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**Modèles d'affaires durables et innovants pour les plateformes de fret
intelligentes : une approche multi-outils stratégiques et un guide pour les start-
ups**

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Mémoire présenté en vue de l'obtention du diplôme de *Maîtrise ès sciences appliquées*

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Ce mémoire intitulé :

Modèles d'affaires durables et innovants pour les plateformes de fret intelligentes : une approche multi-outils stratégiques et un guide pour les start-ups

présenté par **Tomas Agustin BAS**

en vue de l'obtention du diplôme de *Maîtrise ès sciences appliquées*

a été dûment accepté par le jury d'examen constitué de :

Martin TRÉPANIÉ, président

Samira KEIVANPOUR, membre et directrice de recherche

Amina LAMGHARI, membre

DÉDICACE

Ce mémoire est dédié à ma partenaire de vie Micaela, à mes parents Ana Maria et Tomas Gabriel et à ma sœur Lucrecia Elisa, dont le soutien indéfectible et l'amour ont été essentiels dans mon parcours. Leur présence, même sans être physique, a été une lumière directrice à chaque étape et une source constante de force.

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RÉSUMÉ

L'industrie du camionnage fait face à un problème d'inefficacité, qui entraîne des coûts élevés et un impact environnemental négatif. Ce problème est causé par le fait que de nombreux camions circulent à vide ou sous-chargés, en particulier dans le transport longue distance.

Cette recherche met en évidence l'émergence de start-ups avec des idées innovantes et des algorithmes dans la correspondance de fret numérique (Digital Freight Matching - DFM). Elle révèle un manque dans la littérature existante concernant l'efficacité stratégique et les modèles d'affaires de ces start-ups, en particulier dans le contexte des systèmes de courtage de fret numérique. Par conséquent, elle vise à combler cette lacune en fournissant un guide complet avec des outils pratiques pour les start-ups dans le secteur du camionnage de fret, les aidant à construire des bases d'affaires solides et à réussir sur le marché.

Ce mémoire est structurée en deux articles principaux. Le premier article se concentre sur l'application d'outils stratégiques tels que l'analyse SWOT, le modèle EFQM-2020, et une Toile de Modèle d'Affaires à Triple Couche. Cet article examine une plateforme de fret d'une start-up canadienne, soulignant la nécessité de minimiser les trajets à vide, de maximiser les charges utiles et d'améliorer la durabilité globale dans l'industrie du camionnage. Cette approche globale aide les nouvelles entreprises à établir des structures fondamentales solides.

Le deuxième article se concentre sur l'évolution de l'industrie du camionnage et l'escalade des plateformes de correspondance de fret numérique. Il présente une analyse comparative de divers modèles d'affaires DFM, se concentrant sur leurs avantages, inconvénients, processus opérationnels, stratégies de génération de revenus et niveaux de numérisation.

Les résultats de cette recherche incluent (1) l'intégration de la durabilité avec la technologie dans les modèles d'affaires de plateformes de fret intelligentes, soulignant l'importance des pratiques durables dans l'industrie du fret en évolution. (2) Une analyse comparative des modèles d'affaires DFM pour les startups, mettant en évidence le changement de l'industrie vers la numérisation et l'évolution des modèles de courtiers de fret.

En conclusion, la recherche souligne le besoin urgent de solutions innovantes dans l'industrie du camionnage. Elle offre un aperçu du paysage diversifié et dynamique des modèles d'affaires de correspondance de fret numérique dans le secteur du transport routier.

ABSTRACT

The trucking industry is facing an inefficiency problem, which results in high costs and negative environmental impact. This problem is caused by the fact that many trucks run empty or underloaded, especially in long-distance transport.

Addressing this inefficiency, this research highlights the emergence of start-ups with innovative ideas and algorithms in the Digital Freight Matching (DFM). It reveals a gap in the existing literature regarding the strategic efficacy and business models of these start-ups, particularly in the context of digital freight brokerage systems. Therefore, it aims to fill this gap by providing a comprehensive guide with practical tools for start-ups in the freight trucking sector, assisting them in building solid business foundations and succeeding in the market.

This thesis is structured into two main articles. The first article focuses on the application of strategic tools such as SWOT analysis, EFQM-2020 model, and a Triple Layer Business Model Canvas. This article examines a Canadian start-up's freight platform, emphasizing the need to minimize empty trips, maximize payloads, and improve overall sustainability in the trucking industry. This comprehensive approach assists new businesses in establishing strong foundational structures.

The second article focuses on the evolution of the trucking industry and the rise of digital freight matching platforms. It presents a comparative analysis of various DFM business models, shedding light on their advantages, disadvantages, operational processes, revenue generation strategies, and levels of digitalization.

The outcomes of this research include (1) the integration of sustainability with technology in smart freight platform business models, emphasizing the importance of sustainable practices in the evolving freight industry. (2) comparative analysis of DFM business models for startups, highlighting the industry's shift towards digitalization and the evolution of freight broker models.

In conclusion, the research underlines the urgent need for innovative solutions in the trucking industry. It provides insights into the diverse and dynamic landscape of digital freight matching business models in the road transport sector.

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LISTE DES SIGLES ET ABRÉVIATIONS

3L BMC	Triple Layer Business Model Canvas
ABM	Agent-Based Model
AHP	Analytic Hierarchy Process
AI	Artificial Intelligence
ALMT	Automated Last Mile Transport
AMoD	Autonomous Mobility-on-Demand
AVs	Autonomous Vehicles
BM	Business Model
BMC	Business Model Canvas
CO ₂	Carbon Dioxide
CVs	Conventional Vehicles
DEMATEL	Decision Making Trial and Evaluation Laboratory
DFM	Digital Freight Matching
DRT	Demand-Responsive public Transport
EDI	Electronic Data Interchange
EFQM	European Foundation for Quality Management
ELD	Electronic Logging Device
FIFO	First In First Out
FRT	Feuille de Route Technologique
GHG	Greenhouse Gases
GPS	Global Positioning System
GQT	Gestion de la Qualité Totale
HDFS	Hadoop Distributed File System

I4.0	Industry 4.0
IOT	Internet of Things
IT	Information Technology
KPIs	Key Performance Indicators
LoRaWAN	Long Range Wide Area Network
MaaS	Mobility as a Service
MAT	Modèle d'Affaires à Toile
MATC	Modèle d'Affaires à Triple Couche
MCDS	Multiple Criteria Decision Support
ML	Machine Learning
ODD	Objectifs de Développement Durable
PEST	Political Economic Social Technological
RFID	Radio-frequency identification
RFP	Request For Proposal
SaaS	Software as a Service
SDGs	Sustainable Development Goals
SUMO	Simulation of Urban Mobility
SVM	Support Vector Machine
SWOT	Strengths Weaknesses Opportunities Threats
TLBMC	Triple Layered Business Model Canvas
TMS	Transport Management System
TMT	Technology Media Telecom
TRM	Technology RoadMap
TQM	Total Quality Management

CHAPITRE 1 INTRODUCTION

1.1 Contexte du problème

L'industrie mondiale du camionnage, un acteur essentiel dans le mouvement des marchandises, fait face à des défis persistants ayant des implications économiques et environnementales (Rodrigue, 2020). Au Canada, le transport de fret par camion est responsable d'environ 85% des émissions totales de tous les types de transport de marchandises (Transport Canada, 2019). Un problème critique mis en évidence dans ce secteur concerne l'efficacité stratégique du chargement des camions. Selon Transport Québec (2018), en moyenne, 36% des camions retournent vides à leur point de départ après des livraisons de longue distance, tandis que plus de la moitié fonctionnent à moitié capacité ou moins. Cela impacte non seulement les coûts financiers de l'industrie, y compris le carburant, la main-d'œuvre et la maintenance, mais pose également un défi environnemental significatif (Browne et al., 2023). Ce problème n'est pas unique à une région spécifique ; il s'étend même à des acteurs économiques majeurs tels que le Canada, où l'industrie du camionnage constitue une part substantielle du commerce transfrontalier. Les méthodes traditionnelles de transit de marchandises, reposant sur des intermédiaires tels que les courtiers en fret, ont exacerbé cette inefficacité.

Parmi ces défis, l'industrie du camionnage voit émerger des start-ups dotées d'idées prometteuses et d'algorithmes innovants. Dans le paysage dynamique de l'entrepreneuriat, ces entreprises font face à des obstacles significatifs au cours de leurs premières années, un pourcentage notable cédant face à des obstacles imprévus (Baisya, 2021). Malgré l'étincelle initiale de créativité propulsant ces start-ups en avant, le succès exige plus que des concepts révolutionnaires. Cette juxtaposition souligne le besoin crucial d'outils fondamentaux et d'une orientation stratégique pour aborder à la fois les problèmes ancrés au sein de l'industrie du camionnage et les défis auxquels font face les start-ups s'aventurant dans ce secteur vital (Ney et al., 2019).

Avec ces nouvelles idées qu'ont les startups, la plupart d'entre elles utilisent les modèles Digital Freight Matching (DFM) qui sont un outil technologique qui facilite la mise en relation avec les expéditeurs avec des transporteurs via des plateformes numériques et en temps réel. Il repose sur des algorithmes avancés pour associer efficacement les besoins en transport avec les capacités

disponibles, ce qui permet d'améliorer l'efficacité logistique, de réduire les délais d'attente et souvent de baisser les coûts. Le DFM est une solution numérique pour l'optimisation du transport de marchandises. Les clients d'un modèle DFM peuvent être à la fois les transporteurs et les expéditeurs. Les transporteurs utilisent ces plateformes pour trouver des chargements correspondant à leurs itinéraires et capacités, tandis que les expéditeurs les utilisent pour trouver des options de transport fiables et efficaces pour leurs marchandises.

Intrigant cependant, la littérature existante, n'offre ni analyses ni comparaisons des différents modèles d'affaires adoptés par les DFM, et encore moins du point de vue d'aider ces nouvelles entreprises dans le contexte numérisé des courtiers en fret. De plus, l'approche multi-stratégique dans le transport intelligent de marchandises reste largement ignorée.

L'absence d'articles examinant les subtilités de ces systèmes pose un défi majeur pour les nouveaux entrants cherchant à comprendre les dynamiques du courtage de fret numériques. Comblar ces vides dans la recherche est impératif pour équiper les start-ups des connaissances et des outils essentiels nécessaires à leur succès dans la situation évolutive du courtage de fret numérique.

Ce mémoire s'efforce de servir de phare directeur pour les startups, mettant l'accent sur l'importance des outils et des stratégies essentiels. Au-delà de l'attrait d'une idée ou d'un algorithme novateur, la pertinence de l'intégration d'outils tels qu'une analyse SWOT et le modèle EFQM-2020 devient évidente (Fonseca, 2022). Les startups, dans leur empressement à progresser, peuvent négliger le potentiel transformateur de ces analyses fondamentales. Une compréhension nuancée de l'environnement interne et externe, associée à une exploration des facteurs influençant la prise de décision, peut être cruciale pour orienter les startups loin des écueils courants (Mikl, et al., 2021).

Le premier volet de notre boîte à outils, l'analyse SWOT, permet une évaluation détaillée d'une entreprise, examinant les forces, les faiblesses, les opportunités et les menaces. Ainsi, les startups acquièrent un point de vue stratégique. Ensuite, le modèle EFQM-2020 sert de boussole stratégique, évaluant l'alignement entre les aspirations d'une organisation et ses méthodologies opérationnelles (Lim et al., 2022). En autonomisant les startups pour identifier les lacunes et explorer des solutions viables, le modèle EFQM-2020 vise à élever la performance organisationnelle. Par ailleurs, un troisième niveau émerge : le canevas du modèle économique à triple couche. Cette représentation visuellement dynamique distille les composants critiques d'un modèle économique, offrant une clarté au milieu des incertitudes inhérentes à l'écosystème des

startups. Complémentant ces outils, un quatrième instrument, l'architecture de modélisation basée sur des agents, entre en jeu, démêlant les complexités des plates-formes, des acteurs et de leurs interactions

En passant au deuxième article, consacré au monde du transport, où le modèle du courtier en fret prend une grande importance, reconnaissant l'évolution de ce modèle, nous explorons la logique derrière le choix des modèles d'affaires DFM (Elbert & Gleser, 2019). Les différents modèles DFM sont explorés en analysant leurs structures économiques. Ce processus implique un examen détaillé de plusieurs éléments : le fonctionnement des modèles, les stratégies de génération de revenus, les aspects de la relation client, et l'utilisation des outils numériques. L'accent est également mis sur le niveau de technologie impliqué et les acteurs clés de l'industrie qui les mettent en pratique. Grâce à cette analyse, les startups peuvent gagner des insights et développer des stratégies adaptées à leurs besoins spécifiques, en s'appuyant sur leurs outils et atouts uniques.

1.2 Objectifs de recherche

Cette étude vise à créer un guide pratique avec différents étapes et outils pour les startups qui se lancent dans le secteur du transport de marchandises par camion et souhaitent construire les bases solides de leur modèle commercial en les dotant des connaissances et des outils nécessaires pour naviguer dans les défis des premières années et, à partir de là, entrer sur le marché et y réussir. En comblant le fossé entre la théorie et la pratique, nous aspirons à apporter des perspectives précieuses à la scène en constante évolution du succès des startups. Le premier objectif est de former une base solide du modèle d'affaires, avec les différents outils réunis. Le deuxième objectif, est la création d'une ressource complète qui aide à la sélection du modèle d'affaires plus personnalisé pour la compagnie, à la base de comparer différents modèles économiques DFM, en mettant l'accent sur l'adaptabilité et l'adaptation aux forces et aux objectifs de l'entreprise.

1.3 Contributions à la recherche

Cette étude propose les contributions suivantes à travers deux articles correspondant aux objectifs de recherche :

Article 1: (Sustainability and Industry 4.0 driven business model for smart freight platforms: Multi strategic tools approach)

- La contribution de cet article consiste à appliquer la combinaison d'outils stratégiques pour analyser la durabilité du modèle économique d'une plateforme de fret intelligente avec des outils technologiques.

Article 2: (Freight Broker Business Models in the Digital Age: A Comparative Analysis and Recommendations for Start-ups)

- L'apport principal de cette étude est de créer une ressource qui facilite la comparaison entre les différents modèles économiques DFM pour les startups, pour sélectionner le modèle commercial le plus approprié.
- Montrer l'évolution du modèle de courtier de fret et pourquoi l'industrie et les compagnies ont tendance à choisir les modèles d'affaires DFM.

1.4 Méthodologie des articles

La Figure 1.1 illustre les composants principaux de chaque article. Ces éléments incluent la revue de la littérature, qui présente un aperçu des travaux antérieurs pertinents; la méthode, où sont décrites les approches et techniques utilisées dans l'étude; l'étude de cas, qui applique la méthode à un exemple spécifique pour illustrer son utilité; et enfin, les applications d'outils, qui démontrent comment les outils spécifiques sont mis en œuvre dans la pratique. Cette figure vise à faciliter la compréhension de la méthodologie employée dans ces articles.

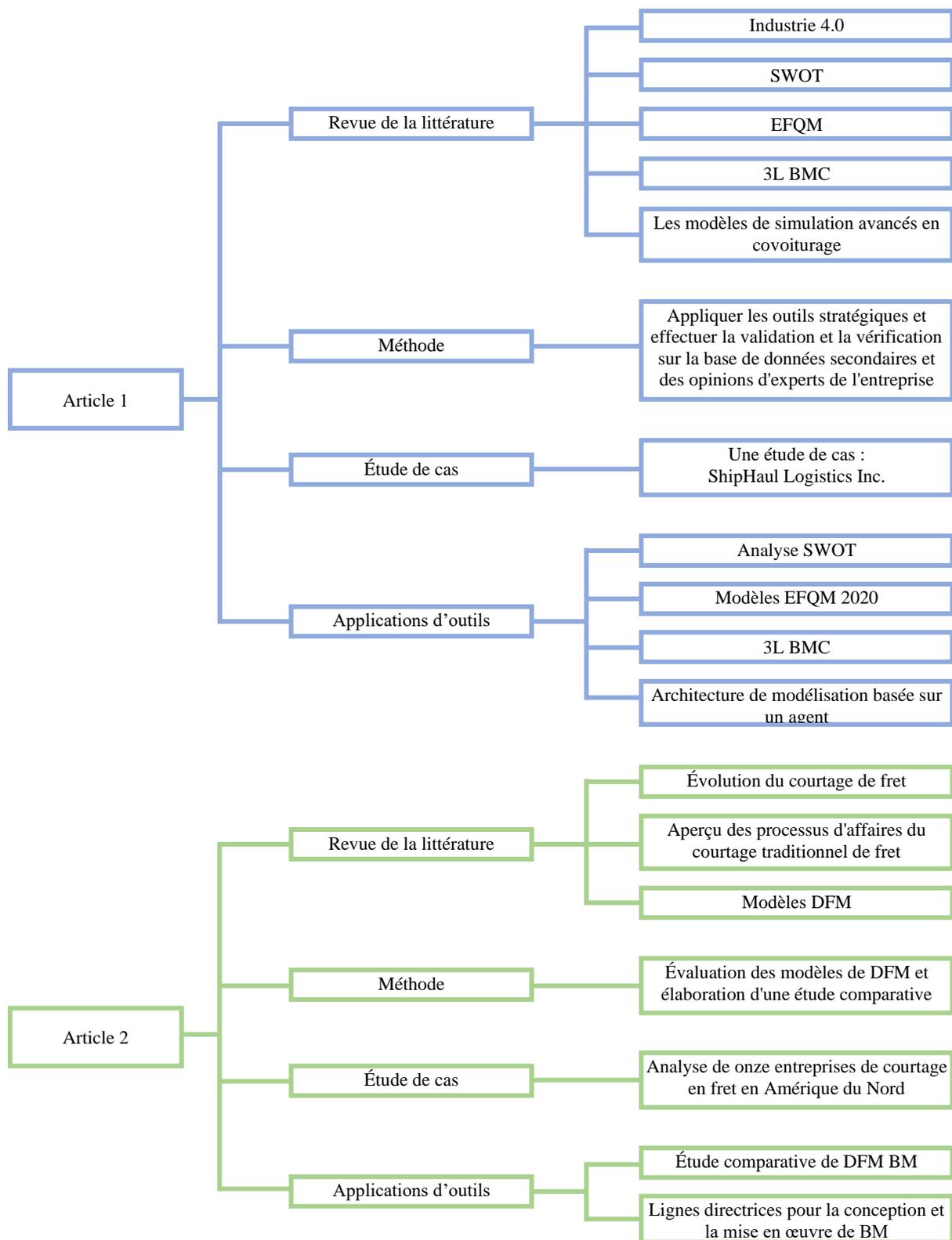


Figure 1.1 Elements des articles de recherche

Le guide présenté dans la Figure 1.2 propose une variété d'outils, présentés à travers deux articles, destinés à orienter les entreprises émergentes qui cherchent à établir des bases solides pour leur modèle d'affaires et à pénétrer avec succès le marché et l'industrie du transport de marchandises par camion. Nous commençons avec le premier article, où sont exposés quatre outils cruciaux dans la prise de décision stratégique de l'entreprise : l'analyse SWOT, le modèle EFQM-2020, le triple layer BMC et l'architecture de modélisation basée sur des agents.

Dans le deuxième article, en approfondissant davantage la partie tactique de l'entreprise, est présentée l'outil d'une comparaison entre les différents modèles d'affaires utilisant des modèles DFM, accompagnée de recommandations pour aider les entreprises à choisir le modèle d'affaires le plus adapté à leurs besoins.

L'objectif de cette mémoire comme déjà mentionné dans la section 1.2 est de proposer une méthodologie basée sur six outils pour aider les startups à créer des modèles d'affaires et des outils stratégiques adaptés aux plateformes numériques de fret. Ces outils sont les suivants :

- L'analyse SWOT, qui permet d'identifier les forces, les faiblesses, les opportunités et les menaces liées à un projet ou à une organisation (approche stratégique).
- Le modèle EFQM-2020, qui est un cadre de référence pour l'excellence organisationnelle basé sur neuf critères : le leadership, la stratégie, les personnes, les partenariats et les ressources, les processus, les produits et services, les résultats clients, les résultats du personnel et les résultats sociétaux. Permettent de définir la vision, la mission, les valeurs et les objectifs à long terme de la startup (approche stratégique).
- Le modèle 3 BL (triple bottom line), qui est un concept qui intègre les dimensions économique, sociale et environnementale dans la définition de la performance d'une entreprise (approche stratégique).
- L'architecture de modélisation basée sur des agents, offre une perspective perspicace sur les rôles dynamiques et les interactions des acteurs au sein de ces systèmes. Elle offre une compréhension plus claire des relations complexes et des interdépendances qui existent entre les différents éléments et parties prenantes impliqués dans ces plateformes.

- Une étude comparative des modèles d'affaires existants dans le domaine des plateformes numériques de fret, qui permet de se situer par rapport à la concurrence et d'identifier les bonnes pratiques et les axes d'amélioration (approche stratégique).
- Des lignes directrices pour la conception et la mise en œuvre des modèles d'affaires et des outils stratégiques adaptés aux plateformes numériques de fret, qui synthétisent les résultats des outils précédents et proposent des recommandations concrètes, en répondent aux besoins des clients, des partenaires, des employés et de la société, tout en assurant la rentabilité et la durabilité de la startup (approche tactique).

La logique de combinaison de ces outils repose sur une approche à la fois stratégique et tactique, permettant aux startups de formuler des stratégies à la fois robustes et flexibles, adaptées aux défis et opportunités du secteur du transport de marchandises par camion. Chaque outil joue un rôle spécifique et complémentaire, contribuant à une compréhension globale et à une mise en œuvre efficace des stratégies d'affaires. Plus de détails seront fournis dans la section 2.6 du deuxième chapitre.

