascading of materials, waste and energy loops (Batista et al. 2018).

This archetype has been proposed to cover the huge variety of circular supply chains practices, which have been the subject of numerous studies covering all the levels, stakeholders and industries likely to be involved (Govindan and Hasanagic 2018). These practices include, for example, eco-efficient production or responsible purchasing (Ghisellini, Cialani, and Ulgiati 2016), new logistics systems like facilities adapted to recycling or remanufacturing (Zhu, Geng, and Lai 2010), the set-up of new standards for circular products quality (van Weelden, Mugge, and Bakker 2016), the development of new information systems to facilitate the tracking of secondary raw materials (Su et al. 2013) or the education of customers to change their consumer behaviour (Hazen, Mollenkopf, and Wang 2017).

These practices are triggered by drivers of different natures, which may be environmental concerns, but also economic ones, such as resource use efficiency (Geng et al. 2009), related to health (Ilić and Nikolić 2016) or to product performance (Su et al. 2013). On the contrary, they can also be slowed down by barriers that operate at all the levels previously mentioned. Examples include the lack of legal provisions promoting the circular economy at the societal level (Li and Yu 2011), challenges at the level of a sector or market such as the lack of take-back practices within an industry (Ghisellini, Cialani, and Ulgiati 2016) or

management issues such as the lack of top leadership involvement or an excess of bureaucracy at the firm level (Y. Liu and Bai 2014).

Research concerning circular supply chains is thus abundant, but there are still some gaps in the literature devoted to them. Among the themes highlighted are collaborative practices (Farooque et al. 2019), although they are one of the pillars of the circular model (Bressanelli, Perona, and Sacconi 2019; Bressanelli, Visintin, and Sacconi 2022). What is known about collaborative supply chains in the circular context is briefly summarised in the next section.

1.2.3 Supply chain collaboration for circularity

As mentioned above, there is a need for research focusing on coordination and collaboration practices that take into account the specificities of circularity, building on the extensive literature already produced on supply chain collaborations in general (Cao and Zhang 2011; Barratt 2004). Supply chain collaboration has been defined as the sharing of information, the taking of joint decisions and the sharing of benefits and risks between two or more chain members in the aim to achieve greater profitability and customer satisfaction. The idea being to reach these goals with more efficiency by acting together rather than working alone (Simatupang and Sridharan 2005). A recent systematic exploration of the literature provided an overview of what is currently known about circular supply chain collaboration (Sudusinghe and Seuring 2022).

Collaborative practices in circular supply chains can be divided into three types of categories: the first concerns internal practices, such as adopting environmental management system, internal process integration or implementing cross-functional coordination. The second concerns external vertical practices, like sharing information, sharing responsibility for product recovery, sharing revenue, sharing infrastructures or sharing logistics among with key suppliers and customers. The third type is about external horizontal collaborations practices, that established with governments, academic institutions, industry associations, NGOs or competitors. These diverse stakeholders bring their experience, expertise

and perspectives for a better systemic implementation of the circular economy (Sudusinghe and Seuring 2022).

These collaborations with non-traditional parties are a specific of the circular economy. Among them, collaborations between parties belonging to different industrial sectors have been pointed as a lever to scale up the circular economy (De Angelis, Howard, and Miemczyk 2018; Tate et al. 2019). This echoes one of the pillars of industrial ecology, which is the diversity of actors involved in an industrial ecosystem (Korhonen, Jouni 2005). This approach is beginning to be seen in the practitioner world, with the emergence of public and private initiatives such as the platforms *Circlean-Symbiosis* ordered by the European Commission or *The Material Marketplace* ran by the United States Business Council for Sustainable Development, which aim to connect the demand and supply of by-products from one industry to another. We also see the publication of recent white papers like *Scaling Up Cross-sector Collaboration for a Circular Economy: Insights from current practice*, in 2017 commissioned by the European Union or *Germany's transition to a circular economy: How to unlock the potential of cross-industry collaboration*, in 2021, ordered by a German business consortium. We also witness the emergence of entrepreneurial initiatives under the form of consultancies offering matchmaking services between companies wishing to create innovative circular collaborations. The value offer of their services is to break down the sectoral barriers between firms through the identification of potential players and the management of relationships with yet unknown partners.

The idea underlying the resort to these collaborations with partners from different industries is that they would give access to new resources, new facilities or new infrastructures whose exchange or sharing would enable the creation of new loops, and thus a wider adoption of the circular model. We have seen that circular supply chains are made possible, amongst other ways, by unprecedented collaborative practices, such as those between organisations bound by horizontal linkages, and it is for this consideration that we devote the next section to justifying the perspective of our study, which is no longer that of the supply chain but that of the supply network.

1.2.4 Supply networks

The concept of the supply chain was invented in the 1980s and is based on the principle that supply relationships form part of a long chain beginning with suppliers and ending with final consumers (Johnsen, Howard, and Miemczyk 2014). One of its most widely accepted definitions is as follows:

“The supply chain is the connected series of activities which is concerned with planning, coordinating and controlling material, parts and finished goods from supplier to customer. It is concerned with two distinct flows through the organisation: material and information. The scope of the supply chain begins with the source of supply and ends at the point of consumption” (Stevens 1989) p1.

Beyond a simple definition relating to the logistics dimension (Cooper, Lambert, and Pagh 1997), it focuses on the dyads formed between customers and suppliers following one another from the initial extraction of raw materials to the final consumer (Harland 1996). Behind this notion of flow and succession of stages, from supplier to consumer, lies a concept of linearity. However, this linear model is criticized because it proposes a simplistic and unidirectional model that does not take into account the lateral links, return loops and two-way exchanges that are the day-to-day basis of practitioners (Lamming et al. 2000). In addition, this model tends to overlook many additional members of the supply chain who play an indirect but vital role in supporting the overall process (Carter, Rogers, and Choi 2015). This is even more relevant in sustainable supply chains where an upstream and downstream alignment of sustainable policies improves the sustainable and market performance of the organisations involved (Blome, Paulraj, and Schuetz 2014) and where upstream and downstream collaborations are needed to implement circular resource flows (Bimpizas-Pinis, Calzolari, and Genovese 2022).

This results in one of the circular supply chain premises recently proposed *“In circular supply chains, the flow of resources in supplier-buyer dyads is potentially bidirectional, in the sense that buyers are latent suppliers of secondary raw materials, and suppliers are latent buyers of secondary raw materials. Under the sustainability-dominant logic, a circular supply chain denotes the existence of*

resource recovery flows in the supply chain of a focal company. Therefore, the supply chain configuration should consider not only upstream-downstream collaboration alignments, but also downstream-upstream collaborations involving internal and external supply chain actors.” (Batista et al. 2023) p 9.

Beyond the upstream and downstream perspectives that needs to be changed given the blurring of boundaries between production and consumption they imply, the horizontal linkages to non-traditional actors and third parties to the supply chain that occur in circular practices necessitate to adopt a network approach (Sudusinghe and Seuring 2022). This is in line with preceding calls to drop the dyad approach for a network perspective when it comes to study circularity (Kanda, Geissdoerfer, and Hjelm 2021) and more generally sustainability practices (Johnsen, Miemczyk, and Howard 2017).

In the light of these considerations, the thesis will adopt the perspective of the network, the term supply network better reflecting the complexity and reality of the supply relationships occurring in the circular context.

1.3 Ontology, epistemology

In order to establish the scientific legitimacy of this research, we conducted an ontological reflection (what is knowledge?) in order to adopt an epistemological position (what is valid knowledge?) (Gavard-Perret et al. 2012). These assumptions shape the research strategy and research questions, the methods chosen and the interpretation of the results in accordance with this strategy (Saunders, Lewis, and Thornhill 2012).

In this section we will briefly define the two main ways of conceiving knowledge in management science and their implications in terms of the research strategy adopted. We point out that there are a large number of ontological hypotheses, philosophical definitions of reality, and epistemological frameworks that derive from them (Gavard-Perret et al. 2012). For the sake of clarity and conciseness, we will base ourselves on a distinction between two major philosophical families relating to the creation of knowledge, positivism and interpretivism (Hudson and

Ozanne 1988). After justifying our epistemological positioning as an interpretivist, we will detail the abductive approach that follows and how this translated into our choice of qualitative research design with the case study method. We also explain how this influenced our analysis of the results.

1.3.1 Positivism vs. Interpretivism

Positivism is a realist current, which postulates that there is only one objective and existential reality, i.e., that it is independent of everything that is perceived and of all the representations that one may have of it (Bhaskar 2013). Research is therefore concerned with knowing and explaining what is strictly observable and with qualifying variables and causal relationships resulting in a phenomenon (Hudson and Ozanne 1988). Positivist researchers are likely to use a highly structured methodology in order to generate theoretical hypothesis that will be validated through quantifiable observations in order to facilitate replication. The resulting knowledge is meant to tend towards generalisation in order to be applied to large number of contexts (Darby, Fugate, and Murray 2019; Saunders, Lewis, and Thornhill 2012; Gavard-Perret et al. 2012).

Interpretivism differs as it considers that reality is subjective, i.e., it is inseparably linked to both the situation itself and the subject who experiences it. Interpretive research therefore states that it is impossible to distinguish a cause from an effect given the mutual, simultaneous relationship between individuals and the external world (Lincoln and Guba 1985). It translates in the fact that phenomena are both the product of personal intentions and of the outcomes of aspects of context such as political, cultural or institutional forces. The interpretive research therefore integrates the motives, meaning, experiences to provide “thick descriptions” of a phenomenon that are context-bounded (Geertz 1973), the ultimate aim being to capture deep meanings and provide an understanding of the process leading to a phenomenon rather than explaining an end (Hudson and Ozanne 1988; Darby, Fugate, and Murray 2019; Prasad 2017).

Table 1. Comparison of positivist and interpretive ontologies (adapted from Gavard-Perret et al. 2012; Saunders, Lewis, and Thornhill 2012; Hudson and Ozanne 1988)

	Positivist	Interpretive
Ontology	Reality is single, objective, tangible	Reality is multiple, subjective, holistic
Overriding goal	Explanation	Understanding
Knowledge generated	Context independent and via the generation of causal laws to a phenomenon	Context dependant and via an interpretation of influences resulting in a phenomenon
Research relationship	The researcher concentrates on observable data, remains independent and maintains an objective stance.	The researcher explores the reality through the exploration of experiences, motives and details, the resulting findings cannot be separated from the inquirer.
Data and techniques most often used	Highly structured, large samples, measurement, usually quantitative but may be qualitative (Pagell and Wu 2009).	Small samples, in depth investigations, qualitative

The purpose in the preceding paragraphs is not to determine if an approach is stronger than another one. Both positivist and interpretive research philosophies contribute in distinct but valuable and complementary ways to management research. Rather, the aim was to present them to then demonstrate that the interpretive approach is more in line with the objective of this dissertation.

Here is a brief recall of the research motivations, as an attempt to clarify the ontological and epistemological positioning of this dissertation. The idea of this research emerged after five years of experience in the professional world, where we had our first insider experience of circular economy on one hand and had to deal with the cross-industrial transfer of competences on the other. Having noted the extent to which the processes involved in implementing circularity or, more generally, management initiatives, are complex, dynamic and non-linear in

practice, this research aims to contribute in some small way to a shift towards an economic model that allows for a more harmonious occupation of the planet.

Positivist research assumes that a single and objective reality exists independently of what individuals perceive (Darby et al., 2019) and that reality is external, independent and not accessible through researchers' observations and knowledge (Saunders et al., 2009). Despite their relevance, such assumptions do not align with the multi-stakeholder and multiple level approach of this study, which looks at the convergence processes of different viewpoints and stakes of collaborative parties in the implementation of circularity. A cornerstone of this research is therefore about the reconciliation of multiple realities coexisting deriving from distinct flows of experiences, cultures and perspectives (Hudson and Ozanne, 1988). It is also necessary to recognise the intentional aspect of this research in relation to the goal of sustainability, where it would be factually wrong to defend a purely neutral and non-value-driven approach, which is a further characteristic of interpretivist research (Saunders, Lewis, and Thornhill 2012). Finally, this research is about understanding *how* these new collaborative practices emerge. Taking all these factors into account leads us to adopt an interpretative approach for this research.

1.3.2 Abductive approach and research design

Considering the characteristics of interpretivist studies outlined in the previous section, certain theoretical approaches are therefore more consistent with this research: Given its emphasis of contextualisation in the knowledge construction process (Prasad 2017; Saunders, Lewis, and Thornhill 2012), theory elaboration (Ketokivi and Choi 2014) is one of the most obvious uses of the interpretative approach for sustainable supply chains in general (Darby, Fugate, and Murray 2019) and for our research in particular.

Theory elaboration (Whetten 1989) consists in contextualisation of the logic of a general theory in an empirical context that may not be well-known or understood enough. This context can help introducing new concepts, modifying the relationships between concepts, or identifying potential boundary conditions to

the initial theory : it is about reconciling the general (a theory) with the particulars (contextual idiosyncrasies) to both refine and broaden existing frameworks (Ketokivi and Choi 2014).

This back and forth movement between context and theory that is characteristic of theory elaboration is a common denominator of all interpretive approaches and can be conceptualised in the so-called hermeneutic circle (Bauman 2010; Grondin 2015). This circle visually represents the interpretation process that involves an endless set of movements between text and context (Prasad, 2017).

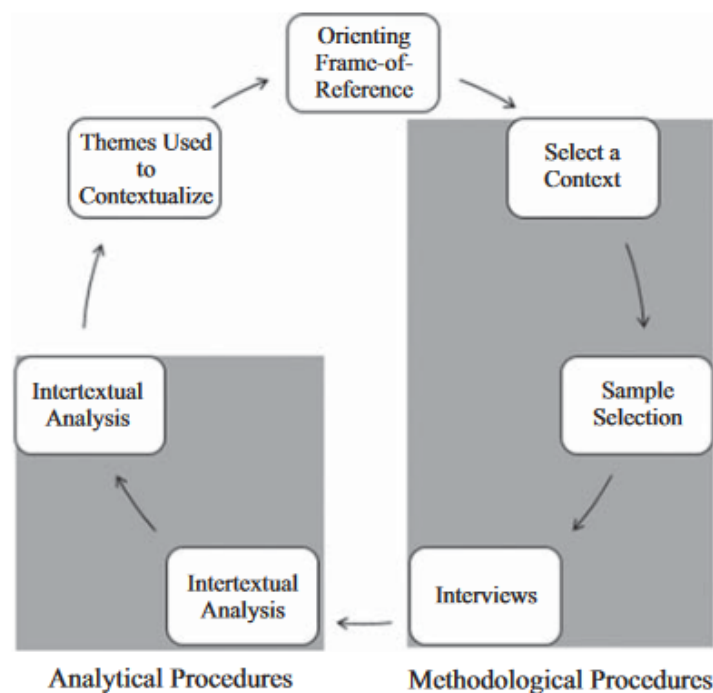


Figure 2. The Hermeneutic circle

Source: (Prasad, 2017)

The hermeneutic circle begins with an orienting frame-of-reference that provides the framework for the methodological and analytical procedures of the research. In our case, it will be the network theory (Granovetter 1983) and the theory of inter-organisational proximities (Boschma 2005), which we describe in detail in the first article of the thesis.

Based on this orienting frame-of-reference, a context is selected driven by its potential to maximize conceptual insights and understanding. For this research, it is the cross-industrial and circular context, the relevance of which we will also defend in article 1 of the dissertation. Within this context, the orienting frame-of-reference is then used as a guide to form criteria and select informants for the study based on their potential to provide descriptive details. Given the emphasis on in-depth understanding in context, the number of informants interviewed is always small. It is generally advised that the number of informants for a single study has typically ranged between 3 and 20 (Fournier 1998; Thompson and Haytko 1997). This is in line with the approach to provide “thick” descriptions (Geertz 1973) to allow explanation rather than accumulating data in an objective of generalisation that belongs to the positivist approach (Saunders, Lewis, and Thornhill 2012). We describe our respondent selection process in the methodological sections of articles 2 and 3 of the thesis. We are aligned with this criterion with a number of 16 respondents for article 2 and 17 for article 2. A summary of the realised interviews can be found in appendix.

The next step of the research is to collect data. Within interpretive research, there are several data-gathering techniques, including interview in which informants describe their experiences with descriptive details and in a setting where the informant is comfortable. The interview setting should be at the discretion of the informant to ensure open conversation and facilitate empathetic understanding by creating opportunities to get close to the informant and experience the empirical context directly (Darby, Fugate, and Murray 2019). Most of the thesis has been conducted in the Covid 19 context, so most of the interviews were realised via visio-call, so even if the choice of place for interviewing was legally restricted, the resulting environment was familiar and convenient to the informant, as most of the calls were emitted from their homes or personal offices.

Before the interview, the general purpose of the research is first explained to the informant followed by an assurance of confidentiality and anonymity. Following the assurance of confidentiality, the researcher requests to record the interview. If it is not permissible to record the interview, extensive field notes are taken (Darby, Fugate, and Murray 2019). In line with this requirement, a sample invitation letter

to respondents outlining the intentions of the research project and guaranteeing the confidentiality of the exchange in appendix.

Because of the emphasis on experience and personalization of context, the interview should consist of short open-ended questions by the researcher followed by lengthier responses from the informant. The format should be semi-structured: the researcher uses the orienting frame-of-reference as a guide, and the overall interview's progression is a dynamic recurring interaction between the researcher and the informant (Saunders, Lewis, and Thornhill 2012). We have followed this recommendation and an example of interview guide that has been inspired by the theoretical frame of reference (the theory of networks and inter-organisational proximity), but which was only a general direction given to the conversation, can be found in the appendix.

1.3.3 Analytical procedures

Qualitative data analysis is a continuous and iterative process (Miles and Huberman 2003). The first phase of analysis uses the orienting frame-of-reference to interpret the text in context for each informant. The researcher reads several times the interview transcripts for each informant in order to understand temporal sequencing of the experiences recounted. The goal of this phase of analysis is to capture each informant's contribution in full contextual detail. After the completion of this step, the analysis continues by interpreting across informants. At this stage, the researcher searches for commonalities among the narratives and moves up a level of abstraction (Prasad 2017). The storylines that emerge become the overarching themes that are compared with the theoretical frame-of-reference, until a contextualized version of the orienting-frame-of-reference develops and eventually becomes the contribution of the research (Darby, Fugate, and Murray 2019). Examples of the analysis of the transcripts, realised with the qualitative coding tool Quirkos can be found in appendix.

1.4 Thesis Structure

We have seen in the conceptual background of the study that conceiving business ecosystems like natural ecosystems requires closed loops, collaborative approaches, diversity of actors. In accordance with these principles, one of the levers for the scale-up of the circular economy can be systemic operations involving collaborations going beyond traditional sectoral or industrial boundaries (De Angelis, Howard, and Miemczyk 2018; Tate et al. 2019; Domenech et al. 2019; Jensen 2016; Ashton 2008). This research therefore proposes an exploratory study of collaborative operations across traditional industrial boundaries, their facilitation, their operationalisation, and the opportunities they offer for the circular economy.

To carry out this research project we have divided this dissertation into three stages. The first step consists of a state of the art and a conceptualisation of cross-industrial circular collaborations. The second is a study of the actors that facilitate these collaborations and support the circular supply network that straddles several industrial sectors. The third and final part focuses on these collaborations, their emergence and implementation.

Figure 3 below presents a visual representation of the thesis, linking the overall problem to the different research questions posed and the methods used to answer them

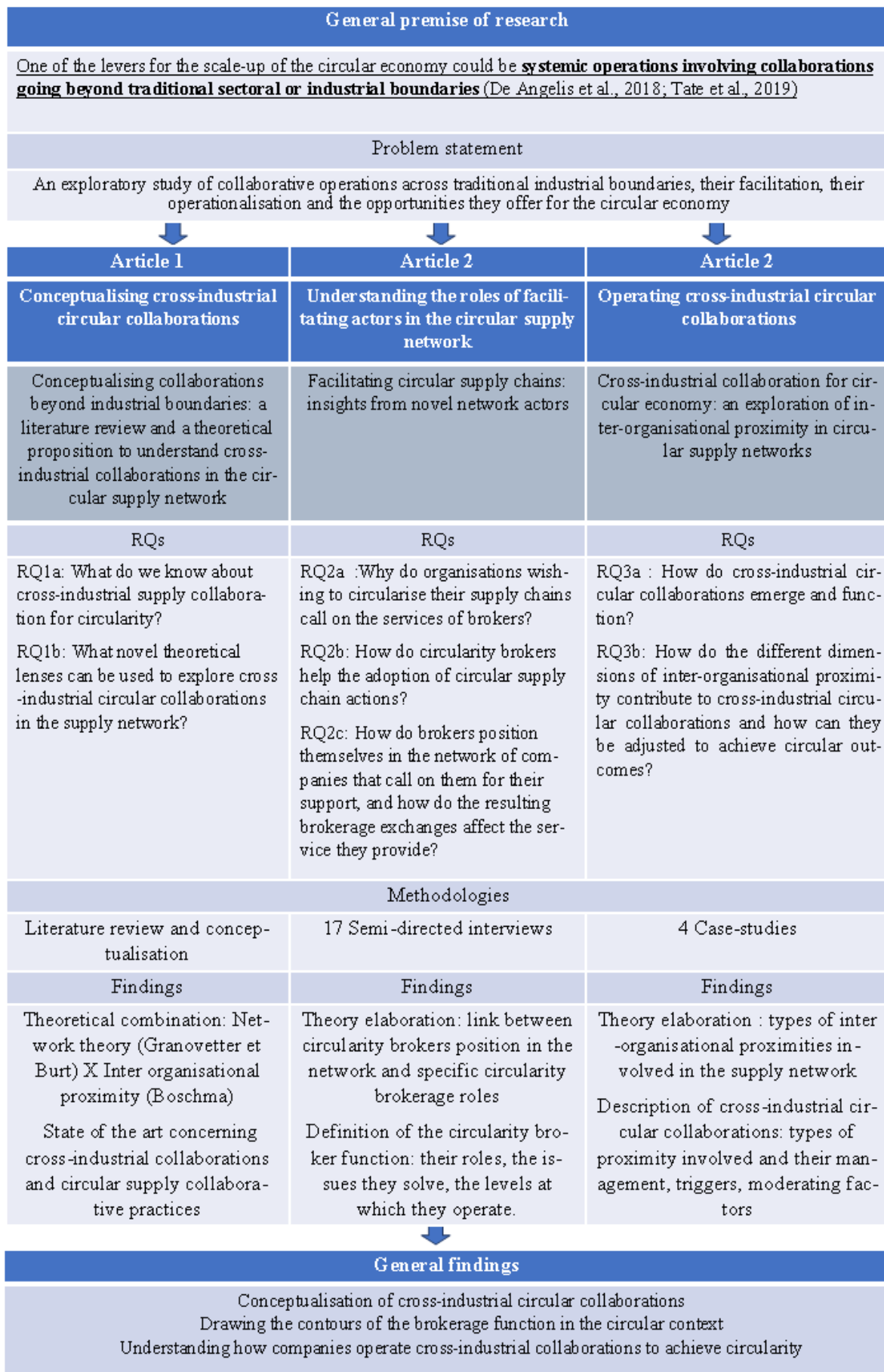


Figure 3. Visual representation of the thesis

1.5 Abstracts of articles 1, 2 and 3

1.5.1 Abstract article 1: Conceptualising collaborations beyond industrial boundaries: a literature review and a theoretical proposition to understand cross-industrial collaborations in the circular supply network

This state-of-the-art review paper aims to provide an overview of the current research in supply chain and management on cross-industrial collaborations. It also formulates a theoretical proposition to study them. This research on cross-industrial collaborations is carried out in the more specific context of the circular economy, as the scale up of this economic model has the particularity of requiring collaborations between organisations from different industrial sectors, a subject that remains to date relatively unexplored. The paper is divided in two parts. The first part is a literature review. A presentation on current knowledge on supply chain collaborations for the circular economy is realised, followed by a literature gap exploration of cross-industrial collaborations. The second part is a theoretical proposition. Concepts of the network theory and of the inter-organisational proximity framework and their relevance are explained, followed by a proposition of combination of the two views to conceptualize cross-industrial collaborations. The objective of this concept paper is to provide a thematic and theoretical background for future studies to understand how to connect non-traditional actors within a supply network, how companies from different industries manage to collaborate, and to assess the opportunities and pitfalls of these collaborations for the scale-up of the circular economy.

1.5.2 Abstract article 2: Facilitating circular supply chains: insights from novel network actors

This research studies circularity brokers, the economic actors facilitating the transition of companies towards circular operations. The purpose is to extend our understanding of “circular brokerage”, deriving from the concept of brokerage existing in network theory and applied to the specific context of the circular supply network. Recent papers have been devoted to the study of particular facets of circular brokerage, with studies specifically dedicated to circular incubators or platforms. This study proposes how these new actors can have a significant role in developing circular supply chains. The methodology is qualitative through 17 semi-structured interviews of circularity brokers. The theoretical approach draws on the network view and builds on the recent developments of the theory in the contexts of sustainability and the circular economy. Circularity brokers provide assistance to organisations and their networks, helping them to overcome the problems that stand in the way of adopting circular economy at different levels (micro, meso and macro). To do this, circularity brokers deploy a wide range of activities involving technical, methodological and relational skills. The position that circularity brokers occupy in the network gives them special dispositions for completing the mission for which they are commissioned, but the research extends previous research by proposing how these new actors can provide benefits beyond exploiting their network position. This research provides evidence on the role of circularity brokers and moves the state of knowledge from specific sector or cases to other sectors and a broader role beyond network position specifics. Network theory, with the constructs of broker exchanges and the influence of embeddedness, is used to develop theoretical implications.

1.5.3 Abstract article 3: Cross-industrial collaboration for circular economy: an exploration of inter-organisational proximity in circular supply networks

Recent supply chain research highlights the importance of studying collaborative practices to achieve circular economy and shows that one lever for scaling up the model could be systemic operations involving collaborations going beyond traditional industrial boundaries. The reasoning behind the argument is that exchanges established beyond the usual limits of a given industry provide access to new resources that are currently inaccessible and will enable the establishment of missing closed-loop flows. This paper studies cross-industrial circular collaborations, how they emerge, how they function and what factors affect their development and outcomes. The methodology adopted for this explorative study is a qualitative multiple case study of four supply networks straddling different industrial sectors. The theoretical approach is based on the inter-organisational proximity framework which captures the geographical, cognitive, organisational, institutional and social alignment factors of these collaborations. The contributions of this study are both empirical, by documenting these specific collaborations in the context of circular operations on the one hand, and theoretical on the other, by adopting the network perspective, which is essential for grasping the systemic implications of the circular model. Managers and policy makers can benefit from this study that provides a first list of facilitating factors and obstacles to the realisation of these cross-industrial circular collaborations, along with examples of actions to help organisations from different industries converge for effective circular outcomes.

2. ARTICLE 1

Conceptualising
collaborations beyond
industrial boundaries: a
literature review and a
theoretical proposition to
understand cross-
industrial collaborations in
the circular supply
network

Fiche de l'article 1

Titre en français : Conceptualiser les collaborations dépassant les frontières industrielles : une revue de la littérature et une proposition théorique pour comprendre les collaborations inter-industrielles au sein du réseau d'approvisionnement circulaire.

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EurOMA Sustainable Operations and Supply Chain Forum, March 2021

IPSERA Doctoral Workshop, April 2021



Conceptualising collaborations beyond industrial boundaries: a literature review and a theoretical proposition to understand cross-industrial collaborations in the circular supply network

Abstract

This state-of-the-art review paper aims to provide an overview of the current research in supply chain and management on cross-industrial collaborations. It also formulates a theoretical proposition to study them. This research on cross-industrial collaborations is carried out in the more specific context of the circular economy, as the scale up of this economic model has the particularity of requiring collaborations between organisations from different industrial sectors, a subject that remains to date relatively unexplored. The paper is divided in two parts. The first part is a literature review. A presentation on current knowledge on supply chain collaborations for the circular economy is realised, followed by a literature gap exploration of cross-industrial collaborations. The second part is a theoretical proposition. Concepts of the network theory and of the inter-organisational proximity framework and their relevance are explained, followed by a proposition of combination of the two views to conceptualize cross-industrial collaborations. The objective of this concept paper is to provide a thematic and theoretical background for future studies to understand how to connect non-traditional actors within a supply network, how companies from different industries manage to collaborate, and to assess the opportunities and pitfalls of these collaborations for the scale-up of the circular economy.

Keywords

Supply Networks; Circular Economy; Collaboration; Cross-Industry innovation; Inter-Organizational Proximity

2.1 Introduction

From the beginning of organised societies until the industrial era, “closing loops” was an integral part of value-creating economies (Desrochers 2000). The industrial revolution, by offering the possibility to provide for human needs

effectively and at low cost, opened the Pandora box (Frosch and Gallopoulos 1989) of an economic model with infinite growth perspectives in a world of limited resources (Meadows et al. 1972). While this paradigm has improved the lot of people everywhere, thus becoming synonymous with progress, its negative externalities that will lead them to downfall have long been unanticipated and remain uncontrolled.

Renouncing the dominant model by decoupling resources extraction, waste generation and carbon emissions from economic activity is the circular economy proposition. Companies can contribute to this by operating circular supply chains intensifying, slowing, narrowing, dematerialising and closing the resources loops in their operations (Geissdoerfer et al. 2017). In concrete terms, it means integrating activities of reuse, repair, remanufacturing or recycling to their business models (Bocken et al. 2016). Collaboration is central to the adoption of the circular economy (Bressanelli, Perona, and Saccani 2019) and recent systematic literature reviews confirm the central roles of collaborative practices among circular supply networks with the particularity of involving non-traditional actors (Sudusinghe and Seuring 2022; Danvers, Robertson, and Zutshi 2023). Among them, systemic operations involving collaborations going beyond traditional sectoral or industrial boundaries could be a lever for scaling up (De Angelis, Howard, and Miemczyk 2018; Tate et al. 2019) as already demonstrated in the adjacent research field of industrial symbiosis (Neves et al. 2020). Supporting this point, numbers of private and public initiatives emerge, like the Circlean-Symbiosis missioned by the European Commission or the Material Marketplace ran by the United States Business Council for Sustainable Development, both platforms aimed to connect the demand and supply of by-products from one industry to another. We also see the publication of recent white papers like *Scaling Up Cross-sector Collaboration for a Circular Economy: Insights from current practice*, in 2017 commissioned by the European Union or *Germany's transition to a circular economy: How to unlock the potential of cross-industry collaboration*, in 2021, ordered by a German business consortium. Another signal is the flourishing of consultancies offering matchmaking services between companies wishing to create innovative circular collaborations. The value offer of their services is to break down the sectoral barriers between firms through the

identification of potential players and the management of relationships with yet unknown partners. The range of evidence coming from both research and business practice leads us towards this study. In order to understand and to explain practices in a complex network of collaborating companies it is necessary to draw on several organizational theories and frameworks in combination (Halldorsson et al. 2007). It has moreover been recently highlighted that these new perspectives are required to understand emerging supply chain phenomena such as the ones developing in the sustainable context (Knight et al. 2022). For this purpose, constructs of the network theory related to connection between distant members of a network, combined with an explanatory framework of the dynamics of inter-organisational collaboration, provide interesting lenses (Shepherd and Suddaby 2017; Boxenbaum and Rouleau 2011; Okhuysen and Bonardi 2011; Spina et al. 2016). In this paper we aim to answer the three following research questions:

RQ1: What do we know about supply collaborative practices for circularity?

RQ2: What do we know about cross-industrial collaborations?

RQ3: What novel theoretical lenses can be used to explore cross-industrial circular collaborations in the supply network?

In response to those questions, the paper is articulated in a literature review section and a theoretical section. The literature review first exposes the current state of knowledge in supply management and operations on collaborative circular practices and then explores the literature gap on cross-industrial collaborations in the supply, innovation and management fields, that are to date scarcely studied. These two streams of literature are reconciled through the second section of the paper proposing a conceptual development bringing together constructs of the network theory (Granovetter 1983; Burt 2009) and the five dimensions of inter-organisational proximity (Boschma 2005) to conceptualise and explore cross-industrial circular collaborations.

2.2 Literature review

This first part is a literature review. We found that there have been recent systematic literature reviews on circular economy research (Lahane, Prajapati, and Kant 2021), as well as on collaborative practices in circular supply chains (Sudusinghe and Seuring 2022; Danvers, Robertson, and Zutshi 2023). We thus deducted that the stake was less to conduct an additional one that would have been redundant than to propose a summary of what has already been established (part 2.1) and to highlight the gaps in the literature regarding the exploration of circular cross-industry collaborations thus allowing us to justify our research angle (part 2.2). We then explore this gap with a literature search focused on cross-industry collaborative practices. We detail our methods (part 2.3), results (part 2.4) and discuss the best perspective to adopt to study them in future empirical research in the context of the circular economy (part 2.5).

2.2.1 Background

In a world of limited resources (Meadows et al. 1972), the race towards consumption threatens the earth system and has resulted in 2022 in the transgression of the sixth of the nine planetary boundaries (Rockström et al. 2009; Wang, Burke, and Zhang 2022), bringing even closer a global disruption of the system disabling the preservation of favourable conditions of human habitation of the planet. Sustainable development (Brundtland 1987), consisting of economic performance guaranteeing along the way social and environmental capital protection and restoration, has become imperative (Geissdoerfer et al. 2017). The reversal of the current economic paradigm requires the full commitment of all actors in society, including companies, whose actions in favour of sustainability are scrutinised by their stakeholders (S. Seuring and Müller 2008). Paradoxically, but understandably, the management of their supply chains is the key : in the current model supply chains are the instruments through which firms exert pressure on the environment but their sustainable conversion can drastically transform their impact (Matthews et al. 2016).

In this context, the adoption of circular economy is seen as a pathway leading to a more sustainable development and a harmonious society (Ghisellini, Cialani, and Ulgiati 2016). Our present linear model of production and consumption processes take in raw materials to generate products to be sold then disposed along with the waste generated. It allows to meet humans needs effectively and at low cost but turns out to be the Pandora's box of the industrial era (Frosch and Gallopoulos 1989). Yet, long before the emergence and then dominance of this development pattern, closed loops were integral of growing economies (Desrochers 2000) and the circular economy proposes to come back to this cyclical, cradle to cradle model (Ellen Macarthur Foundation 2013; McDonough and Braungart 2010). The origin of the term "circular economy" is debated (Murray, Skene, and Haynes 2017), and while its scope varies slightly (Korhonen, Honkasalo, and Seppälä 2018), it can be defined as *"a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling"* (Geissdoerfer et al. 2017) (p3).

Adopting the circular economy requires companies to redesign their models and operations. Within the immense variety of business models six main patterns have been identified: repair and maintenance; reuse and redistribution; refurbishment and remanufacturing; recycling; cascading and repurposing; and organic feedstock. (Lüdeke-Freund, Gold, and Bocken 2019). Reshaping business models towards circularity is enabled by circular supply chains, defined as *"the coordinated forward and reverse supply chains via purposeful business ecosystem integration for value creation from products/ services, by-products and useful waste flows through prolonged life cycles that improve the economic, social and environmental sustainability of organisations."* (Batista et al. 2018) (p10). But switching from linear to circular encounters number of difficulties, and the process of transition sees a wide spectrum of political, cultural, human, economic and technological constraints (Genovese et al. 2017). From the supply chain point of view, it implies a redesign of products and processes (through standardisation for example), along with a reshaping of all the facets of the operations, including those that are not traditionally considered as value-creation

stages (such as like end-of-life management). Material and non-materials resources flows such as information and finance also need to be reconfigured and the overall circularisation process necessitates significant investments (De Angelis, Howard, and Miemczyk 2018). Despite the obstacles, there are ways towards the circularisation of supply chains, which could be guided by 4 principles : Circular supply chains involve shifts from product ownership to servitisation; they must be integrated into a regional ecosystem that includes SMEs and innovators in order to establish flexible and local loops; these loops must be both closed and open and involve technical and biological cycles; they should be supported through ambitious procurement policies, more binding than legal minimums ; and finally circular supply chains are enabled by close collaborative practices with suppliers, product designers and regulators, as well with actors within and beyond their immediate industrial boundaries (De Angelis, Howard, and Miemczyk 2018).

The fact that close collaborations are essential to successful circularity products and initiatives (Bressanelli, Perona, and Sacconi 2019) leads us to a deeper investigation of the dynamics more generally at work in collaboration practices within supply chains. Building long-term relationships with key suppliers is central to supply chain management (Kähkönen 2014) and both practitioners and academics have an interest in supply-chain collaboration (Simatupang and Sridharan 2002). Supply chain collaboration is the sharing of information, the taking of joint decisions and the sharing of benefits and risks between two or more chain members in the aim to achieve greater profitability and customer satisfaction. The idea being to reach these goals with more efficiency by acting together rather than working alone (Simatupang and Sridharan 2002). Supply chain collaborations take various forms (Kähkönen 2014) : they vary according to their degree of commitment (Jagdev and Thoben 2001), of formalization (P. J. Singh and Power 2009) and can be vertical (involving suppliers and customers) or horizontal (engaging competitors or NGOs) (Chen et al. 2017). When well executed, supply chain collaborations bring a wide range of benefits, including the decrease of excess inventories, the avoiding of costly bullwhip effects, the enhancing of quality, flexibility and joint innovation. This ultimately translates into a competitive advantage improving the firm's individual financial and overall

performance (Cao and Zhang 2011) as well as for that of the entire chain (Barratt 2004). Despite their advantages, these collaborative practices have been proved challenging to implement. Among the most commonly encountered difficulties are the inability to determine who to collaborate with, tensions in decision making process and the lack of trust between partners (Cao and Zhang 2011; Simatupang and Sridharan 2002). However, these obstacles must be overcome in order to reach a better sustainability of the supply chain. This objective can only be achieved through actions that go beyond organisation boundaries (S. Seuring and Gold 2013), especially in a context where companies are held accountable for the environmental performance of their suppliers (S. Seuring and Müller 2008). These collaborations are essential for implementing environmental practices (Zhu, Geng, and Lai 2010) and to improve their performance (Geffen and Rothenberg 2000). For example, they contribute to robustness and resilience (Scholten and Schilder 2015), to lower carbon emissions (Luo, Chen, and Wang 2016) and to supply chain sustainable innovation (Frey, Iraldo, and Testa 2013; Konietzko, Bocken, and Hultink 2020) (Chen et al. 2017).

As the lack of collaboration is one of the major barriers hindering the implementation of circular models (Kazancoglu, Kazancoglu, and Sagnak 2018), companies shape their circular supply chains in close relationship with their suppliers. Management researchers have repeatedly called for further exploration of the dynamics and implications of collaborative practices (Bressanelli, Visintin, and Sacconi 2022; Farooque et al. 2019; Lahane, Prajapati, and Kant 2021). A recent systematic review of the literature has been performed to make a snapshot of the current knowledge on the subject (Sudusinghe and Seuring 2022). It builds on previous work adopting the same approach for sustainable collaborative supply chains (Chen et al. 2017) and confirms that circular collaborative supply chains can in the same way be distinguished according to whether they implement practices that are internal (for example cross-functional coordination or process integration), external vertical (like the sharing of information with suppliers and customers) or external horizontal. This last sub-category has been modified to incorporate one of the specificities of the circular supply chain: the integration of unusual key players. While the preceding classification proposed mainly collaborations with NGOs and competitors, this new typology, as already

suggested by the literature (Miemczyk et al. 2012), integrates government, entrepreneurs, innovators, industry associations and research institutions (Sudusinghe and Seuring 2022). These non-traditional actors can play a variety of facilitating roles, like helping to match virgin resources demand and equivalent by-products supply or developing integrated approaches to eco-industrial development (Geissdoerfer et al. 2017).

These circular collaborative practices can be distinguished depending on their nature: They can be called relational, operational, or so named “stakeholder practices”. The relational ones are aimed to gain a competitive advantages derived from relational rents, that are the general benefits resulting from the relations established with the network (Dyer and Singh 1998). The operational ones are the ones specifically related to supply chain and operations. The “stakeholder practices” ones are those established with the members of the network who are not parties to the collaboration, but who assist the parties in its realisation (Sudusinghe and Seuring 2022). In this category we can note for example the entrepreneurs and innovators who provide solutions or technologies helping to achieve circularity. The gathering of these new actors, previously unconnected, allows a greater circular ecosystem innovation by ensuring that challenges are approached with multiple and previously unrecognized angles (Konietzko, Bocken, and Hultink 2020).

It is stressed that future research should take in consideration supply chain evolutions necessary to reach a greater circularity, one of the most important being the shift from a dyadic perspective to a network perspective (Sudusinghe and Seuring 2022). This recommendation is in line with the fact that the business ecosystem should be the appropriate point of view to capture the mechanisms that enable the move towards circularity (Kanda, Geissdoerfer, and Hjelm 2021). This enables a better investigation of the coordination processes between stakeholders and the integration of the diversity of their perspectives, especially if the said stakeholders are diverse (Farooque et al. 2019). Reinforcing this idea, a same invitation to adopt this level of analysis (Miemczyk et al. 2012) and to study the distant actors of the network was made earlier, with regard to the more general objective sustainability of supply chains (Johnsen, Miemczyk, and Howard 2017). Another evolution specific to circularisation is the involvement of

unconventional stakeholders (Sudusinghe and Seuring 2022), among which economic actors previously unseen within the traditional limits of the supply network. The facilitation of relationships with these new stakeholders can be realised by intermediaries (Danvers, Robertson, and Zutshi 2023). This is aligned with the principle stating that in order to transition to a circular value system, secondary material flows need to continuously cross industry boundaries (Tate et al. 2019). It echoes that, more broadly, circular supply chains are enabled by close collaboration between partners situated beyond their immediate industrial boundaries (De Angelis, Howard, and Miemczyk 2018).

In this background section, we have summarized what we know about collaboration within the supply network for circularity. We explained the circular model and the switch from linear supply chains to circular ones. We detailed collaborative practices in circular supply chains. We emphasized their specifics in terms of involvement of non-traditional actors and the necessity of adopting the perspective of the network for their analysis.

2.2.2 Gaps and justification of the research

We have seen that collaborative practices with non-traditional stakeholders is one of the characteristics of the implementation of the circular model. This echoes one of the main principles of the circular economy that is the mobilisation of diversity in the development of circular solutions (Velenturf and Purnell 2021). This diversity brings a plurality of perspectives and a culture of exchange and participatory change to coordinate the development, integration and implementation of circular strategies between all actors and at all societal scales. Among the unusual and diverse stakeholder collaborative practices, some have been investigated more than others. Collaborations with government and the public sector have been studied, as well as those with academic institutions, innovation entrepreneurs, NGOs and competitors. However, despite the call of the literature to explore circular collaborations operating beyond traditional industrial boundaries (De Angelis, Howard, and Miemczyk 2018; Tate et al. 2019), recent literature reviews on the subject have not reported studies of circular

collaborations involving different industries (Sudusinghe and Seuring 2022; Danvers, Robertson, and Zutshi 2023).

We proceeded to a first scan of the scientific literature databases to confirm this gap. We found that there was a field of research related to ours that could provide a first basis for our research and also confirmed the importance of investigating circular cross-industrial collaborations. We have found that most of the knowledge provided about cross-industrial collaborations in a circularity perspective belongs to the field of study of industrial and territorial ecology and more particularly of industrial symbiosis that *“engages traditionally separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and/or by-products. The keys to industrial symbiosis are collaboration and the synergistic possibilities offered by geographic proximity”* (Chertow 2000) (p1). It is therefore a question of cross industrial collaborations with materials (often by-products) or water and energy loops, within a given territory. It is argued that the subject of our study, circular supply networks, is a rather broader one as it includes more applications of the circular economy, (such as remanufacturing or reuse) and is not limited to a circumscribed territory (although there is a recent debate in the literature arguing for an exclusion of this criterion in the term industrial symbiosis (Velenturf 2016)). Despite these slight points of divergence in terms of scope, the contribution of industrial symbiosis research to our object of study is indisputable. A particular attention has been paid to scanning the latest developments in the literature (Neves et al. 2020). We found a specific focus on the types of industries and their associated co-products most often engaged (Domenech et al. 2019) and the assertion that the diversity of industries is something that industrial parks should strive for (Côté and Hall 1995). Indeed, research on industrial ecosystems has shown that cultivating a diversity of industries engaged in synergies in a territory can make it more resilient by fostering innovation and the introduction of new ideas (Ashton 2008). Similarly, the areas with the richest industrial diversity are those with the most companies engaged in symbioses. As a result, these territories have higher rates of recycled resources and higher productivity (Jensen 2016).

These findings in the area of industrial symbiosis thus support our initial premise that cross-industrial collaborations should be investigated further in regard to their potential to reach a greater level of circularity. Nevertheless, these studies were more discussions of the conditions of emergence of industrial symbiosis rather than a specific focus on the matching of distant industrial sectors and how their differences could contribute to the achievement of circularity. We concluded that despite the contributions of research on industrial symbiosis, studies were still needed to understand the functioning of circular cross-industry collaborations. We therefore decided to conduct a literature review to explore this gap, whose process is presented in the next section.

2.2.3 Materials and methods

We set the background for this study in the previous section where we have summarised recent reviews of the systematic literature on collaborative circular practices (Chen et al. 2017; Neves et al. 2020; Sudusinghe and Seuring 2022). A first scan of the literature on the intersection between the circular economy and cross-industry collaborative practices provided some preliminary evidence through studies on the benefits obtained from the richness and diversity of industries represented in industrial ecosystems (Neves et al. 2020; Jensen 2016; Ashton 2008). This has confirmed both their potential value to the circular economy in general and the importance of further study of their mechanisms. Not having found any other results related to cross-industry collaborations in the context of the circular economy or sustainability than those related to industrial symbiosis already described in the previous section, we decided to conduct this research in a broad way. We explored cross-industrial collaborative practices as a whole in order to gather as much knowledge as possible on the subject. The literature search took place during winter 2022-2023. The queries were undertaken in Web of Science database, using combinations of the following key words:

- Related to the cross-industry dimension, we enlarged our research to supposed synonyms “inter-industry” and “multi-industry”.

- Related to collaboration, we adopted related key words such as “partnerships”, “relationships”, “integration”, “cooperation”, “coordination” and “cooperation”.
- As our research is at the crossroads of supply chain and management disciplines, we used key words of “supply”, “operations”, “management” and “innovation” in order to capture articles that lied within the two scopes.

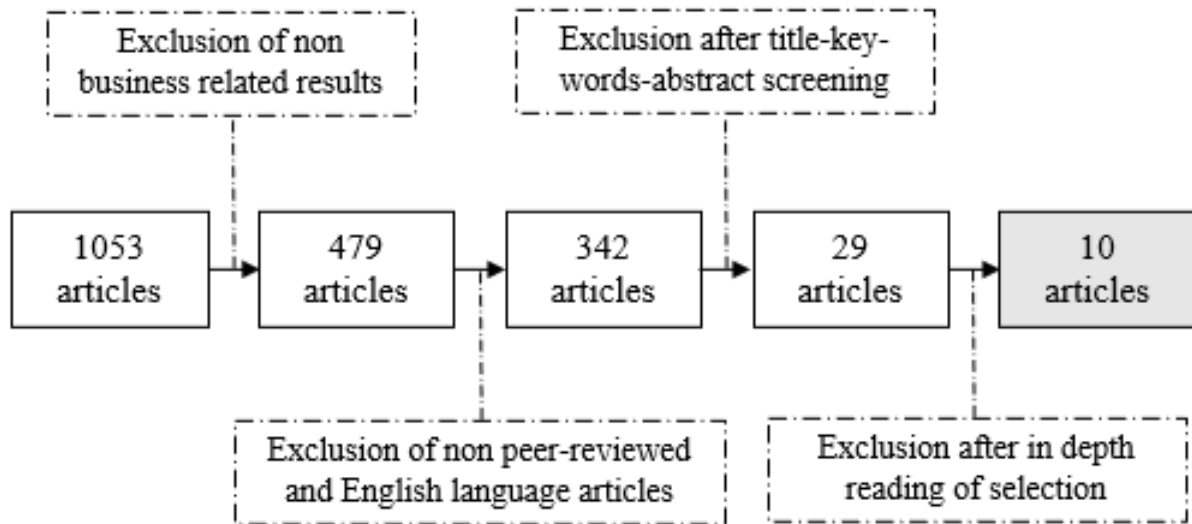


Figure 4. A summary of the literature review steps conducted in this study

The initial search retrieved 1053 articles. After removing results that did not fit our research areas (i.e., that belonged to the fields of engineering, chemistry, materials, computer science, intellectual property law etc and were more generally not business and management oriented) the results set was reduced to 479 articles. We then excluded research that were not peer-reviewed journal articles (i.e., conference proceedings, early access, retracted publications or book chapters) in English language and obtained 342 articles whose we screened the titles, abstract and key words to refine our sample. A vast majority of the articles were excluded because the term “cross-industrial” and other synonyms did not refer to research objects that actually straddled several industrial sectors but to samples where several industrial sectors were represented, reducing the number

of articles to 29. Finally, a reading of the content of the articles allowed us to determine whether the research addressed empirical fields that were de facto cross-industrial without this particular dimension and its implications being specifically investigated, or if the studies were conducted on cases where cross-industry collaborations and their specific mechanisms were the object of the research. We have selected the latter option, ultimately reaching a number of 10 articles. A special attention was given to the studies with a sustainability dimension when reading the sample. Figure 4 summarises the literature review steps.

2.2.4 Findings

The final sample mainly belonged to journals specialized in the management of innovation (*R&d Management* (3), *International Journal of Innovation and Technology Management* (1), *International Journal of Innovation Management* (1), *Creativity and Innovation Management* (1), *Technovation* (1), *Technological Forecasting and Social Change* (1), *Strategic Management Journal* (1), *Journal of Cleaner Production* (1)). The small number of articles found allowed an analysis based on an inductive approach to identify the key themes of the research area. The content of the selected paper has been read and summarized below and in Table 2.

At the term of this literature search, we found that cross-industry cooperations lead to significantly more innovative products than traditional approaches (Kotabe and Scott Swan 1995). It can be explained by the fact that exchanges that occur without an underlying competition context enable an open learning climate and prevented intra-company power struggles, ultimately resulting in an exploration of wide varieties of perspectives (Gattringer et al. 2021). The theoretical approach of absorptive capacity has been often mobilized to help the firms to prepare to engage into distant collaboration (Enkel and Gassmann 2010) on various fronts. For example, the management of cognitive heterogeneity of firms belonging to distinct industrial background as been discussed. In this context, knowledge transfer operates through an iterative pattern of conveying starting with knowledge discovery, then transit ultimately outcoming to integration (Enkel

and Heil 2014). It happens through a process of retranslation (Hilda Bø Lyng and Brun 2018; Hilda B. Lyng and Brun 2019) and a management of the motivation and behaviours of the experts engaged (Enkel and Bader 2016). Another example is the importance of socialization that has also been highlighted: shared common social activities and personal interactions have been proved to allow a better consideration of the partner's background standards, knowledge and values. They also increase the partner's commitment and ultimately lead to the emergence of a common language with no industry-specific differences (Dingler and Enkel 2016). Finally, a specific focus dedicated to facilitators bridging different industries (Gassmann, Daiber, and Enkel 2011) has been realised, resulting in a typology : innovation multipliers, leveragers and broadeners, each relying on different combination of competencies to either transfer innovations from a sector to another or to coordinate competences from distinct sectors in order to elaborate them. A number of related concepts revolve around the field of cross-industrial collaborations, such as the notion of boundaries work, which is relatively broad, dealing about the collective efforts among organisations (Langley et al. 2019) and industry alignment (Heil and Bornemann 2018).

The question of collaborations between stakeholders with diverse profiles for the scale up of sustainability (Ciulli et al. 2022; Velter et al. 2020) or for an optimum resource sharing (Acquier, Carbone, and Massé 2019) is still emerging and there are few works that have specially focused on cross-industry collaborations in a sustainable context. The two only examples of the result of our literature review are in the field of the bioeconomy on possible industrial bridges with the very specific sector of agroforestry (Guerrero and Hansen 2021) or for the case of phosphate by-products recovery (Carraresi, Berg, and Bröring 2018).

Table 2. Overview of the literature themes and findings relevant to our study

Article	Findings related to our research
On innovation outcomes of cross-industrial collaborations	
Kotabe, M.; Scott Swan, K. The Role of Strategic Alliances in High-Technology New Product Development. <i>Strategic Management Journal</i> 1995, 16, 621–636.	Innovations resulting from cross-industry cooperations tend to produce significantly more innovative products than products introduced by firms that are cooperating within the same industry (Kotabe and Scott Swan 1995).
Carraresi, L.; Berg, S.; Bröring, S. Emerging Value Chains within the Bioeconomy: Structural Changes in the Case of Phosphate Recovery. <i>Journal of Cleaner Production</i> 2018, 183, 87–101.	Among the challenges hindering the emergence of novel value chains are missing complementary competencies and difficulties in integrating different industrial sectors to engage in cross-industry innovation (Carraresi, Berg, and Bröring 2018).
Heil, S.; Bornemann, T. Creating Shareholder Value via Collaborative Innovation: The Role of Industry and Resource Alignment in Knowledge Exploration. <i>R&D Management</i> 2018, 48, 394–409.	Differences in the focal and partner firms' industry domains contribute to the value of collaborative innovation. There is a positive relationship between industry distance and investors' valuation of the collaboration's expected future performance (Heil and Bornemann 2018).
Gattringer, R.; Damm, F.; Kranewitter, P.; Wiener, M. Prospective Collaborative Sensemaking for Identifying the Potential Impact of Emerging Technologies. <i>Creativity and Innovation Management</i> 2021, 30, 651–673.	Due to the cross-industry approach (without competitors), an open learning climate could evolve, intracompany power struggles were prevented and there was no need to develop a 'common sense', which facilitated adopting a wide variety of perspectives and thinking in scenarios (Gattringer et al. 2021).

On knowledge aspects related to cross-industrial collaborations	
Enkel, E.; Gassmann, O. Creative Imitation: Exploring the Case of Cross-Industry Innovation. <i>R&D Management</i> 2010, 40, 256-270.	Cognitive distance cannot be confirmed as having a positive or negative effect on the innovation outcome in cross-industry innovation (Enkel and Gassmann 2010).
Enkel, E.; Heil, S. Preparing for Distant Collaboration: Antecedents to Potential Absorptive Capacity in Cross-Industry Innovation. <i>Technovation</i> 2014, 34, 242-260.	Inter-organisational cognitive distance can be measured. Three approaches are proposed to prepare for cross-industrial collaboration based on the degree of technology centralisation and the amount of resources of the firms wishing to engage in cross-industry innovation (Enkel and Heil 2014).
Lyng, H.B.; Brun, E.C. Knowledge Transition: A Conceptual Model of Knowledge Transfer for Cross-Industry Innovation. <i>Int. J. Innovation Technol. Management</i> 2018, 15, 1850043.	Knowledge transfer for cross-industry innovation can be understood as a three phases process: Knowledge discovery, knowledge transit and knowledge integration (Hilda Bø Lyng and Brun 2018).
Lyng, H.B.; Brun, E.C. Making Your Knowledge Mine: The Integration of External Knowledge in Cross-Industry Innovation. <i>Int. J. Innov. Mgt.</i> 2019, 2050050.	Knowledge adoption in cross-industry innovation is developed through a process of iterations between knowledge conveyance and knowledge convergence until the actors are able to adopt the external knowledge. Retranslation is a highly facilitative communicative enabler to adopt an external knowledge (Hilda B. Lyng and Brun 2019).
On social aspects related to cross-industrial collaborations	
Dingler, A.; Enkel, E. Socialization and Innovation: Insights from Collaboration across Industry Boundaries. <i>Technological Forecasting and Social Change</i> 2016, 109,	Socialisation is made of shared social experiences, common activities and personal interactions. Socialisation influences knowledge transfer among industries by enabling to take into account the partners' background knowledge, prevalent standards and values ultimately

50–60.	resulting in the knowledge being presented in the partner's industry specific language. The outcome is the emergence of a distinct language with no industry specific differences. It increases the commitment of the partner (Dingler and Enkel 2016).
On intermediaries facilitating cross-industrial collaborations	
Gassmann, O.; Daiber, M.; Enkel, E. The Role of Intermediaries in Cross-Industry Innovation Processes. <i>R&d Management</i> 2011, 41, 457–469.	There are three types of intermediaries who bridge gaps between industries for cross-industrial innovation: innovation broadeners, leveragers and multipliers. They have different combination of technological or methodological skills or reliance on their network to either develop cross-industrial innovations or to transfer innovations from an industry to another (Gassmann, Daiber, and Enkel 2011).

2.2.5 Discussion

We have made progress in our understanding of industrial collaborations. Four themes have been previously explored by the research: outcomes of cross-industrial innovations, knowledge aspects of cross-industrial innovations, social aspects of cross-industrial innovations and cross-industrial intermediaries.

We draw the following conclusions from this literature review: Most of the studies have been carried out at the level of the organisation and the individuals that make it up, and the resulting knowledge therefore focuses on this level of analysis, and it remains to discover the dynamics at play at the organisational network level. The angle of the supply chain and operations remain uncovered, along with the specificities of sustainable or circular aspects. Although a typology of intermediaries facilitating the elaboration of innovations between different industries or the transfer of innovations from an industry to another has been realised, the knowledge remains embryonic on the emergence of these collaborations, especially concerning the mechanisms of connection between firms of distinct industrial sectors. We argue that further research could explore these current uncovered areas. In a perspective of dissemination of the circular economy conditional on the establishment of collaborations beyond the industrial boundaries of the network, it seems important to study a number of areas among which :

- the mechanisms of connections between companies belonging to distinct industrial sectors (mutual awareness, approach, contact, selection of the relevant partners)
- the mechanisms of functioning of collaborations between companies belonging to distinct industrial sectors (initiation and functioning, dynamics of circulation of resources and information between the partners)
- the facilitating and hindering factors in all these processes.

In this first literature review section, we have summarized the current state of knowledge on collaborative supply practices in the context of the circular economy. We have also reviewed what we know about cross-industrial collaborations, that are a lever for the scale-up of the circular model. We have finally stated that further explorations of mechanisms underpinning cross-industrial collaborations within the supply network need to be realised in order to facilitate their realisation in the objective of contributing to a broader diffusion of the circular model.

2.3 Theoretical Proposition

This section exposes an appropriate theoretical approach to analyse the dynamics of cross-industrial collaborations occurring in supply networks and to propose a generalisation of the results.

We recall that one of the principles of the circular economy is its holistic nature: it takes a whole system approach to understand the challenges and the potential of proposed solutions for a sustainable circular economy (Velenturf 2016). This echoes the fact that circular change needs to happen at all scales, with collaborations operating at multiple levels and particularly at the level of the network of organisations (Danvers, Robertson, and Zutshi 2023). In this sense, the production of research mobilising the network theoretical framework is encouraged (Lahane, Prajapati, and Kant 2021), as it should have the potential to advance research on circular supply chains (J. Liu et al. 2018). Our theoretical proposal will therefore be based primarily on the network theory, and we argue in this sense in the following section.

2.3.1 Network theory to understand dynamics of resources circulation and connection practices

One specific theoretical framework stands out as particularly suitable for exploring networks in the discipline of supply chain management as it provides an overview of inter-organisational interactions, emphasises the influence of partner relationships on an organisation's activities and focuses on the fit between organisations that plan to enter into cooperative relationships. This is

network theory, which postulates that the performance of a company depends not only on the effectiveness of its cooperation with its direct partners, but also on the quality of its partners' cooperation with their own partners. The idea is that cooperation between network members combining their resources achieves more benefits than the sum of each member's individual efforts. Network theory is one of the most relevant tools for the discipline and is used preferentially when mapping supply chain actors, activities and resources since it emphasises the construction of long-term cooperative relationships between the parties but also their mutual adaptation through exchange processes (Halldorsson et al. 2007).

These exchanges concern the circulation of resources of all kinds, material and immaterial, between the organisations involved in the network. This circulation takes place according to dynamics that are based on two major and complementary concepts. The first concerns the “strength of weak ties”. According to Granovetter (who anchors his postulate in sociology, i.e., in relationships between individuals), the strength of a tie is estimated according to the amount of time spent together, the emotional intensity and the degree of intimacy between two subjects. Strong ties bring cohesion, but paradoxically, as they are established between individuals who are very close and therefore whose most of interactions take place within their mutual relationship, there is little chance that it is through them that a new opportunity will arise. For this reason, it is the weak links, those established with individuals who are more distant, whose interactions present more of an interface with the outside world, that are the most valuable (Granovetter 1973). Later, he extended his thinking from the level of the individual to that of groups and organisations (Granovetter 1983). In the management discipline, the objects of studies are companies, which are also connected by ties of varying strength. Strong ties are established between firms with a high degree of congruence in their business relationships while ties between companies with less close relationships are comparatively weaker. These companies that are linked through weak ties however present strong links with other unknown parties. These yet unknown partners are those who have novel resources towards which these weak ties build bridges. This is the “strength of weak ties” between organisations: the less intense ties are the channels through which the new resources that companies are likely to need circulate. The second

concept is that of “structural holes”, which follows the same logic. This construct describes how the mesh of a network, its structure, constitutes a competitive advantage for some of its members over others. Within a network, structural holes separate firms whose relationships are not tightly knit together. These firms are often linked by unique ties which means that through this linkage these firms expand their respective networks to a more diverse set of contacts and are the only ones to have access to the resources offered by this connection, that ultimately translating into entrepreneurial opportunities. These companies can therefore act as intermediaries between organisations situated on opposite sides of the bridge they form, and thus broker the flow of information or control the form of projects on opposite sides of the structural hole. (Burt 2009). When there is a lack of weak ties or structural holes within the networks, it results in a phenomenon of “embeddedness” leading to a low potential for novel opportunities.

Our research is a study of the collaborations between companies belonging to different industrial sectors. These collaborations therefore imply that companies establish links outside their usual field of influence. The resulting network thus has a high probability of weak links or structural holes, opening opportunities to important exchanges. A summary of these concepts and their relevance to our research is presented in Table 3.

The postulate of the strength of the weak ties has been supported in the field of sustainable supply chain management, where weakly connected network members are pivot to introduce innovations (Tate, Ellram, and Gölgeci 2013). Brokers, organisations that bridge two sides of a structural hole, fulfil this role by establishing connections that allow the emergence of new opportunities within the network. The connection practices of brokers have been analysed with a finer granularity in the sustainable context, the outcome being that their positioning in the supply network allows the mobilisation of stakeholders for different purposes. The degree to which they are embedded and the way in which they interface with other nodes condition specific types of exchanges that are of particular use at different stages of the realisation of sustainable initiatives: five types of interfacing with the network have been described, resulting in five types of brokers (coordinator, consultant, gatekeeper, representative and liaison) (Saunders et al.

2019). These five types of exchanges present different advantages for creating, disseminating and adopting sustainable initiatives. Other facets of the benefits offered by brokers in monitoring sustainability performance or developing sustainability capabilities have been further developed and reported in a recent comprehensive review of the literature on the intersection of network theory and sustainable supply chain management (Alinaghian, Qiu, and Razmdoost 2020). The importance of these actors has also been discussed in other related theoretical streams, as in the intermediation theory, where intermediaries, actors dedicated to the support of supply chain management (Vedel and Ellegaard 2013) through the circulation of information, development of knowledge and the management of supply risk (Cole and Aitken 2020) contribute to the tackling of sustainability grand challenges (Rosca et al. 2022).

In the more precise perspective of circularity, a first discussion on this type of actor has recently taken place. The constructs of brokers and structural holes have been explored for the facilitation of the circularity of the food supply chain. A first definition of the circularity broker has been established: "*circularity brokers are positioned along a supply chain and connect actors with products or materials that have no value to them, on one side, with other actors that can use those products or materials for their own consumption or as inputs for their activities, on the other side. The circularity broker may bring together disconnected parties or link actors who are already tied to one another for certain supply chain activities but are disconnected for the transfer of waste.*" (Ciulli, Kolk, and Boe-Lillegraven 2019) (p6). The authors complete this definition by proposing that circularity brokers bridge the circularity holes through six brokering roles that are connecting, informing, protecting, mobilising, integrating and measuring.

Table 3. Congruence of the subject of the study with the network theory

Network theory constructs	Relevance to circularity & cross-industrial supply chain collaboration
Tie strength	Effective supply networks are those that are aware of their ecosystem, within which all companies matter, even if the links between them are of different strengths. What differentiates strong and weak ties are the number of connections, the frequency of the exchanges and the reciprocity of the ties. Weak ties are the more prone to allow a good circulation of information and resources (Granovetter 1983; Burt 2009)
Structural holes	In a network, a structural hole appears between organisations who are weakly connected. Structural holes allow to access and to mobilize novel resources between organisations positioned opposite to the structural gap (Burt 2009).
Circularity holes	Building on the concept of structural holes, circularity holes are missing connexions in the supply network. The link through which waste can be transferred to recover its value with another agent is not yet established and there is a potentiality to create circularity (Ciulli, Kolk, and Boe-Lillegraven 2019).
Brokers	They establish ties and are situated across a structural hole. They form a bridge that facilitate knowledge and resource transfer and coordinate efforts on both sides of the bridge they form. Brokers are considered as key players in networks and their specific positioning grant them particular abilities for the development, diffusion or implementation of sustainable initiatives (Saunders et al. 2019).

2.3.2 Proximity approach to understand mechanisms of collaboration practices

Once the challenging work of connexion between companies belonging to different industries is done, the issue becomes to function properly together. Following a homophily logic postulating that it is easier to interact and a fortiori collaborate with a partner that is different in number of ways, it sounds challenging or less probable for firms to create successful cross-industrial partnerships. Belonging to different industries induce what has been described as a form of distance between firms (Enkel and Gassmann 2010; Enkel and Heil 2014).

The notion interorganisational distance takes roots in the study of proximity, the spatial distance between two subjects, a construct naturally mobilized in the geographic and economics fields. It was also adopted in a more metaphoric understanding by the discipline of sociology that defines that proximity should be measured through the number and strength of interactions between subjects: between close actors, interactions are more probable and stronger. In the management sciences, the subject was discussed in the early 2000's in France under the umbrella term of "proximity dynamics" (Talbot and Kirat 2005; Talbot 2009). Several proximity frameworks coexist and there is a call for an unification of the lenses to perform effective studies of supply chain problematics (P. Klimas and Twaróg 2015). The proximities frame proposed by Boschma (Boschma 2005), that is the more mobilized one, was developed for understanding the mechanisms underpinning innovation. It postulates that proximity can be broken down in five subcategories.

- Cognitive proximity, the amount of shared knowledge between actors, as a needed basis to allow communication, understanding and processing information.
- Organizational proximity, the degree of similarity in the style of governance and control of the organisations. It can be extended to the types of channels used to

coordinate, transfer and exchange information within and between the organizations.

- Social proximity, the relations formed at the individual level: trust, friendship, and shared experiences.

- Institutional proximity, the equivalent of social proximity at the group level: the set of common habits, routines, practices, rules and laws shared by individuals at the collective level.

- Geographic proximity, the spatial distance between actors. This proximity by itself is neither a prerequisite nor a sufficient condition for effective innovation: it facilitates interactions by reinforcing the four other dimensions of proximity.

Proximities under its different forms does not have a linear effect: there is an optimal degree for each form of proximity. *“Too much and too little proximity are both detrimental to learning and innovation”* (Boschma 2005) (p7) To function properly, proximity requires some, but not too great, distance between actors or organizations. The different dimensions of inter-organisational proximities and their associated challenges are summarized in Table 4.

Table 4. Forms and features of proximities and management means associated, from Boschma, 2005

Form of Proximity	Key dimension	Too little proximity	Too much proximity	Possible solutions
Geographical	Spatial distance	No spatial externalities	Lack of geographical openness	Mix of local “buzz” and extra local linkages
Cognitive	Knowledge gap	Misunderstanding	Lack of source of novelty	Common knowledge base with diverse but complementary capabilities
Organisational	Coordination and control	Opportunism	Bureaucracy	Loosely coupled system
Social	Trust based on social	Opportunism	No economic	Mixture of

	relations (micro-level)		rationale	embedded and market relations
Institutional	Trust based on formal (laws or rules) and informal (cultural norms and habits) institutions (macro-level)	Opportunism	Lock in and inertia	Institutional checks and balances

In the supply management field, the literature has focused on certain dimensions of these proximities with different theoretical approaches, such as cognitive proximity with for example focus on knowledge diffusion (Marques, Yan, and Matthews 2020) or on learning mechanisms within a supply network using the knowledge-based-view theory (Santos, Silva, and Pereira 2023; Silva, Pereira, and Boffelli 2023). These approaches are particularly useful as they enable to go into the details of the mechanisms of a proximity dimension and to grasp its fine workings. The inter-organisational proximity approach is complementary because it allows a coordinated vision of the five dimensions and their potential interactions. However, supply chain management literature using the proximity lenses remains scarce and is mainly of conceptual nature. The studies are usually exploratory and operating under the methodology of the case study although their mobilisation can improve the understanding of complex and collective activities of the supply network (Patrycja Klimas 2017; P. Klimas and Twaróg 2015) by allowing the study of the intangible dynamics of coordination processes like the social or organisational factors associated with the different forms of collaboration between firms (Carbone and Blanquart 2013; Rallet and Torre 1999; Velenturf 2016). In the specific field of collaborative supply chains, given the expected benefits already cited, the proximities framework seem underused, only once to our knowledge (Blanquart and Carbone 2014), out of the 87 studies censused by a recent systematic literature review (Ülgen et al. 2019).

2.3.3 Combining the network theory and the proximity approach to understand cross-industrial circular collaborations

In a context where it has been stressed that management sciences applied to operations management are becoming increasingly a-theoretical, or that theory lies most of the time on the periphery of the inquiry (Schmenner et al. 2009), it is encouraged to produce theory-oriented operations and supply chain research (J. Liu et al. 2018; Markman and Krause 2016; S. Seuring et al. 2020) for the purpose of contributing to make the discipline stronger (Touboulic and Walker 2015). One of the proposed areas of improvement is to tackle the lack of variety in the theories mobilized in the discipline by diversifying research paradigms through the mobilization underused theories or the creation new alternative ones (Halldorsson et al. 2007). This has been recently emphasized, especially for the study of sustainable supply and purchasing problematics, as *“old theories tend to lead to the same focus and the same conclusions. New theoretical lenses are required, which may be borrowed and adapted from other fields, or developed for purchasing and supply management”* (Knight et al. 2022) p5. For the purpose of the vitality of our discipline (Touboulic and Walker 2015), it is among others recommended to use several theoretical approaches (Halldorsson et al. 2007). For example, two theories can be used to generate complementary research questions (Moxham and Kauppi 2014). Another example is the use of combination of theories or rearrangement of constructs belonging to different theories to understand a management phenomenon (Shepherd and Suddaby 2017; Boxenbaum and Rouleau 2011; Okhuysen and Bonardi 2011), as for example in [105]. The combination of theories allows to provide *“useful insights”* to *“generate a coherent, broad, and useful explanation of management phenomena”* (Shepherd and Suddaby 2017) p16.

We have seen in the previous paragraphs how network theory and Boschma's framework of proximities are both relevant to the study of our research object. We believe that the two approaches can enrich each other. Following the invitation to propose applications of alternative theoretical approaches, we see a potential for lenses combination (Okhuysen and Bonardi 2011). This theoretical approach has

advantages, such as the ability to create bridges between disciplines when the combined lenses are preferentially mobilized in distinct fields. By this way, it contributes to counter the tendency to create knowledge silos induced by the necessary specialization of research. The first theoretical pillar of our reasoning, network theory, has been proposed as one of the four most relevant theoretical theory for the supply chain discipline (Halldorsson et al. 2007) and its methodological derivative, social network analysis, is the most used in the study of industrial symbioses (Neves et al. 2020). The second pillar is the proximity approach. It has been mobilised almost exclusively in the management discipline (Talbot 2009) and the recent emergence of its use (Hamouda 2015) has been encouraged (Spina et al. 2016). In the case of our study, which is at the crossroads of these two disciplines, this combination serves the purpose of decompartmentalizing research and de-siloing knowledge.

To be properly realized, the combination of lenses must be based on two dimensions: their proximity regarding the phenomena they address and the congruence of their underlying assumptions. In this case, proximity refers to the conceptual distance that exists between the phenomena that the lenses address in their original conception. The congruence of underlying assumptions refers to the degree to which the two theories follow the same mechanisms and dynamics, making them compatible (Okhuysen and Bonardi 2011).

We have already established above that the two theoretical bases have in common the fact of dealing with the description of the complex phenomena of cooperation within the supply network, there is thus a proximity between the two frameworks. It remains to highlight their compatibility. The central assumption of the network theory is that *"no strong tie is a bridge"* (Granovetter 1973) (p1364) meaning that the weak connections provide the best resources and opportunities. The central assumption of the proximities framework is that *"to function properly, proximity requires some, but not too great, distance between organizations"*(Boschma 2005) (p12). Boschma himself highlighted this congruence when he stated that the firm embeddedness level and its innovative performance follows an inverted U shape (Boschma 2005) and that this *"positive relationship between embeddedness and innovation is more or less in line with*

Granovetter's idea" (Boschma 2005) (p15). The compatibility of the assumptions underpinning the theories is thus established and visually represented in Figure 5.

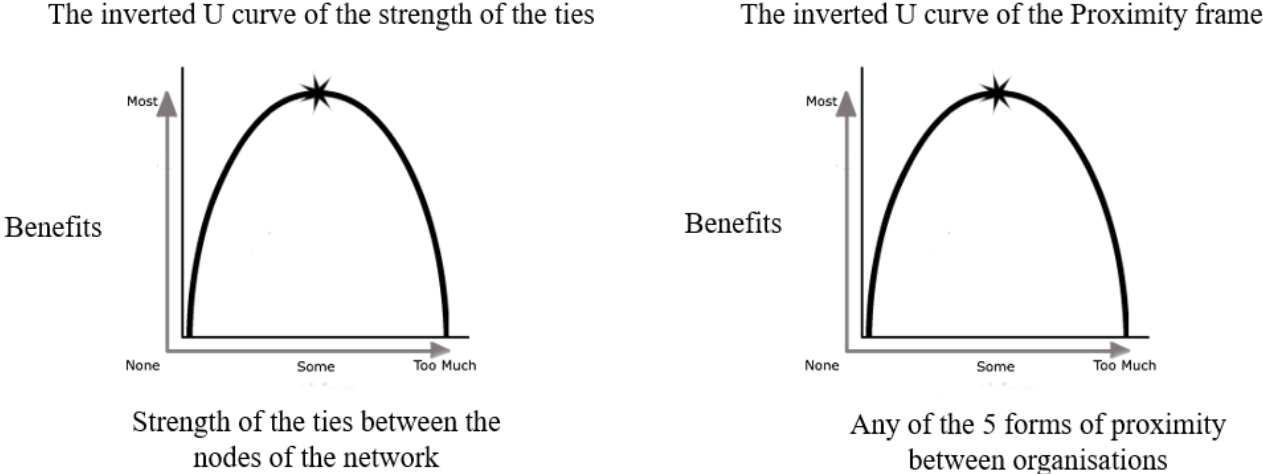

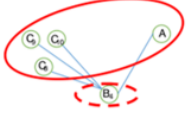
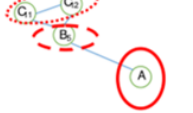
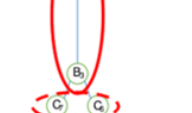
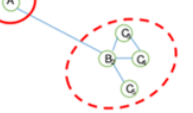


Figure 5. High compatibility between the assumptions of the network theory and the Proximity frame

This configuration of high proximity and high compatibility of the two theoretical lenses is the most frequently encountered in theoretical combinations, as it is very straightforward to figure. Its main value is that it allows to elaborate on a phenomenon in greater depth by enabling a greater nuance in reasoning. The main pitfall of this combination lies in the fact that it is easy and predictable and, therefore, more than being an actual theoretical contribution it is more usually an explanatory model adopted to observe a developing empirical phenomenon. One way to overcome this and to enhance the value of this type of theoretical combination is to *“go the extra mile”* and exploit the similarity in phenomena and underlying assumptions fully (Okhuysen and Bonardi 2011) (p5). We propose to move in this direction by building on the extension of the network theory operated by Saunders et al. 2019 that elaborated a categorisation of brokers according to their position in the network. Beyond this typology, the authors proposed that these specific places in the network offered different efficiency potentials in the performing of brokering missions. For example, the greatest added value of a broker occupying the liaison position consists in the creation of

the sustainable initiative, while that of a coordinator is to putting it into practice (Saunders et al. 2019). This can be explained by the degree of embeddedness of these types of brokers: a broker with little embeddedness (e.g., a liaison), i.e., linked by weak ties to the companies in the network, imports elements to which it has access, such as new resources or contacts or, more simply, innovative ideas. It is therefore more likely to create and develop sustainable initiatives. On the other hand, an embedded broker (e.g.: a coordinator), has strong links with the members of his network and contributes not to the access to new resources within his network but to its cohesion. Its added value therefore lies in the process of assimilation of the sustainable initiative within his network. Table 5 summarises the types of brokerage exchanges and their implications.

Table 5. Brokerage exchange types and associated forces for sustainability initiatives management, adapted from Saunders et al., 2019

Broker Type					
Force to facilitate	Coordinator Exchange	Consultant Exchange	Liaison Exchange	Representative Exchange	Gatekeeper Exchange
The development of sustainable initiatives (i.e.: creating the initiative)			+++	+	++
The adoption of sustainable initiatives (i.e.: turning the initiative to practice)	+++	++		+	

We propose that Boschma's framework of proximities allows for a finer reading of the specific capabilities of brokers that arise from their position in the network. In the case of our study of collaborative practices between firms belonging to different industries with a view to circularity, we propose that brokers allow for the establishment of an adequate proximity so that cross-industry collaboration can take place. We develop this idea below.