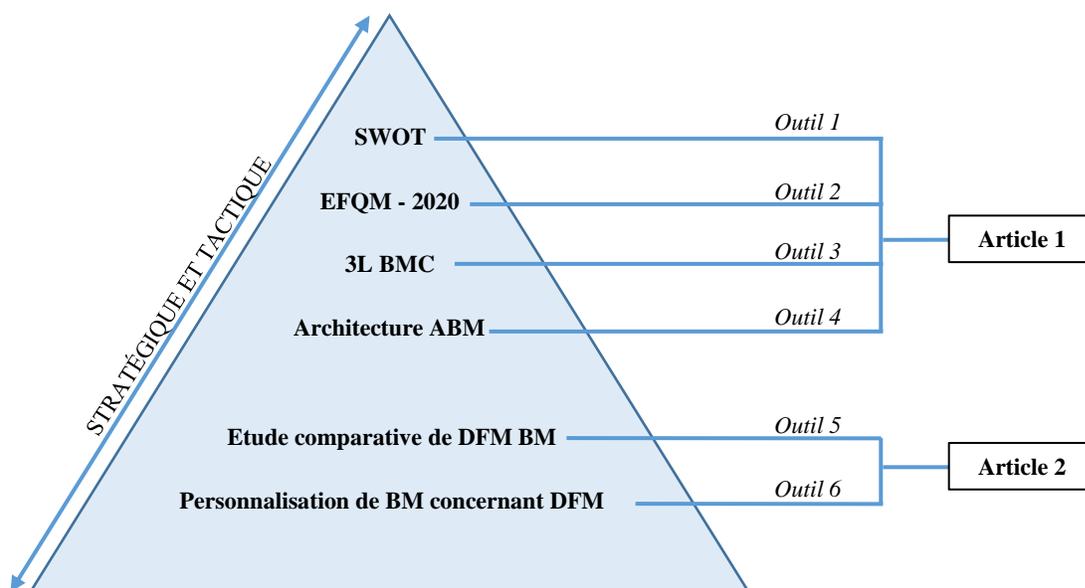


Figure 1.2 Cadre d'outils appliqués

1.5 Plan de mémoire

Le chapitre 2 présente l'état de l'art dans des domaines pertinents tels que l'évaluation des impacts environnementaux, la correspondance et la tarification dans le contexte du covoiturage et du partage de fret. Les lacunes dans la littérature scientifique sont également soulignées. Les chapitres 3 et 4 représentent les contributions de cette étude. Plus précisément, le chapitre 3 présente le premier article, intitulée : *sustainability and industry 4.0 driven business model for smart freight platforms: multi strategic tools approach*. Le chapitre 4 comprend le deuxième article intitulé : *freight broker business models in the digital age: a comparative analysis and recommendations for start-ups*. Ils sont suivis du chapitre 5 où la conclusion et des recommandations sont présentées.

CHAPITRE 2 REVUE DE LITTÉRATURE

2.1 Méthodologie de recherche

Pour réaliser la revue de littérature, la priorité a été donnée à la collecte d'informations validées provenant de sources pertinentes, les bases de données consultées étaient : Web of Science, Scopus, Science Direct, Statistique Canada, Compendex, Derwent, IEEE, Inspec. Cette combinaison a permis d'éviter les doublons d'articles pouvant exister entre ces bases de données.

2.2 Actualité et évolution du courtage de fret

La revue de littérature sur le courtage de fret met en lumière l'évolution de l'industrie et les défis actuels. Elle souligne les difficultés à équilibrer l'offre et la demande en matière de transport routier, souvent influencées par des facteurs tels que les changements économiques, les avancées technologiques et la psychologie humaine (Eriksson et al., 2022 ; Caplice, 2021 ; Pickett, 2018 ; Negrutiu et al., 2020). La revue insiste sur l'importance de prédire les tendances du marché malgré ces incertitudes.

Revenant aux origines du courtage de fret, la revue de littérature mentionne ses racines dans le commerce initial, où les intermédiaires jouaient un rôle clé dans la connexion entre producteurs et expéditeurs avec les transporteurs (Brown, 1984 ; Luncean & Badica, 2014). Ce rôle d'intermédiaire, bien que plus rudimentaire à l'époque, a jeté les bases des pratiques modernes.

Une transformation significative s'est produite avec l'avènement du transport motorisé et du système autoroutier inter-États aux États-Unis, conduisant à la formalisation du courtage de fret par des licences et régulations (Canna, 2022 ; Danyluk, 2021). La fin du 20e siècle a introduit les systèmes informatiques et l'échange de données électronique (EDI), améliorant l'efficacité de la correspondance fret-transporteur, mais sans altérer fondamentalement le rôle d'intermédiaire des courtiers (Agnihotri & Bhattacharya, 2023 ; Paik & Gharehgozli, 2022 ; Arooj et al., 2022).

Le 21e siècle a marqué un changement notable avec l'émergence des plateformes de Correspondance de Fret Numérique (DFM). Ces plateformes utilisent des algorithmes avancés, des données en temps réel et une connectivité numérique pour connecter directement expéditeurs et transporteurs, contournant potentiellement les courtiers traditionnels (Elbert & Gleser, 2019 ;

Huber, 2021 ; Majeed et al., 2021 ; Choudhury et al., 2023). Cela représente un écart significatif par rapport à la norme historique, remettant en question le modèle traditionnel de courtage de fret et soulignant l'importance continue des intermédiaires dans l'industrie de la logistique et du transport (Liao, et al., 2021).

2.3 Industrie 4.0 dans le contexte du courtage de fret

L'Industrie 4.0 révolutionne le secteur manufacturier avec des technologies avancées qui améliorent l'autonomie et l'agilité dans la production. Des outils tels que le data mining sont essentiels pour une production flexible et économique. Ferreira et al. (2022) soulignent que bien que l'Industrie 4.0 soit cruciale pour la compétitivité manufacturière, son plein potentiel reste sous-exploré, notamment dans l'intégration de ses diverses technologies.

Les avantages significatifs de l'Industrie 4.0 incluent une meilleure traçabilité et maintenance prédictive grâce à la surveillance en temps réel, conduisant à une résolution plus rapide des problèmes. Ferreira et al. (2022) notent également le rôle de la virtualisation et de la décentralisation dans la gestion des processus, facilitées par les capteurs, les données dans le cloud et l'intelligence machine.

Dans le transport de fret, l'intersection de la durabilité et de l'Industrie 4.0 est vitale. Les technologies intelligentes telles que le data mining, l'IoT et le GPS sont essentielles pour réduire les émissions de gaz à effet de serre et améliorer l'efficacité du transport. Kermanshah et al. (2020) ont constaté que les avantages des technologies cyber-physiques dans le transport de fret urbain l'emportent considérablement sur les coûts. De même, Hammond et al. (2020) ont examiné différentes technologies de chargement pour les véhicules de fret, évaluant leur impact sur les émissions de gaz à effet de serre et les coûts de cycle de vie.

Birek et al. (2018) discutent de la méthodologie Machine à Vecteurs de Support (SVM) dans l'automatisation de la prévision du comportement du conducteur, une tâche qui nécessite le traitement de volumes de données énormes. Ce défi est relevé par le cloud computing, qui offre un partage de données et de ressources évolutif, élastique et flexible. Le framework Hadoop, une solution open-source, est particulièrement remarqué pour sa capacité à traiter des données à grande échelle en utilisant des composants de stockage et de traitement distribués.

L'application des technologies intelligentes dans le suivi à travers les technologies de l'intelligence artificielle et de la science des données, avec Chung et al. (2021) soulignent l'importance de la conscience cognitive dans la logistique. Ghadge et al. (2020) et Kumar et al. (2021) explorent la dynamique de l'Industrie 4.0 dans la gestion de la chaîne d'approvisionnement, en soutenant l'intégration des chaînes d'approvisionnement circulaires pour améliorer la durabilité.

Enfin, Ilgin (2021) et Kumar et al. (2021) discutent des défis de l'emploi des technologies de l'Industrie 4.0 dans la logistique inverse, mettant l'accent sur le rôle des réseaux de communication sans fil dans la liaison entre machines, personnes et appareils mobiles. Cette intégration est considérée comme un facteur concurrentiel clé dans l'industrie.

2.4 DFM

L'intégration des plateformes de correspondance de fret numérique (DFM) a initié un changement transformateur dans l'industrie logistique, une perception reprise dans diverses recherches universitaires. Ces plateformes, utilisant des technologies de pointe, ont redéfini l'approche de l'appariement des cargaisons et des transporteurs, représentant un changement de paradigme significatif dans la logistique.

La littérature souligne le rôle des plateformes DFM dans la révolution de l'appariement de fret. Leur adoption marque une nouvelle ère dans la logistique, avec leur puissance technologique étant un thème central. Comme le soulignent Heinbach et al. (2022), ces plateformes ont changé la manière dont les cargaisons sont appariées avec les transporteurs disponibles. L'intégration d'algorithmes, d'analyses de données et de connectivité en temps réel est cruciale, comme le soulignent Liu et al. (2022) et Angelopoulos et al. (2023). Cette avancée technologique ne concerne pas seulement l'efficacité mais aussi la redéfinition de l'essence de l'appariement de fret, comme le suggèrent Wang et Sarkis (2021), qui mettent en évidence l'importance des capacités avancées d'algorithmes et d'analyses de données de ces plateformes.

La valeur multifacette des plateformes DFM a été élaborée par Gorman et al. (2023), soulignant des avantages tels que plus de transparence, des gains d'efficacité et une rentabilité. Zhou & Wan (2022) notent la transparence sans précédent apportée par les plateformes DFM, permettant l'accès à des informations en temps réel sur les expéditions, les itinéraires et les tarifications. Kern (2021)

et Heinbach et al. (2022) reconnaissent les gains d'efficacité significatifs dus à l'automatisation et à l'optimisation de l'appariement des cargaisons et des transporteurs.

Min et Kang (2021) soulignent un aspect révolutionnaire de ces plateformes : leur capacité à établir des connexions directes entre expéditeurs et transporteurs, potentiellement en remodelant la situation logistique et en diminuant la dépendance aux intermédiaires traditionnels tels que les courtiers en fret.

Cependant, la revue de la littérature conclut qu'il existe un écart notable dans les explications et comparaisons détaillées des différents modèles commerciaux de DFM, en particulier du point de vue des startups. Cet écart suggère un besoin de recherches supplémentaires dans ce domaine.

En résumé, l'émergence des plateformes DFM a été un facteur de changement pour le secteur logistique, comme témoigne la littérature étendue. Elles ont apporté plus de transparence, d'efficacité et de connexions directes dans le processus de correspondance de fret. Pourtant, il reste un besoin d'études complètes comparant divers modèles de DFM, en particulier pour aider les startups dans cette situation numérique en évolution.

2.5 Start-ups dans le transport de fret numérique

2.5.1 La connaissance et l'innovation au sein des startups technologiques

Les startups sont reconnues par leur expertise en termes de créativité dans de nombreux domaines innovants (Bikse, et al., 2018). Elles ont acquis une grande importance en révolutionnant différentes industries technologiques de base (Audretsch et al., 2020). C'est le cas du transport de fret numérique à l'ère de l'intelligence artificielle (IA) (Riedl et al., 2018). Ce phénomène témoigne de leur rôle en tant qu'incubateurs d'idées et de développement de technologies innovantes. Ces startups sont souvent le lieu de naissance de solutions qui remettent en question le statu quo, introduisant des approches novatrices pour des problèmes complexes, comme c'est le cas du transport de fret numérique (Mikl et al., 2021). Ce secteur, stimulé par les avancées de l'IA, est un excellent exemple d'un domaine où les startups ont un impact significatif (Skala, 2022). Leur agilité, caractéristique clé de ces organisations naissantes, leur permet de s'adapter rapidement et d'intégrer de nouvelles technologies, restant ainsi à l'avant-garde d'un marché en rapide évolution (Visvizi et al., 2022). Cette agilité est complétée par leurs capacités créatives de résolution de

problèmes, leur permettant de concevoir des solutions innovantes pour les défis complexes inhérents au transport de fret (Negrutiu et al., 2020). Par exemple, les applications d'intelligence artificielle développées par ces startups dans la logistique et la gestion de la chaîne d'approvisionnement révolutionnent la manière dont les biens sont transportés, suivis et livrés, rendant le processus plus efficace et rentable (Elbert & Gleser, 2019).

De plus, les startups dans le domaine du transport de fret numérique montrent souvent une volonté de prendre des risques calculés, un trait nécessaire pour être pionniers dans de nouvelles technologies et approches dans une industrie traditionnellement conservatrice (Wurst, 2021). Cette prise de risques permet de promouvoir l'adoption de l'IA dans le transport de fret, menant à des innovations perturbatrices qui remodelent les normes et les attentes de l'industrie. L'intégration de l'IA par les startups dans le transport de fret numérique est transformative (Mikl et al., 2021). Elle améliore l'efficacité, la précision et la fiabilité, rendant les opérations logistiques plus prédictives et réactives. Les solutions basées sur l'IA vont de la planification optimisée des itinéraires au suivi en temps réel et à la prise de décision automatisée, contribuant ainsi à un processus de transport plus fluide et efficace (Negrutiu et al., 2020).

2.5.2 Les défis de financement et les limitations de ressources

Dans le paysage dynamique et en évolution du transport de fret numérique, les startups technologiques jouent un rôle crucial, mais font face à de nombreux défis qui testent leur résilience et leurs capacités d'innovation (Mikl et al., 2021). Les startups, connues pour injecter des idées nouvelles et innovantes dans les industries traditionnelles, rencontrent des barrières importantes principalement issues de limitations de ressources. Parmi ceux-ci, l'obtention d'un financement adéquat émerge comme un obstacle majeur (Yin et al., 2019). La recherche menée par Doğan (2023) met en lumière les coûts de développement importants auxquels ces nouvelles entreprises sont confrontées, en particulier pendant les phases cruciales de développement et de maturation du produit. Ces coûts sont souvent un obstacle majeur, qui pourrait étouffer le progrès et la mise en œuvre d'idées innovantes susceptibles de révolutionner le secteur du transport de marchandises. Ces contraintes financières limitent non seulement la portée des activités de recherche et développement, mais aussi la capacité des startups à élargir leurs opérations et à apporter leurs innovations à un marché plus large (Macchiavello & Siri, 2022).

En outre, les startups dans le domaine du transport de fret numérique font face à de grandes asymétries de pouvoir avec la présence de transporteurs de camions à grande échelle déjà établis (Corvello et al., 2023). Ces auteurs estiment que ces géants de l'industrie, avec leurs ressources étendues, leurs réseaux de clients enracinés et leurs positions dominantes sur le marché, créent un environnement hautement compétitif dont la pénétration peut s'avérer difficile pour les startups. La domination du marché de ces grandes entreprises éclipse souvent les efforts des startups, ce qui peut grandement leur compliquer l'établissement et la visibilité dans un marché hautement compétitif (Steiber, & Alänge, 2021). Cette compétition avec des entreprises bien établies exige que les startups adoptent des stratégies et des modèles d'affaires innovants qui puissent les différencier des acteurs traditionnels (Poszler et al., 2019; Huang & Pollio, 2023). Par conséquent, les entreprises émergentes comme les startups doivent être expertes non seulement dans le développement de la technologie mais aussi dans les partenariats stratégiques, l'acquisition de financement et l'analyse de marché (Jonek-Kowalska & Wolniak, 2021). Elles doivent construire des réseaux solides, interagir avec des investisseurs qui comprennent la vision à long terme de leurs innovations et s'adapter continuellement au paysage technologique en rapide évolution (Rementeria, 2022). Cette agilité et cette résilience leur permettent de surmonter progressivement ces défis et de contribuer significativement à l'évolution et à la modernisation de l'industrie du transport de marchandises numérique (Weber et al., 2021).

2.5.3 Les alliances stratégiques

Dans le domaine dynamique et compétitif des nouvelles entreprises technologiques, en particulier dans le secteur du transport de fret numérique, les alliances et partenariats stratégiques jouent un rôle crucial (Wagner, 2021). Ces collaborations, souvent formées pour accéder à des ressources et compétences qui pourraient manquer aux nouvelles entreprises, peuvent accélérer de manière significative la croissance et la pénétration du marché. L'essence de ces alliances stratégiques réside dans leur capacité à offrir aux entreprises émergentes l'accès à une variété de ressources (Kryvovyazyuk et al., 2023). Celles-ci peuvent inclure l'expertise technique, la connaissance du marché, les ressources financières et les réseaux de clients (Yang et al., 2022). Pour les startups dans le transport de fret numérique, ces partenariats peuvent être fondamentaux pour surmonter les barrières à l'entrée, étendre les opérations et acquérir des connaissances cruciales sur le marché

(Yin et al., 2019). Dans ce sens, un partenariat avec une entreprise de logistique établie peut offrir à une startup l'infrastructure logistique et la base de clients nécessaires pour déployer rapidement ses solutions innovantes. Cependant, ces alliances comportent souvent des défis inhérents. Les startups, animées par l'innovation et la croissance rapide, peuvent avoir des objectifs différents de ceux de leurs partenaires plus établis (Emami et al., 2022). Ce désalignement peut créer des tensions, en particulier si les attentes et objectifs de chaque partie ne sont pas clairement communiqués et convenus mutuellement dès le début (De Groot et al., 2020). Un autre défi dans ces partenariats est le potentiel d'opportunisme de la part de partenaires plus établis, créant des asymétries de pouvoir (Pérez & Cambra Fierro, 2018; Hora et al., 2018). Dans certains cas, ces entités pourraient exploiter l'alliance pour accéder à des technologies innovantes ou à des connaissances du marché, puis utiliser ces connaissances à leur avantage, potentiellement aux dépens de la startup (Subramanian et al., 2018). Ce risque prédateur souligne l'importance pour les nouvelles entreprises d'évaluer soigneusement les partenaires potentiels et d'établir des limites légales et opérationnelles claires dans toute collaboration.

De plus, les startups doivent trouver le juste équilibre entre bénéficier de l'alliance et maintenir leur autonomie et avantage innovant, car l'opportunisme est souvent une condition des partenaires (Rouyre & Fernandez, 2019). Une dépendance excessive envers un partenaire peut étouffer les capacités de croissance et d'innovation d'une startup, rendant difficile l'établissement de sa propre identité et proposition de valeur sur le marché. Pour atténuer ces risques, les nouvelles entreprises participant à des alliances et partenariats stratégiques doivent considérer certains facteurs (Arora, 2021). Premièrement, elles doivent effectuer une diligence raisonnable approfondie pour comprendre l'historique du partenaire potentiel, sa réputation sur le marché et l'alignement des intérêts. Deuxièmement, des accords clairs et juridiquement contraignants qui décrivent les rôles, responsabilités et avantages de chaque partie peuvent fournir un cadre pour un partenariat sain. Troisièmement, maintenir une communication ouverte et régulière peut aider à résoudre les problèmes rapidement et à maintenir les deux parties alignées sur leurs objectifs partagés (Seo, 2020).

2.5.4 Le progrès technologique et la croissance économique

Dans le paysage économique moderne, les startups technologiques, en particulier dans le secteur du transport de fret numérique, jouent un rôle clé dans la promotion du progrès technologique et la contribution à la croissance économique (Park, 2018). Ces entités sont souvent à la pointe des innovations radicales, introduisant des technologies novatrices qui ont le potentiel d'influencer significativement les économies nationales (Korpysa, 2021). L'impact de ces nouvelles entreprises s'étend bien au-delà de leur secteur industriel immédiat; elles agissent comme des catalyseurs pour des avancées sociales et économiques plus larges (Marcon & Ribeiro, 2021). Les startups dans le transport de fret numérique introduisent des solutions innovantes qui révolutionnent la manière dont les marchandises sont déplacées, suivies et gérées, ayant un impact significatif sur l'industrie logistique (Riedl et al., 2018). Leurs avancées dans des domaines tels que la logistique pilotée par l'intelligence artificielle, la blockchain pour des transactions sécurisées et transparentes, et l'automatisation dans la gestion des charges, améliorent non seulement l'efficacité opérationnelle mais ouvrent également de nouveaux marchés et créent des opportunités d'emploi (Klyukanova, 2021). La transformation de ce secteur a des effets en cascade sur l'ensemble de l'économie, influençant des secteurs tels que le commerce de détail, la fabrication et même la planification urbaine (Wagner & Kurjuweit, 2022). De plus, ces nouvelles entreprises sont souvent des précurseurs de tendances, repoussant les limites de ce qui est possible avec la technologie. Leur volonté d'explorer des territoires inexplorés et d'expérimenter avec des approches novatrices conduit souvent au développement de technologies de pointe (Norval et al., 2021). Cet esprit d'innovation est contagieux et inspire souvent de plus grandes entreprises et même des industries entières à adopter de nouvelles technologies et approches. En faisant cela, elles contribuent de manière significative au dynamisme technologique de l'économie (Tidd & Bessant, 2020).

Les startups font souvent face à des obstacles tels que l'obtention de financements adéquats, la formation d'alliances stratégiques et le maintien d'une position de leader dans un paysage technologique en rapide évolution (Lee et al., 2019). Le parcours de ces nouvelles entreprises implique de s'adapter continuellement aux besoins changeants du marché, aux avancées technologiques et aux pressions concurrentielles. Malgré ces défis, le rôle des nouvelles entreprises dans la promotion de la croissance économique et de l'innovation technologique ne peut être sous-estimé (Mikl et al., 2021). Leurs contributions mènent souvent à une productivité accrue, à la création de nouvelles industries et à la transformation des industries existantes. Le secteur du

transport de fret numérique, propulsé par ces nouvelles entreprises, est un excellent exemple de la manière dont une pensée innovante et un progrès technologique peuvent générer d'importants bénéfices économiques.

2.6 Outils stratégiques et tactiques pour les startups

Dans les sections suivantes, les différentes revues de littérature de chaque outil sont présentées, afin de savoir comment ces outils sont utilisés et exposer les lacunes.