A Liaison broker acts as an agent between parties, as an intermediary (Saunders et al. 2019). To do this, it has the right position between two networks to create a bridge: it creates weak links between these two networks, i.e., a bridge through which resources, contacts, or ideas from both networks can flow. In the cross-industrial supply network, it is probably the agent through which the connection between the two sectors takes place. As the industrial sectors are by nature distant, and therefore different in several dimensions of proximity, we postulate that it probably acts on all the proximities. The liaison broker is the least embedded and therefore the most versatile: it could create a large number of different proximities and covers a wide proximity amplitude. A Coordinator-type broker ensures that members of the same group function together harmoniously (Saunders et al. 2019). It does this by leveraging the strong ties it has within his network. This implies that there is a great deal of knowledge and mutual trust between it and the other members and is ideally positioned to facilitate the adoption of circular collaborative practice within that network. He does this by aligning within the network the internal processes between different members so that collaboration can take place. The coordinator type broker is the most embedded, his added value could consist in creating cohesion within an already formed group. Proximities are a prerequisite for its actions, and it can only act on small amplitudes of proximities and only on a limited number of them. These theoretical intuitions will have to be confirmed in further empirical explorative studies.

In this theoretical part we have first outlined notions from the network theory. The concept of brokerage explains the mechanisms of connexion and bridging between members of the network. The strength of the weak ties describes the dynamics of circulation of resources and information within the network. We then followed with a description of the the proximity framework and the five dimensions of proximity to be managed for fructuous interactions between organisations. Finally, we proposed that the theoretical combination of the two theories could help to conceptualise cross-industrial collaborations in the objective of the diffusion of the circular economy model.

2.4 Conclusion

This paper sought to address three questions: What do we know about supply collaborative practices for circularity? What do we know about cross-industrial collaborations? And what novel theoretical lenses can be used to explore cross-industrial circular collaborations in the supply network?

The paper makes contributions to the literature related to business collaboration. First, it summarises the current knowledge on collaborative practices in supply networks for sustainability and circularity. Then, it completes with a review on cross-industrial collaborations, concluding that the large body of knowledge on the subject falls within the field of innovation management. Within this scope, the cognitive and social factors underpinning the mechanism of knowledge transfer between firms from distinct industries have been explored. It therefore argues that other aspects of collaborations should also be explored, that the perspective of the supply network should be adopted and that the specificities related to sustainability and circularity should be studied. Although the role of intermediaries facilitating collaboration by bridging different industries for the purpose of innovation was examined, the research should also investigate how these collaborations emerge and function.

The paper makes a theoretical contribution. It formulates a theoretical proposition through a combination of the network and the proximity views that can offer a finer analysis of collaborations. Analysing the resources circulation and brokerage exchanges at play in the organisational network with the reading grid of the proximity framework can help to manage the cognitive, organisational, social, institutional, or geographical factors at work between the partners of the collaboration.

Building on this work, future empirical studies could explore further cross-industrial supply networks and enlighten the potential opportunities and pitfalls of these collaborations for circularity purposes. Research could unveil the mechanism of emergence of these collaborations by studying the factors facilitating mutual awareness, approaches, contacts and selection of potential partners to a collaboration. The mechanisms of functioning of these

collaborations, their initiation, their operation, their outcomes could also be studied. Studies of the specifics of the circularity broker function should be envisaged, through an analysis of the proximities management they perform for the collaborations that they support. Other theoretical angles, like the absorptive capacity lenses, could also be adopted to complete preceding studies and dive further into the mechanisms of emergence and management of collaborations between distinct industrial background partners. This future research could lead to a framework linking the capabilities of circularity brokers to issues arising in the specific cross-industrial context.

Future research on cross-industrial collaborations and their mechanisms could contribute to practitioners by providing elements to guide their decision-making process in partners selection and management. Analysis of tangible and intangible factors at play in collaborations between organisations could help them to activate geographical, cognitive, organisational, social and institutional levers to optimise their operations and their performance. Eventually, by enhancing the potential of success of circular cross-industrial collaborations, these studies could contribute to a broader implementation the circular economy model.

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3. Article 2 :
Facilitating circular
supply chains:
insights from novel
network actors

Fiche de l'article 2

Titre en français : Les facilitateurs de l'économie circulaire, nouveaux acteurs du réseau d'approvisionnement

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Facilitating circular supply chains: insights from novel network actors

Abstract

This research studies circularity brokers, the economic actors facilitating the transition of companies towards circular operations. The purpose is to extend our understanding of “circular brokerage”, deriving from the concept of brokerage existing in network theory and applied to the specific context of the circular supply network. Recent papers have been devoted to the study of particular facets of circular brokerage, with studies specifically dedicated to circular incubators or platforms. This study proposes how these new actors can have a significant role in developing circular supply chains. The methodology is qualitative through 17 semi-structured interviews with circularity brokers. The theoretical approach draws on the network view and builds on the recent developments of the theory in the contexts of sustainability and the circular economy. Circularity brokers provide assistance to organisations and their networks, helping them to overcome the problems that stand in the way of adopting circular economy at different levels (micro, meso and macro). To do this, circularity brokers deploy a wide range of activities involving technical, methodological and relational skills. The position that circularity brokers occupy in the network gives them special dispositions for completing the mission for which they are commissioned, but the research extends previous research by proposing how these new actors can provide benefits beyond exploiting their network position. This research provides evidence on the role of circularity brokers and moves the state of knowledge from specific sector or cases to other sectors and a broader role beyond network position specifics. Network theory, with the constructs of broker exchanges and the influence of embeddedness, is used to develop theoretical implications.

Keywords

Supply Network, Brokerage, Circular Economy, Network Theory

3.1 Introduction

The environmental emergency is such that all players in society are being pushed to adopt sustainable approaches, whether by pressure from governments or individuals. This is taking the form of changes in policies and practices, such as punitive or incentive fiscal measures, development of new technologies or innovative business models. These changes are significant, but scattered, because they often address only a fraction of the overall issue. Yet it has been established that only a systemic approach can bring about an overall sustainable transition, and that all societal actors, public and private, from all industrial sectors and at individual, collective and regional levels, must make a collective and coordinated pivot in order to avoid a global social and environmental catastrophe (Mukherji et al. 2023).

The transition to a circular society is one proposed solution for adopting this approach. It calls for collective, coordinated changes at all levels, with unprecedented partnerships (Velenturf and Purnell 2021). However, the transition to a circular model is difficult to implement. From a supply chain and operations discipline perspective, it means adopting a systemic and network thinking (Marques and Manzanares 2022) and helping diverse actors, from different industry sectors for example, to make new connections and collaborate effectively to find alternatives to limited and polluting raw materials and find ways of avoiding operations outputs turning into wastes and further burdens on the environment (Tate et al. 2019).

From a theoretical point of view a particular type of actors, brokers, have been described as potential players when it comes to connecting disparate organisations within the same network (Obstfeld 2005). One of the main assumptions of network theory is that their added value lies in their ability to establish links with new or distant actors to create opportunities for exchange and circulation of new knowledge and resources (Galunic, Ertug, and Gargiulo 2012). They have been studied for their propensity to enable sustainable measures to be adopted or disseminated (Saunders et al. 2019) or to facilitate the introduction of circular practices in the food waste sector (Ciulli, Kolk, and Boe-Lillegraven 2019).

In the latter context, an initial definition of “circularity brokers” has been proposed, stemming from a study of online platform-type players offering agri-food waste recovery services. A limited number of other studies have followed, although with little empirical support, focusing on other types of brokers, resulting in the emergence of a new field of research comprising studies devoted to the different facets of these circular economy facilitators whose number, according to the French national circular economy institute, has “exponentially increas[ed]” in just a few years (‘Les réseaux majeurs de l’économie circulaire en Europe’ 2020) p7. Despite the apparent importance of these central network players for the circular supply network (Marques and Manzanares 2022) and invitations to conduct research on them in order to better understand their contribution to the spread of the circular model (Rosca et al. 2022), there is as yet no empirical research devoted to determining the contours of the general function of circularity brokers across sectors. This is important however, if such actors are to bridge different sectors order to increase the scale and impact of circular supply chains (De Angelis et al., 2018; Tate et al., 2019). Hence this research study asks:

- Why do organisations wishing to circularise their supply chains to call on the services of brokers?
- How do circularity brokers help the adoption of circular supply chain actions?
- How do brokers position themselves in the network of companies that call on them for their support, and how do the resulting brokerage exchanges affect the service they provide?

The first section of the paper provides an overview of the literature regarding circularity from a supply chain perspective and the importance of brokerage roles for circularity-based activities. The next section outlines the methods employed to collect and analyse data on circularity brokers. The findings detail the activities performed by the brokers, the challenges they help to overcome and the position they occupy in the network to perform bridging activities. The paper finishes with a broader discussion of the specific provisions that arise from the way brokers insert themselves into their network, i.e. the links that exist between their positioning and the services they provide to their clients.

3.2 Literature Review

Transitioning to circular supply chains

Humanity cannot deny anymore that to continue development, a transition to a new paradigm allowing a development that meets the needs of the present without compromising the ability of future generations to meet their own (Brundtland 1987) is imperative (Geissdoerfer et al. 2017). To reach this ambitious but necessary goal, all actors have a contribution to make and in this context, companies, through the management of their supply chains, occupy a central position to achieve sustainability (Miemczyk et al., 2012) through the realisation of sustainable development goals (SDGs) (Silva and Figueiredo 2020). An answer among many lies in the adoption of circular economy principles and the conversion of linear supply chains in circular ones. The idea is to move from the extract-use-dispose pattern, where resources are chased, transformed, consumed and thrown away, to a model where the circulation of resources and energy would be retained in a closed loop, allowing a reduction non-renewable new inputs into production systems (De Angelis, Howard, and Miemczyk 2018). Yet, making the switch is challenging (Geissdoerfer, Vladimirova, and Evans 2018) and needs a circular management of all the facets of the products and processes. A first challenge to overcome is the economic issue, as companies can be reluctant to switch from linear to circular because of the economical investment it implies (De Angelis, Howard, and Miemczyk 2018). Other barriers to the adoption of the circular economy in supply chains may be technological, such as knowledge and skill limitations, with for example design challenges to maintain sustainability. Other problems are cultural and market-based, such as when customers are reluctant to consume refurbished products (Govindan et al. 2014). Despite these challenges, the expected benefits of this shift from the linear to the circular supply chain are such that there is an increasing literature on the subject (Batista et al. 2018).

Circular supply chains have a number of specific features, including network configuration (Homrich et al. 2018; Kanda, Geissdoerfer, and Hjelm 2021; Korhonen, Honkasalo, and Seppälä 2018; Marques and Manzanares 2022) and collaborative

practices (Bressanelli, Visintin, and Sacconi 2022; Bressanelli, Perona, and Sacconi 2019) . The network configuration stems from the systemic dimension of the circular economy (De Angelis 2021). As a result, in circular supply chains, resource flows are bi-directional (buyers becoming suppliers and vice versa) and they also involve external players (Batista et al. 2023). Some of these external players are third parties to the supply chain: non-traditional players such as research institutes, NGOs or innovative entrepreneurs. These organisations offer, for example, R&D activities, connections with financial institutions, or support in adopting sharing practices. The use of these horizontal collaborations, like other unusual collaborative practices, such as those with competitors (Sudusinghe and Seuring 2022) or systemic operations involving collaborations crossing immediate industrial boundaries (De Angelis, Howard, and Miemczyk 2018) are a distinctive characteristic of circular supply chains. Generally speaking, collaborative activities in supply chains enrich the firm's capabilities for sustainable development (Chen et al. 2017; Geffen and Rothenberg 2000), are a factor for robustness and resilience (Scholten & Schilder, 2015), enable sustainable innovation (De Marchi 2012; Frey, Iraldo, and Testa 2013; Konietzko, Bocken, and Hultink 2020) and contribute to reduce unnecessary waste across the supply chain (S. Seuring and Müller 2008) along with carbon emissions (Luo, Chen, and Wang 2016). Despite these benefits they have been proved difficult to implement. Among the most common difficulties are the inability to identify who to collaborate with or the lack of trust between partners (Cao and Zhang 2011; Simatupang and Sridharan 2005). To overcome these problems, organisations wishing to engage in collaborative relationships can call on a type of agent described in network theory: brokers.

Network theory and brokers

Brokers are concepts developed in network theory, which is preferentially used when studying supply networks as it offers a large view of cross-organisational interactions, emphasizes the influence of partner-partner relationships on an organisation's operations and focuses on the fit between organisations that are planning to form cooperative relations (Halldorsson et al. 2007). In the same vein, since one of the foundations of the circular economy is systems thinking (Marques and Manzanares 2022), the network perspective and level of analysis are

the most relevant for observing the relationships between stakeholders taking part in the implementation of circularity (Kanda, Geissdoerfer, and Hjelm 2021).

In network theory (Granovetter 1983), business opportunities, in the form of material resources (such as goods) or immaterial resources (such as information and financial flows), circulate between organisations via ties, which are established by agents known as brokers, who have a bridging role (Burt 2004). Depending on the number and redundancy of existing ties, the organisations in the network present different degree of embeddedness, that has an impact on the circulation of resources. If there are no ties at all, resources do not circulate in the network, which translates into an absence of business opportunities. In a configuration where there are too many ties, it means that the linked companies are closed in on each other, there is too high a level of embeddedness and this translates into a potential lack of new opportunities within the network. On the contrary, the right level of embeddedness allows new ideas or innovations to be introduced, which translates into new opportunities within the network. In this process, brokers have a facilitation role in forging and coordinating actions between disparate network members (Obstfeld 2005). These actors supporting the supply chain have been studied conceptually in the sustainable context (Rosca et al. 2022; Saunders et al. 2019) and we follow the invitation previously made to examine their practices for circularity adoption (Rosca et al. 2022).

Circularity brokers as facilitators of circular supply chains

A 2020 report by the French national institute of circular economy emphasises that although structures facilitating sustainable transitions have existed for several decades, their specialisation in circularity is recent and their number has increased exponentially in these last few years ('Les réseaux majeurs de l'économie circulaire en Europe' 2020). In the supply chain management research literature, the first discussion focusing on this type of actor also appeared recently and a first definition of the circularity broker was proposed: "circularity brokers are positioned along a supply chain and connect actors with products or materials that have no value to them, on one side, with other actors that can use those products or materials for their own consumption or as inputs for their activities, on the other side. The circularity broker may bring together disconnected parties or

link actors who are already tied to one another for certain supply chain activities but are disconnected for the transfer of waste.” (Ciulli, Kolk, and Boe-Lillegraven 2019). Beyond the definition, the authors identify six brokering roles assumed by these types of brokers, which are: connect, inform, protect, mobilise, integrate and measure. Other articles followed, focusing on certain types of brokers, such as those operating in the form of platforms (Berg and Wilts 2019; Ciulli, Kolk, and Boe-Lillegraven 2019; Pizzi, Leopizzi, and Caputo 2021; Schwanholz and Leipold 2020), incubators (Millette, Eiríkur Hull, and Williams 2020), or those specifically dedicated to certain types of organisations, such as SMEs (Patricio et al. 2018), or to a particular territory (Patricio et al. 2018) or country (Pizzi, Leopizzi, and Caputo 2021). The positioning of brokers in their network greatly determines their influence (Burt 2009; Obstfeld 2005). However, to our knowledge, the characteristics arising from the specific positions occupied by circularity brokers have not yet been studied. This is a gap that provides opportunity for elaboration. There is also yet no broad exploratory study aimed at mapping the contours of this function. We detail the methodology we chose to address these gaps in the next section.

3.3 Methodology

We have designed the research in an interpretive way, which is an approach that has been recognised as particularly insightful for the study of emerging phenomena. In this conception of research, the aim is not to tend towards the generalisation of the results but to enable the understanding of the phenomenon observed (Darby, Fugate, and Murray 2019). The recommendations for conducting this type of research are to select a small number of informants from a context voluntarily broad, with selection criteria meant to maximise the potential conceptual insights.

The organisation selected had to:

- Act as interface in networks of minimum 3 nodes. The aim of this criterion is to adopt the point of view of the network, the relevance of which we have

already argued in the previous section, and not that of the dyad, which is less suited to the subject under study (Miemczyk et al. 2012)

- Target supply chain activities in the broadest sense as proposed in Geissdoerfer ((Geissdoerfer, Vladimirova, and Evans 2018) p11) in order to include the richest set of relevant activities.
- Aimed to facilitate the reaching of a greater level of circularity, i.e. helping their clients to minimise resource input and waste, emission, and energy leakage by slowing, closing, and narrowing material and energy loops. (Geissdoerfer et al. 2017) p 759

In the context of exploratory research, these broad selection criteria provide a diverse sample (Seawright et al. 2014) whose added value is that it is likely to represent a full variation of a phenomenon and allows to obtain context related information on the studied outcomes (Flyvbjerg 2006). We obtained a diverse sample of 16 organisations, covering different countries, sectors and supplying different types of activities of facilitation of circular economy (see Table 6). When relevant, we relied on recommendations that were made of our research by previous interviewees in order to facilitate data collection. We chose senior personnel of the organisation as respondents (most of the time founder or CEO). Respondents were contacted by email or via the professional social network LinkedIn.

We developed a semi-structured interview guide allowing a dialogue directed by both the experiences of the informant and the object of the research. Our initial questions were both about the broker and its expertise, in order to understand how it proposes to help its customer and its network to reach a better level of circularisation, but also about the organisations the broker considers as its stakeholders, in order to have a clear view of the network in which it is embedded. The researchers used the same interview guide to preserve consistency in the study process but also incorporated specific topics relevant to each organisation. Interviews were carried out between November 2020 and November 2021 (17 Semi-structured interviews covering 16 organisations, with an average length of 50 minutes, recorded and transcribed, and 1 informal interview for which handwriting notes were taken). As the study took place during the covid 19 crisis, social distancing measures had to be applied and all interviews were conducted

by video conference. The interviews were transcribed and analysed using Quirkos analysis software.

For the analysis of the transcripts, we followed the recommended abductive approach (both driven by the empirical data and the theory) (Eriksson 2015), that allows theory elaboration (Ketokivi and Choi 2014). The abductive approach is a combination of induction and deduction that enable to develop the construct of a general theory (here, brokerage) in a specific context (here, circularity) (Kovács and Spens 2005). The first phase of the analysis derived from the theory and consisted of a categorisation of all the brokers in Quirkos using the attribute function. The categorisation derived from the logic and concepts used in the network theory. Concretely, we listed the brokers's characteristics (e.g., type of the organisation – private, public, non-profit-; type of brokerage function – as defined by Saunders et al. 2019 -) and the characteristics of the network in which it is embedded (e.g., territorially circumscribed network or not; cross-industry network or not) to allow a network perspective on the broker. The second phase consisted in the analysis of the interviews with qualitative coding. The coding process was made of several rounds. The first round consisted in an open way of coding to allow for thematic emergences, following an inductive logic during this phase. In the second round, the literature on sustainable and circular supply chain and operations provided the terminology that helped us to dispatch and classify the different themes that emerged into more general categories to facilitate reasoning, following a deductive logic. In a third round of analysis, we identified the patterns linking brokerage roles, brokerage activities and the type of circular collaborations or synergies developed. We have also categorised the types of barriers that lead companies to call on the assistance of brokers and at what level they appear (Miemczyk, Carbone, and Howard 2022).

Table 6. Summary of our interviews and description of our respondents

Code	Profile of the broker (sector, nb of employees, industry of intervention)	Description of the broker
A	Private profit, 51-60, Multisector within Eco-Industrial Parks/territories	A consulting company specialising in project management for sustainable economic development. They particularly advise industrial eco-park projects abroad.
B	Private profit, 2-10, Multisector	A consulting group expert in industrial symbiosis. Works internationally with the private and public sectors to advance the transition to a more circular economy. Provides an online platform for IS.
C	Private non-profit, 2-10, Multisector	A non-profit business association that initiates collaborative projects, platforms & partnerships to scale solutions for CE. Provides an online platform for IS.
D	Private non-profit, 11-20, Multisector	A non-profit business association that initiates collaborative projects, platforms & partnerships to scale solutions for CE. Provides an online platform for IS.
E	Private non-profit, 2-10, Multisector	A non-profit business association that initiates collaborative projects, platforms & partnerships to scale solutions for CE. Provides an online platform for IS.
F	Private profit; 2-10, Multisector within Eco-Industrial Parks/territories	A software editor dedicated to the mapping of flows for business optimization on a territory.

G	Private profit, 11-20, Building & infrastructure	A consulting company in project management for CE projects in the industrial sectors of buildings and infrastructures. Provides an online platform for IS.
H	Private non-profit, 41-50, Design and furnitures	The French national cluster for CE
I	Private non-profit, 250-300, Multisector, specialised in packaging	The French eco-organism/mission driven company, mandated by the municipalities for the strategy and operations of public recycling.
J	Private profit, 31-40, Multisector	A consulting company in project management for CE projects.
K	Private profit, 61-70, Multisector	A consulting company in project management for CE projects. Specializes in the redesign of Circular business models. They offer a variety of online tools to diffuse CE, on an opensource basis. They have a “community” of experts they train and certify (+100 worldwide + 20 countries)
L	Public, 2-10, Multisector within Eco-Industrial Parks/territories	A public organisation in charge of an industrial park with mutualisation of resources and sharing practices.
M	Private non-profit, 2-10, Multisector within Eco-Industrial Parks/territories	An association that brings together public and private decision-makers, mainly from the same territory, in order to create a network of exchange, information and incentives for the implementation of innovative industrial and territorial ecology projects. A private non-profit bringing together public and private actors
N	Private profit, 2-10, Multisector within Eco-Industrial Parks/territories	A software editor dedicated to the mapping and facilitation of flows for business optimization on a territory.
O	Private profit, 1, Multisector	An independent consultant specialising in the management of

		circular and sustainable projects in organisations, often commissioned for public markets.
P	Private profit, 51-60, Building & Infrastructure	A consulting company in project management assistance for CE projects in the industrial sectors of buildings and infrastructures. Also, a R&D engineering office on circular materials, processes and valorisation paths

3.4 Findings

This section presents key pieces of information for understanding the bridging activities the brokers propose, the challenges they perceive and their position in the network.

Activities performed by the brokers

Brokers deploy a wide range of activities, divided into three categories: activities involving technical, methodological and relational skills. They are presented in Table 7.

Table 7. Activities performed by the circularity brokers

Technical activities	Description	Verbatim
Specific circular expertise	The broker provides specific technical solutions to facilitate circularity (e.g materials, design, innovation sourcing, conducting studies)	<p>"We work as a network; we don't use service providers who are not part of our community. So, we have a community of 100 experts in 25 countries. 100 people who are trained and certified by us. We have product designers, we have environmental engineers, we have trainers, we call on them when we need specific expertise." K</p> <p>"Our team carries out a search for innovation and once we have identified the innovators who are relevant to this programme and we have qualified those who are the most interesting, we organise innovation days, when we really get the innovators to meet our consortium members" J</p> <p>"There is the operational aspect of each deconstruction or demolition operation where we provide the technical tools for each mission. For example, we take samples of concrete and draw up concrete characterisation sheets in partnership with laboratories. We also carry out economic studies to show our client the different levers and scenarios for recycling his materials and present him with the economic balance of all this." P</p>
Circular legislation consulting	The broker provides legal consulting or upgrading services for organisations to comply with circularity obligations	<p>At least half of the time customers come to us because they have had a regulation that means they will have to change something" J</p> <p>"We make sure that [small SMEs] can meet people who are willing to help them with their regulatory questions" H</p>

Data Management for circularity	The broker offers data management services to achieve a better level of circularity	“Our solution compiles public data and other data. We're talking about quantitative, qualitative, and now semantic data as well [...] their visualization represents the strengths [of the territory], the weaknesses and the opportunities, in terms of circularity in particular. The database is common, and this is the fruit of our exchanges” F
Online platform edition and management for circularity	The broker publishes and/or manages the administration of an online circular exchanges platform software solution	<p>“We are a software publishing company. We develop a data visualisation software, to highlight the actual or potential interactions between economic and territorial actors, etc.” F</p> <p>“In the early days of our programme we found that we were collecting so much information that a spreadsheet couldn't hold all the information we were collecting and there's nothing on the market. So we started developing a in house software integrating machine learning, artificial intelligence, et cetera, et cetera and it is quite a powerful tool now.” B</p>
Methodological activities		
Specific methodologies circularity oriented	The broker brings into play methodological approaches adapted to the context of circularity (life cycle management, user centred design, systemic thinking)	<p>“We enrich the design phase by anticipating all the life phases of the product or service” K</p> <p>“We support companies with life cycle analysis as a working method, as a method for characterising their projects” O</p> <p>“The big problem with today's products is that most of them do not fit into cycles. And so, before designing the product or service, you have to know the system around you, and you have to design a new system, because all systems fit into each other.” K</p> <p>“We ask them to model the ecosystem of their company in the first tier, the second tier, the third tier, in order to arrive at a systemic perception of a company</p>

		from a territorial point of view, from the point of view of its sector, etc." F
Circular analysis of organisations and networks	The broker provides an analysis of an organisation or a network in order to assess their degree of circularity and propose improvement	<p>"We always start with a circular analysis phase to understand the need and then a sourcing phase, i.e. we look for innovations all over the world that could respond to our clients' problems, and then the third phase, which is more of a steering phase [...] to respond to the problem." J</p> <p>"Whenever a company becomes a member, we send them a questionnaire in order to understand their waste streams. When we know about their waste rates, then we can make them different offers so that we can create a cross sector synergy." B</p> <p>"Before adopting a strategy, we start from the principle that it is important to see all the existing interactions, in terms of networks, energy, etc. And more broadly, we study all the missing links on the scale of a sector ecosystem. And more broadly, we study all the missing links at the level of an ecosystem of sectors." F</p>
Synergies creation	The broker identifies or organises workshops or events with the aim of identifying synergies between actors	<p>"We get company managers to meet together, to talk about their different trades and different sectors and different sizes. We can get people who work in the food industry and the plastics industry to think together about their problems. And each time we do this, there are always lots of subjects, lots of ideas, lots of meetings, exchanges between people. We allow people to meet, to work on their collective intelligence and to find common solutions. That's how we work. » N</p> <p>« When we organise workshops, we take the directors and production managers, then we put them in a room and make them work together for a morning on the subject, so we cut them off from their daily life and their main activity [...] When we do a workshop, we respond to a problem. A waste problem, a resource problem, a skills problem. That's it, that's the angle of attack that we chose and that works." M</p>
Logistics solution proposition and	The broker provides input in terms of flow management and	"there is also the transportation link that we were able to establish with a trucking system that was going right by the different plants and help them connect in that way [...] Typically we deal with a range of material that is not very large, so there

facilitation to enable circular flows	proposes coherent logistics solutions	has to be a system to aggregate those, bring them together, and then get them shipped in an efficient way to reach a recycling plant” C
Horizontal collaboration organisation	The broker organises the mutualisation of services between several geographically close organisations (eg: within an eco-park)	“Our mission is to listen to companies and to provide a service that meets a collective need [...] We set up a collective self-consumption project. [...] In the past, it was mutualisation services for environmental management and planning. This has always been done and we will continue to do so. Today we also offer mutualisation services related to mobility, employment. [...] It also concerns human resources, when some companies need a lot of people in June for example, while others may need fewer people at that time” L
Development and organisation of a circular chain	The broker carries out reflection and actions to create and structure a circular value chain within a sector or across a sector	<p>“A recent example concerned the leather that we are going to recover from our processing centres from the automobile industry in order to build a relatively sustainable sector for office furniture, because we are going to have 500 kilos per year. The idea is to say that we have a subject on leather in the automobile industry, but then we will find this same subject in the boat industry, clothing industry, etc. [...] The idea is to identify this source, which will eventually be multi-sector, and then to create a business model from this multi-field source. The deliverable will be a product made from a hitherto unused waste product. [...] What sources will we work on? How do we identify these deposits? How do we isolate the product? Then, we will work on how this deposit becomes the secondary raw material? Because there are a few steps to transform waste into secondary raw materials. Here, [about leather] do we have to clean it? Does it have to be tanned? At this stage, we don't know. Then we'll try to see prototypes in leather goods to see if they actually meet the legal standards. And then afterwards, we'll try to build an economic model to make it work.” H</p> <p>“Materials often need to be transformed to become useful. Very often you need quite a lot of intermediaries, reprocesses, or innovation from universities. It's never a simple. Quite often, these are quite complex, and you need many levels of expertise to make it successful. The role of the facilitator is to try to put those parts</p>

		in place” B
Stakeholder coordination for circular project management	The broker leads a circular project and for this purpose interfaces and coordinates different actors	<p>"We have set up workshops where we can gather project managers, architects, construction companies, reuse actors and companies in the area. These actors can testify on the state of the art of the sectors, why some are emerging, what are the technical, economic and social obstacles to the development of these sectors of reuse in construction". P</p> <p>"We often work in consortia. The objective is to bring together players around a common problem in order to find these solutions. [...] We will really identify the constraints of each player, how they work with their value chain, with their suppliers, with their customers, what their needs and problems are [...] We then create this common base by sharing with all the members what was said during the interview. [During the meeting days] everyone arrives with their problems and their vision of where they want to go, and then everyone leaves with a pilot defined for the next six months. These days are really crucial, they are enormous accelerators of projects. » P</p>
Relational activities		
Conviviality facilitation	The broker organises socialisation events dedicated to the creation of interpersonal links without the objective of setting up a direct business partnership (afterworks, concerts)	<p>"We organise concerts, which is nice because you get to see people outside of a [work] setting” L</p> <p>"We organise afterworks, which take place every four months, once a quarter. [...] when it comes to company premises visits, it's very structured but when it's an afterwork, we all have our company tag, but afterwards, it's on our personal time, so everyone goes off and talks to whoever they want. People meet a manager; he introduces his wife. We chat, we see each other in a cool way. Well, we break something, so that the next time it's time to pick up the phone and ask a question, it will be easier.” L</p>

<p>Improvement of the mutual knowledge of local economic actors</p>	<p>The broker organises professional events with the aim of improving mutual knowledge between neighbouring companies without the objective of setting up a direct business partnership (open days, company presentation tours)</p>	<p>"We have set up what we call "Welcome Neighbours". Every three months, a company opens its doors to other companies in the park, to other park managers, to present its activity, to show its premises, its production site, its process, its logistics, its production, its design office, etc. This allows for networking" L</p>
<p>Matchmaking</p>	<p>The broker brings organisations together with the aim of creating business partnerships with a circular dimension (arrangement of business meetings, speed-meetings days, identification of stakeholders for a circular project)</p>	<p>"Since 2012, we have been organising a business convention with meetings, numbered tables and a schedule of speed meetings, a quarter of an hour, five minutes between two meetings. My last session we organised 900 business meetings for 350 people." M</p> <p>"Our aim of is not to provide a knowledge base, but to try to connect the right people to each other" H</p> <p>"When we launch a project, we make sure that we align or at least identify all the right stakeholders" " K</p> <p>"We are following all these synergies on weekly basis. And we try to establish the relationships between these companies: there is the platform the companies are free to use to advertise the materials that they would like to give or that they would like to receive. We are matchmaking with our technical capacity" B</p>
<p>Spokesperson</p>	<p>The broker brings together and aligns the interests of</p>	<p>"We have a new subject, the biodiversity subject, that is a new mission. On this, we have an advocacy approach" I</p>

	<p>stakeholders with a common issue in order to represent them and assert their interests collectively</p>	<p>“We have leverage with companies [...], with local authorities, [...] with consumers, with groups and associations, whether environmental or consumer. Our role is to push for progress [...]. This results in quite a big ecosystem and we happen to be right at the middle of it. For example, we can see that today, recycling is no longer sufficient in itself. Because of new uses, new consumption, new materials, new citizen and regulatory pressure. As a result, we now really need to focus on the three Rs (reduce, recycle, reuse) and stop playing the pyromaniac firefighter both in terms of regulations and commitment. So we're pushing for reduction at source and reuse because that's where we're expected.” I</p> <p>“We have a stakeholder committee, which is now an obligation under the AGECE law, and which will bring together stakeholders from NGOs, waste operators, customers, federations, which will then take decisions. It is an approval that will be used by the public authorities, for example on the subject of the ecomodulation, which takes the form of a decree. This approval may not be unanimous within the committee, but nevertheless it will provide a strong basis in terms of decision making for the public authorities.” I</p>
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Brokers of our sample provide technical activities, such as equipping companies with specific software or technological solutions in the field of materials science or industrial processes, offering specific legal advice, or carrying out data mining assignments.

Brokers also provide specific methodological support to circularisation issues, such as an analysis of an organisation's circularity, a product life cycle approach, the creation of common circular synergies (the optimisation of flows based on co-product exchanges for example).

Finally, brokers are specialists in relationship facilitation. In our sample, they organise matchmaking activities (where they identify and introduce potential partners), afterworks or entertainment activities (The interviewees cited concerts or sport competitions, organised for the members of the eco-park to create a social bond between individuals who are not likely to meet spontaneously in order to facilitate future professional interactions.)

The activities can also be hybrid. This is the case, for example with the project management activity, which requires both a relational rapprochement in order to get actors who do not know each other or who do not have the same operating mode to work together on one hand, and a methodological facilitation on the other, in order to take into account the constraints of circularity, such as the optimisation of flows for example. In the case of circular economy activism, the broker often has a double role: in the case where the broker generates legislation in favour of the circular economy, which is a technical skill, there is also spokesperson work to be done, usually with very diverse stakeholders, some of whom are in positions of power and this second part of the mission, strong relational skills are necessary for the broker.

Our results display a diversity of brokers that perform a large variety of brokering activities and demonstrate the wide scope of the issues addressed: "In our team, we have engineers who are more for the R&D part. We have people who have more of a public relations profile, who are involved in interactions and consultations with stakeholders. We have people like me who have a business profile and who are in project management from the beginning to the end of the

programme. We have a bit of all kinds of expertise like that and that's what allows us to intervene in the whole chain. We run training, awareness-raising workshops, seminar to select innovation pilots [...] It's quite broad in terms of scopes." (J)

The scope of brokers' activities may seem so broad that it becomes more explicit to define their activity not for what it is, but for what it is not. The brokers do not achieve the circular transformation of companies but create the appropriate conditions for circularisation to take place. The brokers enable the organisations and networks to "give birth" to their own circular transformation; their value offer is not the transformation, but the maieutic: "We do not create synergy. We create the gathering of people, but the synergy, it's the people and the companies, it's the leader, it's them who will agree that they have something to do together. We're just here to act as a link, so we can put them in contact, we can initiate, we can structure legally, we can shape. But at some point, these stakeholders, these companies, will have to sign the bottom of the page to transform the project into an outcome." (L)

Challenges addressed by the circularity brokers

The brokers described the reasons that prompt their customers to call on their assistance. These are challenges that stand in the way of their circularisation, and the purpose of the facilitation offered by brokers is to overcome these challenges.

These challenges can be distinguished regarding the level of analysis of the broker's network: factors that apply at the organisational -micro-, at the inter-organisational -meso- and the societal -macro- levels. They are presented in Table 8.

Table 8. Challenges cited by circularity brokers

Circular challenge reported by brokers	Explanation	Verbatim
Micro-level (organisation)		
Lack of vision and involvement of top management towards circularity	The success of transition towards circularisation is subject to the will of the leading actors of the organisation	<p>“The obstacle is really the state of mind in the sense that within a company, the management committee must be aware of the challenges of environmental issues and prioritise them in order to place them at the heart of the company's strategy. Because if this is not the case, no one will really be committed to the circular transition, it will never be the priority» J</p> <p>“If the leader is not involved in the decision-making process, there is no progress» H</p> <p>"It's important to have regular and direct interaction with senior management. Because [...] we tend to deal with technicians who think the project is great, especially if it's the company's environmental engineer, for example. But it has never 'gone through' because the management is not sufficiently aware [...] so the fact that you have involved senior management of companies that are able to engage a company [...] is obviously key” A</p>
A short-term orientation incompatible with circular change	Tendency to prioritisation of the daily routine rather than engaging long-term changes	<p>« We realised that companies, even if they saw an interest, fell back into their day-to-day practices» L</p> <p>« Starting out on projects of mutualisation, synergies, means that they must free up time, and that, despite good will, is sometimes extremely difficult [...] people</p>

	towards circularity	<p>always find the ideas all very good, but it is always more difficult to apply them because afterwards, it requires either time or financial means. And these are things that are not necessarily available at the moment. » L</p> <p>« They spent a lot of their time working on their own companies' objectives and, and needs and interests and there isn't a lot of time to proactively go out and find ways to connect with other companies » C</p>
Financial performance of circularity	Companies are looking for the best financial performance and are reluctant to compromise on this aspect. If a circular solution is found, but is more expensive, this is a barrier to its adoption. (incl. lack of adequate KPIs)	"We will present companies with business models that are viable, with return-on-investment times that we consider acceptable. These are never projects that are done at a loss." J
Meso-level (Inter-organisational, network)		
Issue related to the sharing of the value	A barrier to collaboration is the	"There is often a big thing, it's the legal aspect which must be settled very quickly and very early on. You have to sort it out early on and incrementally as you move

<p>created from the circular partnership</p>	<p>problem of identifying where value is created in a collaboration, and how to share it between their members of the circular partnership</p>	<p>your project forward, because often there are questions of intellectual property on the development of an innovation, of framing a project to ensure, for example, that one member of the consortium does not monopolise the technology developed within the framework of the project and that, in fact, all the others cannot benefit from it» J</p>
<p>Lack of network and potential partners awareness, lack of territorial anchorage to achieve the circular partnership</p>	<p>If companies have too little knowledge of their network or their economic environment, they fail to identify these partners and do not progress in their circularisation.</p>	<p>« The most important barrier is actually to create these connections to be in different networks. That's why we make the method available to as many people as possible so that with the legitimacy of the territory, they can activate the CE. The method is one thing, but it's not much compared to the knowledge of the field and all the subtleties that there will be.» K</p>
<p>Perceived risks related to trust, confidence and uncertainty arising from the creation of a novel circular partnership</p>	<p>The setting up of a circular partnership with new members of the network may be slowed down by reticence relating to trust in the new partner (problem of information sharing, confidentiality, uncertainty generated by a new partnership)</p>	<p>“Confidentiality is a big issue in data sharing. [...] it's one of the key problems we face in bringing projects to fruition: being able to easily obtain data that companies are willing to share» A</p> <p>“There is the fear of revealing things when you haven't signed an NDA or even when you have signed one sometimes, there is still a bit of mistrust on the part of an innovator towards a large group and the fact of organising physical days where everyone talks to each other, it really breaks this distance too, it's very important» J</p> <p>“There's a lot of a lot of uncertainty risk as that is perceived. And that has to be overcome » C</p>

<p>Formalism, resistance to change pre-established linear and « business as usual » supply agreement and processes</p>	<p>When pre-existing framework agreements with suppliers prevent the engagement with new circular suppliers, or when cumbersome and slowness of processes hinder the circular collaboration</p>	<p>“We have seen, particularly the bigger companies walk away from something which could be profitable because the collaboration was changing something in their processes or systems, they felt it was too much bother and they didn't have the time to do. » B</p> <p>“The biggest barrier is that it's a new way of sourcing and producing products. And then we'll do a new a new way that has to overcome an existing system that works fine, or the existing system for whatever product is sourced with using Virgin material. typically to shift and engage in a brand-new processing that we're using materials that requires a range of kind of recalibrations a redesign of systems » C</p>
<p>Macro-level (Societal)</p>		
<p>Legal incitations towards circular economy</p>	<p>Progression towards circularisation can be linked to the legal provisions that create favourable or unfavourable conditions for the circular economy.</p>	<p>« The brake that seems to stand out the most when we talk about it is the regulatory brake. » G</p> <p>"We've had several cases where there was a really great business model, and we ran into a regulatory problem with the use of waste. We had a case in Morocco where we wanted to set up a recycling centre. But we realised that the regulatory maturity to achieve this in relation to what was imposed on companies did not allow for an activity of this type, except for very, very simple operations such as waste disposal centres." A</p>
<p>Issue of domestic vs. international legal constraints towards circular economy</p>	<p>A national legal environment conducive to the circular economy is not sufficient in the absence of regional</p>	<p>“ It is all very well to create regulations for the internal market, but we remain in an international market, where in all cases there are imports of raw materials, exports of waste and therefore [...] the economy will remain linear in fine.» I</p>

	or international rules governing markets heading in the same direction	
Technological maturity of circular materials and processes	Technological obstacles to circularisation, such as a lack of maturity of material, a technique or a process	“Often, this is where there is a bit of a gap in terms of technology to be able to really scale up.” J
Consumer/Society's perception and expectations towards circular economy	Society's perception of the circular economy influences patterns of circular products. Some circular economy practices are still perceived as less qualitative than those of business as usual (e.g. : mistrust of secondary raw materials, etc)	<p>“The perception of the subject is important: in 2003 we were preaching in the desert; the notion of circular economy did not exist.” M</p> <p>“I find that the younger generation of leaders is more open, precisely on all that is renewable energies, auto-consumption, sharing of resources, etc. Much more than the older generations. I don't want to make a caricature, but I feel like that.” L</p> <p>“There are the demands of customers, citizens-consumers who have really become aware of the limits of the current consumption model and who are forcing companies to change. In particular, the younger generations who no longer want to make choices, who choose companies and their consumption choices according to their environmental impact.” J</p> <p>“You have two behaviours: You have the behaviour of the manager who is motivated by these questions. And then, afterwards, the real behaviour is the client's request. It's because customer demand is moving towards these issues of reuse that the various manufacturers are asking themselves this question, let's not be mistaken [...] The question that brings people in is that they have a damn client who has asked them that question [the sustainability question] and they don't know what to do with it” H</p>

<p>Lack of knowledge and data to support the adoption of circular economic policies</p>	<p>Public authorities lack reliable data to create effective public policy towards the transition to a circular economy</p>	<p>“There is also a lack of data sometimes, for example, we talk about biodiversity, we talk about carbon, but sometimes there is a lack of real data in terms of impact on both subjects. So it's difficult to build a real operational decision.» I</p>
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At the organisational level, the most frequently challenges cited by brokers are: the will of the management, without which no circularisation approach can succeed, the costs that investments to enable circularisation may entail for the company, the lack of mature technical solutions that allow changing the sources of supply or industrial processes, the prioritisation of the company's day-to-day business that prevents starting a long-term reflection.