Pour construire un modèle d'affaires approprié, le processus commence par une analyse SWOT, qui est généralement la première étape effectuée par les entreprises pour se connaître à la fois en interne et en externe. Ensuite, le modèle EFQM 2020 qui est un cadre d'évaluation de la qualité et de la performance des organisations, est mis en œuvre pour comprendre les lacunes et les solutions pour la création de valeur durable. Le Business Model Canvas est la troisième étape, car grâce aux outils précédents, nous pouvons nous concentrer sur les aspects environnementaux, sociaux et économiques de l'entreprise pour développer le modèle d'affaires souhaitée.

Une fois que nous avons une bonne compréhension de l'entreprise et de son fonctionnement souhaité, nous pouvons recourir à la modélisation basée sur les agents pour une analyse rentable et une application étendue.

Ces outils ont le même objectif global, former une base solide pour le modèle d'affaires de l'entreprise. Cependant, la fonction de chaque outil est différente. Utiliser un seul de ces outils ne suffirait pas à établir un modèle d'affaires solide. Par exemple, un Business Model Canvas ne peut être complet sans avoir d'abord réalisé une analyse SWOT pour connaître les forces et faiblesses internes de l'entreprise, ainsi que les opportunités et menaces externes, pour après avec toutes ces informations, réaliser un Business Model Canvas complet. L'analyse SWOT, bien que basique, est essentielle.

De même, la réalisation d'une analyse SWOT ne conduit pas automatiquement à un adéquat modèle d'affaires ; il doit être développé et ajouté les autres outils mentionnés. La modélisation basée sur les agents, en tant que quatrième outil, sert davantage à démontrer et à faire comprendre aux membres de l'entreprise, aux fournisseurs, etc., comment l'entreprise fonctionnerait ou aimerait fonctionner dans la réalité. Ces outils ont été choisis parmi différents outils utilisés par les plus

grandes entreprises du monde en cherchant à suivre les bonnes pratiques de ces entreprises et une approche multi-stratégique.

Cette approche est adoptée car elle représente, à notre avis, la meilleure manière d'utiliser ces outils pour réussir. Les détails seront approfondis dans le troisième chapitre.

2.6.1 SWOT

L'analyse SWOT, initialement un outil de gestion et de planification stratégique, s'est transformée en une méthode de planification participative qui encourage la discussion interdisciplinaire (Kowalska-Pyzalska et al., 2020). Le SWOT vise à fournir une compréhension complète de l'état de développement d'un secteur industriel en analysant les forces, les faiblesses, les opportunités et les menaces (Chen et al., 2017). L'analyse englobe les aspects internes (forces et faiblesses) et les facteurs externes (opportunités et menaces), où S et W représentent l'état actuel de l'organisation et O et T projettent les conditions futures (Rauch et al., 2015).

Chen et al. (2017) soulignent l'intégration de SWOT avec le modèle PEST pour une analyse approfondie des industries émergentes, évaluant les avantages, les inconvénients et les changements environnementaux potentiels pour formuler des recommandations politiques. De plus, le SWOT est essentiel dans l'évaluation du marché et la proposition d'améliorations pour la diffusion d'un produit ou d'un service. L'objectif principal de l'analyse SWOT est de développer des stratégies qui exploitent les forces et les opportunités tout en atténuant les faiblesses et les menaces (Kowalska-Pyzalska et al., 2020).

En outre, l'intégration du SWOT avec les méthodes de Support à la Décision Multi-Critères (MCDS), en particulier le Processus de Hiérarchie Analytique (AHP), améliore l'évaluation des facteurs SWOT (Kajanus et al., 2012). Cependant, Rauch et al. (2015) mettent en garde contre le fait que les facteurs dans AHP n'opèrent pas toujours de manière indépendante, ce qui pourrait fausser les résultats.

2.6.2 EFQM-2020

Le modèle EFQM 2020, tel que détaillé par Fonseca et al. (2021), est un modèle d'excellence commerciale complet qui intègre les Objectifs de Développement Durable (ODD) des Nations Unies. Il met l'accent sur la durabilité et s'aligne sur les principes de l'Industrie 4.0 (I4.0), en se concentrant sur la transformation et l'amélioration des performances organisationnelles. Ce modèle est particulièrement efficace dans la logistique de transport plus intelligente et durable, réduisant l'utilisation des ressources, le temps opérationnel, les coûts et les impacts environnementaux.

De plus, le modèle EFQM-2020 est décrit comme ayant une approche holistique, combinant des éléments de Gestion de la Qualité Totale (GQT), d'I4.0 et de durabilité au sein d'un cadre unifié. Cette intégration est essentielle pour atteindre les objectifs communs décrits dans la revue de littérature.

Teixeira et Tavares-Lehmann (2022) soulignent l'importance d'une intégration forte dans les processus et les dynamiques de données pour la planification stratégique de la qualité au sein du cadre EFQM-2020. Cette intégration est cruciale pour renforcer l'agilité, la flexibilité et les opportunités, nécessitant la participation de politiques publiques pour favoriser l'innovation et la personnalisation des processus. Les auteurs suggèrent également que le modèle EFQM-2020 favorise l'efficacité organisationnelle, la productivité globale et la compétitivité à long terme.

2.6.3 BMC à trois couches

L'importance des modèles d'affaires durables est de plus en plus reconnue dans les cercles académiques et industriels. Comme le soulignent Cardenal et al. (2020), les entreprises explorent des moyens d'améliorer leur impact sur les trois piliers de la durabilité : économique, social et environnemental. Ce virage vers la durabilité n'est pas seulement une tendance, mais un changement essentiel, nécessitant de l'innovation et divers outils méthodologiques. L'un de ces outils est le Modèle d'Affaires à Triple Couche (MATC) en anglais BMC, une adaptation du Canvas original d'Osterwalder & Pigneur (2010). Le MATC intègre la durabilité dans les modèles d'affaires en se concentrant sur la création de valeur sociale et environnementale. Joyce et Paquin (2016) voient cet outil comme pivot dans la conception de modèles d'affaires durables, fournissant une

structure aux problématiques de durabilité dans les modèles d'affaires actuels. Il introduit deux dimensions analytiques : la cohérence horizontale et verticale.

Dans des secteurs spécifiques comme le transport, le Modèle d'Affaires à Toile (MAT) aussi en anglais BMC est crucial. Il organise les opérations commerciales, en tenant compte des dynamiques horizontales et verticales et de l'impact de l'Industrie 4.0. Parodos et al. (2022) suggèrent d'adapter le MAT pour les plateformes numériques comme approche stratégique. De même, García-Muiña et al. (2020) soulignent l'importance croissante de la durabilité dans la fabrication, en particulier dans des secteurs intensifs en ressources comme le camionnage. Güemes-Castorena et Toro (2015) mettent en lumière le rôle de l'innovation technologique et des demandes du marché dans la formation des stratégies d'entreprise, préconisant une utilisation combinée de la Feuille de Route Technologique (FRT) et du MAT.

Cardenal et al. (2020) discutent des défis de développement de modèles d'affaires durables, notant des conflits potentiels entre les trois dimensions de la durabilité. Cette discussion mène au concept d'économie circulaire, en particulier dans l'industrie du camionnage. Lewandowski (2016) plaide pour une transition d'un modèle économique linéaire à un modèle circulaire, motivée par des avantages financiers, sociaux et environnementaux. Cependant, la mise en œuvre d'un tel modèle nécessite des changements profonds dans la culture, la politique publique et les stratégies financières, ainsi qu'une compréhension systémique de la conception de modèles d'affaires circulaires. Ces changements sont essentiels pour promouvoir l'économie circulaire dans les secteurs du transport.

2.6.4 Modélisation de simulation basée sur des agents

La modélisation par simulation basée sur les agents est un outil puissant pour comprendre les systèmes complexes et est largement utilisée dans divers domaines, y compris l'économie et la dynamique du marché. Cette revue de littérature fournit des aperçus précieux sur l'application de la modélisation basée sur les agents à travers divers marchés et mécanismes, en se concentrant particulièrement sur son rôle dans la compréhension du comportement des agents et la promotion de l'innovation dans les modèles commerciaux.

Un aspect clé de la modélisation basée sur les agents est sa capacité à fournir une vue nuancée des interactions des agents et de leurs conséquences. Cela est évident dans des études telles que celles d'Asgari (2020), Lafkihi et al. (2019), et Reis (2019), qui utilisent ces modèles pour enquêter sur différents aspects des enchères quantitatives. Par exemple, la recherche d'Asgari révèle l'impact de la sélection des agents dans des environnements d'enchères compétitifs, tandis que Lafkihi et al. se concentrent sur les mécanismes d'incitation dans les réseaux de transport collaboratifs décentralisés. Reis, d'autre part, examine les effets des politiques de transport sur le comportement des transporteurs, soulignant la complexité des interactions dans ces contextes.

Janssen et Verbraeck (2005) étendent ces aperçus aux mécanismes d'enchères en temps réel dans le secteur des transports, démontrent comment la modélisation basée sur les agents peut identifier des corrélations entre la logique du marché et les gains d'efficacité. Cette approche n'est pas limitée au transport mais trouve également des applications dans d'autres domaines, tels que le travail d'Araújo et al. (2017) sur l'allocation de créneaux basée sur les enchères dans les aéroports et l'exploration par Zolfagharipour et Ahmadi (2021) des marchés locaux et des facteurs socio-économiques dans le comportement d'enchères.

De plus, la modélisation basée sur les agents est cruciale pour comprendre les facteurs économiques dans les processus d'enchères. Cela est évident dans des études comme celles de Miyashita (2014), qui introduisent des modèles pour les enchères de biens périssables, et de Vaya et al. (2012), qui se concentrent sur l'optimisation des coûts de recharge pour les véhicules électriques à l'aide d'enchères basées sur les agents.

Dans l'ensemble, ces études soulignent la polyvalence et l'importance de la modélisation basée sur les agents pour fournir des aperçus profonds dans les systèmes économiques. Les éléments communs d'interaction des agents et de facteurs économiques dans ces études offrent de nombreuses opportunités pour des applications interdisciplinaires et des recherches futures dans divers scénarios d'enchères. La capacité de la modélisation basée sur les agents à simuler des systèmes complexes et à prédire les résultats en fait un outil indispensable pour comprendre et innover dans divers contextes économiques.

2.7 Synthèse de la revue de littérature

La revue de littérature explore de manière approfondie l'évolution de l'industrie du courtage de fret, mettant en lumière sa transformation des pratiques traditionnelles vers une ère numérique impulsée par les avancées technologiques et l'Industrie 4.0. Elle souligne le rôle crucial des plateformes de Correspondance de Fret Numérique (DFM) dans la restructuration de l'industrie par la facilitation des connexions directes entre expéditeurs et transporteurs, et met l'accent sur les contributions innovantes des startups, notamment dans l'exploitation de l'intelligence artificielle. Cependant, la revue identifie des lacunes significatives, y compris le besoin d'études détaillées sur les impacts à long terme de ces changements technologiques sur les modèles de courtage de fret, l'intégration harmonieuse des technologies de l'Industrie 4.0, et les défis auxquels les startups sont confrontées pour sécuriser des financements et former des alliances stratégiques. De plus, elle souligne un manque d'applications pratiques et d'études de cas dans l'utilisation de cadres stratégiques tels que SWOT et EFQM-2020, et dans la mise en œuvre de modèles d'affaires durables et de la modélisation de simulation basée sur les agents dans le secteur du fret. Cette synthèse révèle une dynamique de l'industrie marquée par des avancées technologiques rapides mais souligne également la nécessité de recherches supplémentaires pour comprendre pleinement et exploiter ces changements dans l'industrie du transport de fret.

En résumé, bien qu'il y ait eu des avancées significatives dans le courtage et le transport de fret, notamment avec les technologies numériques, il existe des lacunes notables dans la compréhension de l'impact complet de ces changements, en particulier dans les domaines de l'adaptation des modèles d'affaires, de l'intégration des technologies de l'Industrie 4.0, et du rôle des startups dans cette perspective en évolution.

CHAPITRE 3 ARTICLE 1: SUSTAINABILITY AND INDUSTRY 4.0

DRIVEN BUSINESS MODEL FOR SMART FREIGHT PLATFORMS: MULTI STRATEGIC TOOLS APPROACH

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Bas, T., Keivanpour, S. (2023, November 21)

Abstract. *New business models are currently being developed in the context of truck freight transport, which influence sustainability and play a key role in reducing traffic and emissions. Although there are some case studies in the context of new business models in carpooling, only a few cases have addressed the influence of freight transport systems driven by Industry 4.0. One of the problems of freight transport by truck is that a large percentage return empty to their starting point after deliveries, which means significant economic losses and environmental pollution. Many organizations need to transport their goods but lack the right truck for their needs at the right time and at a convenient and reasonable price. This leads to the search for a better freight service based on sustainable logistics to optimize operations. This research explores the case of a start-up based in Canada, looking for a window of opportunity to develop and grow dynamically in an ever-changing world of agent-based intelligent transportation. The start-up role is to provide a simultaneous service by acting as an intermediary between different parties (Carriers and Shippers) in the quest for more sustainable and efficient transport through the deployment of a smart platform. The platform aims to optimize service connections, reduce empty or under-capacity truck trips, optimize schedules and routes, improve the coordination and reliability of freight transport services, and improve the resilience of supply chain logistics. In this study, a multi-strategy tools approach is applied to analyze the business model and address the long-term sustainability and impacts of technology enablers on these new enterprises.*

Keywords: *Sustainability, Industry 4.0, Smart freight platform, Agent based modeling, Business model, SWOT, EFQM-2020.*

3.1 Introduction

Over the years, there has been a gradual increase in the transport of goods using trucks (Freight) that cover large distances per year. At the same time, a complication has arisen with the carrier and shipper industry, as many of these trucks circulate a large part of their time without a full load, i.e., they go to their destination with a full or half-full load and often return empty. This situation has a direct impact on the industry's financial costs (fuel, man hours, and spare parts) as well as on environmental sustainability through carbon dioxide (CO₂) emissions, which is a major source of environmental pollution and an accelerator of climate change. Based on this equation, the article analyses a series of measures that seek to optimize the different variables mentioned using a variety of technologies currently available and are grouped under the umbrella of "industry 4.0". Along the same lines, the SWOT analysis will be used to understand the strengths, weaknesses, opportunities, and threats related to the company and to analyze potential improvements in the industry. Following that, the EFQM-2020 model will provide insights into the purpose of the company and its future expectations. Moreover, the three-layer business models or triple impact Business Model Canvas (Environmental, Social, and Economic) can be used to explain the strategy followed by the Start-up and analyse the logistics and sustainability of trucking. To observe the applicability and potential scope of these models at a reasonable cost, agent-based modeling will be employed. Through an intelligent platform developed by a Canadian start-up, which acts as a link between two types of clients (carriers and shippers), the aim is to fine-tune the logistics of the trucking industry, reducing the distances traveled by unloading trucks, maximizing the kilometers with a full load, while optimizing the best routes to use, which together results in a positive impact on the medium and long-term sustainability of this type of transport and considerable savings in costs associated with this industry. The research contribution of this article is applying the combination of strategic tools for analyzing the sustainability of the business model of a smart freight platform with technology enablers. To the best of our knowledge, the multi-strategic tools approach has not received much attention in the literature in the context of smart freight transportation. The article is organized as follows: section 2 provides a literature review on industry 4.0 and SWOT; EFQM; triple layer BMC and advanced simulation modeling in Ride-sharing. Section 3 provides a research approach, section 4 of the application of the multi-tools in the case of the start-up intelligent platform, and finally, section 5 concludes with some remarks and future research.

3.2 Literature review

The analysis of the theoretical framework aims to address the impacts of traditional logistics systems in the trucking industry on the environment and the economic costs associated with widespread malpractices. Therefore, the implication of Industry 4.0 in transportation business models is one of the keys to optimizing these systems. Here we refer in particular to the SWOT and EFQM analysis that allow us to validate their potential in logistics and the sustainability of truck transport. Additionally, we explore the Business Model Canvas models and their evolution towards the three layers: environmental, social, and economic, along with the advanced simulation tools based on ride-sharing agents. These different tools provide further insights into the application and effectiveness of the mentioned models.

3.2.1 The implications of Industry 4.0 on the transportation business models

Industry 4.0

Industry 4.0 (I4.0) technologies are set to bring an unprecedented advance in the human vs. machine relationship, considering a more autonomous and agile production, based on tools such as data mining that allow any industry a more flexible and affordable production. As Ferreira et al. (2022) point out, I4.0 is a central strategy to strengthen the competitiveness of the manufacturing sector, but there is still a lack of understanding of the true capacity of the different tools that are part of these technologies to be able to speak of a true integrative process. Some encouraging benefits can be seen in traceability and predictive maintenance through real-time monitoring of devices, machines, and data, which anticipates a rapid detection and solution of problems. Similarly, according to Ferreira et al. (2022), it enables virtualization through sensors, data in the cloud, and connectivity to manage processes remotely. This leads to decentralization through machine intelligence, allowing them to self-regulate according to changes and market demand in a more strategic way. Another benefit can be seen through software that serves as cloud-hosted services to provide greater customer support.

It is crucial to address the relationship between the impact of freight transport, the importance of sustainability, and the rise of I4.0 from the application of different types of smart technologies such as data mining, internet of things, specialized GPS, mobile phone usage, carpooling, modeling and

simulations, driver assistance through miniaturization of information technologies (Li and Yu, 2017; Yin et al., 2018; Birek et al., 2018). From this perspective, the I4.0 revolution is interesting due to its impacts on sustainability and the reduction of greenhouse gases (GHG) caused by combustion transport. Kermanshah et al. (2020) consider that the use of GPS-supported cyber-physical technologies can be of great benefit not only for freight transport in urban areas but also for the economy, sustainability, and society. The authors perform a cost-benefit analysis of the use of cyber-physical technologies, estimating that the benefits can be up to seven times greater than the costs in terms of present values. Other authors use CIMS-Freight to simulate different scenarios that influence the adoption of charging technologies. In addition, the simulated market for each technology is used to calculate GHG emissions in different scenarios, while analyzing the life-cycle cost of the vehicle and each technology (Hammond et al., 2020). Birek et al., 2018 use a basic principle that drives the calculation mechanism of the Support Vector Machine (SVM) methodology, maximizing the headroom capable of handling the volume of data and requirement calculations associated with the automated prediction of a driver's intention and behavior. A major difficulty arises with the enormous amount of data to be processed simultaneously, so "cloud computing" enables ubiquitous and on-demand access to shared data and processing resources (servers, storage, applications, and services, etc.), thus enabling three key supports of big data: scalability, elasticity, and flexibility (Borgi et al., 2017). In addition, the authors discuss Big Data technologies involving commercial and open-source platforms and services for storing, protecting, accessing, and processing data, many of which are based on what is known as the "Hadoop framework", a widely used open-source code. It is an open-source framework designed to process data at scale using clusters of commodity hardware. It consists of a distributed storage component: Hadoop Distributed File System (HDFS) and a processing component: the MapReduce programming model. It is crucial to learn how to track through intelligent technologies (IT) that refer to the applications of artificial intelligence and data science technologies, such as machine learning, and big data, to create cognitive (autonomous) awareness of an object with the support of information and communication technology such as IoT and blockchain (Chung et al., 2021). Ghadge et al., (2020) develop a System Dynamics model to understand the impact of Industry 4.0, as they argue that this industry should bring new supply chain challenges. This can be coupled with the dynamics of I4.0 through the adoption of the circular supply chain integrated into I4.0 to help to ensure the sustainability of supply chain operations Kumar et al., (2021). Ilgin (2021), as well

as Kumar et al., (2021), use the DEMATEL methodology and the factors hindering the effective use of Industry 4.0 technologies in reverse logistics as a key competitive factor involving the integrated use of many technologies in wireless communications linking a complex network between machines, people, and mobile devices.

3.2.2 SWOT

SWOT analysis was born as a tool for management, analysis, and strategic business planning, however, over time it evolved as a participatory planning method, where interdisciplinary discussion is encouraged (Rauch et al., 2015; Kowalska-Pyzalska et al., 2020). In this sense, SWOT is an analysis of strengths, weaknesses, opportunities, and threats, which seeks to facilitate a deeper understanding of the state of development of a given industrial sector (Chen et al., 2017). In basic terms, it can be said that SWOT intervenes in the internal strengths and weaknesses of the organization, while on the other hand, it monitors external opportunities and threats. On the other hand, the letters S and W represent the current state of an organization, while the letters O and T rehearse the future conditions that could be expected (Rauch et al., 2015; Kowalska-Pyzalska et al., 2020). Chen et al., 2017 emphasize that in many opportunities the situation and macro-environment analysis model (PEST-SWOT) is used to analyze the development strategies of some emerging industries on advantages and disadvantages, development opportunities, and potential challenges of changes in the environment and thus formulate related policy recommendations SWOT analysis can also be used to assess the market and propose the solutions to improve the diffusion of a certain product or service. The overall objective of each SWOT analysis is to develop a strategy, which builds on strengths and opportunities while eliminating weaknesses and threats (Kowalska-Pyzalska et al., 2020). The extension of a SWOT analysis with Multi-Criteria Decision Support (MCDS) methods should be a very useful instrument in a more orderly evaluation related to SWOT factors (Kajanus et al., 2012). Rauch et al. (2015) emphasize that the most used MCDS method is the so-called Analytic Hierarchy Process (AHP) which uses a pairwise comparison of factors concerning the stated strategies, however not always the stated factors operate independently, which could distort certain results.

3.2.3 EFQM (European Foundation for Quality Management)

The EFQM 2020 version is a comprehensive and updated business model of business excellence that incorporates the United Nations Sustainable Development Goals (SDGs) and comprehensively frames sustainability (Fonseca et al., 2021). At the same time, the authors show that this model shares characteristics with I4.0, emphasizing the transformation and improvement of organizational performance, but with different theoretical and practical foundations, which makes it suitable for use in smarter and more sustainable transport logistics. It is a model that enables a reduction of resources used in operational processes and times, and costs and minimizes environmental impacts and consumption of natural resources, leading to environmental sustainability. The EFQM-2020 model has an integral holistic vision, incorporating principles and approaches of Total Quality Management (TQM), of I4.0 and sustainability, framing within a framework of common objectives with what has been analyzed in this literature review.