Brokers cite a variety of challenges at the network level hindering the circular collaboration, including the lack of awareness of the local network and of the potential partners capable of jointly addressing its circular issues. The issue of value creation is also recurrent, with the problem of value sharing which must be clarified and satisfy all parties to the collaboration. There are also the risks related to trust and confidence when it comes to initiate a collaboration with a new partner, that pairs with the difficulty of overcoming previous suppliers' relationships and regular processes.

Finally, brokers also mention problems which go beyond the mere borders of the network and apply to society more generally. These problems include the lack of technological means - when technical advances, materials or industrial processes do not yet allow for circular advances- , the lack of domestic legal maturity -when the national legislation fails to create appropriate conditions that encourage companies to circularise-, and also legal problems stemming from globalisation, like the lack of alignment between national and international regulations, resulting in the lack of protection of the competitiveness of local circular companies on the regional or global market (the absence of a carbon tax for imports at the EU borders was cited).

Position of brokers in the network

The brokers occupy specific positions in their networks. Some brokers were already deeply embedded in the network of organisations for which they facilitated circular exchanges (Brokers L and M). These actors have a high degree of embeddedness due to the fact that they have been sharing the same geographical space as the business network to which they provide services (in our sample, an eco-park or an administrative region) for several years. Another one is

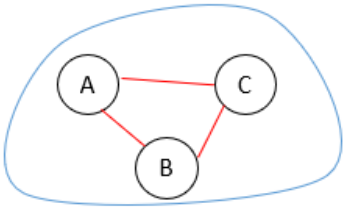
H that is the French national cluster for circular economy which coordinates actions within the network formed by its members.

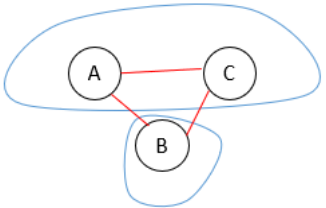
Other brokers (A, F, K, N, O) were external to the networks that asked them to intervene. These networks of organisations were already constituted before calling on the brokers and needed a circular solution that did not exist within their members. In other words, the brokers imported a solution into their network. These brokers often provide a software solution or a circular methodological expertise to a locality or a region.

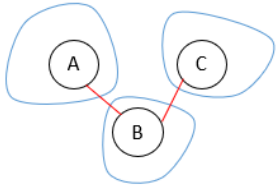
Finally, many of the brokers studied (B, C, D, E, G, I, J) did not belong to the networks of the organisations that needed their services, and these organisations were not themselves connected to each other. These brokers established a bridge between organisations for the specific purpose of the implementation of a circular solution “We try to establish the relationships between these companies: there is the platform [that] the companies are free to use to advertise the materials that they would like to give or that they would like to receive. We are matchmaking with our technical capacity” (B). Such brokers operated as private consultancies whose mission for their client is to design a new circular process and are in charge of bringing in new actors to deal with the specific issues raised in this context. Some of them also operated as online platforms or circular event organisers to connect supply and demand for a specific waste stream.

It is important to note that it is common for a broker to perform facilitation tasks within different networks and the broker’s position varies according to these different missions. For these results, we have based ourselves on the most standard or frequent type of exchange, as described by brokers in interviews. They are presented in Table 9.

Table 9. Position of the circularity brokers in their networks

Broker's position in the network	Broker	Broker's major exchange type
 <p><i>Brokers are embedded in the network of organisations for which they facilitate circular exchanges</i></p>	<p>L- A public organisation in charge of an industrial park with mutualisation of resources and sharing practices</p>	<p>The broker leads the network formed by the member companies of the park. It coordinates joint actions between several members, negotiates joint purchases and provides tools for managing the flow of resources at the park level.</p>
	<p>M- An association that brings together public and private decision-makers, mainly from the same territory, in order to create a network of exchange, information and incentives for the implementation of innovative industrial and territorial ecology projects. A private non-profit bringing together public and private actors</p>	<p>The broker organises training and workshops on industrial and territorial ecology for the companies and organisations of its district</p>
	<p>H - The French National Cluster (Pôle de Compétitivité/Branch association) for circular economy (private non-profit with public mission, accreditation, and financing)</p>	<p>The broker organises workshops, training courses and exchange days between cluster member companies. It encourages and supports partnerships between the members of the cluster.</p>
	<p>N- A software editor</p>	<p>The broker provides a network (an ecopark, a</p>

 <p><i>Brokers are external to the business network that ask them to intervene</i></p>	dedicated to the mapping of flows for business optimization on a territory	municipality, a region) with an IT platform that facilitates the exchange of materials, tools and manpower.
	F - A software editor dedicated to the mapping of flows for business optimization on a territory	The broker provides a network (an ecopark, a municipality, a region) with an IT platform that facilitates the exchange of materials, tools and manpower.
	K- A consulting company in project management for CE projects. Specializes in the redesign of Circular Business Models. They offer a variety of online tools to diffuse CE, on an opensource basis. They have a “community” of experts they train and certify (+100 worldwide + 20 countries)	The broker makes its circular expertise, methodologies and tools available to companies or networks of companies and organisations.
	A- A consulting company specialising in project management for sustainable economic development. They particularly advise industrial eco-park projects abroad.	The broker makes its expertise in eco-parks available to international organisations or public and private players that want to create and manage an eco-park
	O- An independent consultant specialising in the management of circular and sustainable projects in	The broker puts its circular expertise (life cycle assessment...) at the service of organisations or groups of organisations

	organisations, often commissioned for public markets	
 <p><i>Brokers do not belong to the networks of the organisations that need their services, and these organisations are not themselves connected to each other</i></p>	<p>B - A consulting group expert in industrial symbiosis. Works internationally with the private and public sectors to advance the transition to a more circular economy. Provides an online platform for IS.</p>	<p>The broker is a specialist in industrial symbioses and its main activity is to explore industrial opportunities for synergies and to organise workshops where companies meet to create symbioses. It also offers an online platform to connect demand and supply of secondary raw materials at the European level.</p>
	<p>C/D/E –A non-profit business association that initiates collaborative projects, platforms & partnerships to scale solutions for CE. Provides an online platform for IS</p>	<p>The broker is a specialist in the transfer of secondary raw materials and its main activity is to explore industrial opportunities for synergies. It also offers an online platform to connect demand and supply of secondary raw materials at the national level. It facilitates the exchange of materials by providing a legal framework for transfers and logistical solutions.</p>
	<p>G - A consulting company in project management for CE projects in the industrial sectors of buildings and infrastructures. Provides an online platform for IS</p>	<p>The broker fulfils missions of assistance to the contracting authority in the deconstruction and reuse of buildings for which it brings together different stakeholders. It also offers a connecting platform for the exchange of secondary raw materials in the building industry at the national level</p>

	<p>I -A French eco-organism/mission driven company, mandated by the state for the strategy and operations of public recycling. (private non-profit with public mission, accreditation and financing)</p>	<p>The broker fulfils its function of organising the collection and recycling of packaging waste by bringing together all stakeholders in committees. There are about ten committees, which bring together national, regional and local public players, the companies in charge of collection and recycling, the large companies that issue packaging, etc.</p>
	<p>J - A consulting company in project management for CE projects</p>	<p>The broker organises innovation days by sector, where it brings together numerous and diverse stakeholders in workshops to find collaborative circular solutions for product development or industrialisation</p>

In this section, the findings of the research have been presented, which outline the function of circularity brokers: the activities that constitute their value proposition, the challenges they face and the place they occupy in the network to achieve their mission. To wrap up the solutions offered by circularity brokers, B states: “There is an example that I often use because I think everybody can relate to it. If I'm a baker, I use eggs and I have no use for the shells. I throw the shells away. I do not know [their value] because as a baker, I make cakes. I do not know that the shell has collagen, which is useful for pharmaceuticals, high value product. I don't know that it has mineral content that is useful for cement industry or other applications, that's the type of knowledge that I would never have. I will never understand the pharmaceutical industry. I will never understand the cement industry, those are pieces of knowledge I will never have. [...] I can get a software program to tell me in a nutshell that there's collagen and minerals, that I've got value, but even then, I wouldn't know where to start. I don't know anybody in the pharmaceutical industry. I don't know anybody in the cement industry. So, you need the people to make the introductions and help, help develop.”

3.5 Discussion

Circularity brokers roles and definition

The supply chain literature has paid particular attention to the functions of facilitating material flows in particular (Li & Choi 2009) and within the specific framework of the circular economy and the lens of network theory the first theoretical concept of circularity brokers, supporting actors connecting the supply and demand of secondary raw materials, has been formulated (Ciulli, Kolk, and Boe-Lillegraven 2019).

Nevertheless, it has been established that flows within the supply chain are not limited to physical material flows, but also include other supporting flows, such as those represented by finance or information transfer (Carter, Rogers, and Choi 2015). In the present research and contrary to the perimeter of the study previously adopted for the definition of circularity brokers, we therefore propose

to extend the concept of circularity brokers to the actors that create immaterial bridges within networks to facilitate the adoption of circularity measures. We propose that circularity brokers can also link supply actors, connecting by providing relational, methodological and technical expertise, in order to achieve circularity through the circular inputs, products, processes and flows.

The previous definition of the circularity broker proposed that the broker helps to fill circularity holes by playing a variety of roles: Connecting, Informing, Protecting, Mobilizing, Integrating and Measuring (Ciulli, Kolk, and Boe-Lillegraven 2019). As we did not limit our sample of circularity brokers whose mission was strictly dedicated to the conversion of a waste flow to a resources flow, new roles emerged from our data and we propose to add two new categories of roles: Supporting and Equipping (with a tool, a methodology, a solution).

Specific challenges faced by circularity brokers

Challenges to the adoption of circularity within businesses have already been identified, (Tura et al. 2019) as have challenges to collaborative relationships between supply chains (H. Singh, Garg, and Sachdeva 2018). Similarly, the specific challenges faced by supply chain intermediaries in improving sustainability have also been explored (Rosca et al. 2022). In the present study, the focus has been on the intersection that these different challenges entail and the specificities inherent in the work of circularity brokers. We have proposed a reading based on the level at which the challenge emerge.

A number of remarks can be made about this list. First, it should be noted that some of these challenges are likely to occur at different levels of the network: indeed, for example, a lack of sustainable vision by decision-makers in favour of the transition to the circular economy can affect the organisation alone (micro level) as well as a partnership (meso level) or a lack of technological solution (macro level).

Secondly, it can be emphasised that the circular economy is a particular context that gives rise to the macro level of these challenges : compared to brokers of

generic relationships between organisations, circularity brokers' facilitation work is intended to provide answers to social and environmental problems by means of a circular reorganisation of our economic model within society and this objective, which tends towards a paradigmatic change in value creation, therefore goes beyond the issues relating to the facilitation of classic economic exchanges, which are played out at the level of the organisation and its network. Other challenges come from the emerging nature of the circular economy that leads to a rapid renewal of legal frameworks, necessitating a regular updating of the legal knowledge for the brokers and the companies. This same emerging nature also explains the technological immaturity in terms of materials and processes that would facilitate circular practices.

Finally, the starting point of this research was the facilitation of inter-organisational exchanges outside the traditional sphere of influence of companies to scale up the circular economy. This implies that brokers who facilitate the creation of circular partnerships by bridging circularity gaps will have to operate at the meso-level (that of inter-organisational relationships). It can therefore be deduced that it is the challenges at this level in particular that will most significantly be a barrier for this type of broker.

Circularity broker network position and related roles

One of the assumptions of network theory is the importance of the broker in facilitating and coordinating exchanges between the companies it connects, and this power of influence derives from the position it occupies in the network (Obstfeld 2005). Previous studies on circularity brokers have not focused specifically on this aspect and we have therefore endeavoured to analyse a potential link between the roles played by brokers and their position in the network. For this purpose, we have based our interpretation on the classification proposed by Saunders and coauthors. This classification postulates that exchanges that pass-through brokers can be of different types, depending on their degree of embeddedness in the network. The added value of a broker who is not deeply embedded in the network is that it comes with novel knowledge, which allows for the import of new sustainability practices within the network (this type of broker is often referred to as a "consultant"), whereas a broker who is

deeply embedded will be in the ideal position to ensure the proper implementation of sustainable practices within the network (a "coordinator"). Three other types of exchanges are also described, such as "the liaison" exchange, where the broker is brokering an exchange between two members of the different networks in which it is not a member ; the "gatekeeper" exchange where the broker is controlling access to the knowledge of its network and the "representative" exchange where the broker is the only agent to present a connection outside of its network, thus being a representative of it (Saunders et al. 2019). All these configurations can be visualised in Figure 1.

The types of exchange relationships were analysed during the coding process in order to understand the position of the studied brokers within their networks. The classification enabled us to schematise the various ties established by the brokers and to theoretically visualise the dynamics of resource circulation within the supply network. We identified the brokers fully part of an existing network as coordinators. The brokers that were not part of an existing network that necessitated an external circular expertise were labelled as consultants. Finally, the brokers that established a bridge between organisations that were not previously connected were identified as liaisons. However, we have found that there are limits to this classification and we experienced difficulties to apply this typology to our empirical study. As a matter of fact, the brokers we interviewed all described several types of brokerage exchanges when explaining their professional practices. We thus deduced that a circularity broker mobilises different types of exchanges. Despite this deduction, for the purpose of theorising and reasoning, we classified our sample by retaining the type of exchange that was described as major by the interviewed broker, although we were aware that this simplification implied a loss of information that prevents us from grasping the complexity of the circularity brokerage practice.

We attribute the fact that circularity brokers report multiple types of exchanges to their relative (i.e., not absolute) nature. As described by Saunders and co-authors, the types of exchanges are not absolute, but conditioned by the perspective adopted to consider them: depending on the organisation considered as the focal company to perform the analysis of the network, the type of brokerage exchanges changes. For example, the gatekeeper and representative types of exchange

represent the same link but in mirror image. This relative nature did not allow us to determine whether one of these two exchange types were major in the practice of our respondents, so we did not retain them in our analysis. In addition, we believe that these two types of exchange cannot be observed in a "pure" way on the field, as it seems unlikely that, in practice, the broker would be impossible to bypass, which would effectively cancel out these two types of exchange. We therefore propose that the classification of brokerage exchanges proposed is useful from a theoretical point of view, but that in practice a broker mobilises different types of exchange and that a label limiting it to a position in the network cannot be relevant for an empirical study. However, this classification has helped us to theorise the links between types of exchanges and the positioning adopted by the broker in its network.

The following figure presents the types of brokers and the generic and specific roles they are likely to take on. It should be noted that many of the roles of circularity brokers are generic and can be assumed by brokers, regardless of their place in the network.

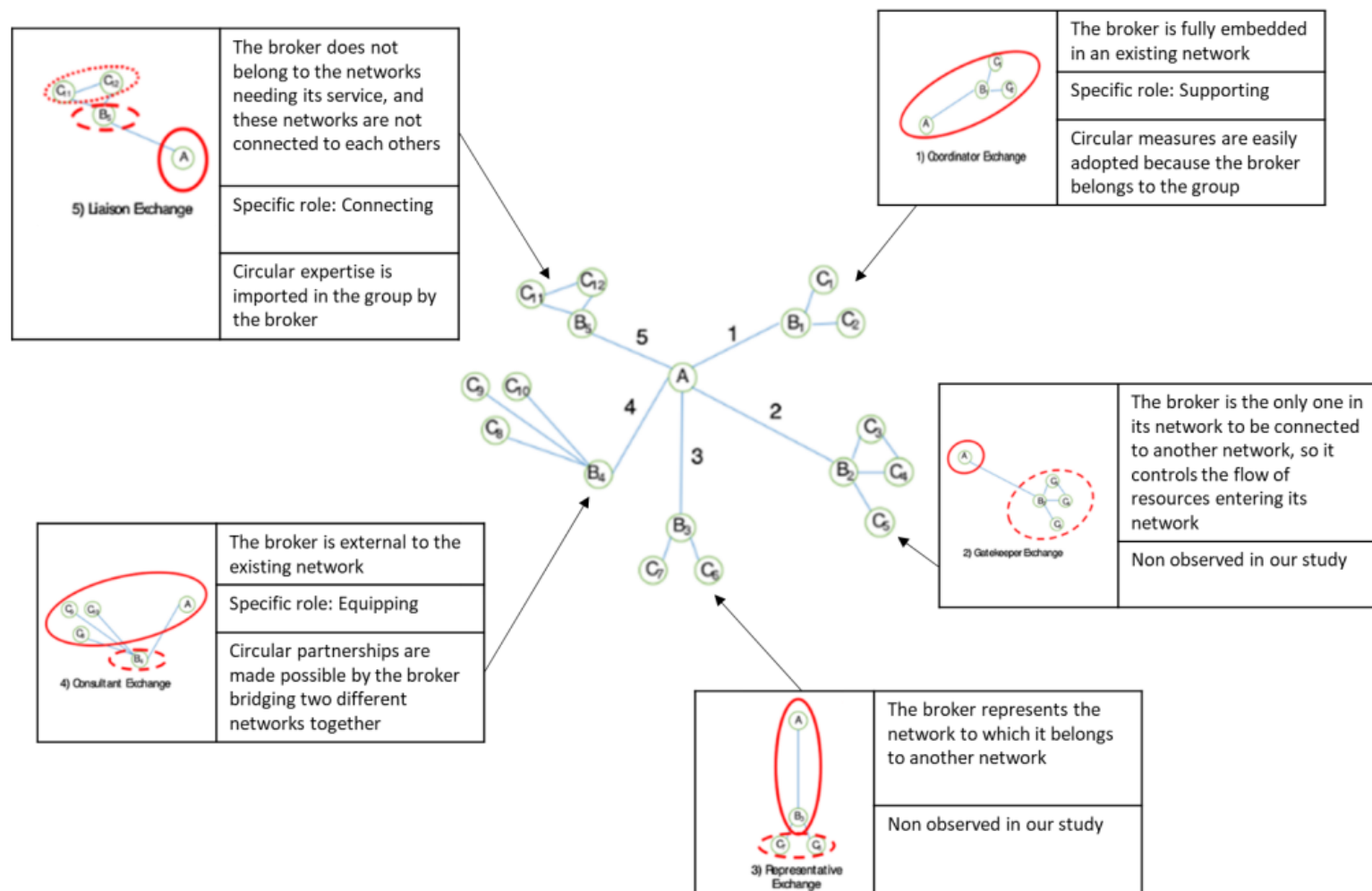


Figure 6 Relationship between circular brokerage exchange types and specific circular brokerage role

From a practical point of view, this conclusion points that the choice of broker should be conditioned by the circularity needs of organisations which combines both generic issues but also network specific ones. Even if a lot of roles can be fulfilled by brokers regardless of their position in the network, some specific activities seem to be successful only if the broker occupies a particular position in the network. For example, a company seeking to be put in contact with partners who do not belong to its usual network - operating in another industrial sector for instance- will have an interest in using a broker who can create a bridge to this new sector, i.e. a liaison. In this case, a broker who is strongly embedded in the usual network of the company, i.e., a coordinator, will not be as efficient, as it is likely that such a broker will not be able to introduce a new partner, as the respective networks of the focal company and the broker probably overlap. To the contrary, in line with Saunders' findings that the implementation of sustainable practices within a network is facilitated by the fluid communication enabled by a broker strongly embedded in that network, the participation of a coordinator that has very close links with each of the members of the network is necessary. Finally, if there is a need to import specific circular knowledge or tools to equip a network, it is a matter of bringing new means into the network and for this a consultant-type broker should be chosen. Several brokers can be used for the overall implementation of a circularity approach and the appropriate choice of brokers will facilitate the success of the circular approach. Our study did not enable us to find a link between type of brokerage exchange and level of action. However, it does suggest other links, such as the fact that the facilitators of circularity who are able to act at societal level are those who to some extent work directly with public authorities, which is reflected, for example, in circular brokerage actions of lobbying. Figure 7 below is a visual proposition to link the position in the network of the broker with favourable circular brokerage roles

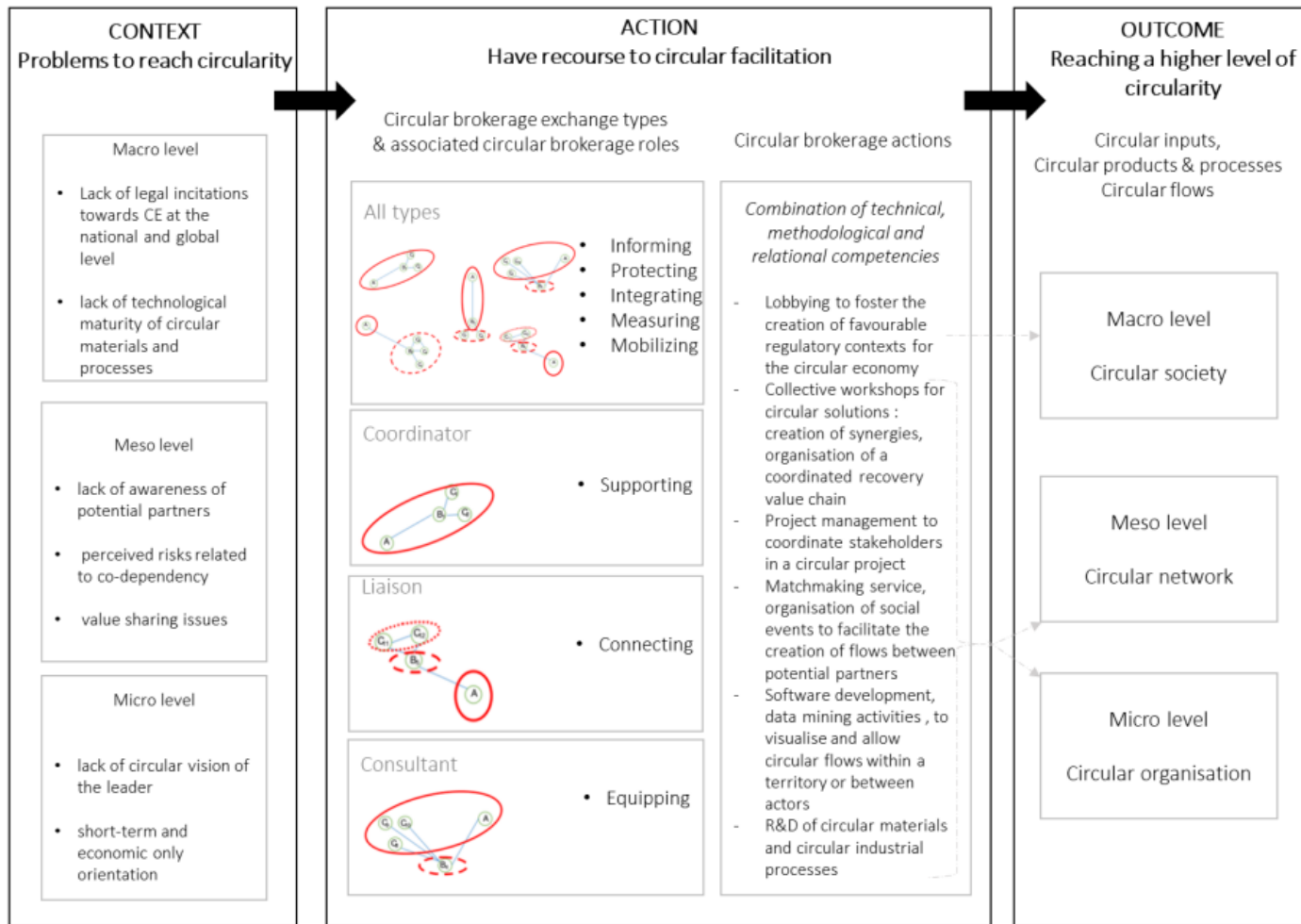


Figure 7. Framework linking position in the network, circular brokerage roles and levels of circularity

The fact that most of the brokers in our sample have predominantly liaison-type exchanges suggests that establishing connections is central to the practice of circularity brokers. This goes in the same direction as a recent conceptual study postulating that in the context of circularity one of the essential issues lies in the power of brokers to establish numerous links and to occupy a central place in their networks (Marques and Manzanares 2022). We attribute the predominance of this connecting role to the specificity of circularity brokers compared to other sustainability facilitators, namely that their ultimate goal is to establish a new flow in the form of a loop.

Although the connection role is dominant, the existence of the other 7 roles (supporting, equipping, informing, protecting, integrating, mobilising, measuring) suggests that the facilitation of circularity also relies on other actions. We deduce that the actions of connections within the network are necessary but not sufficient to facilitate circularity. Consequently, we conclude that the position in the network deals with one issue of circularity needs but other needs (like the need for new circularity tools and methods) must also be met and are not related to the position of the broker, which opens up new avenues to be explored in future research, which we will detail in the conclusion.

3.6 Conclusion

Implications for research

The literature on circular supply chains has recently been enriched by discussions on "circularity brokers", new actors whose added value is to create new ties between supply chain actors in order to enable unprecedented circular exchanges. Various studies have focused on certain types of these circular economy facilitators, those of the platform type, some dedicated to a particular type of waste or even dedicated to a particular geographical region. This paper contributes to this emerging stream of research by proposing an exploratory study aimed at defining the contours of the function of circularity brokers. The research is based on an exploratory set of data collected from a diverse range of brokers of different sizes, performing different activities and based in different

locations, all having in common the objective of facilitating the adoption of circular economy for their clients and associated network. A number of conclusions have been formulated in order to develop current knowledge and provide insights into the potential impacts of brokers in the further development of circular economy imperatives.

This study contributes to the circular supply chain and more particularly to the circular brokerage literature. The first insight from this research is that brokers help to develop circularity initiatives with a wide range of different activities like providing services of data management for circularity, logistics propositions to enable return flows or matchmaking services to identify the right partner to establish material synergies. These activities require technical, methodological, or relational skills. Most often brokers do not offer isolated units of activity but solutions that compile several complementary competences and this results in support involving a combination of these three types of skills. Based on the premise that circular economy is not limited solely to the closed-loop circulation of material resources, but also of immaterial resources, we have not limited our sample to brokers strictly dedicated to the conversion of a waste stream into a resource stream and new roles emerged from the activities that were highlighted by our data. We thus propose to add two new categories of roles to complete the previous list: Supporting (in the adoption of circularity measures) and Equipping (with a tool, a methodology, a solution) in addition to Connecting, Informing, Protecting, Mobilizing, Integrating and Measuring. The second insight of this paper is to explore the reasons why organisations wishing to circularise turn to facilitators for help. The literature has already looked at the barriers to the adoption of the circular economy in general, this study adds to that knowledge by focusing on the barriers that require the intervention of a circularity broker. These obstacles occur at the level of the organisation, its network and society in general. The level boundaries between these challenges are sometimes blurred, as a challenge emerging within a company can also be found with other members involved in circular collaboration and thus exist at the network level. This highlights the potential need to address circularity with a broad range of stakeholders and that brokers might be a necessary but not sufficient condition to impactful circularity initiatives. The third insight reflects on the nature of the

broker exchanges that these organisations engage in. Again, while there is not a clear mapping between the types of activities and the nature of the broker exchanges, brokers do tend to focus on specific types of exchange. The majority of brokers in this study show a tendency to interact in liaison types exchanges between disparate parts of networks. Liaison brokers providing the interface between organisations that are not otherwise connected, this supports the idea that circular initiatives require new relationships with actors who are not part of a focal company's network. The brokers that have a high degree of embeddedness in the existing network, coordinator type of exchanges, focus mainly on supporting their networks in the adoption of circular practices, through actions of coordination between members of the network. Conversely, brokers that operate separately from networks, consultant type of exchange, focus on developing and sharing technical expertise, thus equipping networks with novel circular solutions. We have deduced from these various conclusions that the specificity of circularity brokers compared to sustainability facilitators lies in their aim, which is to establish new connections aimed at setting up new material flows in return loops. These insights constitute a contribution to the area of network theory related to brokers. This study complements previously formulated conjectures that associated the broker's position in the network with a variable degree of success in creating, adopting or disseminating sustainable measures. Our research confirms this logic by associating the broker's position in the network with particular roles in facilitating circularity.

Implications for practice

Our study has implications for practitioners and policy makers. Our study provides an initial overview of the type of challenges that circularity brokers can help to overcome, as well as the solutions they can provide. In a context where the adoption of circularity is an objective adopted by both public authorities and companies concerned about their impact, this information can help practitioners to select suitable circular economy facilitators based on the expertise or the service they need. This work can also inspire policy makers to explore how they can support circular economy adoption initiatives within local or regional networks or industrial and cross-industry clusters, for example. Finally, the proposed conceptual framework for the use of circular facilitation can be used as

a first approach to diagnose a circular network and see where the gaps in circularity are in order to initiate actions to have recourse to facilitation.

Limitations and avenues for future research

The interpretive approach to this research, which is recommended for the exploration of emerging phenomena, is geared towards the conceptualisation and understanding of these phenomena rather than the generation of generalisable results. Other studies intended to pursue this aim are therefore required. An example of such research could be a study of a larger sample of brokers, thus reaching theoretical saturation and potentially finding examples of brokerage types not represented here, such as those of representative and gatekeepers. Future research could also be devoted to circular brokerage activities to determine which activities are most successful and which are not. Other theoretical perspectives could also complement this research, such as the adoption of capability lenses to check whether capabilities align well with network exchange positioning. Finally, again as this research adopts an interpretive approach doubled with a network perspective which both maintain that it is the diversity of the viewpoints of the parties involved in a phenomenon that makes it possible to grasp its complexity, it would have been relevant to supplement the results of the brokers' interviews with other perspectives, such as those of the brokers' customers. As the circular economy is by nature systemic, it is the studies carried out on the entire network and all its members that enable to determine the best way to disseminate the model.

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4. Article 3

Cross-industrial
collaboration for circular
economy: an exploration of
inter-organisational
proximity in circular supply
networks

Fiche de l'article 3

Titre en français : Economie circulaire et collaborations inter-industrielles : une exploration de la proximité inter-organisationnelle dans les réseaux d'approvisionnement circulaires

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Cross-industrial collaboration for circular economy: an exploration of inter-organisational proximity in circular supply networks

Abstract

Recent supply chain research highlights the importance of studying collaborative practices to achieve circular economy and shows that one lever for scaling up the model could be systemic operations involving collaborations going beyond traditional industrial boundaries. The reasoning behind the argument is that exchanges established beyond the usual limits of a given industry provide access to new resources that are currently inaccessible and will enable the establishment of missing closed-loop flows. This paper studies cross-industrial circular collaborations, how they emerge, how they function and what factors affect their development and outcomes. The methodology adopted for this explorative study is a qualitative multiple case study of four supply networks straddling different industrial sectors. The theoretical approach is based on the inter-organisational proximity framework which captures the geographical, cognitive, organisational, institutional and social alignment factors of these collaborations. The contributions of this study are both empirical, by documenting these specific collaborations in the context of circular operations on the one hand, and theoretical on the other, by adopting the network perspective, which is essential for grasping the systemic implications of the circular model. Managers and policy makers can benefit from this study that provides a first list of facilitating factors and obstacles to the realisation of these cross-industrial collaborations, along with examples of actions to help organisations from different industries converge for effective circular outcomes.

Keywords

Cross-industrial collaboration, Supply networks, Circular economy, Network Theory, Inter-organisational proximity

4.1 Introduction

In a context of environmental urgency recalled by the 6th IPCC report published a few months ago (Mukherji et al. 2023), companies and their supply chains have a role to play in moving towards a sustainable development (Miemczyk et al. 2012) and can in this perspective take inspiration from natural ecosystems (Winn and

Pogutz 2013). Following this logic demands to adopt ecosystems principles, among which are to engage in interconnected, circular and diverse relationships (Korhonen 2001; Tate et al. 2019; Velenturf and Purnell 2021).

Circularising supply chains (Geissdoerfer et al. 2018) requires adopting a multi-level perspective (Miemczyk, Carbone, and Howard 2022) and to engage in multi-tier collaborations with diversified partners (Sudusinghe and Seuring 2022). Collaborations with non-traditional partners in an objective of circularity has already been studied with focus on relationships with the public sector, NGOs, competitors or innovators (Sudusinghe and Seuring 2022). However, and despite the facts that an enabler of circular economy is collaboration between partners belonging to distinct industrial sectors that can potentially allow the establishment of missing flows of resources (De Angelis, Howard, and Miemczyk 2018; Tate et al. 2019) and that we are witnessing the publications of recent practitioners or commissioned by public authorities white papers encouraging these initiatives (Rheinbay et al. 2021; Brennan and Sacconi 2017), cross-industrial circular economy remains to our knowledge a rather unexplored topic.

An adjacent but slightly different field of the literature provides however some initial insights to the topic: Research on Industrial symbioses (Chertow 2000) states that a higher representation of different industries in eco-industrial parks results in business and environmental benefits such as an enhanced productivity and recycling performance (Neves et al. 2020). These results support our idea of investigating cross-industrial circular collaborations. Nevertheless, the literature on industrial symbioses concerns solely a portion of circular relationships that are bound by physical proximity and does not elaborate on how these cross-industrial circular collaborations are set up, nor how they are operated. The idea behind this research is based on the following tension: exchanges between companies from different industries have a promising novelty potential for establishing new circular flows; however, these exchanges can be made difficult by the divergences that are likely to exist between industries. To explore this paradox, research focusing on cross-industrial collaborations in the context of innovation management provides some initial reflections, but is almost exclusively devoted to knowledge exchange, whereas this research tries to grasp the other dimensions that contribute to the establishment of physical flows that are

constitutive of the circular economy (Marques and Manzanares 2022). In order to capture all the elements of these exchanges, we mobilise Boschma's framework of inter-organisational proximity. This conceptualisation of dissimilarities between organisations allows us to understand how companies from distinct industrial sectors differ (cognitively, organisationally, socially, institutionally, and geographically) and how these divergences are fruitful for achieving circular objectives. Our study will therefore seek to answer the following research questions: How do cross-industrial circular collaborations emerge and function? How do the different dimensions of inter-organisational proximity contribute to cross-industrial circular collaborations and how can they be adjusted to achieve circular outcomes?

This research paper is structured as follows. It first reviews the literature on our research topic, then introduces the method adopted, which is based on a multiple case study of four cross-industrial circular collaborations. It finally presents the results of our research before formulating propositions to understand cross-industrial circular collaborations.

4.2 Literature review

Circular supply chains

Almost half a century after the publication of *The Limits to Growth* and more than thirty years after placing environmental issues at the centre of the United Nations agenda to allow [a] *Common Future* to humankind, the switch towards a development compatible with a harmonious occupation of the planet is still unrealised (Brundtland 1987; Meadows et al. 1972; Mukherji et al. 2023). To allow such a future to happen, the circular economy model proposes a systemic approach to reshape the way of producing and consuming by adopting various principles among which are the setup of return flows of resources, the reduction and decoupling of resource use and the coordinated mobilisation of the all the actors of society at all levels (Velenturf and Purnell 2021). In this context, companies, whose social and environmental impacts are increasingly scrutinised by their stakeholders (S. Seuring and Müller 2008), can contribute to this model by

circularising their supply chains to turn them in restorative and regenerative instruments (Howard, Hopkinson, and Miemczyk 2019). Recent studies have conceptualised circular supply chains (Batista et al. 2018; 2023; Geissdoerfer et al. 2018), their drivers, barriers (Govindan and Hasanagic 2018) and pointed practices to be preferentially explored in future supply chain management developments (Farooque et al. 2019). In this category, research on supply chains collaboration mechanisms has been described as urgent, important, with high potential impact and with a large research gap to be filled.

Collaborative practices in circular supply networks

Following this call, internal and external collaborative circular supply practices have been the subject of studies which have recently been systematically reviewed (Danvers, Robertson, and Zutshi 2023; Sudusinghe and Seuring 2022). Their key insights are that current collaborative circular practices enable to reach the three sustainable pillars that are economic viability along with social outcomes, such as addressing health, safety and human rights issues; and environmental outcomes such as energy and materials efficiency, waste and water management, land use and greenhouse gas emissions. To reach these objectives, companies adapt their operations to implement reduce, recycle, resell/reuse, remanufacture, repair, refurbish strategies. A conclusion of these studies is that taking circularity into account implies a systemic approach along with an evolution of the supply chains collaborative practices (Danvers, Robertson, and Zutshi 2023). One of these evolutions concerns the relationships between supply chains actors, which are no longer dyadic, but networked with multi-tier perspectives and integrate non-traditional actors whose diverse stakes, and resources allow the development of systemic solutions that lead to a better implementation of circularity. In this context, collaborative practices with non-traditional actors like NGOs, public sector organisations or entrepreneurs have already been extensively studied (Sudusinghe and Seuring 2022).

Inputs from the Industrial symbiosis field

In the same vein, engagement with unusual and diverse stakeholders, like collaborative operations involving organisations belonging to different sectors, are

encouraged for the scale-up of the circular model (De Angelis, Howard, and Miemczyk 2018; Tate et al. 2019). Despite these calls, the specificities related to these cross-industrial circular collaborations have, to our knowledge, not yet been documented. However, an adjacent current in the literature does provide some initial elements of knowledge on the subject: Industrial symbiosis “engages traditionally separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and/or by-products. The keys to industrial symbiosis are collaboration and the synergistic possibilities offered by geographic proximity” (Chertow 2000) (p1). According to this definition, industrial symbioses are cross-industrial collaborations with by-products or water and energy loops within a given territory. They thus cover only a portion circular practices and are limited to a circumscribed territory (although there is a recent debate in the literature in favour of excluding this criterion in the definition (Velenturf 2016)). Despite these minor points of divergence in terms of scope from circular economy in general, the contribution of industrial symbiosis research to cross-industrial circular collaborations research is undeniable and provides a basis for understanding them. Indeed, the results of industrial symbiosis research supports the argument that circular economy is enabled by collaboration between actors from distinct industrial sectors (De Angelis, Howard, and Miemczyk 2018). As a matter of fact, these studies show that the level of diversity of industries is a determining factor (Domenech et al. 2019; Jensen 2016) for the success of an eco-park as it increases the number of synergies established and translates into better recycling rates of resources and a better productivity of the area (Ashton 2008). The industrial symbiosis research field also brings information on the types of industries and of materials that are the most engaged in symbioses (Neves et al. 2020) but does not realise a specific focus on the mechanisms of establishment of these specific collaborations. It remains to be explained how the work of organisational rapprochement necessary for the emergence of these collaborations is operationally carried out as well as the mechanisms of adjustment from one industry to another for their realisation. That is the object of our first research question: How do cross-industrial circular collaborations emerge and function?

Previous studies on cross-industrial collaborations

Apart from any consideration of circularity, empirical cases of cross-industrial collaborations have been previously examined in the context of research on innovation management. These studies provide initial elements to understand the outcomes of cross-industrial innovations (Carraresi, Berg, and Bröring 2018; Gattringer et al. 2021; Heil and Bornemann 2018; Kotabe and Scott Swan 1995). They also describe the mechanisms related to the transfer of knowledge between organisations belonging to distinct industries (Enkel and Gassmann 2010; Enkel and Heil 2014; Hilda Bø Lyng and Brun 2018; Hilda B. Lyng and Brun 2019) or to the construction of social relations between professionals taking parts in cross-industrial partnerships (Dingler and Enkel 2016). The actors facilitating these cross-industrial innovations have also been studied (Gassmann, Daiber, and Enkel 2011). Most of these studies are based on the theoretical framework of absorptive capacity and have in common their level of analysis, which is that of the individual participating in the collaboration or that of the organisation. Such a perspective, however, cannot be applied to the study of collaborations aimed at achieving a higher level of circularity, as it has been established that the study of the circular economy model must be grounded in a systemic perspective, by adopting an analysis centred on the network of organisations, and not the organisations themselves (Marques and Manzanares 2022; Korhonen, Honkasalo, and Seppälä 2018; Merli, Preziosi, and Acampora 2018). This research therefore proposes to complete the knowledge already produced by adopting a supply chain perspective and a network level of analysis, meaning that we do not limit the study to the dyadic upstream and downstream relationships between the customer and the supplier and extend our analysis to the inter-connections established between their respective supply chains (Lamming et al. 2000).

Inter-organisational proximity to study cross-industrial circular collaborations

Most of these studies focus on knowledge exchanges and the interpersonal aspects that make cross-industrial innovation possible. However, we argue that the circular model is based on operational exchanges within the network, and that they must therefore be studied more broadly than previously proposed. In this context, the theoretical framework of inter-organisational proximity allows additional dimensions to be taken into account. The theory of inter-organisational proximity (Boschma 2005) postulates that two given companies have an ideal

degree of similarity for the realisation of effective partnerships that can be appreciated through different dimensions : their cognitive proximity (the knowledge base on which they base their expertise), their organisational proximity (their modes of governance or functioning), their institutional proximity (their culture, the values that animate them), their social proximity (the affinities that link the individuals who compose them) and their geographical proximity (the distance that separates their locations). A lack of convergence in these dimensions makes the collaboration fail as the similarity between the partnering organisations is not sufficient, while too much proximity leads to an overlapping effect that degrades its quality. It is an optimum degree in each of the dimensions of proximity that enable effective collaborations (Boschma 2005). The mobilisation of this theoretical model will allow us to understand how companies from different industries can be connected together to create a common circular supply network and how they manage their inter-organisational proximity to implement and operate collaborations (Ratsimandresy and Miemczyk 2023). The empirical context of the network straddling several industrial sectors seems particularly compatible with this theoretical approach. Indeed, belonging to different industries implies differences in the different dimensions of inter-organisational proximity that require convergence work to ensure the success of the collaboration. We therefore formulate the second research question of this study: How do the different dimensions of inter-organisational proximity contribute to cross-industrial circular collaborations and how can they be adjusted to achieve circular outcomes?

This study thus proposes to fill two gaps in the literature, the first being empirical, complementing the knowledge on cross-industrial collaborations already produced, by focusing on the supply chain and operational aspects of these exchanges and the specific features involved in the circular model; the second being theoretical, by adopting a network perspective and proposing to study the mechanisms of collaboration using Boschma's framework of inter-organisational proximity.

4.3 Methodology

For the elaboration of our research design we followed the recommendations of the case study approach applied to operations management (Barratt 2004). Case studies are particularly suitable for an explorative research at the early phase of study of a phenomenon (Gibbert, Ruigrok, and Wicki 2008) and present the advantage of providing exemplars that strengthen disciplines of social sciences (Flyvbjerg 2006) to whom management research belong. To ensure the trustworthiness of our method, we detail below the recommended criteria for a rigorous case study approach. We have ensured the reliability and dependability of our approach by detailing the logic of our theoretical sampling, by not revealing the names of the respondents and the organisations studied, and by detailing the data collection and analysis processes. A description of the theory used (Boschma's theoretical framework of inter-organisational proximity) was detailed in the previous section of the article in order to confirm the external validity and transferability of the study. We followed the recommendation to triangulate the data in order to satisfy the criterion of credibility and internal validity of the study. Finally, the recommendations on objectivity and confirmability were followed with the recording of data, the transcription of verbatim reports and the clarification of the separation between first and second order findings in the analysis process (Lincoln and Guba 1985; Shah and Corley 2006; Gibbert, Ruigrok, and Wicki 2008).

In order to select relevant cases, online databases, directories of networks, lists of participants at trade fairs, specialised newsletters dedicated to circular initiatives were searched (<https://www.circulareconomyclub.com/>, www.economiecirculaire.org, www.reseau-synapse.org www.produrable.com...). We contacted potential respondents via the social network LinkedIn who could give us access to the cases. We followed the recommendation of selecting four cases (Eisenhardt 1989) and followed a strategy of diverse sampling (Seawright et al. 2014) that is encouraged for exploratory research. Indeed, a selection of diverse cases (in terms of size, form of organisation etc) is likely to represent a full variation of a phenomenon and allows to obtain context related information on the outcomes of the cases (Flyvbjerg 2006). In our final sample, this variation is

obtained with a wide range of maturity of the cases, different industrial sectors engaged in the cross-industrial collaborations, different types of supply collaborations (Sudusinghe and Seuring 2022), different configurations of circular practices (R2 reuse, R3 repair, R7 recycle and R8 recover energy and water (Reike, Vermeulen, and Witjes 2018)) and targeting various combinations of the three dimensions of the triple bottom line of sustainability needed for effective circular economy: economic, environmental and social goals (Geissdoerfer et al. 2018).

The selection criteria of the cases were the following:

- Supply chain collaborations (Simatupang and Sridharan 2002)
- Involving at least 3 members in order to move away from the dyadic configuration and place ourselves in the supply network perspective by collecting data from at least two or three stages of the supply chain (S. A. Seuring 2008)
- Integrating circular strategies (Reike, Vermeulen, and Witjes 2018) within their circular supply and operations management (Geissdoerfer et al. 2018).
- And with these collaborations carried out in a network involving several industrial sectors.

We precise that our sample has the limitation of only including collaborations that are currently functioning and that the study of cases of failed attempts of collaborations could have provided useful additional insights. Contact and information gathering took place between October 2022 and March 2023.

The description of the selected four cases is provided in table 10 below.

Table 10. Summary of the 4 cases

Case	A	B	C	D
Formalisation	Eco- Park	Joint-venture and associated supply network	Supply network	Project founded by the French national environmental agency
Description	A complex of industries organised around a biorefinery, linked by several intertwined flows of materials, water and energy.	A material supplier joint-venture co-created by an agriculture cooperative and an automotive supplier. The joint venture provides bioplastics materials integrating agricultural by-products for the automotive industry	A design furniture company and its supply network. The material suppliers use secondary raw materials made from recycled plastic waste, shuttlecocks, oysters shells	A project to repair and lend fleets of older generation iPhones to vulnerable beneficiaries. The repair process is carried out by students enrolled in IT technician and engineer courses.
Members of the network interviewed	<ul style="list-style-type: none"> - A1, Agriculture cooperative of 2000 farmers - A2, Industrial gases and chemistry supplier, MNC of 70k employees - A3, Cosmetic ingredients manufacturer, 8000 	<ul style="list-style-type: none"> - B1, Agriculture cooperative of 2500 farmers - B2, Automotive supplier, MNC of 150k employees - B3, Automotive OEM, MNC of 180k employees - B4, Material supplier (JV between B1 and B2), 50 	<ul style="list-style-type: none"> - C1, Design furniture editor, 8 employees - C2, Material supplier, from aquaculture by-products, 9 employees - C3, Material supplier, from sport association waste, 4 employees 	<ul style="list-style-type: none"> - D1, IT NGO, providing electronic waste related environmental education, 30 members - D2, Life-cycle analysis specialized consultancy, 1 employee - D3, High school public education, 25 students

	employees - A4, biomass fuel manufacturer, 30 employees - A5, professional association coordinating the eco-park	employees	- C4, Material supplier, from plastic waste, 25 employees	involved - D4, NGO (representative of the consortium between D1, D2, D3)
Industrial sectors involved	Agriculture, chemistry, energy, cosmetics	Agriculture, automotive material,	Furniture, waste management, aquaculture, sport	Electronics, consulting services, public education
Seniority	Since 30 years	Since 12 years	Since 3 years	Since 2 years
Supply chain collaboration	Internal & external horizontal & external vertical	Internal & External vertical	External vertical	External horizontal
Circular economy approach	R8 Recover energy & water R7 Recycle	R7 Recycle	R7 Recycle	R3 Repair R2 Re-use (servitization)
Triple bottom line dimension	Environmental, financial	Environmental, financial	Environmental, social, financial	Environmental, social

We collected data from several sources:

- Primary data in the form of transcribed 17 semi-structured interviews of an average length of 50 minutes. We chose as respondents people who were at the origin of or directly in charge of the collaborations (founders, decision-makers, people in charge of logistical and operational aspects of the collaborations). A semi-structured interview guide was developed to enable a dialogue based both on the informant's experiences and on the subject of the research. The questions asked concerned the nature of the cross-industrial circular collaboration studied, the partners and flows involved, the origin of the collaboration, the factors favourable or unfavourable to its realisation, and the circular outcomes. The researchers used the same interview guide to maintain the consistency of the study process, but also included questions specific to each organisation.
- Primary data from notes taken during work meetings we were invited to attend
- Internal secondary data provided by respondents (e.g.: PowerPoint presentations)
- External secondary data (scan of responding companies' websites and press articles)

The data set was compiled. We carried out a thematic analysis of the data (Miles and Huberman 2003) using the qualitative coding software Quirkos. We followed an abductive approach (Ketokivi and Choi 2014), with a first round of inductive coding to allow a spontaneous emergence of themes. A second round of coding followed a deductive approach with a classification of the previously emerged themes according to the constructs of the inter-organisational proximity framework (the geographical, social, institutional, cognitive and organisational dimensions of the collaboration) in order to explore simultaneously and in a balanced way the theory and the context. Finally, a third round of analysis was performed to identify a pattern between the sequences of brokerage actions, triggers and factors affecting the process and outcomes of the cross-industrial circular collaborations. Parallel to the thematic analysis of the corpus of data, an analysis of each case was carried out. This consisted of reconstructing the supply

networks studied, with a schematisation of the networks, a reconstruction of the case histories, resource flows and outcomes mentioned in the interviews and in the secondary sources.

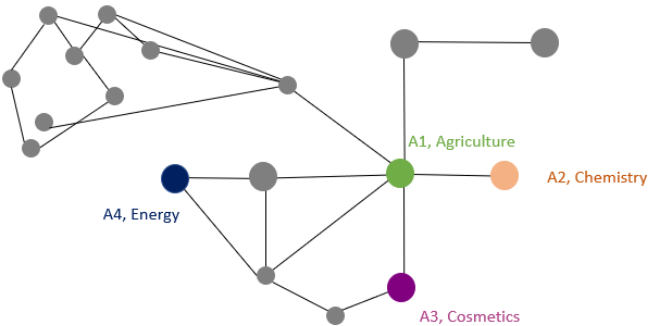
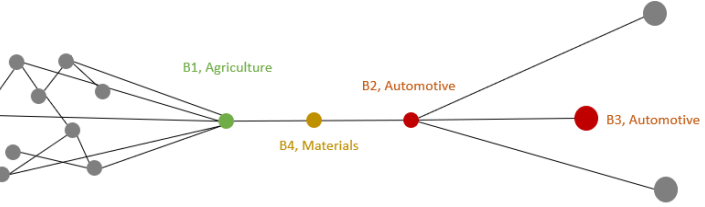
The following sections present the results of this analysis in two parts, a within-case and cross-case analysis of the study.

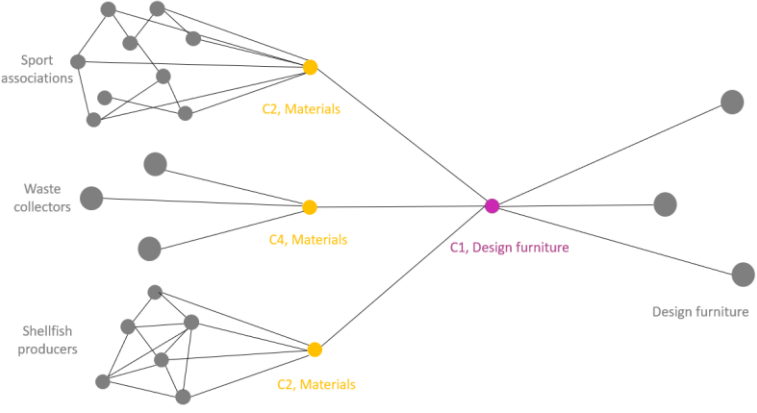
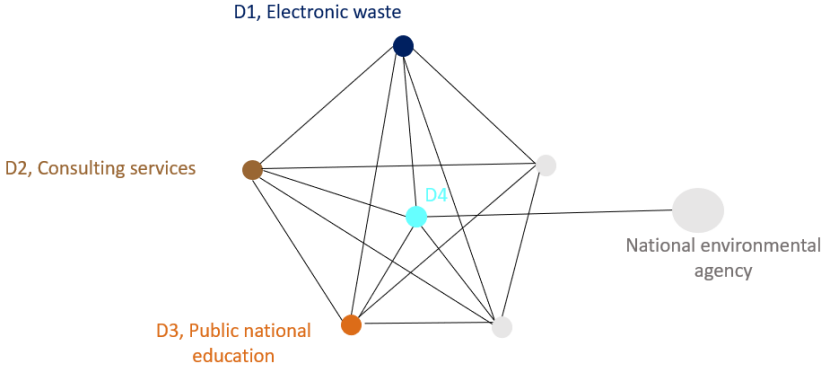
4.4 Findings

4.4.1 Within case analysis

The within-case analysis describes the four cases: a visual representation of the networks (see Table 11), the story of the network and their outcomes.

Table 11. Description of the four cases

Case	Schematisation	Members interviewed
<p>A, Eco- Park :</p> <p>a complex of industries organised around a biorefinery, linked by several intertwined flows of materials, water and energy.</p>		<ul style="list-style-type: none"> - A1, Agriculture cooperative of 2000 farmers - A2, Industrial gases and chemistry supplier, MNC of 70k employees - A3, Cosmetic ingredients manufacturer, 8000 employees - A4, biomass fuel manufacturer, 30 employees - A5, professional association coordinating the eco-park
<p>B, Joint-venture and associated supply network :</p> <p>a material supplier joint-venture co-created by an agriculture cooperative and an automotive supplier. The joint-venture provides bioplastics materials</p>		<ul style="list-style-type: none"> - B1, Agriculture cooperative of 2500 farmers - B2, Automotive supplier, MNC of 150k employees - B3, Automotive OEM, MNC of 180k employees - B4, Material supplier (JV between B1 and B2), 50 employees

<p>integrating agricultural by-products for the automotive industry</p>		
<p>C, Supply network : a design furniture company and its supply network. The material suppliers use secondary raw materials made from recycled plastic waste, shuttlecocks, oysters shells</p>	 <p style="text-align: right;">2</p>	<ul style="list-style-type: none"> - C1, Design furniture manufacturer, 8 employees - C2, Material supplier, from aquaculture by-products, 9 employees - C3, Material supplier, from sport association waste, 4 employees - C4, Material supplier, from plastic waste, 25 employees
<p>D, Project founded by the French national environmental agency: A project to repair and lend fleets of older generation iPhones to vulnerable beneficiaries. The repair process is carried out by students enrolled in IT technician and engineer courses.</p>		<ul style="list-style-type: none"> - D1, IT NGO, providing electronic waste related environmental education, 30 members - D2, Life-cycle analysis specialized consultancy, 1 employee - D3, High school public education, 25 students involved - D4, NGO (representative of the consortium between D1, D2, D3)

Case A

The biorefinery studied is located in the Reims region of France. It is the result of a close encounter between local personalities. On the one hand, the representative of the region's farmers and, on the other, the president of the Reims medical faculty and deputy mayor. Their shared vision was to develop the region's economy by stimulating local industry on the one hand, while finding outlets for local agricultural by-products on the other. They set up a working group to create a research centre dedicated to locally produced agricultural by-products in 1990. The recruitment of managers from the chemical industry has led to the arrival of complementary industries using by-products such as alcohol, gas and active plant ingredients in the cosmetics, chemicals, food and energy sectors. By 2021, the eco-park brings together around ten production sites from different industries, generating 2,000 jobs, organised around industrial flows based on by-products from the processing of cereals and sugar beetroots (3.5 million tonnes of raw material).

Case B

French hemp growers are organised in a professional association to pursue the objective of revitalising the industry, which had died out following the adoption of cotton and synthetic fibres after the Second World War. For this purpose, they engaged in cross-industrial R&D programmes organised by the industrial clusters related to fibres R&D. In 2009, automotive equipment manufacturer B2, which was introduced by the fibre R&D programme, joined forces with hemp growers' cooperative B1 and together they created B4, a joint venture tasked with finding and producing new materials made from the by-products of hemp cultivation. B2's interest was in finding alternatives to plastic, with the aim of protecting the company from rising oil prices by reducing its dependence on petroleum fibres and producing lighter materials that would enable their vehicles to consume less petrol during use. Car manufacturers were initially reluctant to incorporate this new type of bio-based material. Industrialisation became possible in 2013 thanks to the composite material's first customer, B3, an automotive OEM whose

materials director comes from a farming family in the region where the hemp used in the solution is grown. His very close knowledge of the agricultural world and of the regional players involved in production was initially a hindrance to the collaboration before helping to establish a relationship of trust with the supplier. By 2021, 17 vehicle models will be equipped with this material, representing 13 million units worldwide.

Case C

The supply network under consideration brings together various players in the furniture value chain who share a sustainable vision. The two initial partners (a furniture design company founded in 2019 – C1- and a company producing materials from plastic waste founded in 2018 -C4-) are both based in the Paris region and were put in touch by a mutual colleague and friend from the design field in 2020. The other two partners (companies producing materials from sports competition - badminton shuttlecocks, C3- and aquaculture waste, C2) were respectively introduced in 2022 and 2023 by the French furniture trade association via a working group on sustainable issues of the branch. The company producing the materials from plastic waste (C4) is supplied by major waste treatment companies. The company producing materials from sports waste (C3) obtains its supplies from badminton clubs, thanks to the acquaintances of its founder who is himself a badminton club manager and materials expert in the aeronautics industry. The company, which produces materials from aquaculture waste (C2), was founded by a furniture and materials designer from an oyster-farming family, and sources its materials from shellfish farmers and restaurants in his native region. The furniture design editor (C1), sources his materials from C2, C3 and C4 and estimates that 17k tonnes of material were recycled since the beginning of its activity.

Case D

The project brings together a diverse group of members (from the nonprofit-D1-, private – D2- and public – D3- sectors) who are all based in the Paris region of France and who knew each other beforehand. They initially met at various events

related to the sustainable development/circular economy or had been introduced to each other by mutual acquaintances. Some had already worked together on previous projects. A call for projects launched by the French Environment Agency in 2020 structured the partnership. The project involves setting up a programme to refurbish obsolete smartphones. The aim is to develop a new OS and to train students preparing a diploma of IT technician specialising in the reconditioning of mobile equipment to carry out the reconditioning. The ultimate aim is to create a sustainable city-wide programme of refurbished smartphones for vulnerable citizens selected by the local council in order to tackle the digital divide, as well as a dedicated specialised diploma at the local high school. Each member of the collaboration took on part of the mission statement according to its expertise and an association representing them was created (D4). The members work on this project in parallel with their other contracts, making individual progress between each collective milestone. In May 2021, the project was selected as a winner by the French Environment Agency and received funding to enable it to be launched. By 2023, 20 students had been trained in refurbishing and around 30 smartphones had been refurbished.

4.4.2 Cross-case analysis

Cross-industrial circular collaborations under the proximity lenses

Geographical proximity

We recall that geographical proximity is relative to the physical distance between the collaborating organisations. The measure (metric or perceived) between the actors indicates the intensity of the geographical proximity. Geographical proximity was cited by all cases as central to their sustainable and circular approach in terms of rationalising their logistics practices through the reduction of transport-related environmental footprint. In the specific case of eco-parks, a high geographical proximity is necessary to some synergies like exchange flows of steam and shared infrastructures. Geographic proximity also induces benefits in terms of transparency and traceability. This local aspect also affects supply chain robustness, in a context where the recent covid 19 highlighted the lack of resilience of global value chains that were suspended during the crisis. The fact that the founders of the companies initiating the partnership were from the same

region was also cited as a facilitating factor that overcame the initial reluctance to collaborate in an unusual collaboration. Finally geographical proximity through the “made in France” image benefited the collaborations.

Institutional proximity

We recall that institutional proximity is relative to the sharing of formal (professional networks, professional certifications) and informal (culture, habits, values) institutions between the collaborating organisations. The degree of similarity of shared institutions between the actors indicates the intensity of institutional proximity. Institutional proximity was cited in all our cases in its informal form, i.e., the sharing of the sustainable vision by all the members of the network. Often, this aspect was one of the only ones truly common to the parties and it is perceived as necessary to create cohesion and facilitate collaboration in a context where the other dimensions of proximity are lacking. "I don't have the impression that there are common factors [...] except that we all belong to a generation that wants to be convinced by what we do. We speak the same language because we are curious to see what is being done elsewhere on this type of [sustainable] project and given that exchanges are made easy." Case C, C4. For some of our respondents, institutional proximity under the form of sharing a same professional network, the same stakes, or attending the same events were at the origin of the collaboration. Conversely the lack of institutional proximity under the form of having a very different sectoral culture hinders the collaboration.

Cognitive proximity

We recall that cognitive proximity is relative to the degree of overlap in terms of knowledge field between the collaborating organisations. The degree of similarity between the actors indicates the intensity of the cognitive proximity. Interviewees illustrated cognitive proximity with examples mainly related to the studies background of the individuals working in the companies or the area of expertise of the companies. More generally, cognitive proximity has been described as having the same “intellectual structuration”, Case D, D3 facilitating the collaboration. On the other hand, divergence of cognitive proximity in the specific

form of being or not innovation oriented has been cited has a hindering factor. Finally, all the cases cited the fact that benefitting from perspectives coming from partners who had different capabilities or area of expertise allowed the access to new opportunities or more generally to progress more effectively "Coming from different worlds was very beneficial for us because we didn't know about all the manipulations we could do with our products. The world of research opened my eyes a lot and also the eyes of all those we worked with to see how a plant can give a product that can be used in many other products." Case A, A1

Organisational proximity

We recall that organisational proximity is relative to the degree of congruence in terms of functioning (control, governance, hierarchy, work routines) between the collaborating organisations. The degree of similarity between the actors indicates the intensity of the organisational proximity. In Case 1, one of the partners emphasised that it was the lack of visibility on the organisational modes and ways of working of its future partner that were blocking elements before committing to the collaboration "I was not presented with who or what was B4, what skills, what working methods, organisation, processes that could have reassured me that I was not coming across the local manager [of an SME] who had a brilliant idea the day before and who smoked hemp. It was really this organisational side and everything, I was thinking "this is absolutely not future-proof, what is this stuff?"" Case B, B3. In the cases that were only composed of private for-profit actors (Cases A, B), it was cited that one of the most important factors in alignment was the fact that companies collaborating have in common the stake of profit making. To the contrary, in Case 4, that involves members of the public sector (education) or non-profit sector (association), this alignment factor was not shared among all members, and it created difficulties.

Social proximity

We recall that social proximity is relative to the importance of personal bonds (friendship, kinship, mutual knowledge of each other's personal history, degree of overlap in personal network) between the individuals that are part of the collaborating organisations. Social proximity was mentioned as a facilitating factor

in the initiation of collaboration in several of our cases: it was in a family, friendly or leisure context that the respondents got the idea of collaboration. Social proximity seemed to always be combined with another proximity in our sample. Most of the time it had a supporting role to the collaboration, like facilitating cognitive proximity (through information sharing for example) or institutional proximity (like understanding the partner's stakes or creating cohesion for example). Our respondents cite shared social moments or shared infrastructures (like sharing meals in a common company's restaurant) as factors creating social proximity.

Table 12 summarises the impacts of each dimension of inter-organisational proximity reported in our study.

Table 12. Impacts of proximity dimensions on the cross-industrial circular collaboration

Proximity dimension	Case A	Case B	Case C	Case D
Geographical proximity	<p>Geographical Proximity allows a reduction of environmental impact related to transport</p> <p>Geographical Proximity can be seen with shared logistic</p> <p>Flows in Industrial Symbiosis necessitates geographical proximity</p> <p>Geographical Proximity contributes to transparency</p>	<p>Geographical Proximity allows a reduction of environmental impact related to transport</p> <p>Geographical Proximity can overcome an initial reluctance to engage in an unusual supply collaboration</p>	<p>Geographical Proximity contributes to transparency</p> <p>Geographical Proximity contributes to the resilience of SC</p> <p>Geographical Proximity enhances the local image of the product</p>	<p>Geographical Proximity can overcome an initial reluctance to engage in an unusual supply collaboration</p>

	<p>Geographical Proximity contributes to the resilience of SC</p> <p>Geographical Proximity enhances the local image of the product</p> <p>Geographical Proximity can overcome an initial reluctance to engage in an unusual supply collaboration</p>		<p>Geographical Proximity can overcome an initial reluctance to engage in an unusual supply collaboration</p>	
Institutional proximity	<p>Sharing a professional network facilitates the collaboration</p> <p>Attending the same events facilitates the collaboration</p> <p>Being driven by the same values allows to</p>	<p>Sharing a professional network facilitates the collaboration</p> <p>Being driven by the same values allows to overcome other areas of divergence</p> <p>A very different sectoral</p>	<p>Sharing a professional network facilitates the collaboration</p> <p>Attending the same events facilitates the collaboration</p>	<p>Sharing a professional network facilitates the collaboration</p> <p>Attending the same events facilitates the collaboration</p>

	<p>overcome other areas of divergence</p> <p>A very different sectoral culture can make it difficult to access collaboration</p> <p>Sharing the same stakes facilitates collaboration</p>	<p>culture can make it difficult to access collaboration</p>	<p>Being driven by the same values allows to overcome other areas of divergence</p> <p>A very different sectoral culture can make it difficult to access collaboration</p>	<p>Being driven by the same values allows to overcome other areas of divergence</p> <p>A very different sectoral culture can make it difficult to access collaboration</p> <p>Sharing the same stakes facilitates collaboration</p>
Cognitive proximity	<p>Having the same way of thinking facilitates the collaboration/ Having a very different way of thinking hinders the collaboration</p>	<p>Having the same way of thinking facilitates the collaboration/ Having a very different way of thinking hinders the collaboration</p>	<p>Having the same way of thinking facilitates the collaboration/ Having a very different way of thinking hinders the</p>	<p>Having the same way of thinking facilitates the collaboration/ Having a very different way of thinking hinders the</p>

	<p>Having external point of view from people with different capabilities allows progression</p> <p>A partner with a different cognitive background can give you a better understanding of your own product and thus access to new opportunities</p>	<p>Having external point of view from people with different capabilities allows progression</p> <p>A partner with a different cognitive background can give you a better understanding of your own product and thus access to new opportunities</p>	<p>collaboration</p> <p>Having external point of view from people with different capabilities allows progression</p>	<p>collaboration</p> <p>Having external point of view from people with different capabilities allows progression</p> <p>A partner with a different cognitive background can give you a better understanding of your own product and thus access to new opportunities</p>
Organisational proximity	Profit making is an alignment factor, it creates organisational proximity	Lack of organisational proximity creates reluctance to engage into the collaboration	Lack of organisational proximity creates reluctance to engage into the collaboration	Profit making is an alignment factor, it creates organisational proximity

	Enrichment from difference of size of companies	Profit making is an alignment factor, it creates organisational proximity Enrichment from difference of size of companies	Profit making is an alignment factor, it creates organisational proximity	
Social proximity	Sharing the same infrastructures for non-work moments (during the lunch break for example) facilitates relationships and creates cohesion between companies of a same eco-park Shared social moments creates opportunities for rapprochement Social proximity (through family or	Sharing the same infrastructures for non-work moments (during the lunch break for example) facilitates relationships and creates cohesion between companies of a same eco-park Shared social moments creates opportunities for rapprochement Social proximity (here through family) creates	Social proximity (here through family) creates an opportunity for the collaboration idea	Social proximity (here through family) creates an opportunity for the collaboration idea

	friendship) creates an opportunity for the collaboration idea	an opportunity for the collaboration idea		
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Triggering factors

Respondents reported three types of factors that provided the impetus for collaboration. The first was the expectation of financial gain. This factor is shared by the three most mature cases, which share the characteristic of being organised around a profitability objective (A, B, C). We attribute this discrepancy to the stage of development of Case D (which is a pilot project under development) and to its associative form and funding (mainly provided by the national environment agency). Under the umbrella of profit expectancy, the reported triggers are the market/customer pressure towards sustainability, law and fiscal incentives that favour or sanction activities in regard to their environmental impact, the opportunity to diversify clients by reaching new markets by finding a new industrial outlet for a by-product and the will to protect the company from fluctuating energy and commodity prices.

The second trigger reported is the sustainable vision, that has been reported by cases A, C and D. The sustainable motive was not a trigger of the collaboration for case B, that was driven by the search towards a better technical performance (vegetal fibres allowing lighter plastics embedded in vehicles), but became later a reinforcing factor, when sustainability became a larger trend in the automotive sector.

Finally, for half of the case, the collaboration was created under a public sector impulse, either by the local administration of the region (Case A) or the national environmental agency (Case D).

Confirming the intuition that cross-industrial exchanges enable new circular flows to be put in place, our respondents emphasised that it was outside their usual sphere that they finally found access to new resources that met their needs. "During that year I was working with my brother-in-law, an oyster farmer, who sold his oysters every weekend to make money for my business project [...] during the week as a designer I couldn't find any local, French materials that met the technical characteristics of waterproofing, solidity, weight issues. And every weekend in parallel I threw away shells, mainly oysters, mussels, scallops [...] I

recovered them, I carried out tests and I obtained concrete results from the material, which met my specifications well." Case C, C2.

Brokering actions

Respondents detailed the measures taken to enable convergence between the organisations so that they could work together. The brokerage actions described took place when the collaboration was set up. They fall into three categories that are found in all cases: actions to ensure the financial fairness of the collaboration, those to converge processes and those to consolidate a common knowledge base. Among these categories different examples of actions have been reported by the respondents.

Actions to ensure the financial fairness are the setup of agreement on value sharing, financial risk sharing among the partners, actions of co-investment in common infrastructures and co-investment at the product development stage. "We remain in companies that have financial objectives. In industry, private business is like that, there is a need to make margins. It's always a factor of alignment" Case A, A2

The convergence of processes was ensured with actions such as modification of internal processes, the support of the partner in changing its industrial processes, the creation of return-loop of information to the partner about the flows, the creation of a common entity, the formalisation of an agreement on common industrial processes and finally shared-logistics.

The organisations were taking steps to build up the common knowledge base needed for collaboration, through actions such as knowledge sharing during the co-development of a product, the hiring ambidextrous staff (that had previous experience in the partner's company or industry) or the engagement in horizontal collaboration with academics, industrial clusters and other stakeholders for R&D or for a public project.

All the cases present brokerage actions, but it is notable that these actions are more numerous in the mature networks (A and B), which are also the networks where the formalisation of collaboration (in the form of the creation of a joint

venture for case B) or the greatest number and variety of flows are represented (within the Eco Park in case A). It is logical that the number and range of rapprochement actions should be more significant in cases where the involvement between partners is deeper.

Moderating factors

Respondents also reported factors which, unlike the triggers, were not at the origin of the collaboration, but which had a facilitating or slowing effect on it. A facilitating factor shared by all cases was the involvement of a third-party broker to the collaboration, that was either a public actor (Case A and D) or shared acquaintance or network, like a common participation in a workshop or a programme organised by a professional association (all the cases).

Another reported moderating factor is the fact that cross-industrial circular collaborations are part of global trends in supply chain management practice. For example, respondents emphasized the fact that the supply chain disruptions caused by covid 19 crisis, along with the demand towards more transparency and traceability lead to a trend of relocation of supply chains that favours local loops. Similarly, these new partnerships are leading to greater commitment between collaboration partners, whether in terms of information sharing or co-development of products and processes, which is in line with the trend towards long-term relationships between suppliers and customers. Likewise, concerns about the sustainable impacts of supply chains provide fertile ground for organisations to engage in circular collaborations. However, some respondents pointed out that this favourable context can be counterbalanced by the emerging nature of the new materials and processes used, which are still subject to prejudice on the part of buyers or the end consumer. These reinforcing factors belonging to supply chain general trends have been reported by the three more mature cases (A, B and C). The last case, which was less mature, did not report this factor, probably because the small scale of the case had not yet allowed these considerations to emerge.

The final moderating factor is the amount of investment required to set up the cross-industrial circular collaborations. Indeed, the respondents from mature

cross-industrial circular collaborations (Cases A, B and C) all stressed that setting up collaborations requires a significant investment (financial, in time and generally in human and material resources) that organisations may be reluctant to spend. This may be counterbalanced by the opportunity represented by a pool of waste that was available and previously unexploited (A, C and D) or by the fact that the new material derived from secondary raw material exploited in the collaboration does not require major innovation in terms of treatment or industrial process (for example, in case C, the materials used to create designer furniture have the same properties as conventional materials and therefore do not require the acquisition or use of new cutting machines, which greatly facilitates their adoption). Finally, case B highlights that one of the factors that motivated the organisation to make substantial investments in adapting their agricultural co-products for use in the automotive industry was the expectation that the work carried out would be usable in the future to reach other industries: the prospect that the investment made could also be used in other sectors to further diversify their customer base was decisive.

Table 13 below summarises the triggers, brokering actions and moderating factors reported in our study.