When analyzing the EFQM-2020, as well as the tools discussed above, it is clear, as Teixeira and Tavares-Lehmann (2022) explain, that to generate strategic quality planning, a strong integration is necessary not only in the processes, but also in the dynamics of data that promote agility, flexibility, and opportunities, but always with the involvement of public policies for greater innovation and more efficient customization of processes. In this sense, the same authors estimate that EFQM-2020 stimulates organizational efficiency, global productivity, and long-term competitiveness.

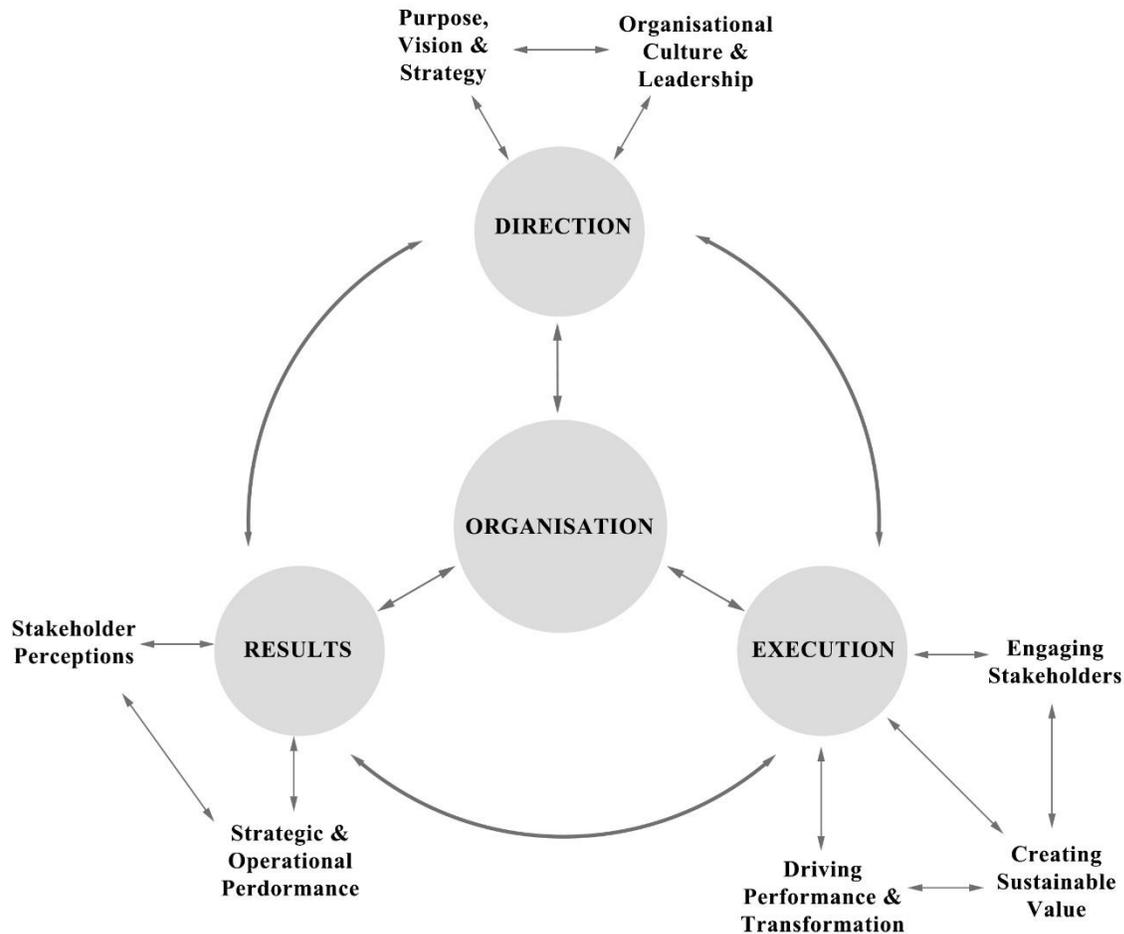


Figure 3.1 EFQM-2020 model (adapted from EFQM, Private Foundation, 2022)

3.2.4 Triple-layered BMC

The topic of sustainable business models is growing in the literature and in the industry, driving companies to seek new opportunities to improve their positive impact on three basic pillars of sustainability: economic, social, and environmental as expressed by Cardenal et al. (2020). This leads us to think that sustainable business models, more than a trend, are an imperative need that is addressed from innovation through the use of different methodological tools. The use of the Triple Layered Business Model Canvas (TLBMC), which is an extension of the Canvas designed by Osterwalder & Pigneur (2010), adds key elements of sustainability through the creation of social and environmental value. Joyce et Paquin (2016) consider that this new tool contributes to the investigation of more sustainable business models by providing a design tool that allows, in a way,

to structure more coherently the various sustainability issues related to current business models. In addition, it creates two new dynamics of analysis: horizontal coherence and vertical coherence. It is important to highlight the importance of the development of a Business Model Canvas (BMC) in the transport industry, which allows the organization of the business, not only from the horizontal and vertical dynamics but also from the use of Industry 4.0 and its implications in agent-based approach in transport business models. Parodos et al. (2022) describe a proposal for a company's business model using BMC adapted to digital platforms as the most appropriate strategic tool. Other authors such as García-Muiña et al., 2020 estimate that the transition towards sustainability is becoming increasingly relevant at the manufacturing level, especially for resource-intensive and energy-intensive industries such as trucking. On the other hand, we can observe how Güemes-Castorena and Toro (2015) analyze how technological development and market demands accelerate changes in the world and how technological innovation is a key success factor for the improvement of company performance and survival. The authors propose the structured development of a Technology Roadmap (TRM) and a BMC to build a robust business strategy proposal considering the pros and reducing the cons of each strategic tool to its maximum exponent. Cardenal et al. (2020) analyze the difficulty in the process of developing sustainable business models due to potential conflicts between the three dimensions (environmental, economic, and social) for organizations. This leads us to think of the circular economy as an important factor in the trucking industry. Lewandowski (2016) analyses this variable from a shift from the current linear use-and-waste economy model to a circular one based on design to avoid waste. The rationale for this is based on potential financial, social, and environmental benefits, in the style of the triple-layer BMC, but these are not changes that can be made without societal and state intervention through comprehensive public policies. Profound cultural, public policy, and financial changes, as well as systemic knowledge of the design of circular business models, are needed to stimulate and foster the implementation of the circular economy in transport.

3.2.5 The advanced simulation models in Ride-sharing

In the optimization of resources related to the trucking industry, it is fundamental to consider the idea of ride-sharing. This could directly affect mobility, fuel consumption, and CO2 emissions into the atmosphere, as well as drivers' man-hours, in addition to the use of truck inputs and components

(tires, spare parts, and drivers). In this sense, some research analyses how switching from private vehicles to shared mobility services can directly affect energy consumption and CO₂ reduction. This is validated through agent-based traffic simulation packages such as SUMO, which allows for reproducing traffic activities for different types of trips (Sun et al., 2022). In the same way, the problem in public transport of what are known as automated, driverless coupled vehicles (CVs) can be addressed, where an agent-based simulation model called Automated Last Mile Transport (ALMT) is proposed. A dispatching algorithm distributes trip requests among available vehicles using a FIFO sequence and selects a vehicle based on a set of specific control conditions (Scheltes et al., 2017). In this way, it is possible to relocate empty vehicles or allow the pre-booking of vehicles which would provide a significant reduction in the average passenger waiting time. Other studies analyze the importance of autonomous vehicles (AVs) to make comprehensive public policy recommendations based on the reduction of accidents and environmental pollution. They use an agent-based modeling approach to develop market penetration simulation, thus helping to quantify the motives and opportunities that consumers visualize when choosing an AV (Baskutis et al., 2022; Silva et al., 2022). Other authors analyze what is known as demand-responsive public transport (DRT) as an alternative that helps to complement existing public transport services using an agent-based approach through simulation as a mobility alternative for a region, obtaining information on the impact on operational, user, and system performance indicators. DRT scenarios are tested for different fleet sizes, vehicle occupancy rates, and cost policies (Kagho et al., 2021). Other authors use agent-based modeling for mobility as a service (MaaS) to integrate the supply and demand of new transport modes under a shared system to solve some mobility problems that plague traffic-clogged cities. Others use a sort of co-simulation of two independent agent-based simulators: MATSim and IMSim (Giorgione et al., 2019; Giorgione et al., 2022). The first simulator generates a realistic transport demand for a city: assigning travelers the best mobility option according to their preferences, while IMSim provides a real operational implementation of autonomous and manual transport fleets. Using two simulation tools, the authors analyze how they complement each other to provide superior autonomous mobility-on-demand (AMoD) modeling capabilities. Thus, the authors evaluate the impact produced in various AMoD scenarios from different points of view, both from the perspective of the traveler and the operator, as well as from a city perspective, demonstrating the importance of approaching the transport problem in the spirit of integration of all stakeholders.

3.3 Methodology framework

The research approach (presented in Figure 3.2) begins with a comprehensive literature review to establish a solid foundation of existing knowledge and identify gaps in the field of study. This step helps to inform the subsequent stages of the research. Next, a SWOT analysis is conducted to assess the internal and external factors that influence the company. This analysis helps to identify the strengths, weaknesses, opportunities, and threats in the business environment. By understanding these factors, the research can better evaluate the company's position, competitive advantages, and potential risks in the logistics industry.

To further understand how the organization should set its purpose and deliver its values, an EFQM-2020 Model is applied. This model provides a structured framework for assessing and enhancing organizational excellence. It helps to define the organization's vision, mission, and core values, as well as identify areas for improvement and innovation. To gain a comprehensive understanding of the company's operations and sustainability, a Triple Layer Business Model Canvas (TLBMC) is designed. This model examines the organization based on three key pillars of sustainability: environmental, social, and economic. The TLBMC enables a holistic view of the company's activities, value propositions, and potential areas for improvement. Subsequently, an agent-based architecture is developed for a smart freight platform.

This involves designing and implementing a system that utilizes agent-based modeling techniques to optimize freight operations. The architecture takes into account factors such as resource allocation, route optimization, and real-time decision-making to enhance efficiency and effectiveness in the logistics domain. After the architecture is developed, a rigorous validation and verification process is undertaken. This involves assessing the elements of the system, both through secondary data analysis and exchanges with experts from the company. This step ensures that the components of the agent-based architecture are accurate, complete, and aligned with the requirements and objectives of the study. If any discrepancies or deficiencies are identified, the process loops back to the previous step to address and rectify them.

Throughout the research process, validation and verification steps are performed after each application of the strategic tools: SWOT analysis, EFQM-2020 Model, TLBMC, and agent-based architecture. These steps ensure the accuracy, reliability, and robustness of the findings and recommendations derived from each tool. Finally, based on the insights gained throughout the

research process, relevant recommendations are proposed to enhance the company's operational, strategic, and excellence perspectives. Conclusions are drawn based on the comprehensive analysis conducted, highlighting the significance of the research findings and their implications for the logistics industry. By following this three-phased research approach, encompassing tactical/operational, strategic, and learning/excellence perspectives, the study provides a comprehensive understanding of the freight platform's functionality, sustainability, and potential for improvement.

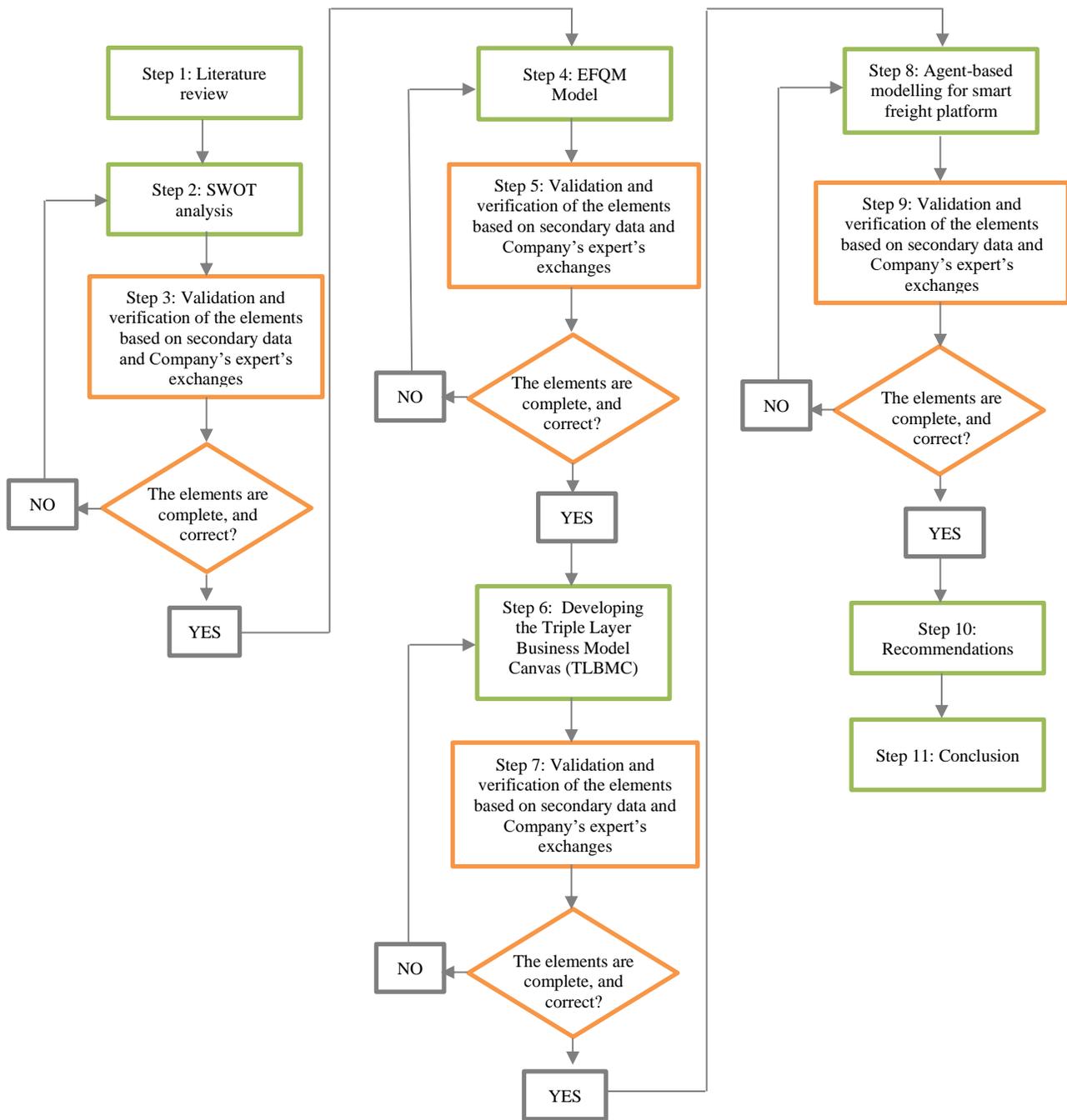


Figure 3.2 Methodology framework

3.4 Case study

3.4.1 SWOT Analysis for Start-up

An analysis SWOT of the company (Table 3.1) was made to better know and understand where the company is now and how the ecosystem can affect the Start-Up. SWOT analyses the internal and external environment of a company as well as the factors that can affect the viability of a business decision, in the direction of raising awareness of what factors impact business decisions and establishing business strategies.

Currently, the company does not have a real position in the market. But as internal strengths the Start-up has the platform and service offered in French and English that almost no other competitor offers, also the company has a highly-skilled, innovative IT team and engineering competencies that with the support of the internet of things can obtain valuable data through different technologies to have for example a real-time detection and reaction capability on driving onboard through a centralized platform. As threats clients can form a path dependence or other enterprises can imitate the operation model and applications, also there are some well-established logistics and freight brokering companies in the market but there is good startup support and community in Montreal, especially for innovative and technological startups and with this, provide tools for the company growth.

Table 3.1 SWOT

<p>Strengths</p> <ul style="list-style-type: none"> • The company has a highly-skilled, innovative IT team and engineering competencies. • Low cost of operation and maintenance (the use of the latest technologies allows the reduction of operating costs). • Offer a service in French and English. • Applicable to all kinds of goods demand, the market is broad. • Support by the Internet of Things Technology, improving customer service. • Increase driver safety and job satisfaction for both types of clients. • Value data obtained through different technologies. These different technologies complement each other and the different processes. • Real-time detection and reaction capability on driving deviations onboard. • Accurate trajectory generation and deviations mode determination due to onboard truck state and parameter estimation. • Supply chain integration and profitability. • Flexibility in system organization and expansion. • Centralized web platform for contracting. • Well-established and clear business relationships. • Personalized and automatic rules configuration in the system. • The use of telematics features. • Visibility of the truck all along the route • Shippers and Carriers have control when they book the shipment. • Use of technologies that are very recent to the market and not offered yet by competitors. 	<p>Opportunities</p> <ul style="list-style-type: none"> • Not many direct competitors in the Canadian Market. • New technologies such as asset tracking, IoT, blockchain, fleet management software, and mobile applications. • Good startup support and community in Montreal, especially for innovative and technological startups. • Canada has a good technological base to be able to develop the project, with cameras, routes in good condition, etc. • Market awareness of this type of technology is growing, as this technology is getting a lot of traction in the market lately. • No direct competitors are offering service in French. • The reverse relationship between logistics demand and supply promotes the development of logistics. • Logistics enterprises seek cooperation, and multimodal transport is mature. • Networking, information, and intelligent technology to promote the promotion of intelligent logistics. • High central unit computation power for cloud platform possibility. • Steady growth in the volume of cargo transportation by road. • Increase in society's requirements for the delivery of goods. • Stakeholders interested in and searching for this kind of service (shippers and carriers). • Efficient identification and verification of proper carriers. • Improving learning algorithms and developing practical models. • Consolidating multiple applications into one to simplify our technology stack.
<p>Weaknesses</p> <ul style="list-style-type: none"> • No cash flow yet. • No experience in the logistics sector. • No market presence. • Need policy support. • The industry standards and development policies are missing because it is an emerging industry. • Still needs to connect with other logistics systems; the overall logistics level is subject to the integrated level of multimodal transport. • Limited reaction capability on driving deviations onboard. • High requirements for communication latency. • Complexity in urban freight consolidation. 	<p>Threats</p> <ul style="list-style-type: none"> • Many new and well-established direct competitors. • A monopoly of large companies. • Political and economic factors such as United States border tariffs can impact the logistic industry in Canada. • Uncertainty of the price market. • Imitate or copy the operation model and application. • The policy system is complex. • Clients can form a path dependence and continue to do business with each other if they always do the same route or shipment. • A lot of road work and maintenance make it difficult to have a clear route to the destination. • High risk of cargo transportation under difficult meteorological conditions. • Excessive bureaucracy in terms of transport and control documents. • The low level of information technology among urban freight transport stakeholders. • Information and decision sharing between shippers and carriers companies lead to extra negotiation time.

3.4.2 EFQM-2020 Model of Start-up

The EFQM Model searches to create sustainable value for the stakeholders of the company as well as help them to understand the gaps and possible solutions available, empowering them to progress and significantly improving the organization's performance. By examining the coherence and alignment of an organization's future ambitions concerning its current working methods, the EFQM model is ideally suited for assessing the coherence and alignment of its strategic and operations plans. In this case, the 2020 EFQM model is used, this new version of the model simultaneously delivers outstanding performance while managing the paradigm shift brought about by Industry 4.0. It integrates total quality management (TQM), industry 4.0, and sustainability principles and approaches to improve organizational performance. It is important to understand that the focal point of the EFQM-2020 model is the link between the purpose and strategy of an organization, and how these two are used to deliver outstanding results for its stakeholders.

Table 3.2 EFQM-2020 criterions and sub-criterions (adapted from EFQM, Private Foundation, 2022)

DIRECTION	EXECUTION	RESULTS
1. Purpose, Vision & Strategy 1.1 Define purpose & vision 1.2 Identify & understand stakeholders needs 1.3 Understand the ecosystem, its own capabilities & major challenges 1.4 Develop strategy 1.5 Design & implement a governance & performance management system	3 Engaging Stakeholders 3.1 Customers: build sustainable relationships 3.2 People: attract, engage, develop & retain 3.3 Business & governing stakeholders – secure & sustain ongoing support. 3.4 Society: contribute to development, well-being & prosperity 3.5 Partners & suppliers: build relationships & ensure support for creating sustainable value	6 Stakeholder Perceptions 6.1 Customer perception results 6.2 People perception results 6.3 Business & governing stakeholders perception results 6.4 Society perception results 6.5 Partners & suppliers perception results
2 Organisational Culture & Leadership 2.1 Steer the organization's culture & nurture values 2.2 Create the conditions for realizing change 2.3 Enable creativity & innovation 2.4 Unite behind & engage in purpose, vision & strategy	4 Creating sustainable value 4.1 Design the value & how it is created 4.2 Communicate & sell the value 4.3 Deliver the value 4.4 Define & implement the overall experience 5 Driving Performance & Transformation 5.1 Drive performance & manage risk 5.2 Transform the organization for the future 5.3 Drive innovation & utilize technology 5.4 Leverage data, information & knowledge 5.5 Manage assets & resources	7 Strategic & Operational Performance 7.1 Achievements in delivering purpose, strategy & creating sustainable value 7.2 Fulfilment of key stakeholder expectations 7.3 Economic & financial performance 7.4 Achievement in driving performance & transformation 7.5 Predictive measures for the future

Direction

When the direction is analyzed, it is sought that the organization manages to be well-positioned in the market to carry out its objectives. For this, it must have a purpose, which through its activity inspires, provides values, and manifests its responsibility in terms of the ecosystem. A vision where the objectives are described and these function as a guide for the different decision-making. And a clear and detailed strategy, which goes together with the purpose and vision set out.

Table 3.3 Direction: purpose, vision & strategy

<p>1.1. Purpose, mission, and vision</p> <ul style="list-style-type: none"> • Offer an online solution for both shippers and carriers companies, to fulfill their logistics requirements by matching them and managing their shipments and fleets. • The Start-Up wants to improve the shipping process and make it more pleasant and efficient by offering a simple yet powerful platform to manage, optimize and automate the shipping process. 	<p>1.4. Strategy</p> <ul style="list-style-type: none"> • Shippers can submit shipping service quotas and get freight offers from carriers. • Shippers can track their shipment in real-time • Manage their current past and future shipments. • Track different sensor data such as temperature tracking. • Manage their fleet in a single online platform • Evaluate the service, resources, capabilities, and availability to best match the freight service.
<p>1.2. Needs of interest groups</p> <ul style="list-style-type: none"> • Reduce costs and times in freight transportation. 	<p>1.5. Governance & performance management system</p> <p>Roles that provide direct operational services:</p> <ul style="list-style-type: none"> • Freight Agent providing customer service related to the freight. • Customer service relating to administrative such as billing. • Technical service providing technical help on the platform. <p>Roles that provide indirect operational services:</p> <ul style="list-style-type: none"> • Accounting and finance. • Human Resources. • Business development. • Engineering.
<p>1.3. Business ecosystem</p> <ul style="list-style-type: none"> • Seek to rely on existing companies that have a quick response when looking to send products or find a possible client. The ecosystem is the business-to-business for-hire motor carrier freight shipping and targets the spot rate market with FTL freight and LTL freight. 	

Creating a culture within the organization where leadership behaviors are evident at all levels and areas helps to establish principles, values, and standards for the company. An organization that aspires to be recognized in its ecosystem achieves success by focusing on the criteria outlined in Table 3.4.

Table 3.4 Direction: organizational culture & leadership

<p>2.1. Steer the organization's culture & nurture values</p> <ul style="list-style-type: none"> • The company culture seeks to create different areas where each one has a specific objective. If a problem arises, the areas will meet to solve it jointly. • This culture focuses on the personal and professional development of its work team, promotes social values, and encourages motivation, creativity, teamwork, collaboration, responsibility, diversity, and quality. 	<p>2.3. Enable creativity & innovation</p> <ul style="list-style-type: none"> • In the work teams there is a diversity of areas and backgrounds, in this way different perspectives and solutions are provided on a subject. • Promote a culture that motivates its employees to propose new ideas.
<p>2.2. Conditions to make the change a reality</p> <ul style="list-style-type: none"> • Monthly meetings of areas to show progress and discuss problems and improvements. • Offer internships to students, who can bring new challenges and ideas. • Provide training to always be updated and prepared for possible changes. 	<p>2.4. Unite behind & engage in purpose, vision & strategy</p> <ul style="list-style-type: none"> • The company wants to promote a culture of innovation to develop the best tools that would improve the shipping experience and make it more efficient. Since the customer experience is a top priority for the company, they commit to provide a great customer experience through its software and to offering top-quality customer support to the shippers and carriers customers.

Execution

It is necessary to identify the different stakeholders and understand their needs and expectations to generate a relationship with them and achieve collaborative work with responsibility and trust.

Table 3.5 Execution: engaging stakeholders

<p>3.1. Customers</p> <ul style="list-style-type: none"> • To build sustainable relationships with customers: personalized attention 24/7. • Economic attention (seniority, volume, discount, payment on time, etc.). • Anticipate problems. • Transparency with clients. • Ratings among customers to keep them on the platform. 	<p>3.3. Investors and Regulators</p> <ul style="list-style-type: none"> • Transparency in the company in terms of functionality and economics. • Demonstrate progress. • Detailed reports are presented every month.
<p>3.2. People</p> <ul style="list-style-type: none"> • Flexible work. • Training depends on the needs of the market and employees. • Promote a good communicative work environment. • That the employee manages to get involved and develop professionally within the company. 	<p>3.4. Society</p> <ul style="list-style-type: none"> • Contribute to the development of existing companies. • Generation of new jobs. <p>3.5. Partners and Suppliers</p> <ul style="list-style-type: none"> • Transparency. • Demonstrating progress. • Work together for the future mutual growth of the companies. • Constant and effective communication showing optimal results. • Technological tools that improve the relationship with suppliers.

Sustainable value creation is an essential part of any organization's long-term success and economic strength. Below in Table 3.6, the different stages of creating sustainable value are presented.

Table 3.6 Execution: creating sustainable value

<p>4.1. Designing value and how it is created</p> <ul style="list-style-type: none"> • Search for optimal routes. • Logistics digitization. • Seek the balance between the needs and interests of both parties to increase productivity, reduce the use of energy and gasoline, and thus reduce the environmental impact. 	<p>4.3. Deliver the Value</p> <ul style="list-style-type: none"> • Offers a platform to help companies find freight transportation services and manage their shipments. And help transportation companies offer their service through the platform and manage their freight operations on the platform.
<p>4.2. Communicate and sell the value proposition</p> <ul style="list-style-type: none"> • Social networks. • Website. • Events conferences and exhibitions. • Forums and blogs. • Online advertisement. 	<p>4.4. Define & implement the overall experience</p> <ul style="list-style-type: none"> • With the automation of the operations, such as reducing the communication to find and offer freight services, reducing the time for the preparation and managing of documents, and optimizing the fleet's operations.

To achieve the objective, it is necessary to manage in parallel the operation of its current activities and the continuous changes that arise both inside and outside the company. In this way the company, while achieving daily goals, prepares to reach its final objective.

Table 3.7 Execution: driving performance & transformation

<p>5.1. Drive performance and manage risk</p> <ul style="list-style-type: none"> • Study possible threats to anticipate them. • Optimize the overall cost of risks. • Leverage the strengths to be able to combat risks 	<p>5.4. Take advantage of data, information, and knowledge</p> <ul style="list-style-type: none"> • Create results reports through the acquired data. • The data and information generated by the different metrics and measurements can be used to optimize the operation of the platform. • Feedback.
<p>5.2. Transform the organization for the future</p> <ul style="list-style-type: none"> • Assess and determine vulnerabilities. • Establish prevention strategies. • Communicate information clearly to all employees. • Flexibility and adaptability to possible changes 	<p>5.5. Manage assets and resources</p> <ul style="list-style-type: none"> • Classify them through a dynamic structure. • Optimization of resources by properly planning processes. • Indicators of performance (KPIs).
<p>5.3. Drive innovation and use technology</p> <ul style="list-style-type: none"> • Invest in a software solution that offers integrated management of the organization, to know the critical elements of the company. • Promote the use of new simulation and optimization software for the platform. 	

Results

For the results section, as the company is a start-up, they don't have a presence in the market, so it can't measure results or show what was achieved on what was proposed. Likewise, it is an important part of the model to then compare the results proposed and the real ones, at the moment that the company does have a presence in the market. Therefore, in this section, assumptions and results expected will be proposed by the company, as well as suppositions and hypotheses that would be optimal to achieve.

The results obtained, through different channels and stakeholders, helps to understand the company where it stands, if it manages to transmit the purpose and values established previously, and understand if the needs of these stakeholders are still the same or changed, to determine which paths to take to reach the desired objective.

Table 3.8 Results: stakeholder perceptions

<p>6.1 Customer perception results</p> <ul style="list-style-type: none"> Measured through different types of indicators as well as questionnaires to know how satisfied the client is with the service provided. Customers are satisfied with the service provided. 	<p>6.3 Investor and regulatory perception results</p> <ul style="list-style-type: none"> They are satisfied with the progress and with also the transparency and clarity of the reports.
<p>6.2 People's perception results</p> <ul style="list-style-type: none"> The person feels comfortable and valued at work, to give their opinion on business decisions. A good workspace was generated, where the person wants to continue growing and developing with the company. Good interaction between the members of the company. 	<p>6.4 Society's perception results</p> <ul style="list-style-type: none"> A turnover of interns, who are trained within the company. The development and growth of existing companies by acquiring the services.
	<p>6.5 Partner and supplier perception results</p> <ul style="list-style-type: none"> They see development in the company along with the number of companies joining the platform to use the services. Constant and effective communication makes them want to continue working together with the company to continue obtaining optimal results.

As part of this criterion, the organization's performance is measured in terms of how well it fulfils its purpose, delivers its strategy, and creates sustainable values about the stakeholders and their perceptions, to understand and improve the performance and a plan for the future of the Start-up.

Table 3.9 Results: strategic & operational performance

<p>7.1 Achievements in delivering purpose, strategy and creating sustainable value</p> <ul style="list-style-type: none"> Through indicators, the achievements made so far will be evaluated, to verify compliance with the values established both in the strategy and in the principles of sustainability. 	<p>7.3 Economic and financial performance</p> <ul style="list-style-type: none"> Financial and non-financial metrics will be applied to measure your strategic and operational performance.
<p>7.2 Fulfilment of key stakeholder expectations</p> <ul style="list-style-type: none"> Understand the relationship between different stakeholders, and their current performance, to be able to accurately forecast how their performance will evolve in the future. 	<p>7.4 Achievement in driving performance and transformation</p> <ul style="list-style-type: none"> Understand where the company is at the moment, to evaluate and reflect on the decisions needed to achieve the originally formulated objectives.
	<p>7.5 Predictive measures for the future</p> <ul style="list-style-type: none"> Use current performance to accurately devise a future plan.

3.4.3 Triple Layer Business Model Canvas for Start-up

We present the business model canvas (Table 3.10) of the Start-up to summarize and visually illustrate the most important information of a company's business model and provide continuous dynamic clarity from the hypotheses that must be validated all the time.

Table 3.10 Business model canvas

Key partners <ul style="list-style-type: none"> • Carriers and shippers. • Connected networks of logistics services. • Technologies and innovation companies. • Companies in the insurance area. • Universities. • Non-profit organizations. 	Key Activities <ul style="list-style-type: none"> • Fleet telematics. • Logistics digitization. • Sharing economy. • Shipment and fleet management technologies. 	Value Proposition <ul style="list-style-type: none"> • Freight Brokerage Marketplace. • Shipment Management. • Shipment Tracking. • Customer Service. • Asset Tracking. • Truck GPS Maps and Navigation Software. 	Customer Relationships <ul style="list-style-type: none"> • Direct phone contact and email. • Social media and online messaging channels. • Webinars. • Conferences and exhibitions. • The company website and the application. • Affiliate Marketing. 	Customer Segments <ul style="list-style-type: none"> • Shipping or logistics department of a distribution center company. • Shipping or logistics department of a manufacturer company. • Sales or operations department of a trucking company.
Costs Structure <ul style="list-style-type: none"> • Promotional budget with the different promotional channels and the yearly budget. • Computing service costs. • Direct labor cost. • Indirect labor cost. • Office expenses. • Marketing expenses. 	Key Resources <ul style="list-style-type: none"> • Data logistics service. • Platform with mobile application and web page. • Human resources. • Financial. • Virtual resources. 		Channels <ul style="list-style-type: none"> • Direct-to-customer model. • Website company. • Forums and blogs. • Magazines. • Events, conferences, and exhibitions. • Social media. • Google ads. 	
Costs Structure <ul style="list-style-type: none"> • Promotional budget with the different promotional channels and the yearly budget. • Computing service costs. • Direct labor cost. • Indirect labor cost. • Office expenses. • Marketing expenses. 		Revenue Streams <ul style="list-style-type: none"> • IoT shipping services like IoT shipment tracking or truck maintenance management. • Sale and rent of IoT equipment and integration services. • Advance shipment, fleet management and analytics. • Three price strategies: Value base strategy, competitive price strategy, and volume discount price strategy. 		

The Start-up's current target market is the business-to-business for-hire motor carrier freight shipping and targets the spot rate market offering full truckload and less than truckloads freight services. The Initial region target market would be the east Canada Quebec and Ontario regions starting from Montréal and then expanding into both Provinces. The company offers the most demanded types of truck types such as dry-van, flatbed, refrigerated, and container.

Start-up should carefully monitor the demand and offer to balance them, it should have a capacity of offer that exceeds the demand by at least 20% to make sure that there can match a freight service when a shipper makes a request. As the Value proposition, the company offers different services as mentioned in Table 3.10, and by using the automatic capabilities of the system, the shippers and carriers can automate many of their operations such as reducing the communication to find and

offer freight services, reducing the time preparing and managing documentation, getting, or offering the best freight service, optimizing the fleet's operations.

By using technology and algorithms the company aims to become a more efficient logistic service by optimizing shipment operations and by matching the best carrier service to the shipment's requirements. This would be possible with technological integration, which gives access to data such as information about truck location and freight market information, and with fleet telematics which allows the capture and exchange of information between the fleet vehicles and central system to gather data, providing useful information to the vehicles.

For companies looking to extend the original economically oriented business model canvas concept, be more environmentally responsible, and have a social value creation, there is the tool named, the Triple Layer Business Model Canvas (TLBMC) where the environmental layer (Table 3.11) and social layer (Table 3.12) of the Start-up are added (Joyce et Paquin, 2016).

Table 3.11 Environmental Layer

Supplies and Out-sourcing	Production	Functional Value	End-of-Life	Use Phase
<ul style="list-style-type: none"> • Energy. • Electricity. 	<ul style="list-style-type: none"> • Energy for IT. • Cloud IT. • Logistics. 	<ul style="list-style-type: none"> • Platform. • Software update to cover more devices and existing versions. • Promote the use of cell phones. 	<ul style="list-style-type: none"> • Donate materials to companies that are dedicated to reusing. • Should the materials needed by the company be bought or rented? like the Cloud. 	<ul style="list-style-type: none"> • Energy. • Wi-Fi. • Electricity. • By using a device to use the platform. • Use of vehicles (fuel).
	Materials		Distribution	
	<ul style="list-style-type: none"> • Computers. • Cell Phones. • Sensors. 		<ul style="list-style-type: none"> • The freight transportation is done by trucks. • Seek to encourage hybrid trucks. 	
Environmental impacts		Environmental Benefits		
<ul style="list-style-type: none"> • Excessive use of energy for the platform to work 24/7. • Device battery due to prolonged use of the app. 		<ul style="list-style-type: none"> • Use of optimized routes. Reduces the use of gasoline, as well as CO2 pollution. • A constant decrease in electricity uses due to the use of wireless devices. • Digitization of the platform. • Reduced carbon footprint. 		

In the TLBMC, the environmental layer focuses on how the organization generates more environmental benefits than environmental impacts. The Start-up, by providing services and being a type of intermediary between shippers and carriers, does not have trucks that pollute or the need to transport/manufacture products that end up having an environmental impact. Therefore, its greatest negative impact is the constant use of the platform and the batteries or materials that can be discarded for this use. But, on the other hand, it has several positive impacts as detailed in Table 3.11. The minimization of total distance will be involved in the reduction of CO₂ as well as promote the use of hybrid trucks.

Table 3.12 Social layer

<p>Local Communities</p> <ul style="list-style-type: none"> • Integration of small companies so they can reach the client without needing a greater expense. • Integration of students and people who look for personal growth as well as a team within the company. 	<p>Governance</p> <ul style="list-style-type: none"> • Set purpose. • Purpose Led Management. • Transparency in decision-making. <p>Employees</p> <ul style="list-style-type: none"> • Flexible work days. • Nutritional communication between the members of the company. • Diversity of the staff-gender-ethnicity-education. 	<p>Social Value</p> <ul style="list-style-type: none"> • Developing long-term value from mutually beneficial relationships with the shippers and carriers. • Increases the productivity of transport, as well as its automation. 	<p>Social Culture</p> <ul style="list-style-type: none"> • Promote a business and social culture of diversified and collaborative thinking, where employees and customers form a whole. <p>Scale of Outreach</p> <ul style="list-style-type: none"> • Long-term Relationship with local shippers and carriers. • Individuals, small, medium, and large companies starting in Montreal to reach all of Canada and the United States. 	<p>End-User</p> <ul style="list-style-type: none"> • Individuals. • Small companies. • Medium companies. • Big companies. • Brings shippers and carriers together on a platform to make the logistics of transporting a product more efficient at a competitive price.
<p>Social impacts</p> <ul style="list-style-type: none"> • Possible replacement of truckers with professional road knowledge by inexperienced truckers who follow the platform. 		<p>Social Benefits</p> <ul style="list-style-type: none"> • Creations of jobs. • Professional and personal growth for shippers and carriers. • Flexible work. 		

The social layer of the TLBMC captures the mutual influences between stakeholders and the organizations by using a stakeholder approach to the original business model canvas. The purpose is to capture the key social impacts of the organization that derives from those relationships. The objective of the Start-up would be enhanced transport productivity and automation by integrating

small to large companies, so they can reach their clients without incurring greater costs, building long-term relationships with shippers and carriers that are mutually beneficial.

3.4.4 Smart freight transportation platform of Start-up

A start-up smart freight platform in Montreal (hereafter referred to Start-up) was considered in this research to apply strategic tools and analyze the value creation processes of the company in the sustainability context.

The source of the data is the website of the Start-up, the reports of the company, the literature review/secondary data, and the others existing platforms in the market.

The Start-up offers a platform to help companies find freight transportation services and manage their shipments. It also helps transportation companies offer their service through the platform and manage their freight operations on the platform. The platform aims to improve the shipping experience and efficiency for both shippers and carriers.

With this platform offered by the Start-up, shippers can submit shipping service quotes and get freight offers from carriers that best match their shipment requirements. When a shipping service contract is made with the Start-Up, the shippers would be able to track their shipment in real-time from pickup to delivery as well as manage their current, past, and future shipments. In addition to real-time tracking, the platform would also work with Internet of things devices to track different sensor data such as temperature tracking.

Carriers' companies can use the Start-up service to get freight service contracts and manage their fleet in a single online platform. They can use the service to manage their drivers, equipment, schedules, routes, etc. The Start-up with the help of the platform would then find the carriers that would best match the freight service by looking at the current carriers' resources, capacities, preferences, and availability.

The Start-up's mission is to improve the shipping process and make it more pleasant and efficient by offering a simple yet powerful platform to manage to ship, automatize, and optimize the shipping process.

Detailed explanations of the Start-up and the services they offer will be addressed in depth in the company's business model.

3.4.5 Use of Agent-based modeling architecture to explain the elements of platform, actors, and interaction

The modeling of an agent-based architecture is divided into four steps:

3.4.5.1 The first step is the choice of agents (agentification)

This step aims to identify the elements of the problem that will be defined as agents.

Agents:

- Intelligent Logistics Services Platform (Start-up Platform)
- Shippers
- Carriers (can have one truck or several)
- Trucks (considered as an agent to simplify the implementation in the simulation software, although it is theoretically a resource of carriers).

3.4.5.2 The second step is the definition of the environment of an agent

The environment of the agent is what it perceives and what it can act on. We can choose different ways to represent the environment. In this case, the most suitable is a geographic information system (GIS). We can find data and information through the open data of Montreal, Quebec, or Canada.

3.4.5.3 Presentation of the behaviour of the agents

The behavior of an agent can be defined as the set of reactions/reflections, processes, role protocols, and decision rules that it implements in different situations. The agent in this case will have intelligent behavior with learning functions (Figure 3.3).

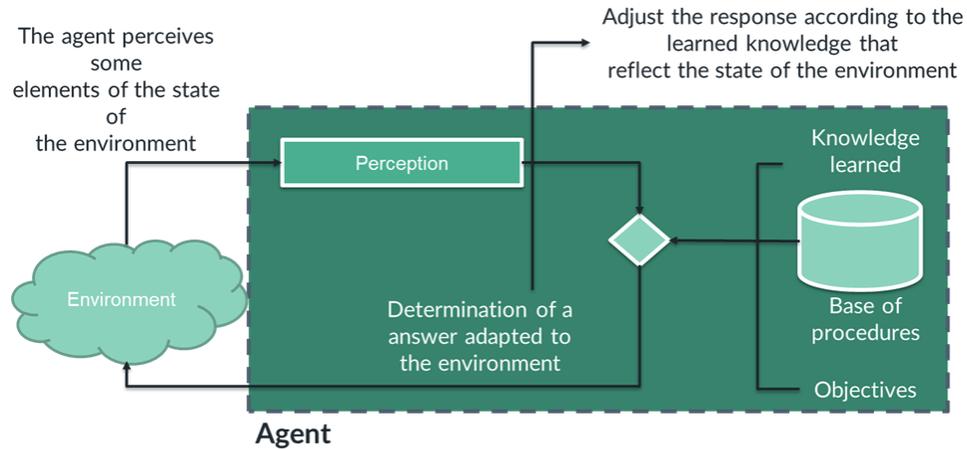


Figure 3.3 Intelligent behaviour with learning function

The behavior of an agent can be represented using different mechanisms of interactions or decision diagrams.

The control architecture is a structure involving a set of mechanisms aimed at coordinating decisions and structuring information exchanges between the different elements of the system. In this case, a quasi-heterarchical control architecture will be used (Figure 3.4).