Table 13. Proximities at the initiation phase of the collaboration

	Case A	Case B	Case C	Case D
Triggering factors	<ul style="list-style-type: none"> • Financial gain <p>Protect the company from fluctuating energy and commodity prices</p> <p>Opportunity to diversify clients and markets</p> <ul style="list-style-type: none"> • Sustainable entrepreneurial vision • Public sector impulse 	<ul style="list-style-type: none"> • Financial gain <p>Protect the company from fluctuating energy and commodity prices</p> <p>Opportunity to diversify clients and markets</p>	<ul style="list-style-type: none"> • Financial gain <p>Customer pressure</p> <p>Law & fiscal incentives</p> <ul style="list-style-type: none"> • Sustainable entrepreneurial vision 	<ul style="list-style-type: none"> • Financial gain <p>Customer pressure</p> <p>Law & fiscal incentives</p> <ul style="list-style-type: none"> • Sustainable entrepreneurial vision • Public sector impulse
Brokering actions	<ul style="list-style-type: none"> • Ensuring economic fairness 	<ul style="list-style-type: none"> • Ensuring economic fairness 	<ul style="list-style-type: none"> • Ensuring economic fairness 	<ul style="list-style-type: none"> • Ensuring economic fairness

	<p>Ensuring a fair value sharing among the partners of the collaboration/ Agreement on value sharing</p> <p>Financial risk sharing among the partners</p> <p>Co-investment in common infrastructures</p> <ul style="list-style-type: none"> • Convergence of processes <p>Co-investment in common infrastructures</p>	<p>Ensuring a fair value sharing among the partners of the collaboration/ Agreement on value sharing</p> <p>Financial risk sharing among the partners</p> <p>Co-investment in common infrastructures</p> <p>Co-investment at the product development stage</p> <ul style="list-style-type: none"> • Convergence of processes <p>Modification of internal</p>	<p>Ensuring a fair value sharing among the partners of the collaboration/ Agreement on value sharing</p> <p>Financial risk sharing among the partners</p> <p>Co-investment at the product development stage</p> <ul style="list-style-type: none"> • Convergence of processes <p>Modification of internal processes</p> <ul style="list-style-type: none"> • Convergence of 	<p>Ensuring a fair value sharing among the partners of the collaboration/ Agreement on value sharing</p> <ul style="list-style-type: none"> • Convergence of processes <p>Creation of a common entity</p> <ul style="list-style-type: none"> • Convergence of knowledge <p>Knowledge sharing during the co-development of a product</p> <p>Horizontal collaboration</p>
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	<p>Modification of internal processes</p> <p>Support the partner in changing its industrial processes</p> <p>Return-loop of information to the partner about the flows</p> <p>Creation of a common entity</p> <p>Shared-logistic</p> <p>• Convergence of knowledge</p> <p>Knowledge sharing</p>	<p>processes</p> <p>Support the partner in changing its industrial processes</p> <p>Return-loop of information to the partner about the flows</p> <p>Creation of a common entity</p> <p>Shared-logistic</p> <p>• Convergence of knowledge</p> <p>Knowledge sharing during the co-development of a product</p> <p>Hiring ambidextrous staff</p>	<p>knowledge</p> <p>Knowledge sharing during the co-development of a product</p>	<p>with academics, industrial clusters and other stakeholders for R&D/ Horizontal collaboration with entrepreneurs, university, NGOs for a public project</p>
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	<p>during the co-development of a product</p> <p>Hiring ambidextrous staff</p> <p>Horizontal collaboration with academics, industrial clusters and other stakeholders for R&D/</p> <p>Horizontal collaboration with entrepreneurs, university, NGOs for a public project</p>	<p>Horizontal collaboration with academics, industrial clusters and other stakeholders for R&D/</p> <p>Horizontal collaboration with entrepreneurs, university, NGOs for a public project</p>		
<p>Moderating factors</p>	<ul style="list-style-type: none"> • Involvement of a third-party broker <p>Public actor</p>	<ul style="list-style-type: none"> • Involvement of a third-party broker <p>Shared acquaintance/network</p> <ul style="list-style-type: none"> • Supply Chain practice trends 	<ul style="list-style-type: none"> • Involvement of a third-party broker <p>Shared acquaintance/network</p> <ul style="list-style-type: none"> • Supply Chain practice trends 	<ul style="list-style-type: none"> • Involvement of a third-party broker <p>Public actor</p> <ul style="list-style-type: none"> • Supply Chain

	<ul style="list-style-type: none"> Supply Chain practice trends <p>Trend to relocate SC to increase resilience, traceability and transparency favors local loops</p> <p>Long-term supplier/customer relationship</p> <p>Market and consumer demand and awareness towards sustainable SC</p> <p>Cross-sectorial reflexion</p> <ul style="list-style-type: none"> Amount of investment needed 	<p>Market and consumer demand and awareness towards sustainable SC</p> <p>Long-term supplier/customer relationship</p> <p>Cross-sectorial reflexion</p> <ul style="list-style-type: none"> Amount of investment needed <p>Reluctance to invest (finance, time, resources)</p> <p>Investments made to adjust to a new industrial sector is a steppingstone to reach others and favour diversification</p>	<p>Trend to relocate SC to increase resilience, traceability and transparency favors local loops</p> <p>Market and consumer demand and awareness towards sustainable SC</p> <p>Long-term supplier/customer relationship</p> <p>Cross-sectorial reflexion</p> <ul style="list-style-type: none"> Amount of investment needed <p>Reluctance to invest (finance, time, resources)</p>	<p>practice trends</p> <p>Cross-sectorial reflexion</p> <ul style="list-style-type: none"> Amount of investment needed <p>An unexploited pool of material (future secondary raw material) creates opportunity</p>
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	<p>Reluctance to invest (finance, time, resources)</p> <p>An unexploited pool of material (future secondary raw material) creates opportunity</p> <p>Investments made to adjust to a new industrial sector is a steppingstone to reach others and favour diversification</p>		<p>An unexploited pool of material (future secondary raw material) creates opportunity</p> <p>Configuration in which a new material does not necessitate heavy innovation in terms of treatment and processes facilitates the implementation process</p>	
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4.5 Propositions and visual framework

Interpretation of these results has led us to formulate five proposals for understanding the cross-industrial circular collaborations.

The four cases studied confirm previous supply chain management literature by emphasising that, within the supply network, cross-industrial circular collaborations correspond to material flows (the circulation of secondary raw materials, for example) and immaterial flows (financial or information flows) which occur between different nodes in the network. These nodes between which the flows circulate are brokers in the sense of network theory (Granovetter 1983; Burt 2009). As already described in the literature, these brokers are either parties to the supply chain, or parties that support the supply chain (Carter 2015 and Rosca 2022) without directly facilitating material flows but providing them immaterial flows such as financial and knowledge resources (Cole and Aitken 2020). This is in line with studies that emphasise the systemic nature of the circular economy, which involves a multitude of actors of different natures and is understood at all levels (Miemczyk, Carbone, and Howard 2022; Marques and Manzanares 2022; De Angelis 2021).

The realisation of these material and immaterial flows with a view to achieving greater circularity in the network is made possible by the brokers' management of the five dimensions of inter-organisational proximity. Examples of the implications of the five dimensions of proximity are given below but are not limited to this interpretation alone. Geographical convergence enables the effective circulation of material resources through the implementation of closed-loop logistics flows. Cognitive convergence makes it possible to provide the intellectual elements needed for movement between industries, for example through circular innovation, which sets standards for a secondary raw material so that it can be used in any industry. Organisational convergence makes it possible for the parties involved in the collaboration to work together by ensuring that industrial processes are compatible with a view to achieving circularity. Institutional convergence is the common foundation, the lasting *raison d'être*, the circular vision of the partnership which can act as a cement when the other

convergent dimensions are lacking. Social convergence at the start of the partnership creates the conditions for the emergence of the idea of the cross-industrial circular collaboration, then, during the course of the collaboration, it creates fluidity in the relationships between individuals who are parties to the partnership.

Proposition 1: Cross-industrial circular collaborations involve material flows and immaterial flows engaged by supply chain brokers and supporting brokers that manage the different dimensions of proximities.

Considering collaborations from a lifecycle approach, we can divide them into three stages: the first is the idea of collaboration, prior to any formalisation; followed by an initiation stage, which corresponds to the implementation of convergence measures that enable effective collaboration; and then an operational stage. This echoes a study of cross-industrial collaboration which distinguished these three stages in terms of the cognitive alignment required to set up open innovation operations (Hilda B. Lyng and Brun 2019)

The three phases are sequential depending on the state of the proximities present. During the first phase there are pre-existing proximities and proximities in deficit. The pre-existing proximities are those which form the basis of the collaboration, and the deficient proximities are the fertile ground for the emergence of a hitherto unseen collaboration: "Coming from different worlds was very beneficial for us because we didn't know about all the manipulations we could do with our products. The world of research opened my eyes a lot and also the eyes of all those we worked with to see how a plant can give a product that can be used in many other products." Case A, AI This goes in the same direction as previous research on cross-industrial collaborations that found that they are beneficial thanks to the adoption of a variety of perspectives allowing an open-learning climate (Gattringer et al. 2021) and the chance to integrate complementary competencies (Carraresi, Berg, and Bröring 2018).

The second stage is when the brokerage work consists of compensating for the proximities that were previously in deficit. In our sample, this was a stage in the formalisation of the collaboration and the work of rapprochement required to

achieve it. It involved putting in place measures to ensure the financial viability for each party to the collaboration, adapting processes and putting in place a common knowledge base to ensure the effectiveness of the partnership. According to our respondents, this stage is the most challenging and requires the most investment and work on proximity. "The rapprochement with the agricultural sector was complicated at the beginning because we don't have the same issues, the same ways of working, the same objectives, the same problems, the same sizes, the same networks. We are completely different. The beginning was complicated, really, and now, with the years, we know each other extremely well and we often talk about it saying, "at the beginning it was tough". Convergences are complicated." Case B, B2.

At the last stage we observed, the functioning phase, the proximities have been managed to a level that allows a "new-normal" mode. The convergence work has resulted in a situation where there are no longer any particular difficulties in working with a player from a different industrial sector to the one to which you belong. The work of proximity management was carried out during the previous stage, and a lesser amount of management is needed as the proximities have reached an adequate level for compatibility and just need to be maintained. "The materials have been deployed for over 10 years in the automotive industry. All the questions were asked at that time." "It's always a matter of fine-tuning. But it's not the same once the tools are launched". Case B

Proposition 2: Cross-industrial circular collaborations follow a 3 stages model. The 3 phases sequence according to the degree of convergence of the proximities involved.

In our sample, at the idea stage, the initiators of the cross-industrial collaboration either share social or institutional proximity: They share either friendship or family ties, or a professional or associative network relating to their enduring values that pre-exist the collaboration, and it is in this context that the idea of collaboration emerges. This may explain the novel nature of these collaborations, which are 'accidental' or at least seem to emerge 'at random', unlike collaborations between members of the same industry, where opportunities to collaborate are frequent and easy to set up. The personal bonds or the common values of the initiators of

these collaborations allow them to imagine the potential benefits of their collaboration although they do not share the same expertise (knowledge proximity) and the same modes of organisation (organisational proximity).

We can interpret the fact that the brokering actions implemented in the cases studied mainly target the geographical, organisational and cognitive dimensions of inter-organisational proximity as an indication that these are the most central proximities in the implementation of cross-industrial circular collaborations.

We draw this proposition from the interpretation we give to the proximity dimensions targeted by the brokerage measures described in the cases of our sample. Measures to implement shared logistics, flow sharing, or supply chain relocation correspond to a moderation of the geographical dimension of proximity, making circular flows possible. Measures relating to circular innovation (through the creation of shared knowledge concerning the reuse of a pool of waste, or the creation of an innovative secondary raw material whose use is compatible with conventional processes or tools) are in line with the creation of the organisational and cognitive proximity which is part of the greater standardisation movement necessary for the implementation of the circular economy (Suchek et al. 2021).

Cognitive and organisational proximity are also facilitated by the introduction of common industrial processes and return loop of information about the flows, the creation of a common entity or the hiring of ambidextrous staff (individuals with previous experience in both industries involved in the collaboration). Finally, measures taken to clarify issues associated with the sharing of created value (with agreements on value sharing, measures of financial risk sharing or co-investment in the R&D of the common developed product) are in line with an organisational alignment based on the imperative of generating a profit compatible with the lasting viability of the partnership and the economic survival of the organisation involved (Sudusinghe and Seuring 2022).

However, there is a limit to our interpretative logic. It can be argued that the effects of these brokering actions on proximity are difficult to isolate. Some actions aim to create a particular type of proximity, but they also have indirect, or

at least unintended, effects on other proximities. For example, in Case B, a convergence of processes with the setting up of physical meetings was necessary to adapt to the agricultural sector where conference calls were not compatible with an effective collaboration (organisational convergence) and had then, according to the interviewee, an indirect effect of a better interpersonal knowledge of individuals (social convergence). This has been emphasized by previous studies that postulate that proximity management can result in unintentionally managed proximities (Beaugency and Talbot 2018).

We propose that this particular configuration of initially pre-existing and deficit proximities (high social and institutional proximities in phase 1, geographical, cognitive and organisational proximities to be managed in phase 2) is due to the circular cross-industrial nature of the collaborations studied. We postulate that this configuration would be different in other types of collaboration. Thus, we think that in collaborations between organisations belonging to the same industrial sector, cognitive proximity would probably not be in deficit because the organisations would probably share a greater common knowledge base. Similarly, a collaboration that does not aim to achieve a higher level of circularity would probably not require as strong a base of enduring values and would therefore not have as much pre-existing institutional proximity.

Proposition 3 a: In the case of cross-industrial collaborations, the proximities present during the idea phase are social and institutional proximities.

Proposition 3b: In the case of cross-industrial circular collaborations, the proximities to be managed at the initiation stage are geographical, organisational, and cognitive proximities.

Triggers found in this study, such as protecting the business from fluctuations in energy and raw material prices, expected growth through the opportunity to reach new customers and markets, responding to customer pressure for sustainability and complying with legislation or tax incentives are in line with previous literature. They had already been described in numerous articles related to circular supply chains with different perspectives, such as that of the focal firm or suppliers and in different industrial contexts , and compiled in a systematic

literature review whose ambition was to draw up an inventory of the circular economy drivers most widely shared by organisations (Govindan and Hasanagic 2018).

Proposition 4a: Cross-industrial circular collaborations are triggered by expected financial gain, sustainable entrepreneurial vision or a public sector impulse.

Following on from the triggers described above, our study has highlighted the specific actions taken by the organisations involved in the collaboration to facilitate its development. Many of these practices had already been described in the literature on collaborative practices within circular supply chains, such as the sharing of infrastructures or logistical activities to ensure geographical convergence; the implementation of common industrial processes or the adaptation of individual industrial processes in order to facilitate common operations to ensure organisational convergence or co-development of the product, joint R&D activities with the partner and third-party organisations such as universities or NGOs to ensure cognitive convergence (Sudusinghe and Seuring 2022). We propose that the brokering actions implemented by organisations are specific to each collaboration because the combination of proximities to be managed and the means engaged depend on the specific characteristics of each organisation involved.

Proposition 4b: Organisations actively facilitate collaboration with brokering actions aimed to make their inter-organisational proximity converge. These brokering actions depend on the organisations' engaged and the types of proximity that need to be managed.

In addition to the brokering actions actively undertaken by the organisations involved in the collaboration, our study found general contextual elements that reinforced or limited the development of cross-industrial circular collaborations. Examples of these contextual elements are the general trends that apply to supply chain management, such as the relocation of the supply chains (Ashby 2016; Fratocchi et al. 2014) or the expectations of the market and consumers

towards sustainable products (Tseng et al. 2019). The trend towards long-term supply relationships such as supply chain integration or collaborative practices between customers and supplier for environmental performance is also a factor in the adoption of cross-industrial circular collaborations, as well as cross-sector thinking with suppliers and customers to find eco-friendly solutions for logistics, transportations or supply innovations (Tseng et al. 2019; Suchek et al. 2021). Contextual factors also include the presence of public or private stakeholders, such as a professional networks, who act as facilitators of these collaborations (Rosca et al. 2022). Lastly, cross-industrial circular collaborations have been described as requiring a significant investment in financial resources and time, which can make organisations reluctant to commit to them. Contextual factors can mitigate the level of investment required, such as the existence of a hitherto unexploited pool of waste that constitutes a source of low-cost secondary raw materials or for which there is little competition in terms of supply. Another favourable contextual factor also lies in the advances brought about by circular innovation (Suchek et al. 2021): Indeed, cross-industrial circular collaborations benefit from efforts to standardise products, which can make a new material immediately usable without requiring major changes to industrial processes in order to use it, and thus allow it to spread to other sectors and thus reach new customers. We therefore propose that, in addition to the actions specific to each collaboration that are actively put in place by the partner organisations, broader contextual elements also reinforce or limit the development of circular cross-industry collaborations.

Proposition 4c: Cross-industrial circular collaborations are affected by contextual elements that facilitate or hinder their development.

Taken together, these proposals have led us to draw up a theoretical framework for understanding cross-industrial circular collaborations, which we present in figure 8 below

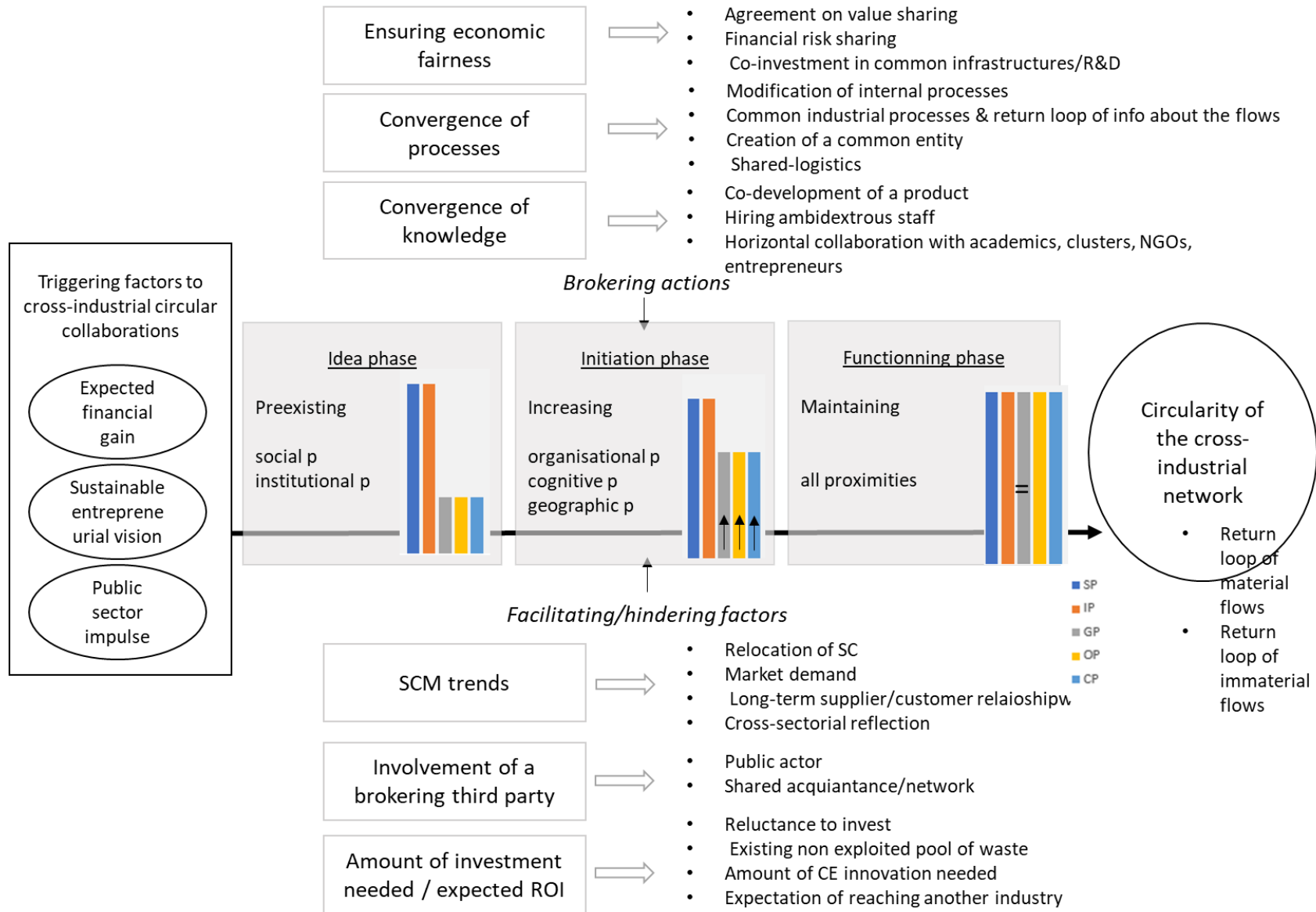


Figure 8 - Cross-industrial circular collaborations

4.6 Conclusion

The article builds on previous literature in supply chain management that emphasises the importance of collaborative practices and their study (Bressanelli, Perona, and Saccani 2019; Lahane, Kant, and Shankar 2020; Farooque et al. 2019) and postulates that a lever for scaling up the circular economic model lies in the adoption of collaborations involving systemic operations that cross the traditional industrial boundaries of the supply network (De Angelis, Howard, and Miemczyk 2018; Tate et al. 2019). Previous studies have looked at the specific features of circular collaborations involving unusual stakeholders (Sudusinghe and Seuring 2022), or proposed initial mechanisms to explain how cross-industrial collaborations work in the broader context of innovation management (Enkel and Gassmann 2010; Hilda B. Lyng and Brun 2019). But, to our knowledge, the intersection of these two fields remained unexplored. Moreover, our initial assumption lies in the difference between a sustainable supply network and a circular supply network, the latter requiring the implementation of operational material flows between the nodes of the network. For this reason, all the dimensions of inter-organisational proximity (geographical, cognitive, organisational, social and institutional) need to be taken into account if collaborative practices aimed at achieving circular results are to be put in place.

Our study targeted the two research questions How do CICC emerge and function? and How do the different dimensions of inter-organisational proximity contribute to CICC and how can they be adjusted to achieve circular outcomes? By studying four cases of cross-industrial circular collaborations, this study offers some initial insights into these specific collaborations.

This explorative study builds on the network theory (Granovetter 1983; Burt 2009) and the five dimensions of inter-organisational proximity (Boschma 2005) by proposing that cross-circular collaborations involve material flows and immaterial flows (Carter, Rogers, and Choi 2015) engaged by supply chain brokers and supporting brokers to the supply chain (Rosca et al. 2022). Extending our understanding of cross-industrial learning mechanisms (Hilda B. Lyng and Brun

2019), it proposes that cross-industrial circular collaborations follow a three-stages model, each stage characterised by a progressing degree of convergence of the proximities involved. The first stage is characterised by preexisting social and institutional proximities, the second one being a stage of convergence of the geographical, organisational and cognitive distance between the collaborating organisations and the last one being reached when the five dimensions of inter-organisational proximities attain a degree of convergence that is comparable to any collaboration taking place in the supply network. The convergence of the geographical, organisational and cognitive dimensions is essentially achieved during the second phase with brokerage measures aimed at ensuring economic fairness, convergence of processes and convergence of knowledge among the parts to the collaborations. The study also identifies the triggers for these collaborations, such as an expected financial gain, the sustainable entrepreneurial vision of the initiators or an impulse of a public entity. It also lists factors that facilitate or hinder the progress of cross-industrial circular collaborations. The existing links between management of the dimensions of proximity and the specific features required by the circular economic model are also discussed.

The practical contributions of this study are directed primarily towards companies who are preparing for cross-industrial circular collaborations: it gives initial directions to managers to be aware of the different dimensions of proximities at work in a project of collaboration and how to engage in their management at the right time. It also provides insights in the process of selection of an adequate facilitator to engage in a cross-industrial circular collaboration project (i.e., a broker or support broker that can target a relevant proximity for a specific issue). The article also sets a first list of examples of brokering activities meant to create an adequate degree of convergence between collaborating partners aiming to reach a higher level of circularity in their common operations. The study also is also aimed for public actors, policy decision-makers and their stakeholders as the study gives insights on how to stimulate the right proximity at the right time for a given circular project or for a on a given territory wishing to enhance its circularity rate for example.

The most important limit to this study is that the case studies chosen have all in common to be success stories to date and studies of failed attempts or more

mature initiatives could provide useful elements to detect threats and pitfalls of these collaborations. More contextual data is also needed to deepen the analysis of the cross-case studies and to highlight the divergences between the collaborations studied. Data from collaborations involving large organisations, for example, would enable us to interview both respondents from the top management of these collaborations and people involved in the day-to-day implementation of these operations. For future research we thus encourage to complete this explorative and interpretative study with larger empirical samples grounded in a wider range of empirical data, including data from collaborations in a further progressed stage of realisation to validate these first results. In-depth single case-studies could provide complementary insights to uncover more detailed and deep mechanisms at work at all steps of these collaborations.

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Appendices of the article

Table 14- Proximity dimensions and cross-industrial circular collaborations

Proximity dimension	Impact on cross-industrial circular collaboration	Indicative verbatim
Geographical proximity	Geographical Proximity allows a reduction of environmental impact related to transport	"We consider that it is more interesting from an environmental point of view, even if we don't characterise it in a quantitative way, to say :well, my by-product instead of being sent 500km to a pig farm in Holland is sent to the distillery through a pipe 300 metres away." Case A, A5
	Geographical Proximity can be seen with shared logistic	"The one that uses the most train loads is [A1] with the ethanol cars. They do dozens a week. I do one a week. We share resources. I use their resources to fill my trains and to benefit from their competence in rail transport." Case A, A2
	Flows in Industrial Symbiosis necessitates geographical proximity	"Steam needs to be close, otherwise it condenses. Hot water can withstand greater distances if there is good insulation." Case A, A4
	Geographical Proximity contributes to transparency	"The fact that we are local allows us to be transparent. Our factory is 4km from Paris and it allows us to invite people to come and see what's going on [...] it gives people a sense of ownership of the brand and the product." Case C, C4
	Geographical Proximity contributes to the resilience of	"There is an issue, which is strategic for large companies, relating to the covid effect with the geopolitical and logistical crisis on materials. There

	SC	was a shock when we understood that most supplies come from elsewhere, not from Europe, and that we have to repatriate our supplies. This psychological shock in the decision-making centres means that they are interested in products like ours which are more stable." Case C, C4
	Geographical Proximity enhances the local image of the product	"There is a very marketing and communication aspect to the "Made in France" dimension. It has a fairly strong impact on purchasing decisions, whether in B2B or B2C." Case C, C4
	Geographical Proximity can overcome an initial reluctance to engage in an unusual supply collaboration	"If I say I'm from Brittany, it helps, and if I say I worked in oyster beds, the discussion immediately starts. That really helped. The slightly chauvinistic Breton side of things really helps too". Case C, C2
Institutional proximity	Sharing a professional network facilitates the collaboration	"It works a lot like that, you join systems and then the business happens within that system [...] You have to join organisations, associations. So, the representatives of our company will be able to make connections there." Case D, D2
	Attending the same events facilitates the collaboration	"We intensified our relationship because we regularly crossed paths at trade fairs and on forums and one thing led to another." Case D, D3
	Being driven by the same values allows to overcome other areas of divergence	"I don't have the impression that there are common factors [...] except that we all belong to a generation that wants to be convinced by what we do. We speak the same language because we are curious to see what is being done elsewhere on this type of [sustainable] project and given that exchanges are made easy." Case C, C3
	A very different sectoral culture can make it difficult to access collaboration	"It's a bit of a cliché, but it's the type of environment that's quite closed, quite rough. The fishing industry, fish farming, even if it's a bit of a cliché, it's still a bit of a big shot. This is not the case for my brother-in-law, but it is the case for his colleagues. It's true that it helps to have contacts at

		that level." Case C, C2
	Sharing the same stakes facilitates collaboration	"I don't hide when I talk to a [badminton] club manager, I say "I am a manager too, I understand your problems". That helps me to put myself on the level of my interlocutors". Case C, C3
Cognitive proximity	Having the same way of thinking facilitates the collaboration	"We have the same approach, the same philosophy, the same intellectual structure, and it immediately clicked, and one thing led to another. Between people of good company, we work well. We want to do things, we meet people who want to do things and things get done." Case D, D3
	Having a very different way of thinking hinders the collaboration	"I come from industry and have a managerial approach, but I have to admit that people who are formatted from public national education don't have the same software and when you present them with something a bit innovative, it's not easy to be followed". Case D, D3
	Having external point of view from people with different capabilities allows progression	"This allows us to have outside opinions on the way we think. We know very well that we are not competent on all subjects, so we rely on their expertise to continue to move forward." Case D, D3
	A partner with a different cognitive background can give you a better understanding of your own product and thus access to new opportunities	"Coming from different worlds was very beneficial for us because we didn't know about all the manipulations we could do with our products. The world of research opened my eyes a lot and also the eyes of all those we worked with to see how a plant can give a product that can be used in many other products." Case A, A1
Organisational proximity	Lack of organisational proximity creates reluctance to engage into the collaboration	"I was not presented with who or what was X, what skills, what working methods, organisation, processes that could have reassured me that I was not coming across the local president [of an SME] who had a brilliant idea the day before and who smoked hemp. It was really this organisational side and everything, I was thinking this is absolutely not

		future-proof, what is this stuff?" Case B, B3
	Profit making is an alignment factor, it creates organisational proximity	"We remain in companies that have financial objectives. In industry, private business is like that, there is a need to make margins. It's always a factor of alignment. » Case A, A2
	Enrichment from difference of size of companies	"It's always good to work with a bigger or a smaller partner because each has its own problems that complement each other." Case A, A1
Social proximity	Sharing the same infrastructures for non-work moments (during the lunch break for example) facilitates relationships and creates cohesion between companies of a same eco-park	"People know each other, they meet at the joint company restaurant. We also have our links with our customers and suppliers because we have these relationships. There is a specific will on this site: living together through this interdependence allows us to better develop all of our value chains" Case A, A3
	Shared social moments creates opportunities for rapprochement	"I can share a little anecdote. One day I was with a quality manager, we went to a restaurant for lunch, and he got into my car, a 308. He said to me, you see, your car has a defect there, a defect there, a defect there. I didn't see anything, it was a difference in colour, there was a discrepancy. He saw it straight away, and afterwards I could only see that. It gave me an insight into things and enabled me to understand when they asked me for quality, it was to eliminate these defects. It's at times like this that you realise that there are things that we don't even suspect, even though it's a real problem for people in the automotive industry." Case B, B1
	Social proximity (here through family) creates an opportunity for the collaboration idea	"During that year I was working with my brother-in-law, an oyster farmer, who sold his oysters every weekend to make money for my business project [...] during the week as a designer I couldn't find any local, French materials that met the technical characteristics of waterproofing, solidity, weight issues. And every weekend in parallel I threw away shells, mainly oysters, mussels, scallops [...] I recovered them,

		I carried out tests and I obtained concrete results from the material, which met my specifications well." Case C, C2
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Table 15 - Brokering actions to facilitate cross-industrial collaborations

Objective of brokering action	Type of brokering action	Indicative verbatim
Ensuring economic fairness	Ensuring a fair value sharing among the partners of the collaboration/ Agreement on value sharing	"We are working on the digital commons, I am pushing for creative common licenses, but as a result many things are shared and many people will have to be brought in, and we have to make sure that the actors are still rewarded". Case D, D1
	Financial risk sharing among the partners	"They invested, and on our side we agreed for a 10 years partnership to have a unit that belongs to us. This made it possible to have a win-win collaboration because we didn't put any money on the table and they had the guarantee that they would have volume over 10 years." Case A, A3
	Co-investment in common infrastructures	"We have a collaborative flow because we made a co-investment in recycling alcohol". Case A, A3
	Co-investment at the product development stage	"They made me pay full price for prototypes because I understood that they were afraid to invest time, money and manpower before they were allowed to produce. So now I invest in machines and welding templates. Since then, we've been seeing each other regularly, we've been having a good time and the project has been launched." Case C, C1

Convergence of processes	Modification of internal processes	<p>Our initial prospects were less technical. We didn't need criteria as detailed as those required by B2. Of course, we had to adapt. We had carried out tests on very specific samples, but we did not have enough volume to have industrial processes. Once these tests were done, we had the basic material and we had to produce more. [...] It was industrialisation, by adding a machine, selecting the straws, i.e., the raw material, to better correspond to their products, and a tighter control of the material at the end of the process in order to fit into the spectra that we were asked to produce. [...] They asked to have sufficient stocks of raw materials to be able to be supplied for the whole year. And to have back-up stocks in case there is a complicated year. We created a buffer stock cell, and we changed our harvesting techniques. Case B, B1</p> <p>"With the distillery, we have an important flow because they use our wastewater as fertiliser. We had to change our production and treatment methods to make it work (we changed the soda for potash)" Case A, A3</p>
	Support the partner in changing its industrial processes	"We help the customer to understand how to process the materials. Plastic contains a vegetable filler. So, there are a few rules. The first is the processing temperature. The material must not be injected too hot, otherwise the fibres will be burnt." Case B, B4
	Return-loop of information to the partner about the flows	"The knowledge of gases, that they don't have. We are constantly discussing their processes. We try to guide them and help them with these molecules. I will have to call them on the analysis of gases, which is our job. I see a level of sulphur and tell them you have a problem; we see that on our analyses. We detect the gas at such a level that we can tell them that they have a problem with their processes." Case A, A2
	Creation of a common entity	"In order to be able to produce these materials, the creation of an entity took place [...] This joint-venture therefore now produces these

		materials." Case B, B3
	Agreement on common industrial processes	"Sometimes they make decisions based on their demand for ethanol. Their principle is to fill the tanks with ethanol and not to supply us with a waste product. So, they sometimes have dilemmas. They may be tempted to produce less but that will provide me with less CO2. It's a balance where you have to be vigilant and there has to be a contract on the quality and quantity of molecules so that it doesn't get out of hand." Case A, A2
	Shared-logistic	"You have to know how to handle a train, it's not our job. A1, with its sites, transports dozens of wagons a day, so they have this expertise in rail transport. They weigh our wagons. There are rules for handling dangerous goods wagons. We work together to do this. We benefit from this know-how "Case A, A2
Convergence of knowledge	Knowledge sharing during the co-development of a product	"I have very precise requirement specifications to comply with and I'm not sure that the material producers can keep up. So I ask them, they explain the nature of the material. We feed each other. I tell them "I made a tray with this but it's too fragile" and they tell me "Ok, we will reinforce the material"." Case C, C1
	Hiring ambidextrous staff	"The people at B4 didn't necessarily knew agriculture, but at least they came from B1 and B2. Thanks to them, we already had more of a history of relationships. They were people who had been appointed by the joint management to look after B4 and its industrialisation. They had set up industrial teams, which worked on machines, in an environment which we did not know. They knew the problems they could encounter with materials like ours for the use they wanted to make of them." Case B, B1
	Horizontal collaboration with academics, industrial clusters and other stakeholders for R&D/	"When we started to develop these materials, we had to get closer to all the partners we considered important from the point of view of R&D platforms, academics, competitiveness clusters, to identify the right partners or at the right time and for what reasons to develop the

	Horizontal collaboration with entrepreneurs, university, NGOs for a public project	<p>materials we needed... We built a strong ecosystem around us to help us respond to all the problems we were facing. Now we know well, we master, but we had to set up a very strong network around us." Case B, B2</p> <p>"[French environmental national agency] asked for 6 capability lots, 3 of which were compulsory, and we are 6 organisations. 1 lot on D, in charge of the life cycle management aspects. 1 lot on IT development and research. 3rd lot, environmental communication, represented by D1. 4th lot required public education and research participation. Lot 5, for the economic dimension. The 6th lot is for governance and technical documentation". Case D, D4</p>
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Table 16 - Triggers of cross-industrial circular collaborations

Type of trigger	Example of trigger	Indicative verbatim
Financial gain	Customer pressure	"The consumer wants a natural, renewable product with no health consequences." Case A, A3
	Law & fiscal incentives	"The legal system can create opportunities or obstacles. The opportunity would be on the AGECE [anti waste and circular economy] law which allows us to have openings with the public order which must have 30% of furniture in recycled material." Case C, C3
	Protect the company from fluctuating energy and	"The cost of raw materials has exploded [...] there is also an interest in water management because water is becoming a rare commodity. The same goes for energy management, renewable and on a local scale. [...]"

	commodity prices	<p>This local energy is less dependent on geostrategic variations, as is the case for energy [...] If we had to pay 10 times more for our gas, as we have seen with the recent crisis, we would close the factory. So, for us it's a question of survival. This crossing of flows protects us from price variations that could kill us." Case A, A3</p> <p>"For a biorefinery to work well, the biomass has to be close by. Because the logistical flows are enormous and have a significant cost, and we need to be close to the consumption centres." Case A, A3</p>
	Opportunity to diversify clients and markets	"We have done a lot of work to qualify materials for the automotive industry and today we use them in our daily work for all our productions. Some of our products do not comply with the automotive standard, but they do for other activities." Case B, B1
Sustainable entrepreneurial vision		"We're all very committed, we don't really count our hours and we do it out of personal conviction, which helps things move forward much more quickly [...] it motivates us. The vision, the shared vision is a cementing bond". Case D, D2
Public sector impulse		"I met someone from the municipality and he said "we have to do something to highlight what you do and to valorise your by-products"". Case A, A1

Table 17 - Factors facilitating or hindering cross-industrial circular collaborations

Type of moderating factors	Example of factor	Indicative verbatim
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Involvement of a third-party broker	Public actor	"We have funding from [French environmental national agency] which is for our consortium [...]. The six of us spent a lot of time responding to the [French environmental national agency]'s call for proposals. It was very time-consuming, but it allowed us to get to know each other and to realise that we had the same values and that if it hadn't been for the six of us, we wouldn't have been able to win the call". Case D, D1
	Shared acquaintance/network	"One of the teachers in my course has an association called Matériaupole, which is a gathering of people who work with materials, mainly in environmental research, and he liked my business project. His job in this association is to bring people together and he put me in touch with my current partner, with whom I immediately hit it off. Then he introduced me to another future partner whom I already knew, and the circle was complete." Case D, D2
Supply Chain practice trends	Trend to relocate SC to increase resilience, traceability and transparency favors local loops	"The consumer needs traceability, he asks where the material comes from, is it not going to poison us? [...] we need transparency because our customers are demanding and want to understand how we produce and want to be sure that it is not harmful." Case A, A3
	Market and consumer demand and awareness towards sustainable SC	"When you come up with different materials, which are new, inevitably you are faced with a higher level of resistance than with standard materials that have been around for 30 years. You need to reassure internal and external customers, more than with any other material. These are materials that are going to be described as different, based on natural resources, with intrinsic variability and about which there is doubt on the part of the end users. So, you are obliged to reassure, to set up a structure, to reassure your production units, to set up control systems, to reassure the customers. There is a need to have much

		<p>greater control, and this is done through studies and partnerships with a fairly large network." Case B, B2</p> <p>"There are many people who think that the raw material is waste and therefore should be free. Except that there are 15 stages between the raw material and the sending of the object, which impact the price. There's this side that because it's recycled, it shouldn't be expensive, when in fact it's quite the opposite at the moment." Case C, C2</p>
	<p>Long-term supplier/customer relationship</p>	<p>"The creation of a plant to recover CO2 was a strategic issue to secure a source and supply a depot to the south, hence the idea of creating a site with A1." Case A, A2</p> <p>"We are specific, it is always a big stress for the customers [...] We have never had any problems with the supply chain being broken, but this is an important point. From the moment we say to ourselves if something happens in the factory, we have no instant backup because everything we do is unique." Case B, B4</p> <p>"We can't function, my plant can't produce CO2 if my partner doesn't produce it itself, it's a prerequisite, a total symbiosis. The quality of fermentation is a factor in my unit. If they don't work properly and if they generate a bad molecule, I'll feel it right away on the quality of my output." Case A, A2</p>
	<p>Cross-sectorial reflexion</p>	<p>"I try to meet with Decathlon, Danone, packaging. We try to discover technologies or trends and we ask ourselves whether or not they are applicable to the automobile. It is because it is environmental that it justifies working transversally with other sectors". Case B, B3</p>

Amount of investment needed	Reluctance to invest (finance, time, resources)	<p>"The waste from this industry could be used as fertiliser on the site. But this requires huge investments that the cooperatives cannot make on their own, they need external inputs". Case A, A1</p> <p>"There is always the financial side. R&D, if we want to do it well, is extremely expensive. That blocks us. There is a distance between the ambitions and the capacities of the small company, and everyone says, "it's nice, it's cool, we have to go faster", but we need help to find the financial means to launch the phases that we want to develop." Case C, C2</p> <p>"There are still some clients who, for financial reasons or because they consider that it will be technically too specific, do not take this step." Case B, B4</p> <p>"You have to know that we had been preparing this for a long time. The implementation with our partners has been prepared for about fifteen years, so it wasn't just overnight." Case B, B1</p>
	An unexploited pool of material (future secondary raw material) creates opportunity	"The plant is relatively new and came into being thanks to this partnership to recover the value of waste". Case A, A2
	Configuration in which a new material does not necessitate heavy innovation in terms of	"The extraordinary thing is that this product saves the planet because it uses waste and recycles it over and over again without any technological or industrial revolution. It doesn't require innovation. My chairs and tables, all the technology used in my value chain has been

	treatment and processes facilitates the implementation process	known for decades". Case C, C1
	Investments made to adjust to a new industrial sector is a steppingstone to reach others and favour diversification	"When you have a standard that is set up, when you read the specifications, you get scared, and then you say to yourself that it is a springboard for other customers." Case B, B1

5. Conclusion

5.1 General discussion

The aim of this research was to explore the following proposition, presented in the first chapter on this dissertation: One of the levers for the scale-up of the circular economy are systemic operations involving collaborations going beyond traditional sectoral or industrial boundaries (De Angelis, Howard, and Miemczyk 2018; Tate et al. 2019; Domenech et al. 2019; Jensen 2016; Ashton 2008).