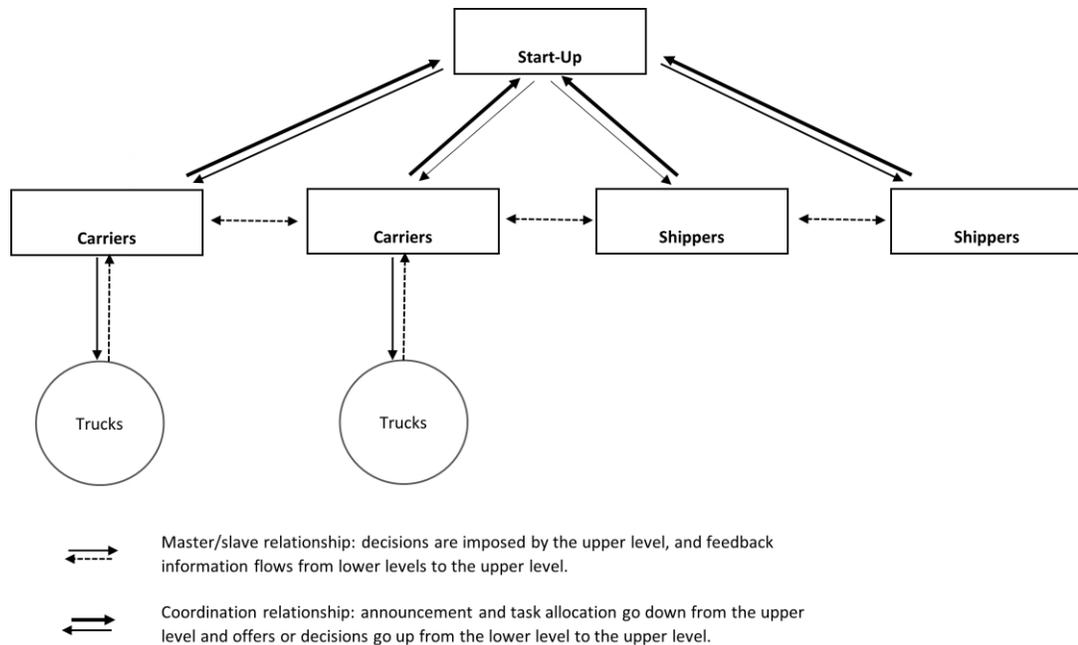


Figure 3.4 Control architecture

We have in the first place, at the very top the Start-up which publishes the delivery requests, to then receive the associated offers which come from the second level. The carriers will then make offers for different delivery requests. At the same time, the carriers will be in contact with the delivery resources of the last level, in this case, trucks. From the point of view of the shipper, there are only 2 actors, the Start-up communicates the possible offers for the transport and the shipper decides which one to choose.

3.4.5.4 Modeling of the interactions between the agents

These interactions represent any mechanism of mutual influence between two or more agents. Interactions between agents sometimes imply the notion of role (asymmetry) and responsibilities of agents. An interaction is an instantiation of a message exchange following a specific interaction protocol. In order to explain the interactions between agents, a diagram has been produced (Figure 3.5) illustrating the different information circulating during the process in the platform.

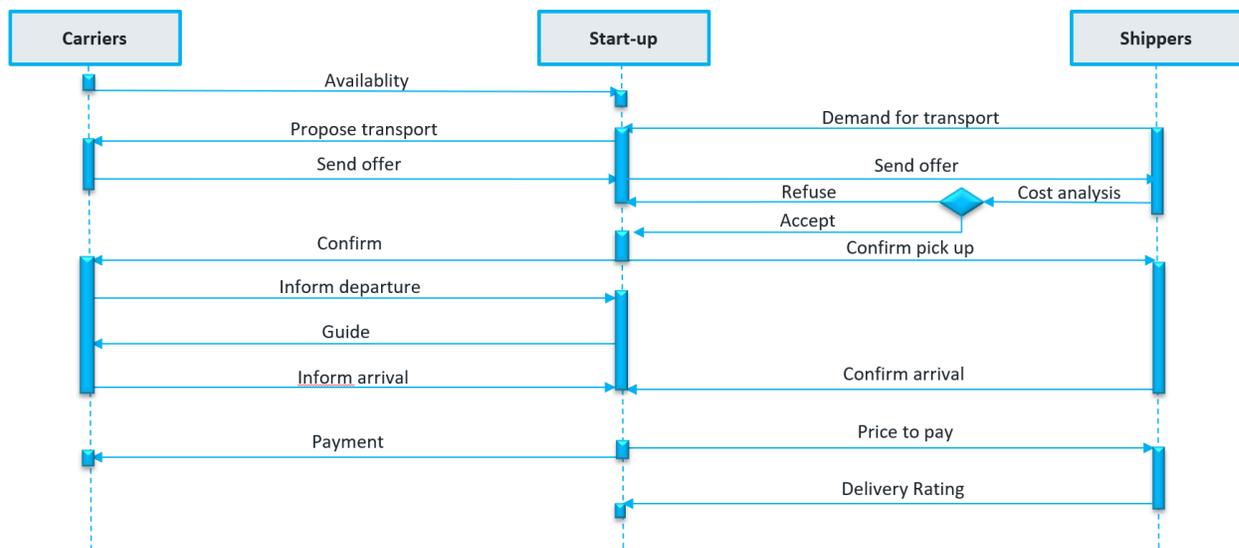


Figure 3.5 Interaction diagram

For a better understanding of the flow information in the interaction diagram, the carriers send their availability to the Start-up, the shippers demand a mode of transport to the Start-up, and the company proposes the transport to the carriers. The carriers send the offer to the Start-up that transmits this offer to the shippers where they going to analyze the offer and decide whether to accept or refuse the offer. If they accept, the Start-up confirms the transport to both, carriers, and shippers. The carriers inform the departure at the Start-up and the company sends back the guide and the optimized route. The carriers inform the arrival of the Start-up and the shippers also confirm the arrival. After that, the Start-up sends the price to pay to the shippers and the payment to the carriers. Finally, the shippers rate the transport and deliver this rating to the Start-up so that the company can then add it to the database.

3.5 Conclusion

This research provides a review of the theoretical frameworks and the case study analysis to assess the business model of the smart freight platform. Multiple-strategic tools including SWOT, EFQM-2020, BMC triple-layer models, and agent-based modeling architecture are conducted to validate their potential in logistics and trucking sustainability. SWOT provided valuable information on the

different opportunities and weaknesses that a service-based business model could encounter. The EFQM-2020 provided a comprehensive overview of the different strategies of the Start-up, its culture, and what is expected from the stakeholders, to have a basis on how to address the different obligations in terms of the services offered through the platform. Moreover, the BMC Triple Layer allowed us to understand the different actors in the company and their position at a given time concerning the target clients. It is essential to mention that the start-up studied is a young company with a limited market presence. Therefore, the different multi-tools aid companies to have a multidimensional analysis of the business model. The combination of strategic tools to analyze the sustainability of the business model of an intelligent freight transport platform with technological enablers is a valuable approach for start-ups. Future research is multiple case studies for more generalization of the outcomes and developing systematic strategic decision dashboards for smart freight platforms to test and analyze the value creation opportunities in the sustainability and technology-driven environment.

CHAPITRE 4 ARTICLE 2: FREIGHT BROKER BUSINESS MODELS IN THE DIGITAL AGE: A COMPARATIVE ANALYSIS AND RECOMMENDATIONS FOR START-UPS

Submitted to the International Conference on Industrial Engineering and Operations Management

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Abstract: *The trucking industry plays a vital role in the supply chain, GHG emissions, and the national economy. In recent years, due to a significant deficiency in freight forwarding, Digital Freight Matching (DFM) models have emerged. These models utilize information technology tools and advanced data analytics techniques to address the problems of the traditional approach. Recently, various DFM business models have been proposed, each with different characteristics. A review of the existing literature reveals a gap in studies examining these business models. In this regard, the present study not only critically reviews the evolution of freight forwarding but also comprehensively analyzes various DFM business models in terms of operational process, revenue, customer relationship, and digitalization. Moreover, it addresses critical questions about the advantages and disadvantages of traditional Freight Brokers and DFM models and their impact on the industry. Finally, the study results offer insightful suggestions, serving as a guide for startup companies looking to choose an appropriate business model. In addition, the result indicates that there is not a universal business model that fits all companies aiming to venture into DFM.*

Keywords: *DFM, Freight brokerage, Trucking industry, Business model, Start-up.*

4.1 Introduction

The trucking industry plays an important role in both macroeconomics and microeconomics. In 2020, trucks transported more than half of Canada's \$384 billion exports to the U.S. and nearly three-quarters of its \$264 billion imports from the U.S. (Fan & Heminthavonf, 2022). Historically, the industry has depended on traditional processes, heavily using intermediaries like Freight Brokers to link shippers with carriers (Van Duin et al., 2019; Huang et al., 2019). While freight forwarding has been pivotal in this sector, literature reviews highlight significant challenges in the trucking industry due to this manual approach, such as empty mileage, extended waiting times for shippers and carriers, and cost inefficiencies. In the past decade, the emergence of new information

technology tools has empowered scholars and industry professionals to develop new business paradigms addressing the aforementioned deficiencies of traditional freight forwarding (Bădică et al., 2020).

The most notable shift in this sector has been the emergence of Digital Freight Matching platforms. DFM leverages technology to link shippers with available carriers by employing real-time data, streamlining transportation requirements, and diminishing inefficiencies (Zhou & Wan, 2022). DFM stands out for its transparency, immediate matching, dynamic pricing, and robust rating system (Armstrong & Associates, 2016). Crucially, while traditional methods relied on paper-based systems, DFM predominantly benefits a data management system by saving and analyzing them using an advanced data analytics tool. This matter empowers decision-makers and stakeholders with key performance indicators (e.g., matching rate and service quality), offering a deeper understanding of market conditions.

A market analysis and literature review indicate that various business models, such as platform-based and brokerage, have emerged for DFM over time (Zintel et al., 2021). A business model outlines how a freight company creates, delivers, and captures value. It includes its operations, strategies, and methods of revenue generation (Casadesus-Masanell & Heilbron, 2015). Essentially, it determines how a company operates and generates income, steering both strategic choices and daily practices.

Despite all the advancements in both academic and industrial sectors of the freight industry, there remains a gap in the literature that offers a reliable resource for startup companies looking to enter the trucking industry. These companies need to review the pros and cons of each business model before establishing their own. Aiming to bridge this gap, the primary goal of this study is to create a comprehensive resource that facilitates a comparison between different DFM business models for startups. To achieve this, a comparative analysis is performed on existing business models, and their key features are highlighted.

Additionally, this study seeks to address the following questions:

What are the respective advantages and disadvantages of traditional Freight Brokers and Digital Freight Matching models, and how do these shape the industry?

How do Digital Freight Matching business models differ in terms of their operational processes, revenue generation strategies, customer relationships, and digitalization level?

This study enriches the literature by proposing a practical framework for comparing various business models in the trucking industry. Furthermore, it offers a scientific resource that comprehensively contrasts the DFM business model with strategies that support startup companies.

The rest of the paper is organized as follows: initially, the evolution of freight forwarding and DFM models are explored. The methodology of the study is then detailed in section 3. Following this, section 5 presents a comparative case study where various business models are critically analyzed. In the concluding section, the contributions and primary findings of the study are discussed.

4.2 Literature Review

This section provides a review of the literature concerning research gaps. It is organized into three subsections. The first explores the evolution of freight brokerage. The second goes through studies focused on the business processes of freight forwarding. In the final subsection, studies relating to DFM models are discussed.

4.2.1 Evolution of Freight Brokerage

Securing sufficient truck capacity poses challenges for freight forwarders seeking to continually rebalance the supply and demand of trucks and drivers (Eriksson et al., 2022). This cycle alternates between relative capacity shortages, which drive up rates due to increased demand, and relative capacity surpluses, which drive rates down (Caplice, 2021). Therefore, it is key to predict future market trends, despite external factors that can bias the results such as economic changes, technological advances, and human psychology that can introduce unpredictability into the equation (Pickett, 2018; Negrutiu et al., 2020). Understanding the progression of freight forwarding is essential in investigating the impact of DFM platforms (Riedl et al., 2018; Wurst, 2021). In this study, we trace key steps in the evolution of freight brokerage (Mikl et al., 2021; Meyer et al., 2022).

The origins of freight brokerage can be traced back to the early days of trade when intermediaries facilitated the movement of goods across long distances (Brown, 1984). They acted to connect shippers with carriers, negotiating deals, and ensuring the smooth flow of commerce (Luncean & Badica, 2014).

The emergence of motorized transportation, particularly trucks and the interstate highway system in the United States, transformed the logistics landscape (Canna, 2022). This era witnessed the establishment of licensed and regulated freight brokers, introducing a degree of formality and accountability to the profession (Danyluk, 2021). The late 20th century saw the integration of computer systems and electronic data interchange (EDI) into freight brokerage operations (Agnihotri & Bhattacharya, 2023). These technological advancements streamlined communications and information sharing, enhancing the efficiency of matching cargo with carriers (Paik & Gharehgozli, 2022). However, it's worth noting that these innovations primarily focused on improving internal processes rather than disrupting the broker's role as an intermediary (Arooj et al., 2022).

The 21st century is a new era with the advent of DFM platforms (Elbert & Gleser, 2019; Huber, 2021). These platforms leverage advanced algorithms, real-time data, and digital connectivity to directly connect shippers and carriers, and potentially get around the traditional broker's role (Majeed et al., 2021; Choudhury et al., 2023). This marks a profound departure from historical norms, where brokers were central to the freight matching process.

Understanding this historical evolution is crucial as we navigate the contemporary landscape, where DFM platforms represent a disruptive force challenging traditional freight brokerage models (Liao, et al., 2021). It underscores the enduring importance of intermediaries in the logistics and transportation industry and sets the stage for evaluating how DFM platforms are redefining this historical paradigm (Herold et al., 2023).

4.2.2 Overview of Business Processes of Traditional Freight Brokerage

As discussed, traditional freight brokerage has long been an integral component of the logistics and transportation industry and its fundamental role revolves around orchestrating the movement of goods efficiently and effectively.

Traditional freight brokerage operations are characterized by a set of manual and multifaceted processes that revolve around matching cargo with suitable carriers. This matching ensures the seamless and efficient movement of goods within the logistics and transportation industry (Alacam

& Sencer, 2021). These operations can be categorized into three parts matching, routing, and pricing.

About matching, one of the basic functions of traditional brokers, to reduce uncertainties (e.g., trip failure), is to enhance the quality of matching by aligning the size of cargo with carrier capacity (Caplice, 2021). This entails evaluating factors such as the size and type of trucks, maximum weight limits, and available space for cargo (Choudhury et al., 2023). Moreover, effective matching requires scheduling coordination to ensure that carriers have availability during the required timeframe and that they can meet the shipment's delivery deadline (Jarašūnienė et al., 2022). Furthermore, the success of cargo and carrier matching depends on the broker's ability to identify carriers that not only meet the logistical requirements but also align with the shipper's specific needs (Li & Yu, 2017). This encompasses considerations like the nature of the cargo (e.g., perishable goods, hazardous materials), specialized equipment requirements (e.g., refrigerated trucks, flatbeds), and any other unique specifications. Efficient matching offers several benefits, including optimized efficiency, cost savings, timely deliveries, and reduced risk (Kim et al., 2021).

Regarding routing, brokers examine the route compatibility taken by carriers and the origin-destination pairs specified by shippers (Pellegrino et al., 2021). The routing aims to identify carriers whose existing routes align with the shipment's itinerary, minimizing detours and optimizing efficiency.

Lastly, the traditional approach plays a central role in negotiating terms and rates that satisfy both shippers and carriers (Karam et al., 2021). They act as intermediaries, leveraging their industry knowledge and negotiation skills to strike mutually beneficial agreements. This may involve rate negotiations, brokers negotiate the freight rates, aiming to secure competitive pricing while compensating carriers fairly for their services (Stölzle & Häberle, 2021). They facilitate the creation of contractual agreements that outline the terms and conditions of the transportation arrangement, covering aspects such as liability, insurance, and payment terms (Feng & Cheng, 2021).

4.2.3 Digital Freight Matching (DFM) models

The emergence of technologies like the DFM platforms has ignited a transformative shift that is reshaping the landscape of the logistics sector (Furr et al., 2022). Through an extensive literature review, we went through the role played by DFM platforms and their profound impact on the logistics industry (He et al., 2022). The adoption of digital technology, specifically DFM platforms, has begun in a new era for the logistics sector (Zhou & Wan, 2022). These platforms represent a paradigm shift in the way cargo is matched with available carriers (Heinbach et al., 2022). They leverage various algorithms, data analytics capabilities, and real-time connectivity to revolutionize the freight matching process (Angelopoulos et al., 2023). Scholarly works by Tsvetkova et al. (2021); Chen and Yang (2022) and Sullivan (2020) have highlighted the role played by DFM platforms in the logistics industry's evolution. These platforms have rapidly ascended to prominence, promising to redefine the very essence of freight matching. Wang and Sarkis (2021) have shed light on the technological capabilities of DFM platforms, emphasizing their advanced algorithms and data analytics capabilities, which have become key drivers of efficiency and innovation (Ortwein & Kuchinke, 2021).

The value of DFM platforms is multifaceted, as highlighted by Gorman et al. (2023). Their ability to streamline the complex freight matching process has resulted in several advantages:

- **Greater Transparency:** DFM platforms bring unprecedented transparency to the logistics process, allowing stakeholders to access real-time information about shipments, routes, and pricing (Zhou & Wan, 2022).
- **Efficiency Gains:** By automating and optimizing the matching of cargo with carriers, DFM platforms have ushered in remarkable efficiency gains, reducing delays and optimizing resource utilization (Kern, 2021).
- **Cost-Effectiveness:** The cost-effectiveness of DFM platforms is a central feature. They enable shippers to find carriers at competitive rates, potentially reducing transportation costs significantly (Meyer et al., 2022).
- **Direct connection:** One of the most revolutionary aspects of DFM platforms, as noted by Min and Kang (2021), is their capacity to enable direct connections between shippers and carriers.

This decreased dependence on traditional intermediaries, such as Freight Brokers, has the potential to reshape the logistics landscape significantly.

As conclusion, through the literature review, many articles were analyzed, starting with the evolution of freight brokerage, moving from traditional business models to the most modern ones called DFM. We note that there is no article that presents a detailed explanation of the world of DFM in its entirety. Some articles explored presented the explanation of some DFM models, but they only presented one model, and they are more general explanations to make the reader understand the idea of what is proposed, but no articles have been found that study and compare the different business models of DFMs, and even fewer from a perspective of helping start-ups in this world of digitalization of freight brokers and selecting one of these models that best suits these new companies.

4.3 Methodology Framework

As Figure 4.1 displays the methodology employed in this study is structured into six steps.

As the first step, a comprehensive literature review is conducted to gain a thorough understanding of the existing body of knowledge in the domain of business models within the logistics industry. This review aims to identify gaps in the field of study and sets the foundation for the subsequent research.

The second step is assessing the emerging business models and conducting comparative studies, which are divided into three main parts. In the first part (step 2.1), we do an exploration of the evolution of freight brokerage in the trucking industry, to do this, a comparative analysis is undertaken to elucidate the distinctions between the traditional freight brokerage model and DFM model. Next, we will examine pricing policies and strategies, and finally, logistics technologies and software solutions. As we navigate through the digital transformation era, the study narrows its focus to delve deep into DFM (step 2.2). This involves an exploration of the benefits offered by DFM, factors influencing clients' selection of DFM providers, the challenges and impediments faced by DFM models, and an examination of regulations governing DFM.

For the third part of the applications and results, a comparative analysis of the different DFM business models is carried out (step 2.3). To do this analysis, we divide the process into six stages.

First, we defined the scope of the comparative study as the freight broker industry in North America. Second, we selected a sample of eleven freight brokers that operate in this region, covering different sizes, markets, and technologies. Third, we identified four dimensions that characterize different freight broker business models: operational model, revenue strategy, customer relationship, and digitalization level. Fourth, we apply classification to group the business models into types based on the elements. Fifth, we validate and refine our typology using secondary data from literature reviews, industry reports, and websites. Sixth, we analyzed our results and derived implications for start-ups who want to enter or innovate in this industry.

Finally, the article concludes with a conclusion and some remarks (step 3). Limitations, and avenues for future research endeavors in this domain, are outlined in the conclusion section, offering valuable insights to further advance our understanding of DFM and its evolving landscape.

Each step of the methodology is designed to build upon the previous one, ensuring a comprehensive and cohesive understanding of the subject matter. By breaking down each step into detailed substeps, we ensure a detailed exploration and development of information necessary for each phase, therefore achieving a holistic view of the industry's evolution and the strategic positioning of DFM models.

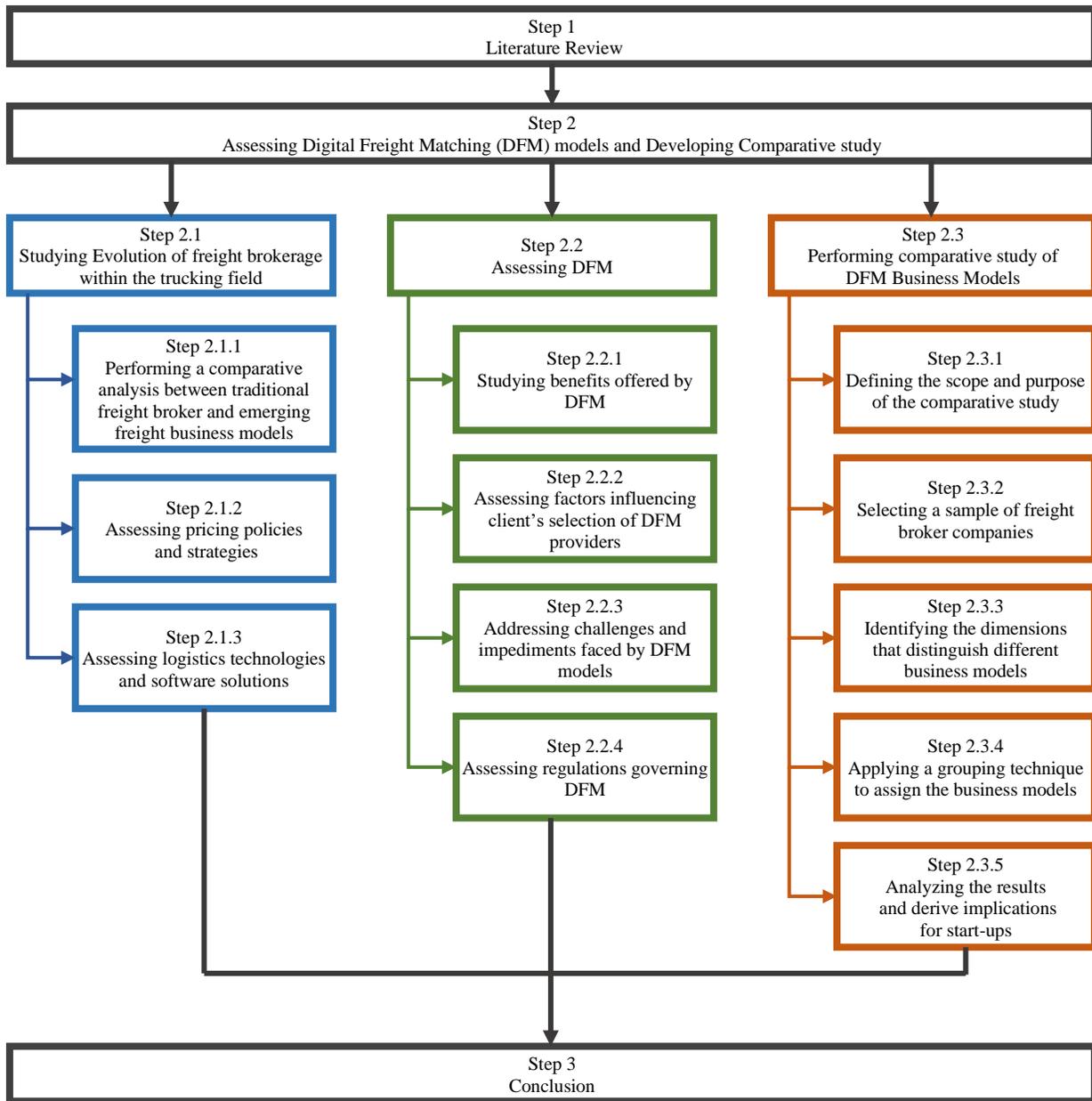


Figure 4.1 Research Methodology Section

4.4 Step 2. Assessing DFM models and Developing Comparative studies

In this section, first, we will detail the evolution of freight brokerage in the trucking industry, moving from traditional freight brokers to DFM. Next, we analyze the DFM model in more depth. Finally, a comparative study is carried out on the different DFM models based on different

dimensions and criteria to guide a new company in the selection and choice of any of these models and their good practices.

4.4.1 Step 2.1. Studying evolution of freight brokerage within the trucking field

As the landscape of logistics continues to evolve and adapts to modern demands, it becomes increasingly imperative to gain a comprehensive understanding of these two approaches. This section seeks to compare various key factors, including the details of the matching process, the level of transparency, economic factors, reliability of services, flexibility for different shipping needs, market access, integration with advanced technology, and their important roles in the constantly evolving logistics ecosystem.

A freight broker serves as an intermediary, facilitating the intricate coordination of transportation services for shippers by engaging carriers. These individuals wield their comprehensive industry expertise and well-established carrier relationships to adeptly negotiate rates, orchestrate cargo dispatches, and synchronize freight movement. Additionally, freight brokers efficiently manage administrative responsibilities such as tracking shipments, troubleshooting issues, and streamlining payment processes.

On the other hand, the advent of DFM introduces a technology-driven paradigm, seamlessly matching shippers with carriers. DFM platforms leverage information technology techniques including algorithms and data analytics to match available transport capacity with shipments awaiting conveyance. This method speeds up the process of finding shipping capacity while also saving costs. For carriers, digital freight matching platforms offer new business opportunities and help make better use of their resources.

4.4.1.1 Step 2.1.1. Performing a Comparative analysis between traditional freight broker and emerging freight business models

Although freight brokers and digital freight matching (DFM) platforms both connect shippers and carriers, they operate differently. Freight brokers provide personalized service with dedicated agents who guide and support throughout the shipping process. In contrast, DFM platforms use

automation for a self-service approach, allowing shippers and carriers to manage their transactions independently.

The following table (Table 4.1) presents a comparative study of some of the most important aspects, between the traditional freight broker and the new DFM models.

Table 4.1 Comparative analysis between Freight Broker Business Model and DFM Business Model

Aspect	Traditional Freight Broker Business Model	Digital Freight Matching (DFM) Business Model
Definition	Acts as an intermediary between shippers and carriers.	Utilizes technology to directly connect shippers with carriers.
Characteristics	Intermediary role	Technology-driven
	Personalized service	Real-time updates
	Industry expertise	Automated processes
Advantages	Flexibility	Cost-effectiveness
	Risk mitigation	Transparency
	Time and cost savings	Efficiency
	Established relationships with carriers	Broader pool of carriers
Limitations	Cost	Technology dependency
	Limited control	Market saturation
	Communication challenges	Lack of personalization
		Potential less industry experience and knowledge
Payment and Rates	Negotiates rates on behalf of shippers	Transparent and competitive rates
	May charge brokerage fees	Potential lower costs for shippers and carriers
Risk Management	Conducts due diligence on carriers	Carrier verification and insurance verification
	Manages cargo insurance and claims	Real-time tracking and monitoring of shipments
Operational Efficiency	Time-consuming process due to manual interactions	Streamlined operations and real-time updates
		Reduced administrative overhead for shippers and carriers
Service Experience	Human interaction and personalized solutions	Automated systems and standardized processes
	In-depth knowledge of the transportation industry	Ratings and reviews for carrier selection
Technology Integration	May or may not utilize digital solutions	Utilizes advanced technology and algorithms
	Paperwork and communication via phone, email, etc.	Mobile apps and web platforms for load matching
Scalability and Reach	Depending on the broker's network and resources	Wide geographical reach and access to diverse carriers
Customer Support	Dedicated customer service and support teams	Technical support for platform users
	Communication and issue resolution via broker	Digital communication channels
Decision-Making Process	Human decision-making with industry knowledge	Automated decision-making based on algorithms and data
Market Presence	Established presence and reputation in the industry	Growing presence in the logistics and transportation technology market

4.4.1.2 Step 2.1.2. Assessing Pricing policies and strategies

In the trucking system, pricing policies are characterized by a multitude of both direct and indirect variables. In other words, no singular particularity or deterministic element governs the formation or evolution of these pricing structures. Instead, there exist more localized mechanisms with regional impact pricing policies, as well as other pricing determinants that apply influence at national or international levels, where pricing policy trends may exhibit a greater degree of cross-cutting ubiquity.

Pricing policies consider various factors, such as inconsistent fuel prices, distance, weight and volume of cargo, toll charges, delivery deadlines, parking fees, government subsidies, different levels of uncertainty, risks due to geopolitical issues, and the use of intelligent art platforms, among others. Presently, the prevailing trend in pricing strategies involves the utilization of tools provided by the industry 4.0 paradigm and platforms enabling more intelligent trucking operations. However, it is important to note that comprehensive studies on pricing policy trends are rare in existing literature. This is likely due to the challenges arising from the diverse variables that influence these policies.

Freight brokerage companies employ various pricing strategies aimed at optimizing their competitive positioning and client acquisition. The following are several common pricing strategies observed within the domain of freight brokerage:

- **Flat-rate Pricing:** Freight brokerage firms may implement a flat-rate pricing scheme, wherein customers are levied a fixed fee for shipping services, irrespective of the shipment's distance or weight. This approach offers pricing transparency and simplicity.
- **Volume-based Pricing:** Volume-based pricing models are also prevalent. Here, clients are incentivized with discounts when shipping larger quantities of cargo. This strategy mutually benefits both the brokerage and its clientele by encouraging greater shipment volume and simultaneously lowering shipping expenses.
- **Dynamic Pricing:** Freight brokers may employ dynamic pricing structures that adjust the cost of shipping based on real-time market dynamics. Variables such as supply and demand, fuel costs, and shipping distances are considered, allowing the brokerage to remain competitive within a fluctuating market.

- **Bid Pricing:** A competitive approach can be seen in bid pricing, where multiple carriers vie for a specific shipment. The carrier submitting the most economical bid secures the shipment. This strategy facilitates the acquisition of optimal shipping rates while offering carriers the opportunity to compete for cargo.
- **Accessorial Fees:** Freight brokerage firms may impose supplementary charges, often referred to as accessorial fees, for extra services such as lift-gate service, inside delivery, and waiting time. These fees serve a dual purpose by allowing brokers to extend their service offerings while concurrently generating additional revenue streams.

4.4.1.3 Step 2.1.3. Assessing logistics technologies and software solutions

A significant change is happening in the field of logistical transportation, marked by a promising future that combines intelligent solutions with sustainable alternatives. Enterprises find themselves compelled to preserve their competitive edge, necessitating the incorporation of cutting-edge technologies aimed at enhancing their distribution centers, warehousing infrastructure, shipping processes, and transport management. It is not feasible for these enterprises to fall behind the technological barrier, as consumer demands can only be met through the seamless integration of logistical technology. It is evident that only those enterprises that harmoniously evolve with technological advancements are poised to endure over the long-term period.

The proliferation of the Internet of Things (IoT) leads to the creation of multifarious connections between commodities, packaging, transport centers, and vehicles. This expansion of IoT technology furnishes an abundance of data, thereby facilitating remote asset management, risk forecasting, optimization of cargo handling, and traffic congestion prediction. When the IoT is synergistically coupled with blockchain technology, it has the capacity to give comprehensive end-to-end package visibility.

Table 4.2 provides a comprehensive overview of various IoT applications, offering detailed descriptions and insights into their functionality, making it easier to understand their specific roles and contributions.

Table 4.2 Internet of Things Technologies

IoT Application	Description
Cold Chain Traceability	Monitoring temperature-sensitive goods through the use of certified temperature recorders.
Cargo Theft Prevention	Implementing discreet, robust, connected solutions, such as magnetic contact-based truck door sensors to prevent theft.
Truck Fleet Tracking	Utilizing multiple wireless communication technologies (e.g., Bluetooth, RFID, LoRaWAN) to track trailers and monitor routes.
Driver Identification	Mandatory use of electronic logbooks for drivers to ensure compliance with driving hours and rest regulations.
Anti-Collision Technology	Incorporating 360-degree cameras and sensors for collision anticipation and prevention.
Cloud-Based Connectivity	Facilitating real-time data sharing among trucks via cloud-based connectivity systems.

Other logistics technologies used in the transport industry include:

- Blockchain technology, a decentralized and distributed innovation explicitly designed to revolutionize commercial operations, record transactions, monitor assets, and establish a transparent and efficient system for managing all documents involved in the logistic process, offers substantial gains in time and cost efficiency. Its integration contributes to the enhancement of supply chain security, particularly through the reduction of fraud, bottlenecks, errors, third-party certification, and the enhancement of overall operational efficiency.
- Transport Management System (TMS) is employed to oversee carrier management and enhance route automation. Its utility extends to real-time driver tracking, cost reduction within the transportation framework, augmentation of transparency, and the elevation of overall customer satisfaction metrics.
- The large amount of data coming from the supply chain is now routinely analyzed to identify trends. This helps logistical companies make necessary organizational changes. The application of Artificial Intelligence (AI) for decision-making within the supply chain domain stands as an effective measure in the reduction of human error. Particularly in the sphere of warehouse management, AI significantly streamlines the planning process by expediting the time required for analysis. Furthermore, the analysis and optimization of last-mile logistics, supplier selection, and workforce planning constitute processes fueled by the incorporation of AI and Machine Learning (ML) methodologies.

In the domain of logistics, recent technological advancements have given rise to software solutions dedicated to optimizing operations within the trucking industry. These software solutions, which are developed by companies as Trimble Transportation (Trimble Transportation, n.d.), Fleetilla Fleet Management (Fleetilla, LLC., n.d.) and Degama's Dynamic Transportation Management System (DTMS) (Degama Systems Inc, n.d.) are integral to modern logistics systems, where they play a fundamental part in enhancing efficiency and accuracy in the execution of transportation activities. In the Table 4.3 we can distinguish the different solutions that each of them offers.

Table 4.3 Software solutions in the trucking industry

Trimble Transportation	Fleetilla Fleet Management	Degama's Dynamic Transportation Management System (DTMS)
<ul style="list-style-type: none"> - FleetFACTZ, a cloud-based, fleet management application. - Maps, satellite imagery, street view, weather, traffic, and other details seamlessly integrated. - Mobility Fleet Telematics. 	<ul style="list-style-type: none"> - Supply Chain Visibility. - Transportation Management Solutions. - Mobility Fleet Telematics. - Video Intelligence. - TMT Fleet Maintenance. 	<ul style="list-style-type: none"> - Electronic Data Interchange (EDI). - Adapt and integrate into existing business processes and software with integration partners. - Request for proposal (RFP). - Electronic logging device (ELD).

In the contemporary world characterized by the rise of technological platforms, it is noteworthy that manual procedures continue to be a central focus. In response to inquiries pertaining to the tools employed for the monitoring and management of Key Performance Indicators (KPIs), it is evident that a substantial proportion of shippers and carriers still prefer the utilization of traditional approaches, including Microsoft Excel, email correspondence, and shared document repositories.

4.4.2 Step 2.2. Assessing DFM

DFM uses an electronic platform or software equipped with advanced technology like AI, machine learning, and big data analytics. This technology improves how shippers and carriers are matched in freight logistics. These DFM platforms exhibit a proclivity to harness diverse repositories of data to facilitate the optimization of the matching process between shippers and carriers. These sources of data encompass but are not restricted to, historical records pertaining to shipping activities, meteorological and traffic conditions, and an array of salient data points pertinent to the process at hand.

4.4.2.1 Step 2.2.1. Studying benefits offered by DFM

Some of the benefits that bring this new approach are as mentioned before.

- Increased efficiency: DFM automates the matching process and reduces the need for intermediaries, which saves time and money.
- Better visibility: DFM real-time tracking provides, improves communication, and enhances supply chain visibility.
- Environmental sustainability: DFM reduces empty miles, improves capacity utilization, and lowers carbon emissions.

4.4.2.2 Step 2.2.2. Assessing factors influencing client's selection of DFM providers

In the process of electing a DFM platform, clients deliberate upon a set of key determinants, encompassing.

- Pricing Model: the selection of an appropriate pricing model assumes paramount importance, with the imperative objective being to establish alignment with the exigencies of the business and fiscal constraints.
- Feature Set: a judicious evaluation of the available feature set is warranted, with specific attention directed towards attributes such as real-time tracking, automated payment mechanisms, and insurance coverage, all of which constitute salient determinants in optimizing operational efficacy.
- Marketplace Size: the choice of a DFM platform necessitates a discerning scrutiny of the marketplace dimensions. It is imperative to opt for a platform that boasts an expansive network of carriers and shippers, as this facilitates the augmentation of freight accessibility and simultaneously mitigates the incidence of unproductive transit miles.
- Customer Support: the selection process is further informed by the quality and timeliness of customer support provision. Optimal operational outcomes are fostered by electing a DFM platform that endorses the delivery of dependable and expeditious support services, aimed at the resolution of issues and the maximization of operational efficiency.

4.4.2.3 Step 2.2.3. Addressing challenges and impediments faced by DFM models

After exploring the advantages and potential of Digital Freight Matching (DFM), let's now examine the challenges and difficulties this technology faces. While the benefits in efficiency and cost savings are clear, it's important to tackle the real challenges that must be overcome for digital freight matching to realize its full potential.

Table 4.4 summarized challenges of current DFM.

Table 4.4 Challenges for DFM

Challenge	Description
Fragmentation within the Industry	Pronounced fragmentation with small, independent carriers and shippers creates difficulties in achieving user mass and service consistency.
Complex Regulations	Complex, jurisdiction-dependent regulations challenge compliance oversight for all participants.
Deficiency in Standardization	The absence of standardization leads to language and data format discrepancies, causing inefficiencies and errors.
Competition from Well-Established Brokers	Competition from established brokers with lasting relationships hampers market share acquisition.
Integration Complexities	Integration with diverse third-party systems (TMS, ELD, Telematics) presents compatibility and data integration challenges.
Cybersecurity Vulnerabilities	Safeguarding against hacking and data breaches requires ongoing investments in cybersecurity technology and expertise.
Dependence on Technological Infrastructure	Heavy reliance on technology demands continuous investments in infrastructure and redundancy to ensure operational stability.

4.4.2.4 Step 2.2.4. Assessing regulations governing DFM

Within the domain of DFM the need for a freight broker license is determined by the services provided and operational practices. Regulatory oversight in the freight brokerage industry mandates broker licensure and bonding. It is worth noting that certain DFM entities may be exempted from this licensure requirement under specific criteria.

For example, a Digital Freight Matching (DFM) entity that mainly acts as a platform to help shippers and carriers interact and negotiate, without directly handling physical freight, can be

considered a 'load board.' This classification may exempt it from needing a license. Conversely, if a DFM entity actively engages in coordinating freight movements, taking on responsibilities like transportation arrangement, rate negotiation, and financial transactions, it is likely to be designated as a freight broker, necessitating the acquisition of a license and bonding. The handling of payment is a key factor in determining whether a digital freight matching company must be licensed as a freight broker. The definition of a freight broker includes those who receive payment for arranging the transportation of goods on behalf of shippers and carriers. However, digital freight matching companies sometimes act as payment facilitators without receiving payment.

- **Payment Handling:** If a digital freight matching company handles the payment process, they must be licensed as a freight broker.
- **Third-Party Payment Facilitation:** If a third-party payment facilitator handles payments, the digital freight matching company may not need a freight broker license.
- **Partial Payment Handling:** If the digital freight matching company only handles a portion of the payment between shipper and carrier, they may not be required to have a freight broker license.

It is important to acknowledge that regulations governing DFM entities and freight brokers may vary from one country or jurisdiction to another, with certain having distinct licensing requirements for freight brokers.

In summary, the requirement for a freight broker license in the context of a DFM entity depends on the specific services offered and operational methods. Therefore, entities should seek guidance from legal and regulatory experts to ensure full compliance with applicable laws and regulations.

4.4.3 Step 2.3. Performing a comparative study: Business Models DFM

In this section, we will delve into a comprehensive, step-by-step process for conducting a comparative study of DFM business models. The aim is to provide a clear roadmap for entrepreneurs and start-ups looking to venture into this dynamic and rapidly evolving industry.

4.4.3.1 Step 2.3.1. Stage 1: Defining the scope and purpose of the comparative study

The scope of this study encompasses a comprehensive analysis of the freight broker industry in North America. The primary objective is to gain a thorough understanding of the operational dynamics within these companies, including their business models and best practices.

4.4.3.2 Step 2.3.2. Stage 2: Selecting a sample of freight broker companies

Eleven companies within the DFM sector have been chosen, ensuring diversity in terms of company size, target markets, and technological approaches. These companies are situated within the geographical area of our study, and our objective is to conduct an in-depth examination and analysis of each one. The eleven companies studied are:

- Aljex (<https://www.aljex.com/>).
- Ascend TMS (<https://ascendtms.com/>).
- CH Robinson (<https://www.chrobinson.com/>).
- Convoy (<https://convoy.com/>).
- Coyote Logistics (<https://coyote.com/>).
- J.B. Hunt (<https://www.jbhunt.com/>).
- Loadsmart (<https://loadsmart.com/>).
- Project44 (<https://www.project44.com/>).
- Schneider (<https://schneider.com/>).
- Transfix (<https://transfix.io/>).
- Uber Freight (<https://www.uberfreight.com/>).

4.4.3.3 Step 2.3.3. Stage 3: Identifying the dimensions that distinguish different business models

We have pinpointed and categorized four distinct dimensions that serve to characterize various DFM business models. These dimensions are fundamental in understanding the diversity within the industry:

- **Operational Model:** Describes how brokers manage their daily operations, including carrier sourcing and logistics management.
- **Revenue Strategy:** Focuses on how brokers generate income, encompassing pricing models and fee structures.
- **Customer Relationship:** Explores how brokers interact with clients, including customer service, communication, and value-added services.
- **Digitalization Level:** Evaluate the integration of digital technologies, software platforms, and data analytics into the broker's operations.

4.4.3.4 Step 2.3.4. Stage 4: Applying a grouping technique to assign the business models

DFM constitutes a technologically facilitated process designed to establish connections between shippers and carriers, with the primary objective of optimizing the discovery and alignment of transportation requirements. In the realm of DFM, an array of distinct business models has emerged, each endowed with specific operational nuances and characteristics:

- **Platform-Based Model:** Within the paradigm of this model, entities function as operators of digital platforms that handle the seamless matching of shippers and carriers. Such platforms effectively streamline the process of load identification and reservation, while concurrently affording stakeholders' insights into the prevailing capacity, pricing structures, and estimated delivery timelines. This enhanced visibility in platform-based DFM promotes expeditious interactions between shippers and carriers, thus engendering a symbiotic ecosystem for load conveyance.

- **Brokerage Model:** This model assumes the intermediary role in facilitating interactions between shippers and carriers, a function achieved through the strategic incorporation of cutting-edge technology. These entities typically possess well-established affiliations with carriers, capitalizing on these relationships to wield prowess in rate negotiations and logistical oversight.
- **Carrier-Based Model:** Organizations adopting the carrier-based model distinguish themselves by the ownership and operation of dedicated fleets of transportation vehicles, providing shippers with a direct conduit for securing transportation services. In pursuit of operational optimization and efficiency, these companies often employ DFM technologies to streamline internal logistics processes.
- **SaaS-Based Model:** This model is predicated on the provision of transportation management software as a service (SaaS) to both shippers and carriers. The software suite offers functionalities encompassing load matching, route optimization, and real-time visibility, thereby empowering clients to execute logistics operations with heightened effectiveness.
- **Asset-Light Model:** Within the asset-light model, business entities function as intermediaries, employing technology to connect loads with an array of available carriers. Significantly, these organizations abstain from direct ownership of transportation assets, instead relying on a network of carrier partnerships to fulfill the diverse spectrum of transportation requisites.

4.4.3.4.1 Revenue strategies

The dynamics of modern logistics have witnessed the emergence of various methods by which DFM models generate income. These methods govern the financial aspects of digital freight services and play a pivotal role in shaping the interactions between shippers, carriers, and DFM. In this context, we identified five distinct income-generation mechanisms adopted by DFM models, delving into their revenue structures and operational implications.

- **Subscription-based Model:** Within this financial framework, the DFM platform implements a recurring subscription fee structure, requiring shippers and carriers to remit regular payments in return for unrestricted utilization of its digital platform.