The tension we wanted to explore was as follows: exchanges between companies from different industries have a promising potential to establish new circular resources flows, the sharing of infrastructures or utilities such as water or energy by enabling the supply chains from which they are originating to be de-siloed; however, these exchanges can be made difficult by the divergences that are likely to exist between industries. The divergences can be for example market conditions like competition or consumers resistance to change; supply of technical capabilities like skilled profiles; financial facilities like allocation of fundings for patents developments; macroeconomics trends affecting prices of inputs or outputs; or the state of science in different branches (Dosi 1988; Zhu and Sarkis 2006). We therefore decided to develop an exploratory study of collaborative operations across traditional industrial boundaries, their facilitation, their operationalisation and the opportunities they offer for the circular economy.

To this end, we have divided our reasoning into three articles. The first is devoted to a conceptual formulation of these circular cross-industrial collaborations (chapter 2), the second article is dedicated to the actors who ensure the facilitation of circular collaborations within the supply network (chapter 3), the third is a study of four examples of these collaborations in order to understand the conditions in which they emerge and how they function (chapter 4). Figure 9 and the following paragraphs summarise the main findings of the three studies, showing how they are interconnected and how the articles, taken together, help to provide answers to our original research statement.

In order to meet the objective of this research, the first stage consisted of a reflection to provide a clear vision of our research topic i.e.: answering the

question "What am I researching?" (Allard-Poesi and Marechal 2014) p48. The aim of this initial reflection is to determine the contours of the empirical phenomenon we wish to study, "the concrete object", before formulating a theoretical construct, "the research object", which enables its study. (Davallon 2004) p32. This was therefore the aim of the first article of this thesis, which consisted of a literature review, making it possible to find "the boundary between knowledge and non-knowledge" (Dumez 2011) p17 : to take a snapshot of what is known about the research topic and what remains to be discovered, thus enabling the emergence of a research gap and giving an original perspective to the thesis. In this part of the thesis, we sought to answer the following question:

RQ1a: What do we know about cross-industrial supply collaboration for circularity?

Recent studies from the supply chain and management disciplines have repeatedly asserted that one of the pillars of the circular economy is collaboration (Hofmann 2019; Farooque et al. 2019; Bressanelli, Perona, and Sacconi 2019; Mishra, Chiwenga, and Ali 2019; Lahane, Kant, and Shankar 2020; Bressanelli, Visintin, and Sacconi 2022). Following the recommendations to engage in further studies dedicated to the phenomenon, two systematic reviews focusing on collaborative practices within circular supply chains were published in 2022 (Sudusinghe and Seuring 2022; Danvers, Robertson, and Zutshi 2023). We relied on these publications to obtain an exhaustive and up-to-date picture of the knowledge recently generated on the subject, and we found that cross-industrial circular collaborations, unlike other collaborative practices specific to the circular model, had not yet been studied. Having established that there were gaps in the supply chain management literature concerning this specific type of collaboration, we continued the review and proposed a summary of what management science research had produced on the subject of cross-industrial collaborations. This review of the literature has enabled to grasp the initial dynamics relating to the functioning of industrial collaborations in the context of innovation management (Kotabe and Scott Swan 1995; Gattringer et al. 2021; Enkel and Gassmann 2010), in particular those relating to the cognitive (Enkel and Heil 2014; Hilda Bø Lyng and Brun 2018; Hilda B. Lyng and Brun 2019; Enkel and Bader 2016) and social bonding (Dingler and Enkel 2016) between individuals involved in these collaborations.

Despite these initial useful insights, it became apparent that the body of knowledge available was not at the appropriate angle for understanding the issues surrounding circularity. Firstly, the level of analysis proposed was not that of the network, which is imperative if we are to grasp the systemic dimension of the circular model (De Angelis 2021). Secondly, the exchanges studied were mainly intangible, whereas the circular model is also characterised by physical flows (Marques and Manzanares 2022). Having established this, and pursuing the idea that a research object consists of a construct formulated by the researcher, the remainder of article 1 sets out to answer the second research question, which was

RQ1b: What novel theoretical lenses can be used to explore cross-industrial circular collaborations in the supply network?

Bearing in mind the limitations found in the current body of knowledge concerning cross-industrial collaborations (namely, the need for a systemic perspective and the need for a holistic view of exchanges between organisations, i.e., taking into account both intangible and tangible resource exchanges taking place during circular operations), we proposed a theoretical contribution that took the form of a “combination of theoretical lenses” (Okhuysen and Bonardi 2011) of the network theory (Granovetter 1983; Burt 2009) and the framework of inter-organisational proximity (Boschma 2005). This theory building approach belongs to the general form of “theoretical bricolage” (Boxenbaum and Rouleau 2011) or “theoretical borrowing and blending” (Whetten, Felin, and King 2009). In order to satisfy the concrete criteria for an admissible combination of theoretical lenses as described by Okhuysen and Bonardi, we have presented the high proximity of the assumptions contained in the two theoretical perspectives we have chosen, as well as their high compatibility (Okhuysen and Bonardi 2011). To our knowledge, although it had already been mentioned that the two theories presented “[ideas] more or less aligned” (Boschma 2005) p15, this operation of theoretical combination had not yet been supported or formalised prior to the proposal made in this article, and therefore constitutes a theoretical contribution. In this theoretical combination, the inputs of the network theory explain the mechanisms of connection and dynamics governing the circulation of resources between the nodes of a supply network while the inter-organisational proximity framework explain the geographical, organisational, cognitive, social and

institutional factors of alignment that explain the emergence and functioning of these collaborations.

After having reviewed the knowledge produced on circular collaborations on the one hand, and cross-industrial collaborations on the other, and after having formulated a conceptualisation of cross-industrial circular collaborations, the second article of the thesis focuses on the actors likely to bring together organisations belonging to different industries wishing to establish joint circular operations. It is thus dedicated to the understanding of the roles of facilitating actors in the circular supply network.

Unlike previous definitions of supply networks, which were limited to mapping the physical flows between network nodes (Choi and Hong 2002), it has been established that other intangible (like financial or information) flows overlay them, thus allowing to the nodes that enable them to be considered as integral parts to supply networks (Carter, Rogers, and Choi 2015). The inclusion of these agents, and their added value to the successful execution of operations taking place within the network, provides a more accurate and complete understanding of the supply network. Following this logic, the circular supply chain “should consider not only upstream-downstream collaboration alignments, but also downstream-upstream collaborations involving internal and external supply chain actors.” (Batista et al. 2023) p 8.

In network theory, organisations that connect nodes of the network and enable flows of resources to circulate through the bridge they create are called brokers (Obstfeld 2005). In the context of the circular supply chain, these brokers are known as circularity brokers. This study provides an initial definition of these agents who facilitate the exchange of secondary raw materials. Other studies also look at other facets of circular facilitators, such as those whose activity is dedicated to a particular geographical region (Patricio et al. 2018), or who specifically adopt a digital platform business model (Berg and Wilts 2019; Schwanholz and Leipold 2020; Pizzi, Leopizzi, and Caputo 2021). The starting point for our second article is as follows: circular economy activities are not limited to converting waste into a resource (i.e. recycling), but also include other types of activities such as reselling, reusing, repairing, refurbishing or the recovery of water

and energy (Reike, Vermeulen, and Witjes 2018). Taking into account these other activities that make up the circular model leads us to seek to complete the initial definition of circularity brokers in order to outline the overall functions of these emerging players. To this end, we set out an initial research question:

RQ2a: Why do organisations wishing to circularise their supply chains call on the services of brokers?

By choosing a broad sample, we were able to collect a wide variety of barriers experienced by organisations that lead them to seek help from circular facilitators. These include barriers at the micro or organisational level (on either side of the bridge created by the brokers who establish connections between the members of a circular collaboration), such as a vision focused exclusively on financial and short-term value creation. Other barriers come into play at the meso level, that of partnerships between organisations, such as the issues related to the sharing of the value created from the circular partnerships, or the lack of potential partner to create common circular operations. Finally, there are barriers at the macro level, those that exist at the level of an industry, such as a lack of maturity of technical circular solutions relating to materials or industrial processes, or at the societal level, when there is a lack of legal provisions to support circular initiatives. The presence of these issues at all levels of analysis pushing to call for the help of circularity brokers echoes many publications theorising the circular economy, which postulates that only a global, integrated change, involving all players in society and at all levels, can lead to widespread adoption of the model (Kirchherr, Reike, and Hekkert 2017; Korhonen et al. 2018; Prieto-Sandoval, Jaca, and Ormazabal 2018; Suárez-Eiroa et al. 2019; Velenturf and Purnell 2021; Miemczyk, Carbone, and Howard 2022). This inventory of needs at all levels brings us to the second question in the article :

RQ2b: How do circularity brokers help the adoption of circular supply chain actions?

We found that circularity brokers provide assistance to organisations and, more broadly, to supply networks by bringing into play activities involving technical, methodological and relational skills. Among technical activities we found for

example expertise related to circular material or design innovation, to circular legislation consulting or services of data mining for the inventory of secondary raw material pools for example. Methodological activities cover the use of approaches adapted to circularity issues, such as life cycle management or the conception and implementation of shared logistics solutions. Finally, circularity brokers are also involved in relationship-based activities, such as matchmaking services that bring together organisations that may have a common interest in exchanging materials.

We point out that the added value of circularity brokers is sometimes based on a combination of these three areas of activity. Lobbying public authorities is one example. It requires a circular technical or methodological component that gives the broker legitimacy. This component is combined with relational skills relating to the adaptation of the message to be delivered and the appropriate mobilisation of the broker's network in order to improve the chances of success in persuading decision-makers.

The authors of the study that first defined the concept of circularity broker proposed six roles that brokers take on as part of their task of transferring waste to a new network node that will use it as a secondary raw material. These six roles are connection, information, protection, mobilisation, integration and measurement (Ciulli, Kolk, and Boe-Lillegraven 2019). As our initial premise was based on the fact that the circular economy was not strictly limited to recycling activities (Reike, Vermeulen, and Witjes 2018), and as we also consider that the support of the circular supply chain also relies on facilitating the circulation of flows other than those that are strictly material (Carter, Rogers, and Choi 2015), our sample covered a wider variety of circularity brokers in terms of activity and industries than those previously studied in the literature. As a result, we have found two new roles for brokers, in addition to the six previously proposed. These two new roles are supporting (in the adoption of circular measures) and equipping (with a circular solution, such as with a circular innovation or a software). Pursuing the idea that a particular interface with the network gives rise to specific dispositions or skills, we have attempted to answer the third question of this article:

RQ2c: How do brokers position themselves in the network of companies that call on them for their support, and how do the resulting brokerage exchanges affect the service they provide?

This angle builds on existing network theory, which postulates that the broker's position in the network conditions a certain number of outcomes (Obstfeld 2005; Galunic, Ertug, and Gargiulo 2012). In the field of sustainable supply chains, the brokerage exchange concept (Saunders et al. 2019), proposes that certain types of brokers, depending on the interfaces they create with their network, are more relevant than others in terms of the facilitative roles they fulfil. Five types of theoretical interface are described, each with more or less developed facilities for different tasks relating to the implementation of sustainable measures within the network in which they are involved. Our article supports these theoretical formulations by providing empirical evidence that are consistent with the assumptions and by establishing a link between the degree of embeddedness of brokers and the success in the facilitation roles they undertake. In our article, we formulate the hypothesis that a broker with a very weak degree of embeddedness, a consultant, is more likely to introduce a circular solution that was previously unknown to the network for which it operates to equip it. Conversely, a broker who is very strongly embedded in its network, a coordinator, is likely to have excellent knowledge of its members, enabling it to understand their needs, as well as providing a legitimacy that it can use to convince them to adopt a circular solution or to manage its implementation through a mission of support. Finally, a liaison broker, forming a bridge between two distinct supply networks, is probably the type of player best suited to fulfilling a connecting role. This discussion contributes to the elaboration of network theory (Darby, Fugate, and Murray 2019; Prasad 2017) by investigating the relationship between the concepts of embeddedness and brokerage (Whetten 1989).

The second article in this dissertation was dedicated to the support brokers, the intermediaries who support the material exchanges of the supply chain via immaterial flows (Carter, Rogers, and Choi 2015; Rosca et al. 2022). The final article focuses on the actors who are part of the supply chain, those between whom the physical flows of resources are established, and more specifically flows that crosses the traditional industrial boundaries of the supply network. The

assumption that we are seeking to reinforce lies in the idea that flows creating a bridge between different industries would give rise to the circulation of resources that were hitherto compartmentalised within their native supply chain, thus enabling the creation of new loops (Frosch and Gallopoulos 1989). This last article therefore aims to understand how cross-industrial circular collaborations are operated. The first research question in this latest article is therefore

RQ3a: How do cross-industrial circular collaborations emerge and function?

We have studied cross-industrial circular collaborations using a lifecycle approach, a perspective that contributes to understand how collaborations occur and enables the protagonists, such as the initiators, project managers or facilitators, to create and run a collaborative process or a collaboration environment (Tellioglu 2008). It has led us to define three successive phases through which successful collaborations pass. We first defined a phase preliminary to any formalisation of the collaboration, during which the idea of cross-industrial collaboration emerges. We found three types of triggers that come into play in this phase, namely the expectation of financial gain, such as the search for protection against fluctuations of the price of raw materials and energy, or the sustainable vision of the entrepreneurs or initiators of the collaboration, or finally the impulse given by the public sector, through a call for projects for example. These three types of triggers that emerge from our article, which studies the perspectives of several members of the network who belong to different industries, had already been described in numerous papers relating to circular supply chains with different perspectives, such as that of the focal firm or suppliers and in different industrial contexts, and compiled in a systematic literature review whose ambition was to draw up an inventory of the drivers of the circular economy most widely shared by organisations (Govindan and Hasanagic 2018).

The second stage of collaboration corresponds to the phase of convergence between the collaborating organisations. This is a stage during which the organisations actively implement brokerage actions designed to guarantee the economic viability of the collaboration in order to determine a fair value-sharing between the parties so that the agreement that binds them together is perennial. The second objective of these brokering actions is to converge the processes of

the organisations, for example by creating common industrial processes or shared logistics practices. Finally, the organisations set up knowledge convergence actions. This involves creating or strengthening the common knowledge base necessary for an effective running of the collaboration. This is achieved through joint R&D actions, or by hiring employees with a good knowledge of the two industrial sectors involved in the collaboration. These initiatives have already been reported in the literature on general collaborative practices within circular supply chains (Sudusinghe and Seuring 2022). Our study extends these findings to the specific case of inter-industrial circularity. Alongside these brokerage actions, which are actively implemented by the parties to the collaboration, a number of contextual factors present positive or negative impacts that facilitate or hinder these collaborations. These contextual factors include, for example, the general trend towards sustainable and local supply chains (Ashby 2016; Tseng et al. 2019), which indirectly favour cross-industrial circular collaborations. Similarly, technical advances in circular innovation, which are leading to the standardisation of materials and processes (Suchek et al. 2021), are also improving the feasibility the circulation of materials from one industry to another.

Finally, the third and last stage of these collaborations corresponds to an operational phase, which takes place once the convergence work has been completed. This first empirical reading of our research object is completed by a theoretical reading, based on the framework of inter-organisational proximity (Ratsimandresy and Miemczyk 2023). The second research question of this last article is therefore as follows:

RQ3b: How do the different dimensions of inter-organisational proximity contribute to cross-industrial circular collaborations and how can they be adjusted to achieve circular outcomes?

We propose that the succession of the three stages, idea, initiation and functioning of circular cross-industrial collaborations correspond to three distinct states of the five dimensions of inter-organisational proximity brought into play between the parties to the collaboration. These three stages of convergence had already been described in studies dedicated to cognitive proximity in open innovation projects which followed the stages of knowledge discovery, knowledge

transit and knowledge integration between companies belonging to different sectors (Hilda Bø Lyng and Brun 2018; Hilda B. Lyng and Brun 2019). This present study extends this understanding to the four other dimensions of proximity at the network level.

We propose that at the first stage only two types of proximity are pre-existing, which explains why cross-industrial circular collaborations are rarely reported despite the opportunities they present for the dissemination of the circular model and are still little described in the literature. Their “accidental” nature stems from the fact that they emerge under specific conditions, which are those of important social proximity (the initiators are linked by family or friendly ties) or important institutional proximity (the initiators share a common set of values geared towards sustainable development, which leads them to share the same professional networks and frequent the same events dedicated to sustainable initiatives).

We propose that the second phase, that of initiation, corresponds to the stage in which the brokering actions described above and the contextual factors with moderating effects on collaboration make the other dimensions of inter-organisational proximity between the parties converge. In the light of the brokering actions and moderating factors reported, we interpret that in the case of cross-industrial circular collaborations, it is the geographical, organisational and cognitive proximities that are more particularly managed during this phase. Thus, for example, we postulate that the introduction of shared logistics practices corresponds to geographical convergence, and that advances in circular innovation that make materials usable indiscriminately from one industry to another correspond to cognitive and organisational convergence. It follows from this interpretation that we believe that the dimensions of proximity brought into play are specific to each collaboration and to the organisations that are part of it. In fact, we believe that it is the circular nature of the collaboration that translates into the importance of institutional proximity (which corresponds to the shared sustainable vision) and geographical proximity (which is a condition for establishing effective recovery flows of water, energy or waste). We therefore formulate the proposition that any type of collaboration follows these three successive stages of convergence and management of proximities, but that the

proximities that represent a particular stake vary according to the participants in the collaboration.

Finally, we propose that the last phase corresponds to the stage in which the five dimensions of inter-organisational proximity have reached a sufficient level of convergence and that the work of proximity management to be carried out by the brokers only consists of maintaining these dimensions at a sufficient intensity to ensure the functioning of cross-industrial collaboration, which then corresponds to a "new normal", where working with a partner from another industry is no more difficult than working within the same industry.

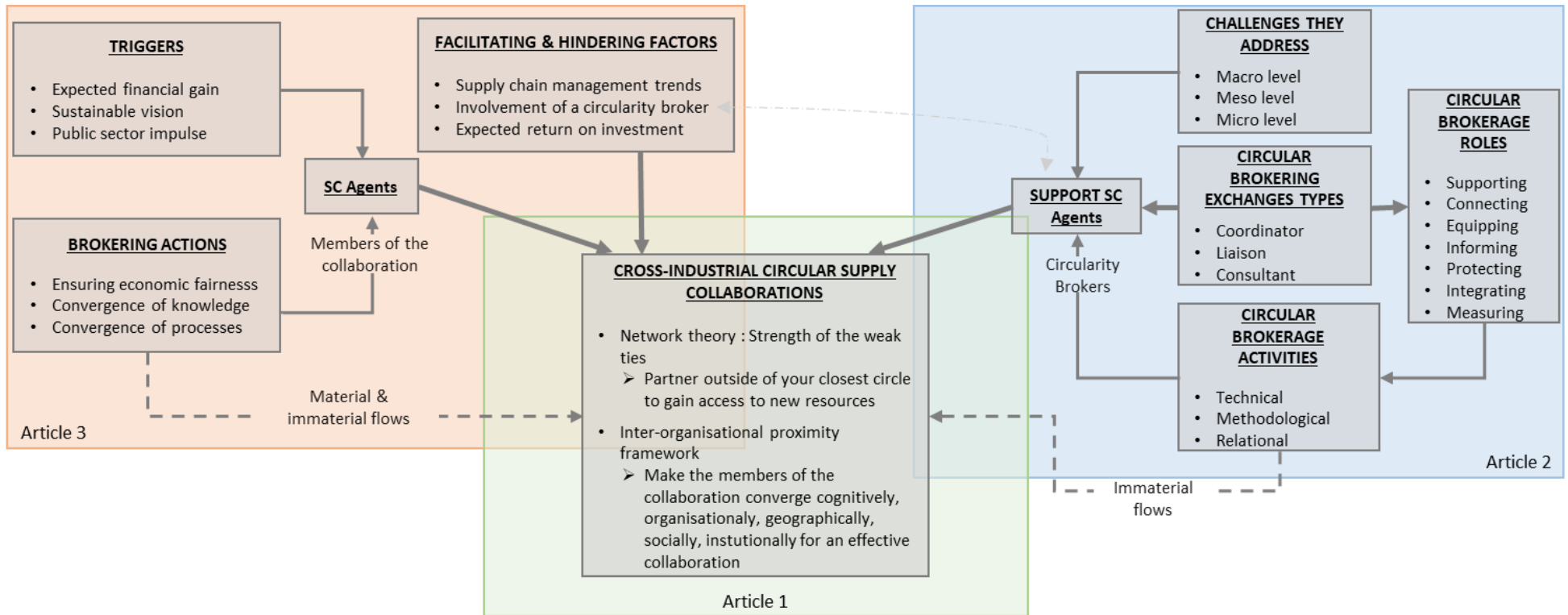


Figure 9 How are cross-industrial circular collaborations operated and facilitated?

5.2 Practical contributions

As explained in the motivation for undertaking this research, this study aims to contribute to the body of knowledge intended to help organisations make the transition to a circular economic model.

This research can have macro-level contributions for policy makers. We saw in article 2 that one of the reasons why companies have recourse to circular economy facilitators is to remain in compliance with new legislative or fiscal measures. Similarly, article 3 showed that one of the triggers for circular cross-industrial collaborations was the impulse given by public authorities, whether it be the opportunity represented by the creation of new markets, for example, with a percentage of equipment in public orders that must be second-hand or made from recycled materials (the *AGEC -Anti-Gaspillage Economie Circulaire* law was cited by some of our respondents) or by the implementation of measures aimed at achieving greater circularity in territories. This can take the form, for example, of cross-industrial circularity programmes coordinated by national agencies, such as the French national environment and energy agency, for calls for cross-industrial circularity projects, the strengthening of programmes for the standardisation of secondary raw materials, or for a global reflection on the reuse of flows within territories. We also saw in article 3 that several of our cases were based on joint R&D activities involving public institutions such as universities or public laboratories. It is therefore conceivable that the national education and research agency could give impetus to cross-industrial R&D programmes, for example by organising groupings of higher education establishments dedicated to specific industries for joint innovation development programmes and in partnership with the private sector.

The same kind of impetus could be given at local level via regional economic, social and environmental councils, in partnership with the local civil service and chambers of commerce and industry. At the same time, and still at regional or local level, this research can benefit the Competitiveness Clusters, institutional players within which companies, universities and laboratories interact, developing

new systems of relationships, sometimes beyond the industry boundaries to which they belong, with a view to creating innovations or entrepreneurial opportunities (de Géry, Glaser, and Laviolette 2021).

At the level of their intervention networks, circular economy facilitators can also benefit from this study by improving their chances of success, for example by targeting companies that are not yet part of their network if they belong to the consultant category, or by choosing to expand their network with companies from industries with which they do not yet have a link in order to build new bridges if they belong to the liaison category. Similarly, an industrial park or a territory wishing to increase its level of circularity may decide to rely on a well-established facilitating organisation to take advantage of its good knowledge of its members in order to coordinate the adoption of shared circularity measures. In the same vein, the conceptual framework proposed for the use of circular facilitation can be used as a first approach to diagnose a circular network and see where the gaps in circularity are, in order to initiate actions to use facilitation.

At the micro level, that of the organisation or the individuals, this research also has implications for practitioners by providing elements to guide their decision-making process in partners selection and management. It suggests approaches for the selection of adequate partners to collaborate with in cross-industrial collaborations along with facilitating organisations to support the collaboration. This study also offers an analysis of tangible and intangible factors at play in cross-industry circular collaborations. By providing examples of rapprochement practices, it suggests the activation of cognitive, social, organisational, institutional and geographical operational levers to optimise practitioners' operations and their performance. Eventually, the knowledge created on circular brokerage and cross-industrial circular collaborations could enhance their potential of success and contribute to a broader implementation the circular economy model.

5.3 Limits of the research and future avenues

This research work has its limitations, which we will present in this section. The first section is devoted to the weaknesses of the articles in the implementation of their methodological approaches. The second section is devoted to potential alternative research, that would have been devoted to our research object, circular cross-industrial collaborations, but with a different epistemological or methodological perspective, and which could therefore provide an additional and complementary vision to the research we have undertaken in this thesis.

Research limits

A major limitation of our study of circularity brokers is that we did not find any brokers whose main type of exchange is a gatekeeper or a representative. We have already explained in the article that we believe that these forms of exchange are above all theoretical and difficult to observe in a "pure" form in practice. However, it is not impossible that an a priori selection of the organisations to be interviewed, with particular attention paid to the specific position that the brokers occupied in their network, could have enabled us to develop conclusions on this type of exchange. A further limitation relates to the composition of our sample in terms of industries and sectors represented: brokers operating in other industries could have led to additional findings. Another limitation of this study is that only the brokers' point of view is studied. We have ensured consistency with the network perspective by choosing brokers who are embedded in a network of at least 3 nodes in carrying out their facilitation mission. However, it would have been insightful to gather the points of view of the companies that have benefited from their services. Finally, the approach we adopted did not warrant a comparative analysis of the facilitator performance (i.e., an increased circularity of their network), but this dimension should be factored in to understand the effectiveness of such new forms of organisations.

The most important limit to the study devoted to cross-industrial collaboration is the fact that our sample of cases does not present stories of failed attempts of collaborations. Moreover, one out of the four cases developed is relatively immature. The reason for this weakness in the selection of cases is the difficulty we had in gaining access to the field. We contacted a large number of organisations from the databases and lists presented in the methodology section of article 3, and a relatively large number of organisations responded positively to our requests for interviews. However, the perspective that we found most relevant to the study of these collaborations was that of the network, and to ensure methodological consistency with this perspective we established as a case selection criterion the fact of being able to interview at least 3 member organisations of the collaboration studied. In the end, we were unable to include them in our article because we were unable to satisfy this criterion: we came up against the fact that many of the organisations involved in these collaborations did not reply to us or expressed no interest in taking part in the study, which prevented us from obtaining interviews from 3 nodes of the same network. We believe that it would have been relevant and useful to be able to supplement our sample of success stories with failed attempts that would have enabled us to detect threats and pitfalls of these collaborations and thus enabling the description of a fourth decomposition of the collaboration phase relating to its end of life (Tellioglu 2008)

Futures avenues for research

The angle we have chosen for this research on an emerging phenomenon is interpretative and explorative. In order to maintain consistency between ontology and methodology, we have respected certain recommendations, such as the limited number of cases and interviews conducted (Darby, Fugate, and Murray 2019). This research must therefore be supplemented by additional studies with a different epistemological perspective. For example, the findings of articles 2 and 3 of the thesis could be supplemented by studies from a different epistemological paradigm, where the aim is to achieve theoretical saturation. In this case, it will be necessary to have more than one individual responding per organisation in order to obtain data covering several points of view thus enabling a greater insight into the phenomenon of circular cross-industrial collaborations or their facilitation. In

the case of large organisations, for example, this would mean interviewing both top management decision-makers and people directly involved in the realisation of operations on the field. Other studies could take the form of in-depth case studies such as one of a mature cross-industrial collaboration or of a circular economy facilitator, ideally using the theoretical proposition described in article 1. Articles 2 and 3 describe the difficulties that stand in the way of adopting the circular model in a cross-industrial context. These findings could give rise to studies dedicated to these specific difficulties, with a view to identifying concrete levers for action.

This research could also be supplemented by studies with different theoretical bases. The perspectives of resourced-based-view or natural-resource-based-view are often used in the field of sustainable and circular supply chains. Derived theories like the resource-heterogeneity approach that focuses on the link between unique resources and competitive advantages could be mobilised to understand the specificities of collaborations between supply chains members initiating a novel cross-industrial collaboration. To take account of the processual aspect or to examine more specifically the sequences of actions to be carried out or resources to be mobilised by the various members of the supply network, the absorptive capacity or dynamic capabilities perspectives are theoretical frameworks that are particularly well suited to the study of supply chain collaboration. For example, they could enable to grasp the mechanisms of skills, competencies or more generally knowledge transfer from one industrial sector to another. We propose that research based on institutional theory could help to understand the mechanisms of convergence of values and practices between members of a cross-industrial supply network. Similarly, agency theory or transaction cost economics could help to understand the best alignment strategies for sharing the value created between organisations participating in a cross-industrial circular collaboration, although particular attention needs to be paid to the coherence between theoretical frameworks and units of analysis, as these two theories are traditionally used to study the buyer-supplier dyad and vertical relationships rather than the supply network and its potential horizontal links. Finally, relational exchange lenses could be a useful theoretical perspective for understanding the mechanisms of social exchange or trust building that

correspond to the social dimension of inter-organisational proximity that we have developed in this study.

Finally, circular economy is by nature systemic, and a limitation of this research is that it is mainly anchored in a single field, that of the supply chain, whereas other perspectives would have provided relevant and complementary insights. Although some papers from the literature in other fields have been read, this study could be supplemented by a more transdisciplinary approach. Until now, the study of cross-industrial collaborations has belonged to the field of innovation management. We have taken a more supply chain approach. We are suggesting more research arising from the intersection of these fields with management or organisational theory, for example. Research also realising a bridge with the literature on public administration could develop the role of public stakeholders. In the same way, studies from economic geography or territorial political economy could also be used to draw on the field dedicated to industrial symbioses or socio-ecological resilience (Cretney 2014). More ambitious because they are more distant, collaborations with disciplines outside the field of social sciences, such as engineering or agronomy, could look at the possible compatibilities between industries and sectors for circular economy by exploring the possibilities offered by the reintegration of materials, which would make it possible to find new areas of cooperation between the biological and technical cycles described in the butterfly framework of the Ellen Macarthur foundation (Velenturf et al. 2019).

5.4 Future as a researcher

This manuscript began with a brief summary of our background as a practitioner, which led us to undertake the thesis at the start of our academic journey. The two experiences, on the one hand that of the reorganisation of human resources to be allocated to new industries in a context of increasing scarcity of missions available in the aeronautical sector in times of crisis, and on the other hand that of immersion in a company *de l'économie sociale et solidaire* with a circular business model aligned with the sustainable development imperatives, have each

contributed to the starting point of this research. These professional experiences also provided the pragmatic anchoring necessary for the undertaking of this thesis in management sciences, so as not to lose the practical purpose of this work, which is in the field of knowledge of collective and organised actions.

As we have already explained, what attracted us in the first place to becoming a researcher was the large amount of time that this work allows us to devote to taking a step back, to reasoning and to transmission. These mindsets were greatly refined with our thesis supervisor, and also thanks to the training we received at the school and to exchanges with more experienced scholars who devoted time to discussing the maturing of this thesis. In the course of this research work on the circular model and on bridges between entities from distinct worlds, we adopted and were able to foster a greater awareness of the holistic, systemic and intangible dimensions of exchanges between organisations. These are the directions we wished we could have developed more in this study and that we would like to take in our future research.

As part of this thesis, we mobilised the inter-organisational proximity approach, which draws on advances made in the geographical, economic, sociological and other social sciences (Talbot 2009). We took particular interest in drawing inspiration from fields other than our own, which also echoed the very nature of the circular model, which is holistic and can only be adopted on a large scale by breaking down the many barriers that currently lead to siloed intellectual and economic exchanges. The intangible aspect of the many resources that will have to be mobilised for the adoption of the circular model, and for sustainable development in general, seems difficult to grasp with a positivist posture, which nevertheless corresponds to a large majority of work in supply chain management (Matthews et al. 2016). We would like to be able to continue our future work by working on intersectional research with colleagues from different fields such as organisational studies, innovation management or entrepreneurship as well as refining our ontological positioning, and be able to pursue the interpretativist angle or explore other epistemological paradigms such as different constructivist approaches (Gavard-Perret et al. 2012). Among our topics of interest for the future, even if this has yet to be developed, we would like to be able to work on circular supply chains as regenerative instruments or roles

and limits of circular economy in the transition of organisations towards post-capitalist and equitable value creation models (Raworth 2017; Parrique 2022) to continue this *conversation between discipline and imagination* (Weick 1989).

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Appendices

Summary of sources of data

Interviews list

Code	Description	Position	Date	Duration
ARTICLE 2				
A	A consulting company specialising in project management for sustainable economic development. They particularly advise industrial eco-park projects abroad.	Consultant and partner	16/11/2020	60
B	A consulting group expert in industrial symbiosis. Works internationally with the private and public sectors to advance the transition to a more circular economy. Provides an online platform for IS.	Founder and CEO	10/11/2020	50
C	A non-profit business association that initiates collaborative projects, platforms & partnerships to scale solutions for CE. Provides an online platform for IS.	Founder and director	04/11/2020	30
D	A non-profit business association that initiates collaborative projects, platforms & partnerships to scale solutions for CE. Provides an online platform for IS.	Director	11/11/2020	60
E	A non-profit business association that initiates collaborative projects, platforms & partnerships to scale solutions for CE. Provides an online platform for IS.	Director	17/11/2020	50
F	A software editor dedicated to the	Co-founder and CFO	21/10/2021	65

	mapping of flows for business optimization on a territory.			
G	A consulting company in project management for CE projects in the industrial sectors of buildings and infrastructures. Provides an online platform for IS.	Consultant and partner	19/10/2021	45
H	The French national cluster for CE	Director	08/06/2021	50
I	The French eco-organism/mission driven company, mandated by the municipalities for the strategy and operations of public recycling.	European affairs director	25/10/2021	45
J	A consulting company in project management for CE projects.	Consultant	18/10/2021	50
K	A consulting company in project management for CE projects. Specializes in the redesign of Circular business models. They offer a variety of online tools to diffuse CE, on an opensource basis. They have a “community” of experts they train and certify (+100 worldwide + 20 countries)	Co-founder and CEO	02/12/2021	25
		Co-founder and CFO	15/11/2021	25
L	A public organisation in charge of an industrial park with mutualisation of resources and sharing practices.	Director	11/06/2021	50
M	An association that brings together public and private decision-makers, mainly from the same territory, in order to create a network of exchange, information and incentives for the implementation of innovative industrial and territorial ecology projects. A private non-profit bringing together public and private actors	Director	09/06/2021	40
N	A software editor dedicated to the mapping and facilitation of flows for business optimization on a	Co-founder and CEO	06/11/2020	80

	territory.			
O	An independent consultant specialising in the management of circular and sustainable projects in organisations, often commissioned for public markets.	Founder and CEO	21/10/2021	50
P	A consulting company in project management assistance for CE projects in the industrial sectors of buildings and infrastructures. Also, a R&D engineering office on circular materials, processes and valorisation paths	Consultants (1 cross-interview with 2 respondents)	18/10/2022	70
ARTICLE 3				
Case A	A complex of industries organised around a biorefinery, linked by several intertwined flows of materials, water and energy.			
A1	Agriculture cooperative	Founder and former CEO	09/03/2023	65
A2	Industrial gases and chemistry supplier	Operations director	06/03/2023	60
A3	Cosmetic ingredients manufacturer	R&D director	23/02/2023	70
A4	Biomass fuel manufacturer	Site director	03/03/2023	50
Case B	A material supplier joint-venture co-created by an agriculture cooperative and an automotive supplier. The joint-venture provides bioplastics materials integrating agricultural by-products for the automotive industry			
B1	Agriculture cooperative	Operations director	06/03/2023	35
B2	Automotive supplier	Materials director	27/01/2023	35
B3	Automotive OEM	Materials director	15/12/2022	60

B4	Material supplier (JV between B1 and B2)	Sales director	10/11/2022	35
Case C	A design furniture company and its supply network. The material suppliers use secondary raw materials made from recycled plastic waste, shuttlecocks, oysters shells			
C1	Design furniture manufacturer	Founder and CEO, in charge of supply chains and operations	05/10/2022	60
C2	Material supplier, from aquaculture by-products	Founder and CEO, in charge of supply chain and operations	06/03/2022	50
C3	Material supplier, from sport association waste	Founder and CEO, in charge of supply chain and operations	28/11/2022	50
C4	Material supplier, from plastic waste	Founder and CEO, in charge of supply chain and operations	09/03/2023	35
Case D	A project to repair and lend fleets of older generation iPhones to vulnerable beneficiaries. The repair process is carried out by students enrolled in IT technician and engineer courses.			
D1	IT NGO, providing electronic waste related environmental education	Volunteer, in charge of communication	03/11/2022	80
D2	Life-cycle analysis specialized consultancy	Founder and CEO	16/11/2022	80
D3	High school public education, 25 students involved	Teacher, founder and in charge of the programme	21/11/2022	80
D4	NGO (representative of the consortium between D1, D2,	Volunteer, in charge of coordination of members of	13/10/2022	60

	D3)	the consortium		
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Other sources

- Notes from site visit and workshops (Case D)
- Notes from work meetings (Case D)
- Company environmental reports (Case B)
- Company websites, press articles (Case A, B, C, D)
- Company presentations (Case A, B)
- Preexisting scientific literature – article, book chapters- (Case A)

Analysis of respondent's networks - article 2

Code of the broker	Size of the broker (nb of employees)	Description of the broker	Industry of intervention	Sector	Stakeholders/ Network composed of	Detailed network	Activities performed by the broker
A	51-60	A consulting company specialising in project management for sustainable economic development. They particularly advise industrial eco-park projects abroad.	Multisector within Eco-Industrial Parks/territories	Private profit	Public territorial actors Public ministries/agencies Private profit: MNCs & SMEs Private non-profit (associations) International organisations and development agencies Research & Education actors	Public territorial actors Région Chablais Coreb (communauté régionale de Broye) Etat de Fribourg Strasbourg communauté urbaine Dunkerque Grand Littoral HAROPA (ports de Paris, Seine, Normandie) Canton de Genève Wallonie-Bruxelles Ville de Bulle Ville de Sion PAS (port autonome de Strasbourg) Public ministries/agencies	Collective workshop Connecting stakeholders Coordination Project Management Matchmaking service Creating/measuring data and info Technical solution for CE

						<p>ADEME</p> <p>AFD Agence Française Du développement</p> <p>UNDP</p> <p>UNDO</p> <p>The World Bank</p> <p>UNEP</p> <p>IFC International Finance corporation</p> <p>Proparco</p> <p>Basel convention</p> <p>MNCs</p> <p>Arcelor Mittal (industry)</p> <p>Bata (fashion)</p> <p>HP (electronics)</p> <p>Dell (electronics)</p> <p>Ikea (furniture)</p> <p>Suez (energy)</p> <p>Romande energie (energy)</p> <p>Groupe Bouygues (building)</p>	
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						<p>Nespresso (food)</p> <p>Holcim (building, mining)</p> <p>Implenia (building)</p> <p>Renault (automotive)</p> <p>UCB (pharma)</p> <p>SMEs</p> <p>CHUV (hospital)</p> <p>CIMO (275hemistry)</p> <p>Private non-profit (associations)</p> <p>World Resource Forum</p> <p>WWF</p> <p>International organisations and development agencies</p> <p>CICR (International red cross)</p> <p>Research & Education actors</p> <p>Ecole Polytechnique fédérale de Lausanne</p> <p>ETH Zurich</p> <p>HEG (Haute école de Gestion de Genève)</p> <p>Empa</p>	
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						Heig-VD Université de Lausanne Université de Genève ISIGE EMPA	
B	2-10	A consulting group expert in industrial symbiosis. Works internationally with the private and public sectors to advance the transition to a more circular economy. Provides an online platform for IS.	Multisector	Private profit	Public territorial actors Public ministries/agencies Private profit: MNCs & SMEs Private non-profit (associations) International organisations and development agencies Research & Education actors	Public territorial actors West Midlands regions Birmingham City Council Hubei Province West Midlands Circular Economy Task Force Public ministries/agencies/ International organisations and development agencies Circlean G7 Germany G7 Alliance on Resource Efficiency Globe Series Global Green Growth Forum (3GF) Global Green Business Summit World Circular Economy Forum (WCEF)	Collective workshop Connecting Stakeholders Coordination Project Management Matchmaking service Social Events CE activist Creating Diffusing knowledge Creating Measuring data information Technical Solutions for CE

						<p>African Roundtable on Sustainable Consumption and Production</p> <p>The South African National Cleaner Production Centre,</p> <p>National Cleaner Production Centre of Ghana,</p> <p>The Kenya National Cleaner Production Centre,</p> <p>Uganda National Cleaner Production Centre,</p> <p>Solid Waste Management Division, Mauritius Ministry of Environment,</p> <p>Sustainable Development and Disaster and Beach Management</p> <p>The Women Environmental Programme, Burkina Faso</p> <p>the Commonwealth Games Sustainability Group,</p> <p>MNCs & SMEs</p> <p>34k organisations</p> <p>Heathrow Airport</p> <p>United Utilities</p> <p>Private non-profit (associations)</p>	
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						SME Recycling Working Group Research & Education actors UK Manufacturing Symbiosis Network Plus (UKMSN+)	
C	2-10	A non-profit business association that initiates collaborative projects, platforms & partnerships to scale solutions for CE. Provides an online platform for IS.	Multisector	Private non-profit	Public territorial actors Public ministries/agencies Private profit: MNCs & SMEs Private non-profit (associations) International organisations and development agencies Research & Education actors	Public territorial actors States of Austin, Michigan, Tennessee, ohio, Ontario Public ministries/agencies Ohio Environmental Protection Agency Private profit: MNCs & SMEs 2200 organisations (recycling sector, manufacturing sector, entrepreneurs) Council of the Great Lakes region Private non-profit (associations) National Association of Manufacturers International organisations and development agencies Research & Education actors	Connecting Stakeholders Coordination Project Management Matchmaking service Social Events Creating Diffusing knowledge Creating Measuring data information Circular Diagnostis of organisations Technical Solutions for CE
D	11-20	A non-profit business association that initiates collaborative projects,	Multisector	Private non-profit	Public territorial actors Public ministries/agencies	Public territorial actors Public ministries/agencies	Collective workshops Connecting

		platforms & partnerships to scale solutions for CE. Provides an online platform for IS.			<p>Private profit: MNCs & SMEs</p> <p>Private non-profit (associations)</p> <p>International organisations and development agencies</p> <p>Research & Education actors</p>	<p>Private profit: MNCs & SMEs (more than 200)</p> <p>Mercedes Benz (automotive)</p> <p>Procter & Gamble (manufacturer, retail)</p> <p>Unilever (manufacturer, retail)</p> <p>Carrefour (retail)</p> <p>The coca cola company (food)</p> <p>Colgate (cosmetics)</p> <p>Hilton (hospitality)</p> <p>Private non-profit (associations)</p> <p>Circular Economy Club</p> <p>International organisations and development agencies</p> <p>European Bank</p> <p>Taiwan Business EBRD Technical Cooperation fund</p> <p>Federal Ministry Republic of Austria Finance</p> <p>Research & Education actors</p>	<p>Stakeholders</p> <p>Coordination Project Management</p> <p>Matchmaking service</p> <p>Creating Diffusing knowledge</p> <p>Circular Diagnostis of organisations</p> <p>Financing CE</p> <p>Legalizing CE</p> <p>Technical Solutions for CE</p>
E	2-10	A non-profit business association that initiates collaborative projects,	Multisector	Private non-profit	<p>Public territorial actors</p> <p>Public ministries/agencies</p>	<p>Public territorial actors</p> <p>Public ministries/agencies</p>	<p>Collective workshops</p> <p>Connecting</p>

		platforms & partnerships to scale solutions for CE. Provides an online platform for IS.			Private profit: MNCs & SMEs Private non-profit (associations) International organisations and development agencies Research & Education actors	Ministry of Economy and Industry (Israel) Private profit: MNCs & SMEs Cisco (IT) Bridgestine (automotive) General Motors (automotive) Nemak (automotive) Private non-profit (associations) International organisations and development agencies United States Business Council for Sustainable development Research & Education actors	Stakeholders Coordination Project Management Matchmaking service Creating Diffusing knowledge Circular Diagnostis of organisations Financing CE Legalizing CE Technical Solutions for CE
F	2-10	A software editor dedicated to the mapping of flows for business optimization on a territory.	Multisector within Eco-Industrial Parks/territories	Private profit	Public territorial actors Public ministries/agencies Private profit : MNCs & SMEs Private non-profit (associations) Research & Education actors	Public territorial actors Agence de développement et d'urbanisme de Dunkerque Flandres Dunkerque Grand Littoral Région Hauts de France CCI Littoral Hauts de France L'eau de Dunkerque	Collective workshops Connecting Stakeholders Matchmaking service Social Events CE activist Creating Diffusing

						<p>Conservatoire du Littoral</p> <p>Agence de l'eau</p> <p>Agriculture et Territoire</p> <p>Dunkerque promotion</p> <p>CCHF (communauté de communes)</p> <p>Public ministries/agencies</p> <p>ADEME</p> <p>MNCs</p> <p>Suez (energy)</p> <p>EDF (energy)</p> <p>GRDF (energy)</p> <p>Groupe Caisse des dépôts (investment)</p> <p>SMEs</p> <p>Private non-profit (associations)</p> <p>Research & Education actors</p> <p>Learning Center Ville Durable</p> <p>Université Clermont Ferrand</p>	<p>knowledge</p> <p>Data Mining</p> <p>Financing CE</p> <p>Systemic circular mapping design</p> <p>Technical Solutions for CE</p>
G	11-20	A consulting company in	Building &	Private profit	Public territorial actors	Public territorial actors	Collective workshops

		project management for CE projects in the industrial sectors of buildings and infrastructures. Provides an online platform for IS.	infrastructure		Public ministries/agencies Private profit : MNCs & SMEs Private non-profit (associations) Research & Education actors	Dunkerque Grand Littoral Public ministries/agencies MNCs Accor & Accor Invest (hospitality) Vinci (infrastructures) Nexity (infrastructure, estate) Sogeprom (banking, building, estate) SNCF immobilier (building, transportation) Icade (building, estate) Engie (energy) Poste Immo (building, estate) SMEs Environmental Protection Encouragement Agency Hamburg Domofrance (electronics and buildings) Ibana (building, estate) Neotoa (building, estate) IGC (building, estate) Private non-profit (associations)	Connecting Stakeholders Coordination Project Management Matchmaking service Technical Solutions for CE
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						Cradle to Cradle certification Research & Education actors	
H	41-50	The French National Cluster (Pôle de Compétitivité/Branch association) for Circular Economy (private non-profit with public mission, accreditation and financing)	Design and furnitures	Private non-profit	Public territorial actors Public ministries/agencies Private profit : SMEs Private non-profit (associations) Research & Education actors	Public territorial actors Région Occitanie Public ministries/agencies Valdelia (eco organism, waste management furnitures) SMEs Makiba (furniture) Merci René (furniture) Private non-profit (associations) IOT Valley Les Défis Batiments santé (health, building) Pôle Ecoconception (building) Research & Education actors	Collective workshops Connecting Stakeholders Coordination Project Management Matchmaking service Social Events CE activist CE incubator Creating Diffusing knowledge Circular Diagnostis of organisations Technical Solutions for CE
I	250-300	The French eco-organism/mission driven company, mandated by the municipalities for the strategy and operations of public recycling. (private	Packaging in multisectors (retail, services, papers, publishing, industries)	Private non-profit	Public territorial actors Public ministries/agencies Private profit: MNCs & SMEs	Public territorial actors Collectivités territoriales (France wide) Public ministries/agencies	Connecting Stakeholders CE incubator Creating Diffusing

		non-profit with public mission, accreditation and financing)			Private non-profit (associations) International organisations and development agencies Research & Education actors Their international counterparts Public service users (citizens)	Censeur d'Etat MNCs Coca Cola European Partner France (food) D'Aucy (agrifood) Lactalis (agrifood) Nestlé Waters (water) Evian (water) Auchan (retail) Carrefour (retail) La Redoute (retail) Antalis France (paper) Société Générale (banking) Veolia (waste) Yves Rocher (cosmetics) Private non-profit (associations) WWF Fédération du commerce et de la distribution Association des petites villes de France (APVF)	knowledge Financing CE Legalizing CE Technical Solutions for CE
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						<p>Interemballage</p> <p>International organisations and development agencies</p> <p>(Their international counterparts)</p> <p>Research & Education actors</p> <p>Réseau Ecole et Nature (REN)</p> <p>Téragir</p> <p>Public service users (citizens)</p> <p>Observatoire Société et Consommation</p>	
J	31-40	A consulting company in project management for CE projects.	Multisector	Private profit	<p>Public territorial actors</p> <p>Public ministries/agencies</p> <p>Private profit : MNCs</p> <p>Private non-profit (associations)</p>	<p>Public territorial actors</p> <p>Public ministries/agencies</p> <p>ADEME</p> <p>Commissariat Général au développement durable</p> <p>Ministère de la transition écologique et solidaire</p> <p>Ecoorganismes (private but with a public mission): Citeo (packaging waste treatment), Ecomobilier (furniture waste management), Re-Fashion (textile waste management)</p> <p>BPI France (public investment bank)</p>	<p>Collective workshops</p> <p>Connecting Stakeholders</p> <p>Coordination Project Management</p> <p>Matchmaking service</p> <p>Creating Diffusing knowledge</p> <p>Creating Measuring data information</p> <p>Technical Solutions for CE</p>

					<p>MNCs</p> <p>Bonduelle (agrifood)</p> <p>Candia (agrifood)</p> <p>Schreiber (agrifood)</p> <p>Carrefour (retail)</p> <p>Céréalia (agrifood)</p> <p>Chanel (luxury fashion)</p> <p>Decathlon (sport retail)</p> <p>Groupe L'Occitane (luxury, cosmetics)</p> <p>L'Oréal (cosmetics)</p> <p>LVMH (fashion luxury)</p> <p>Philip Morris (tobacco)</p> <p>Orange (telecom)</p> <p>U (retail)</p> <p>Sisley (fashion, luxury, cosmetics)</p> <p>Essity (cosmetics)</p> <p>SMEs</p> <p>Charles & Alice (agrifood)</p>	
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						<p>Hachette Livres (publishing)</p> <p>Laiterie de l'hôtel Saint Denis (agrifood)</p> <p>Pierre fabre (chemistry, pharma)</p> <p>Floréale (Agrifood)</p> <p>Eugène Perma (cosmetics)</p> <p>Camif (furnitures)</p> <p>Private non-profit (associations)</p> <p>Febea (fédération des entreprises de la beauté)</p> <p>The Fashion Pact</p>	
K	61-70	A consulting company in project management for CE projects. Specializes in the redesign of Circular Business Models. They offer a variety of online tools to diffuse CE, on an opensource basis. They have a “community” of experts they train and certify (+100 worldwide + 20 countrues)	Multisector	Private profit	<p>Public territorial actors</p> <p>Public ministries/agencies</p> <p>Private profit : MNCs & SMEs</p> <p>Private non-profit (associations)</p> <p>Research & Education actors</p>	<p>Public territorial actors</p> <p>Ville de Paris</p> <p>Communauté d'agglomération Seine-Eure</p> <p>Public ministries/agencies</p> <p>CircularInnoBooster (EU programme)</p> <p>AFD agence française du développement</p> <p>MNCs</p> <p>Peugeot (automotive)</p>	<p>Collective workshops</p> <p>Connecting Stakeholders</p> <p>Coordination Project Management</p> <p>Matchmaking service</p> <p>Creating Diffusing knowledge</p> <p>Circular Diagnostis of organisations</p> <p>Systemic circular</p>

						<p>Imerys (mining)</p> <p>Parot (electronics)</p> <p>Egis (consulting)</p> <p>Unilever (retail)</p> <p>Decathlon (retail)</p> <p>Suez (energy)</p> <p>SNCF (transportation)</p> <p>Vinci (transportation, infrastructures)</p> <p>Sodexo (food services)</p> <p>Bouygues (building)</p> <p>Veolia (waste and water)</p> <p>Intermarché (retail)</p> <p>Orange (telecom)</p> <p>Ikea (furniture)</p> <p>Accor (hospitality)</p> <p>L'Oréal (cosmetics)</p> <p>SMEs</p> <p>Private non-profit (associations)</p>	<p>mapping design</p> <p>Technical Solutions for CE</p>
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						<p>1% for the Planet</p> <p>B corp</p> <p>Change Now</p> <p>TLF Overseas (transportation cluster)</p> <p>Research & Education actors</p> <p>ESCP</p> <p>HEC</p> <p>ISCEA International Supply Chain Education Alliance</p> <p>Ecole Polytechnique</p> <p>AgroParistech</p> <p>Institut Léonard ed Vinci</p> <p>Institut Français des Emirats Arabes Unis</p>	
L	2-10	A public organisation in charge of an industrial park with mutualisation of resources and sharing practices.	Multisector within Eco-Industrial Parks/territories	Public	<p>Public territorial actors</p> <p>Private profit: MNC SMEs</p> <p>Research & Education actors</p> <p>Private non-profit (association)</p>	<p>Public territorial actors</p> <p>Région Auvergne Rhône-Alpes</p> <p>Public ministries/agencies</p> <p>Centre International Ressources et Innovation pour Développement Durable CIRIDD</p>	<p>Collective workshops</p> <p>Connecting Stakeholders</p> <p>Coordination Project Management</p>

						<p>MNCs</p> <p>Carrefour Logistique (retail)</p> <p>Engie (energy)</p> <p>Feu vert (automotive)</p> <p>XPO (logistics transportation)</p> <p>Lactalis (agrifood)</p> <p>Unilever (agrifood)</p> <p>Plastic Omnium (waste)</p> <p>Orano (civil nuclear waste management)</p> <p>BASF (pharma/chemistry)</p> <p>Ventes Privées (retail)</p> <p>SMEs</p> <p>(more than 100)</p> <p>Research & Education actors</p> <p>Private non-profit (association)</p> <p>Eclaira (économie circulaire en auvergne Rhône-Alpes)</p>	<p>Social Events</p> <p>Creating Measuring</p> <p>Technical Solutions for CE</p>
M	2-10	An association that brings together public and private decision-makers,	Multisector within Eco-Industrial Parks/territories	Private non-profit	Public territorial actors	Public territorial actors	<p>Collective workshops</p> <p>Connecting</p>

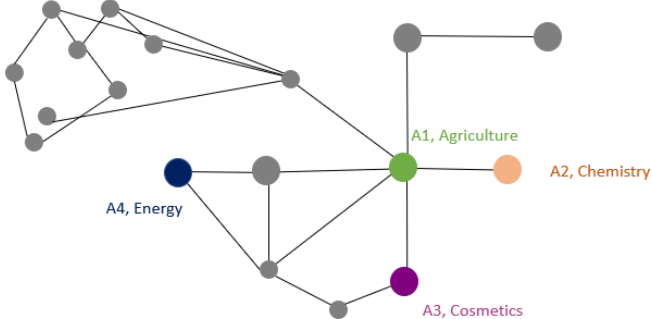
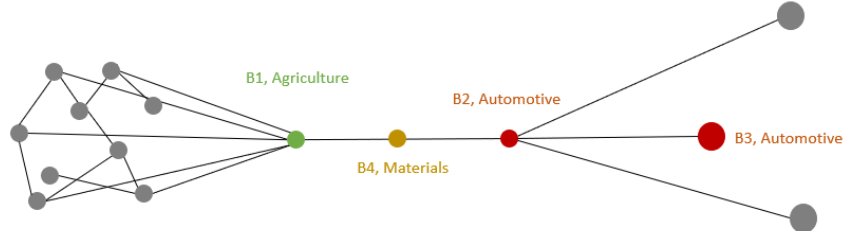
		mainly from the same territory, in order to create a network of exchange, information and incentives for the implementation of innovative industrial and territorial ecology projects. A private non-profit bringing together public and private actors			Public ministries/agencies Private profit : SMEs & MNCs Private non-profit (associations) Research & Education actors	CCI Troyes et Aube Chambre de l'agriculture de l'Aube Public ministries/agencies Troyes Metropole Région Grand Est Public ministries/agencies ADEME SMEs Accuride (Automotive) Artemise (waste) Carbonex (energy) Consultenergy (energy) Coved (waste and energy) Dislaub (waste) Elise (waste) France volets (building) Larbaletier (furnitures) Compostière de l'aube (waste)	Stakeholders Coordination Project Management Matchmaking service Social Events CE activist Creating Diffusing knowledge Technical Solutions for CE
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						<p>Magiline (swimming pools)</p> <p>SMBI (building and furnitures)</p> <p>MNCs Bonduelle (agrifood) EDF (energy) Enedis (Energy) Michelin (Automotive) Veolia (water & waste)</p> <p>Conseil départemental de l’Aube</p> <p>Private non-profit (associations)</p> <p>Convergence (shared employees association)</p> <p>Initiatives durables</p> <p>Institut de l’économie circulaire</p> <p>Cobaty Troyes en Champagne (cluster Building sector)</p> <p>Union des industries textiles (textile)</p> <p>Sol et Civilisation (agriculture)</p> <p>Fondation UTT</p> <p>Research & Education actors</p> <p>Université de technologie de Troyes</p> <p>Yschools</p> <p>Lycée Sainte Maure (technological high school)</p>	
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N	2-10	A software editor dedicated to the mapping and facilitation of flows for business optimization on a territory.	Multisector within Eco-Industrial Parks/territories	Private profit	Public territorial actors Private profit : MNCs & SMEs Private non-profit (associations)	Public territorial actors Région Pays de la Loire Grand Avignon MNCs EDF, ID Logistics SMEs Syndicat de la Plaine de l'Ain Private non-profit (associations) Global Industries RIDE (rencontres pour une industrie durable et ecoresponsable)	Collective workshops Creating Measuring data information Circular Diagnostis of organisations Systemic circular mapping design Technical Solutions for CE
O	1	An independent consultant specialising in the management of circular and sustainable projects in organisations, often commissioned for public markets.	Multisector	Private profit	Public territorial actors Private profit : MNCs & SMEs Private non-profit (association)	Public territorial actors Région Occitatie CCI Haute Garonne Parcours Occitanie Industrie du Futur Ademe MNCs SMEs Sofies (consulting) Socodit consultants (consulting) Opeo Cetim (consulting) VBL conseil	Connecting Stakeholders Coordination Project Management Matchmaking service Social Events CE activist CE incubator Creating Diffusing knowledge

						Private non-profit Circular Economy CLub Club des offreurs de Solutions Industrie du futur Occitanie Association des professionnels en conseil climat énergie et environnement Biotope	Creating Measuring data information Circular Diagnostis of organisations Technical Solutions for CE
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Schematisation of cases - article 3

Case	Formalisation	Description	Schematisation	Members interviews
A	Eco- Park	A complex of industries organised around a biorefinery, linked by several intertwined flows of materials, water and energy.		<ul style="list-style-type: none"> - A1, Agriculture cooperative of 2000 farmers - A2, Industrial gases and chemistry supplier, MNC of 70k employees - A3, Cosmetic ingredients manufacturer, 8000 employees - A4, biomass fuel manufacturer, 30 employees - A5, professional association coordinating the eco-park
B	Joint-venture and associated supply network	A material supplier joint-venture co-created by an agriculture cooperative and an automotive supplier. The joint-venture provides bioplastics materials integrating agricultural by-products for the automotive industry		<ul style="list-style-type: none"> - B1, Agriculture cooperative of 2500 farmers - B2, Automotive supplier, MNC of 150k employees - B3, Automotive OEM, MNC of 180k employees - B4, Material supplier (JV between B1

				and B2), 50 employees
C	Supply network	A design furniture company and its supply network. The material suppliers use secondary raw materials made from recycled plastic waste, shuttlecocks, oysters shells		<ul style="list-style-type: none"> - C1, Design furniture manufacturer, 8 employees - C2, Material supplier, from aquaculture by-products, 9 employees - C3, Material supplier, from sport association waste, 4 employees - C4, Material supplier, from plastic waste, 25 employees
D	Project founded by the French national environmental agency	A project to repair and lend fleets of older generation iPhones to vulnerable beneficiaries. The repair process is carried out by students enrolled in IT technician and engineer courses.		<ul style="list-style-type: none"> - D1, IT NGO, providing electronic waste related environmental education, 30 members - D2, Life-cycle analysis specialized consultancy, 1 employee - D3, High school public education, 25 students involved - D4, NGO (representative of the consortium between D1, D2, D3)

Example of letter of invitation to participate to the research



'Cross-Industrial Circular Collaborations' – ESCP Business School

An invitation to participate in a PhD management research thesis

November 2020

This letter briefly introduces the PhD thesis and invites you to contribute by taking part in a research interview.

THESIS TOPIC I am investigating the rise of the circular economy, a model which emphasizes the importance of circular thinking, regenerative system design and value recapture. My project more precisely examines cross-industrial circular synergies. The idea of the research is that implementing circular supply collaborations between companies belonging to different industries generates new potentialities to fulfil business and sustainability objectives, but also difficulties due to inter-organisational differences. I aim to understand how these partnerships emerge, how they are managed, if they are successful and in what ways. I am particularly interested in the work of "brokerage" or "match-making" that is needed to connect organizations of different sectors or to coordinate cross-industrial synergies.

YOUR INVOLVEMENT I hope that this project is of interest to you and that you will agree to participate in a confidential, recorded discussion lasting approximately one hour. During the interview I will ask you questions around the topics of 'brokerage platform', 'connecting distant companies', 'identifying the need for reused/recycled resources and the right partner', 'management of organizational differences' etc. Some examples of the questions are provided below:

1. Could you describe in your own words what is the activity of your organisation, how do you help your clients?
2. Do you think that the clients you connect share similarities (in terms of technical language, professional networks and events, internal rules and routines, institutions and norms etc?)
3. What do you think are the primary facilitators or barriers of cross-industrial collaborations?

I understand you may know more about some topics than others, so there is always the option to skip and move on to the next question.

CONFIDENTIALITY I understand that confidentiality is crucial to my interviewees, thus, I assure that at no point the research will reveal confidential information. If needed, the conversation will be anonymised, and a transcript of the interview can be provided for validation. In addition, do not hesitate to contact me for more details on my university policy on data protection and research ethics.

PRESENTATION OF PRELIMINARY FINDINGS A presentation of preliminary findings will be made to your organisation or department towards the end of the project.

I hope this is of relevance to your business and look forward to meeting with you soon.

Yours sincerely,

A handwritten signature in black ink that reads 'Anne Ratsimandresy'.

Anne Ratsimandresy, PhD Candidate, ESCP under the direction of Professor Joe Miemczyk, ESCP

Interview guide, article 2

1) The circularity broker

- * Parlez-moi de vous, votre parcours professionnel, votre fonction dans l'organisation.
- * Pouvez-vous décrire l'activité de votre organisation, comment aidez-vous vos partenaires ?
- * Quels sont selon vous les principaux facilitateurs et obstacles de la collaboration ? Cela varie-t-il selon le stade de la collaboration ?

2) Understanding the facilitation mission

- * Comment est-ce que les entreprises qui requièrent votre aide vous connaissent et font appel à appel ? Quand vous accompagnez la réalisation d'un partenariat, il y a-t-il des liens préexistants entre les entreprises que vous accompagnez ?
- * Les entreprises que vous accompagnez ont-elles besoin d'une expertise particulière? Les entreprises que vous accompagnez dans l'établissement d'un partenariat partagent-elles la même expertise, parlent-elles le même langage ?
- * Dans votre processus d'accompagnement, les entreprises ont-elles besoin d'ajuster leurs modes de travail ou d'organisation ?
- * Dans quelle mesure l'aspect géographique (comme la distance parcourue par une ressource par exemple) est-il un critère soulevé par les entreprises qui font appel à vos services ?
- * Diriez-vous que les partenariats de circularité interindustrielle sont une opportunité en termes de performance commerciale et environnementale ?

3) Wrap up

- * De votre point de vue, y a-t-il une question qui aurait dû être posée et qui pourrait être pertinente pour la recherche ? Avec quel membre de votre réseau puis-je poursuivre cette étude de cas en effectuant une interview comme celle-ci ?

Example of a transcript in Quirkos

The screenshot shows the Quirkos interface. On the right, a transcript is displayed with a time stamp [00:32:23.260]. The text discusses the practical mobilization of actors in a workshop, mentioning various problematics like waste, resources, and competencies. On the left, a network visualization shows nodes and connections, with a table of data for 'Ateliers du broker' (203) and 'Capacités du br' (243).

Ateliers du broker (203)

9/195
1/101
2/83
0/169
1/48
3/141
1/99
5/341
2/123
2/115

Capacités du br (243)

6 (243)

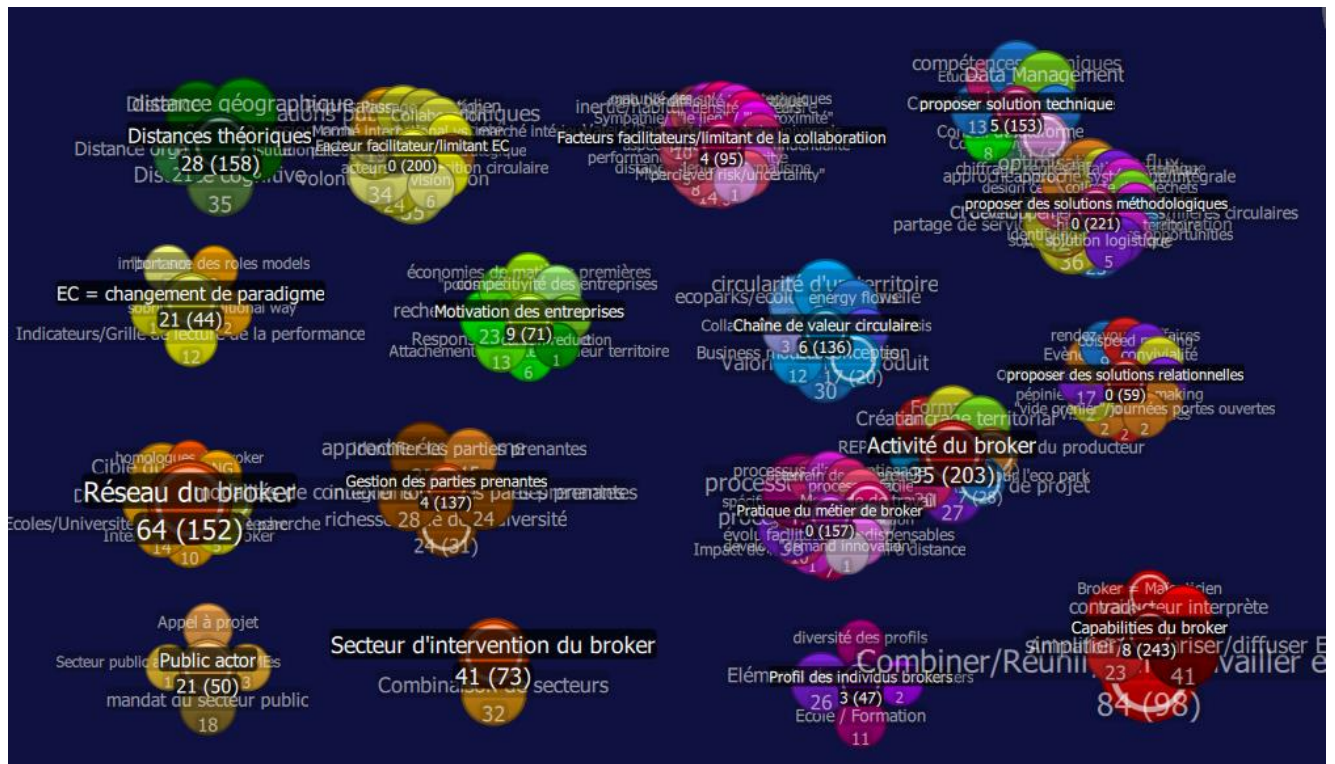
Transcript Text:

[00:32:23.260] Du coup, on les mobilise par un côté pratique. Quand on fait un atelier on répond à une problématique. Une problématique déchets, une problématique ressource, de compétences, avoir une problématique de changement de taille (ils ont libéré de l'espace et on des m2 à mettre à disposition un tiers). Donc, on est là pour répondre à une problématique connexe de leurs activités. C'est ça, c'est l'angle d'attaque qu'on a choisi et qui fonctionne. Ça veut pas dire que ce sera de l'écologie industrielle à chaque fois, ça dépend de leur sujet. on essaie d'être facilitant dans ces cas là. Si on a la compétence, on va les aider. Si on a le réseau, on va essayer de les mettre en relation. Donc, ça va permettre de pouvoir être identifié comme apporteur de solutions et donc ni comme un emmerdeur, certains peuvent nous dire "je vois pas l'intérêt de venir, je vais perdre du temps". Certains peuvent avoir cette posture là, ni comme un prospecteur, c'est à dire comme vous avez centrales téléphoniques sans arrêt pour vendre des produits ou faire des enquêtes qui sont faites, non, on n'est pas là pour ça. D'ailleurs, il n'y a pas besoin d'être membre du club pour participer à nos activités. On essaye d'avoir une position différenciante pour nos membres quand on fait des choses qui sont payantes, mais c'est pas souvent. Et si les membres sont membres, c'est parce qu'ils souhaitent participer à une dynamique. C'est d'ailleurs pour ça qu'on n'a pas énormément de membres. On a une trentaine, mais ils sont fidèles et participent. Les entreprises qui participent à nos ateliers n'ont pas besoin d'être membres. Moi, je n'ai rien à leur vendre. Le fait que je sois fonctionnaire territorial et agent du département. Ça me pose entière neutre.

[00:35:00.660] - ARA

Est ce que ça rejoint la notion de notoriété dont vous parliez au début?

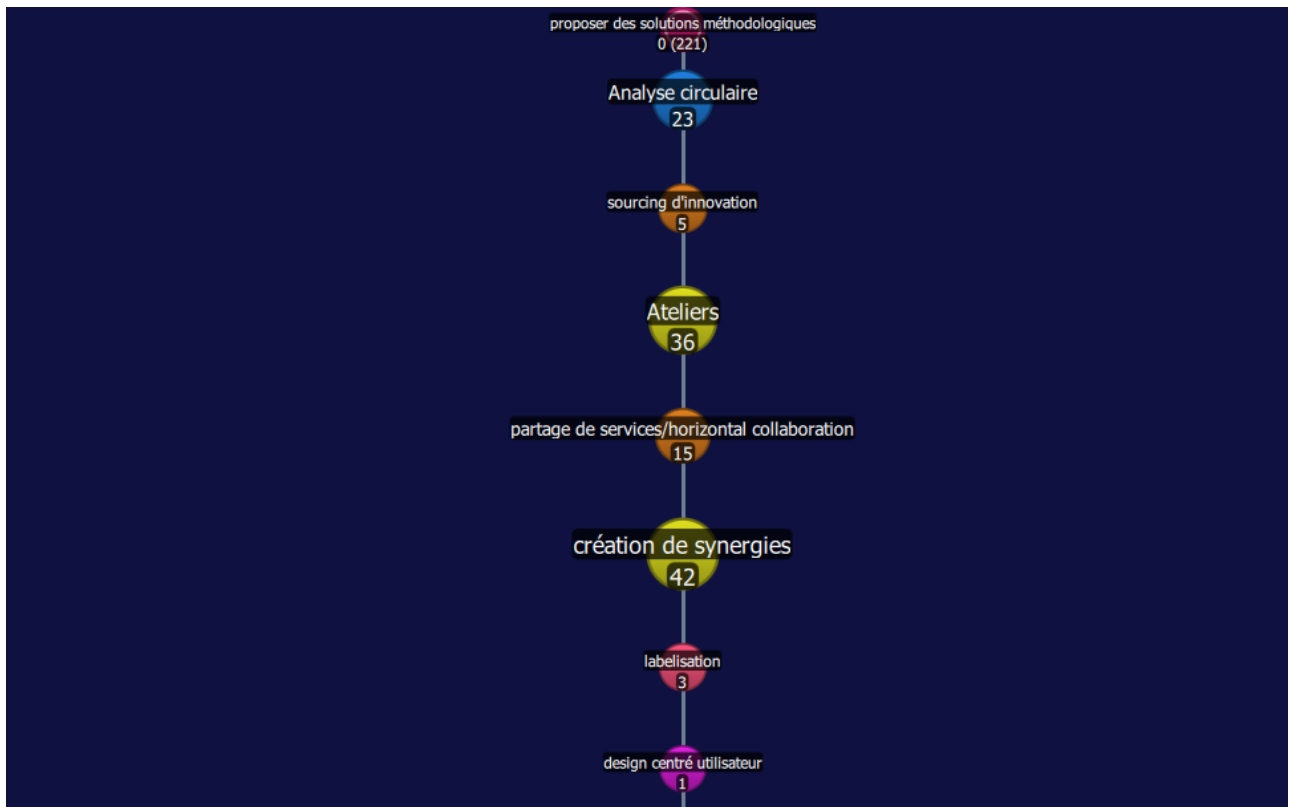
Overview of a project in Quirkos



Coding nodes as “tree view” in Quirkos



Example of a coding node in Quirkos



Example of coding proximities (excerpt from article 3)

Proximity	Code
Social proximity	Trust
	Family bonds
	Friendship bonds
	Co-workers bonds during non-work time
Geographic proximity	Shared logistics
	Shared infrastructures
	Knowledge of the region
	Sense of belonging to the region
	Shared venues
	Local supply chain
	«Made-in-France»
Institutional proximity	Sustainable values
	Professional network/association
	Events
	Sectoral norms/culture
	Stakes
Cognitive proximity	Expertise
	Mindset
	Education/Training
	Technology
Organisational proximity	Governance style
	Administrative structure
	Work routines
	Industrial processes
	Management processes

	Financial imperatives
	Financial (in)dependance btw members
	Size
	Win/Win arrangements

BATIR DES PONTS POUR FRANCHIR LA DISTANCE
ORGANISATIONNELLE AU SEIN DU RESEAU
D'APPROVISIONNEMENT :
UNE ETUDE EXPLORATOIRE DES ECHANGES DEPASSANT LES
FRONTIERES INDUSTRIELLES ET DE LEUR FACILITATION POUR
UNE ECONOMIE CIRCULAIRE

Le déploiement à grande échelle du modèle économique circulaire nécessite l'activation d'un certain nombre de leviers. L'un d'entre eux consiste en la mise en œuvre d'opérations systémiques, collaboratives, et qui dépassent les frontières cloisonnant habituellement les filières industrielles. Cette recherche est donc consacrée à l'étude de ces collaborations et s'attache à explorer la tension suivante : les échanges entre entreprises appartenant à des secteurs industriels différents présentent un potentiel prometteur dans l'établissement de nouveaux flux circulaires de ressources en permettant de décroiser les chaînes d'approvisionnement dont elles sont issues. Or, ces échanges pourraient se révéler difficiles à mettre en jeu du fait des divergences existant entre organisations appartenant à des filières différentes. Cette thèse est donc une étude exploratoire des opérations collaboratives à des fins de circularité impliquant plusieurs secteurs industriels, afin de comprendre leur facilitation, leur opérationnalisation et de saisir les opportunités qu'elles offrent pour le modèle économique circulaire. Pour ce faire, cette recherche est articulée en trois parties. Le premier article de la thèse est consacré à une formulation conceptuelle de ces collaborations circulaires inter-industrielles. Le deuxième est une étude qualitative dédiée aux acteurs qui assurent la facilitation des collaborations circulaires au sein du réseau d'approvisionnement. Le troisième est une étude de cas multiples consacrée à ces collaborations afin de comprendre leurs conditions d'émergence et leur fonctionnement. Les fondations théoriques de la thèse reposent en premier lieu sur la théorie des réseaux dont les apports expliquent les mécanismes de connexion et la dynamique régissant la circulation des ressources entre les membres d'un réseau d'approvisionnement. En second lieu, le cadre de la proximité inter-organisationnelle explique les facteurs d'alignement géographiques, organisationnels, cognitifs, sociaux et institutionnels qui expliquent l'émergence et le fonctionnement de ces collaborations.

Mots clés : Supply chain et opérations, Economie circulaire, Collaboration inter-industrielle, Théorie des réseaux, Proximité inter-organisationnelle

BUILDING BRIDGES TO OVERCOME ORGANISATIONAL DISTANCE IN THE SUPPLY NETWORK: AN EXPLORATORY STUDY OF EXCHANGES OPENING INDUSTRIAL BOUNDARIES AND THEIR FACILITATION FOR A CIRCULAR ECONOMY

The large-scale adoption of the circular economic model requires a number of levers to be activated. One of these is the implementation of systemic, collaborative operations that crosses the boundaries that usually separate industries. This research is therefore devoted to the study of such collaborations and seeks to explore the following tension: exchanges between companies belonging to different industrial sectors present a promising potential in the establishment of new circular flows of resources by enabling the de-siloing of the supply chains from which they originate. However, these exchanges could prove difficult to implement because of the divergences that exist between organisations belonging to different industries. This thesis is thus an exploratory study of collaborative operations for circularity purposes involving several industrial sectors, in order to understand their facilitation, their operationalisation and to grasp the opportunities they offer for the circular economic model. To this end, this research is divided in three parts. The first article of the thesis is devoted to a conceptual formulation of these cross-industrial circular collaborations. The second is a qualitative study dedicated to the actors who facilitate circular collaborations within the supply network. The third is a multiple case study dedicated to these collaborations in order to understand their conditions of emergence and their functioning. The theoretical foundations of the thesis are based firstly on network theory, whose contributions explain the connection mechanisms and dynamics governing the circulation of resources between the members of a supply network. Secondly, the framework of inter-organisational proximity explains the geographical, organisational, cognitive, social and institutional alignment factors that explain the emergence and functioning of these collaborations.

Keywords: Supply chain and operations, Circular economy, Cross-industrial collaboration, Network theory, Inter-organisational proximity