- **Commission-based Model:** In the context of this commercial model, the DFM platform adopts a commission-based compensation system. Under this arrangement, carriers are subject to fees calculated as a percentage of the value of each transaction successfully conducted through the platform.
- **Transaction-based Model:** This economic structure involves the DFM platform imposing transaction fees upon both shippers and carriers for each completed transaction executed via their digital infrastructure.
- **Hybrid Model:** In this multifaceted business paradigm, the DFM platform integrates various revenue streams to foster financial sustainability. For example, logistics enterprises employ a hybrid business model that harmonizes brokerage services, contractual logistics, and digital freight matching to create diverse income channels.
- **Partnership Model:** In this business model, the Digital Freight Matching (DFM) platform partners with other logistics companies to provide a complete solution for shippers and carriers. For instance, a DFM platform works with logistics firms to offer a range of services that include full visibility, optimization, and automation in supply chain operations.

These diverse income-generation mechanisms within the DFM sector underscore the flexibility and adaptability of modern logistics platforms. While subscription-based and commission-based models focus on direct monetization, transaction-based, hybrid, and partnership models showcase innovative revenue-generation strategies that cater to the evolving needs of shippers and carriers. The selection of a specific income-generation mechanism by a DFM platform plays a critical role in determining its competitiveness and sustainability within the digital logistics landscape. As this sector continues to evolve, these various approaches provide stakeholders with the means to navigate an ever-changing terrain of digital freight solutions.

4.4.3.4.2 Industry players.

Companies at the forefront of this digital revolution have harnessed the power of technology to transform freight brokerage. In Table 4.5 the eleven companies are presented, showing what DFM business model they use and how they generate revenues. The chosen business model depends on the field of application of the company.

Table 4.5 DFM business model and revenue strategies used by each company

Companies	Business Models DFM					Revenue strategies				
	Platform-based	Brokerage	Carrier-based	SaaS-based	Asset-light	Subscription-based	Commission-based	Transaction-based	Hybrid	Partnership
Loadsmart	X					X				
Uber Freight	X						X			
Convoy	X							X		
C.H.Robinson		X							X	
Coyote Logistics		X						X		
J.B.Hunt			X					X*		
Schneider			X					X*		
Ascend TMS				X		X				
Aljex				X		X				
Project44				X						X
Transfix					X				X	

*These companies, as they are Carrier-based model, receive the transaction fee from the shipper side.

In the domain of platform-based logistics and transportation enterprises, three prominent entities, namely Uber Freight, Convoy, and Loadsmart, have garnered attention for their distinct approaches to income generation. Each of these firms operates within the platform-based business model, although employing different revenue models that align with their strategic orientations and satisfy the specific demands of their clientele.

Uber Freight, a recognized industry leader, adheres to a Commission-based income model. This method involves the charging of a percentage-based fee on the total value of shipments brokered via its platform. Noteworthy is the scalability of this model, which ensures that, as the volume of transactions rises, so does Uber Freight's income.

Conversely, Loadsmart adopts a Subscription-based model, wherein customers are required to pay periodic subscription fees for access to the platform. This model is structured to cultivate enduring customer relationships by providing consistent access to an efficient and cost-effective logistics solution. Steady subscription revenues offer Loadsmart a reliable income stream, decoupled from transaction volume fluctuations.

In contrast, Convoy deploys a Transaction-based income model, whereby charges are applied for specific services rendered within the transportation process. This affords shippers the flexibility to tailor their logistics solutions according to their precise requirements. Convoy's income, accordingly, scales in line with the utilization of services and features by its customers.

Notably, these enterprises, while employing diverse income generation models, share a common trait in their success within the platform-based business paradigm. This analysis underscores the absence of a universally applicable revenue generation model within this context. It accentuates the significance of an aptly devised strategy, complemented by a profound comprehension of customer exigencies, as determinants of economic success.

In summation, Uber Freight, Convoy, and Loadsmart serve as exemplars within the platform-based logistics sector, illustrating the viability of tailored income generation strategies. In an industry where adaptability and innovation reign supreme, the diversification of income sources emerges as a pivotal factor impacting long-term viability and prosperity.

In the case of the partnership model, companies like Project44 usually partner with logistics companies such as J.B. Hunt or Schneider (carrier-based model) Since these companies have their own fleets of trucks, it is easier to partner with companies that provide them with services and vice versa.

4.4.3.4.3 Customer relationship

Effective customer relationship management is a critical component of the DFM industry, ensuring that the needs of both shippers and carriers are met efficiently. How DFM models approach customer relationships significantly impacts the success and user experience within each model. In the following paragraphs, we will delve into the specific approaches and customer relationship management in each of these DFM business models.

- **Platform-based Model:** Platform-based models prioritize automated and self-service interactions, enabling shippers and carriers to use the platform directly, and fostering efficient and transparent communication with real-time updates and easy service access. However, the challenge lies in reduced personal touch as interactions are primarily digital and automated, potentially impacting the depth of customer relationships.

- **Brokerage Model:** The brokerage model excels in fostering personalized customer relationships by offering hands-on assistance, expertise, and guidance throughout the shipping process. Brokers act as intermediaries, providing personalized service and the ability to navigate complex logistics challenges. Nevertheless, the challenges emerge in its comparative lack of efficiency as fully automated models and customer relationships heavily rely on the broker's performance, which can vary.
- **Carrier-based Model:** In the carrier-based model, the primary customer relationship centers on carriers maintaining relationships with shippers through dedicated account management teams or customer service departments, ensuring direct communication that can lead to strong and consistent relationships. The challenge is the limited control over the entire logistics process, as carriers tend to focus on their specific services, potentially limiting their ability to address the full spectrum of shipper needs.
- **Software as a Service (SaaS):** SaaS providers offer customer support and assistance while primarily focusing on maintaining and enhancing the software platform. This approach allows for scalable, cost-effective, and streamlined customer interactions through the software, although challenges arise from limited involvement in the actual logistics processes, which may necessitate additional communication channels to ensure comprehensive customer support.
- **Asset-light Model:** Asset-light models strike a balance between technology-driven interactions and direct support, offering flexibility and scalability to adapt to evolving customer preferences. They often leverage platform-based models and SaaS solutions to facilitate communication and provide personalized assistance as needed. However, these models face the challenge of managing relationships across various channels while ensuring that technology does not compromise the personalized service that customers may require.

4.4.3.4.4 Digitalization level

Advanced technologies and digitalization have revolutionized the logistics and transportation industry, particularly in the domain of Digital Freight Matching (DFM). These technologies play a fundamental role in streamlining operations, enhancing efficiency, and improving customer experiences. Across various DFM models, digitalization is a common thread, although the extent

and focus of technological integration differ. In the following sections, we will explore how each DFM model leverages digitalization and technologies, their respective advantages, and the challenges that come with these innovative approaches. This analysis sheds light on the impact of technology in influencing the situation of logistics and freight matching.

- **Platform-based Model:** Platform-based DFM models depend on digitalization and advanced technologies, such as algorithms, machine learning, and data analytics, to effectively connect shippers and carriers. These models provide real-time tracking, automated document management, and communication tools, ensuring high efficiency, transparent operations, and immediate responsiveness. They offer the benefits of seamless, real-time communication, transparent pricing, and wide accessibility for shippers and carriers. The challenges arise from the substantial development and maintenance costs of the platform and the intense competition within this field.
- **Brokerage Model:** The brokerage model embraces technology for load matching, communication, and document management, although it may not be as technology-centric as platform-based models. Traditional brokers offer a vital human touch in customer interactions, delivering personalized service and expertise in handling complex logistics challenges. The main advantage lies in the personalized, expert service, yet these models face challenges regarding efficiency in comparison to fully automated models and reliance on brokers whose performance can fluctuate, especially as the industry evolves.
- **Carrier-based Model:** In the carrier-based model, carriers adopt varying degrees of technology, often integrating telematics, GPS tracking, and mobile apps to streamline operations, optimize routes, and enhance customer communication. The advantages include close integration with carriers, potential cost savings, and flexibility in managing shipments. Challenges stem from the limited control over the entire logistics process, reliance on carriers' technological capabilities, and the potential for inconsistencies in service quality among different carriers.
- **Software as a Service (SaaS):** SaaS providers in DFM offer cloud-based software solutions characterized by a high level of digitalization, relying on cloud infrastructure and data analysis to provide features like load matching, tracking, and analytics. These solutions are cost-effective, scalable, and accessible for small and mid-sized businesses, with straightforward integration into existing systems. Nevertheless, challenges arise from the potential inability to offer the same

comprehensive service as platform-based models and limitations in customization that may not fully align with specific customer needs.

- **Asset-light Model:** Asset-light models leverage technology to optimize their operations and network. They often rely on SaaS solutions and platform-based models to efficiently manage loads, track shipments, and communicate with carriers, offering flexibility, scalability, and reduced operational overhead. They provide advantages such as adaptability and scalability, along with access to a wide network of carriers without the need for extensive resources. However, challenges encompass competition from fully digital platforms and the necessity for continuous adaptation to evolving market conditions.

4.4.3.5 Step 2.3.5. Stage 6: Analyzing the results and derive implications for start-ups

Each business model in DFM has its advantages and challenges, and the choice of which model to adopt should align with a company's specific goals, available resources, and market conditions.

Therefore, if a new company aims to enter the world of DFM, the first thing we must understand is that there is no single, universally reliable, and correct recipe. As we have observed, many successful companies employ various business models, all of which yield positive results. This underscores the importance of assessing the specific strengths and resources a company possesses before choosing a business model. For example, if it has developed a highly effective algorithm and boasts a well-functioning technological platform, it might consider the platform-based model. On the other hand, if a company possess extensive expertise in transportation and logistics, backed by a substantial workforce in this field, the brokerage model could be a suitable choice. Conversely, if a startup owns a fleet of trucks, maintains strong relationships with carriers, and has equipped its trucks with advanced technology, the Carrier-based model may be the most advantageous option.

However, it is important to remember that adopting a specific business model, as shown in this study and the analyzed companies, doesn't mean following it completely. Some companies may employ a particular business model while implementing a different revenue strategy compared to another company using the same model.

Another potentially good idea is to employ a hybrid model that aligns with the company's strengths. Select a business model that suits the company's needs, complemented by a revenue strategy that best suits its goals, a customer relationship approach, and technology that aligns with the company's objectives.

To facilitate the explanation and understanding Table 4.6 shows some benefits and complications when using each of these different models, along with recommendations for start-ups.

Table 4.6 Benefits, Complications and Recommendations using DFM models

Business Model	Benefits	Complications	Recommendations
Platform-based Model	Centralized access to a wide network of shippers and carriers.	Dependency on third parties, potentially affecting control.	The company should assess their specific needs and the needs of their target customers.
	Streamlining the logistics process.	Data security concerns when dealing with sensitive information.	Evaluate the trade-offs between centralization and control.
	Providing valuable data and services.	Fees associated with using the platform.	Establish clear partnerships and data security measures to mitigate risks.
Brokerage Model	Expertise and personalized service.	Additional costs, potentially reducing cost-effectiveness.	The company should carefully analyze its capacity to provide expertise and personalized service. Consider the trade-off between costs and added value.
	Risk mitigation through intermediaries.	Potential dependency on intermediaries for service.	Ensure transparent communication with customers regarding intermediary involvement.
Carrier-based Model	Efficient capacity utilization.	Challenges related to data integration and ensuring data quality.	The company should align their model with its expertise and capacity.
	Direct communication with shippers and carriers.	Managing the size and dynamics of the network.	Focus on providing efficient and reliable solutions. Invest in robust data integration and quality assurance processes to build trust.
Software as a Service	Scalability for growing businesses.	Reliance on internet connectivity for operation.	The company should assess its scalability and integration needs.
	Cost-efficiency, often lower initial investment.	Data security concerns when using a cloud-based service.	Weigh the benefits of cost-efficiency and accessibility against potential complications
	Accessibility from anywhere with an internet connection.	Integration challenges when connecting to existing systems.	Ensure data security and offer transparent pricing models.
Asset-light Model	Flexibility and ability to adapt quickly.	Dependence on carrier relationships, potentially impacting service quality.	The company should consider their ability to build carrier relationships and maintain quality standards.
	Cost savings by not maintaining physical assets.	Quality control challenges, especially with limited physical control.	Evaluate competition and identify unique niches where they can excel.
	Focus on specialized expertise and service.	Strong competition in the market, requiring differentiation strategies.	

4.5 Conclusion

This study has provided insights into the diverse features of Digital Freight Matching (DFM) business models in the trucking industry. The research has demonstrated that there is no one-size-fits-all solution when it comes to choosing the most appropriate business model for a company looking to enter the world of DFM. Instead, the choice should be guided by a thorough assessment of a company's unique strengths, available resources, and market conditions.

One of the primary contributions of this study is the creation of a comprehensive resource that facilitates a comparison between different DFM business models. This is particularly valuable for startup companies looking to enter the trucking industry as it enables them to make informed decisions about the pros and cons of each model.

The research also addressed critical questions regarding the advantages and disadvantages of traditional Freight Brokers versus DFM models and how these shape the industry. It further explored the variations in DFM business models concerning their operational processes, revenue generation strategies, customer relationships, and digitalization levels.

The comparative case study conducted in this research shed light on the distinctions within various DFM business models, offering valuable insights for both existing industry players and newcomers. The framework developed in this study provides a practical tool for assessing and understanding the different approaches within the trucking industry.

As demonstrated in the analysis, successful companies in the industry employ different models, each customized to their unique needs. The choice of a business model should be informed by factors such as a company's technological capabilities, transportation expertise, carrier relationships, and technological infrastructure. It's worth noting that companies can also opt for hybrid models that combine elements from various business models to better align with their goals.

Limitations in this study include the analysis of established industry players, possibly overlooking smaller startups or regional companies, which can offer unique insights. Furthermore, the study primarily focuses on internal factors influencing DFM model selection, and there is limited exploration of external factors such as economic conditions, and competitive landscapes that can significantly impact the industry. Future research should aim to encompass a more comprehensive sample of participants and consider a broader spectrum of companies, while also examining the

influence of external factors on the digital freight matching landscape. Additionally, further research into the impact of DFM models on environmental sustainability, including carbon footprint reduction strategies, will be crucial as the industry faces growing concerns regarding its ecological impact. Evaluating eco-friendly initiatives and their impact on operational efficiency could be a focus area.

In conclusion, this study serves as a valuable resource for startups and industry professionals in the rapidly evolving DFM sector, it is essential to have a robust understanding of the practical insight of the various business models and their implications to select the most suitable business model, emphasizing adaptability, and tailoring to a company's strengths and goals. Our research aims to foster continued growth and innovation in the trucking industry, ultimately enhancing efficiency, reducing costs, and improving service quality for all stakeholders.

CHAPITRE 5 CONCLUSION ET RECOMMANDATIONS

5.1 Conclusion

L'industrie mondiale du transport routier, crucial pour le mouvement des marchandises, fait face à des défis économiques et environnementaux liés à des inefficacités, notamment des camions opérant avec des charges sous-optimales. Cette problématique, présente à l'échelle mondiale, affecte même des acteurs majeurs comme le Canada. Des start-ups émergent avec des idées innovantes, mais leur succès nécessite plus que des concepts révolutionnaires, soulignant le besoin d'outils fondamentaux et d'une orientation stratégique. Cependant, la littérature existante ne couvre pas les modèles d'affaires des start-ups du transport routier dans le contexte numérisé des courtiers en fret, ni l'approche multi-stratégique dans le transport intelligent de marchandises posant un défi pour les nouveaux entrants. Comblar ces lacunes dans la recherche est crucial pour équiper les start-ups des connaissances nécessaires à leur succès dans le contexte évolutif du courtage de fret numérique.

Pour répondre à ces préoccupations, deux articles distincts mais interdépendants explorent le potentiel transformateur des plates-formes de correspondance de fret numérique (DFM). Le premier article explore l'intégration de diverses technologies relevant du domaine de l'"industrie 4.0" pour optimiser la logistique dans l'industrie du camionnage. Il utilise des outils stratégiques tels que l'analyse SWOT, le modèle EFQM-2020 et le Business Model Canvas à triple couche pour examiner la plate-forme d'une start-up canadienne, visant à minimiser les trajets à vide, maximiser les charges utiles et améliorer la durabilité globale. Cette approche globale constitue une contribution unique dans la littérature, en particulier dans le contexte du transport intelligent de marchandises.

Le deuxième article se concentre sur l'évolution de l'industrie du camionnage et la montée en puissance des plates-formes de correspondance de fret numérique, abordant spécifiquement le manque de ressources pour les start-ups souhaitant entrer dans ce secteur dynamique. Il propose une analyse comparative approfondie des différents modèles commerciaux de DFM, mettant en lumière leurs avantages, inconvénients, processus opérationnels, stratégies de génération de revenus et niveaux de numérisation. Ce faisant, l'étude offre des aperçus précieux et un cadre

pratique pour les entrepreneurs aspirants naviguant dans les complexités de l'industrie du camionnage.

Bien que les entreprises réussies de l'industrie utilisent différents modèles, adaptés à leurs besoins spécifiques, comme le montre l'analyse, le choix d'un modèle économique doit être guidé par des facteurs tels que les capacités technologiques de l'entreprise, son expertise en matière de transport, ses relations avec les transporteurs et son infrastructure technologique. Il est important de noter que les entreprises peuvent également opter pour des modèles hybrides qui combinent des éléments de différents modèles économiques pour mieux s'aligner sur leurs objectifs.

Dans leur ensemble, ces articles soulignent le besoin urgent de solutions innovantes dans l'industrie du camionnage. Cette étude vise à fournir des éclairages sur la situation diversifiée des modèles économiques de la mise en correspondance numérique du fret dans l'industrie du transport routier. La recherche a démontré qu'il n'y a pas de solution universelle lorsqu'il s'agit de choisir le modèle économique le plus approprié pour une entreprise cherchant à entrer dans le monde du DFM. Au lieu de cela, le choix devrait être guidé par une évaluation approfondie des forces uniques de l'entreprise, des ressources disponibles et des conditions du marché.

5.2 Recommandations

Comme discuté tout au long de cette étude, notre objectif est de guider et de conseiller les nouvelles entreprises (startups) dans ce monde en constante évolution et riche en opportunités, comme c'est le cas dans le secteur du courtage de fret dans l'industrie du transport routier.

Lorsqu'il s'agit de faire des recommandations, il n'y a pas qu'une seule manière de bien faire les choses, et cela ne signifie pas non plus que le succès est garanti si les entreprises suivent ces recommandations. Il existe de nombreux facteurs critiques qui évoluent constamment, comme dans toute industrie. Toutefois, notre première recommandation est de former d'abord une équipe multidisciplinaire après avoir eu une bonne idée pour entreprendre le chemin d'une nouvelle entreprise, puisque nous avons toujours besoin de personnes d'horizons distincts pour que les idées générées proviennent de lieux et de pensées différents. Ensuite, il faut commencer par des outils de marché tels que l'analyse SWOT pour identifier clairement les forces à améliorer, les faiblesses à travailler, les opportunités à saisir, et les menaces externes pouvant affecter l'entreprise.

Postérieurement, un modèle EFQM devrait être développé, qui vise à créer une valeur durable pour les parties prenantes de l'entreprise, en les aidant à comprendre les lacunes et les solutions possibles, permettant ainsi une progression significative et une amélioration des performances de l'organisation. Subséquemment, les entreprises devraient élaborer un 3L BMC pour résumer et visualiser les informations les plus importantes du modèle économique, afin de connaître chaque détail des 9 parties du BMC, la proposition de valeur, les segments de clients, la relation client, les canaux utilisés, les activités clés de l'entreprise, les partenaires clés, les ressources clés, la structure des coûts et les flux de revenus. La couche environnementale se concentrera sur la manière dont l'organisation génère plus d'avantages environnementaux que d'impacts, et la couche sociale visera à capturer les principaux impacts sociaux de l'organisation résultant de ces relations. Avec l'aide de ces 3 études principales, qui doivent être travaillées de manière constante et mises à jour, l'entreprise peut vraiment comprendre sa situation actuelle, comme si ça serait photographie de l'entreprise actuelle pour bien savoir quelles décisions prendre dans le présent et dans le futur.

Une fois ces outils mis en œuvre, il est recommandé de réaliser une modélisation basée sur les agents pour vraiment comprendre les acteurs ou agents présents et fonctionnant dans ce système, comment ils interagissent entre eux, quelles sont les règles et hiérarchies d'interaction, où ils vont interagir (environnement), et tout cela peut aider à lancer les bases d'un futur modèle de simulation pour simuler ces modèles complexes.

Après avoir établi toute la structure de base de l'entreprise, où le marché aura déjà été analysé, il faudra connaître les différents modèles d'affaires réussis actuellement utilisés, les entreprises qui les utilisent, et commencer à comparer et observer comment l'entreprise devrait s'adapter et choisir le modèle d'affaires le plus approprié. À cette période, ayant déjà mis en œuvre les outils précédents, l'entreprise comprend parfaitement comment elle fonctionne actuellement et où elle souhaite aller, de sorte que la sélection du modèle d'affaires devrait être plus simple par rapport aux entreprises qui n'ont peut-être pas effectué tout le processus précédent avec les outils mentionnés.

Rappelons que pour la sélection du modèle d'affaires, ces modèles varient en interne. Il se peut qu'une entreprise utilisant un modèle d'affaires particulier ait une manière de générer des revenus différents d'une autre entreprise utilisant le même modèle. C'est pourquoi, étant donné cette variété

d'options, nous recommandons également un modèle plus hybride selon les convenances du marché et les spécificités de l'entreprise.

Finalement, nous voulons souligner une fois de plus qu'il n'y a pas de solution unique et que ces recommandations ne garantissent pas le succès, mais nous croyons qu'elles aident à l'atteindre dans un pourcentage plus élevé, comme cela a été observé à travers les différentes études.

5.3 Implication de la recherche

Ce mémoire a des implications pratiques et académiques. Avec l'aide de ce guide destiné aux start-ups, il y aurait davantage d'entreprises ayant de bons résultats dans ce secteur. Cela pourrait aider à gérer plus efficacement les opérations de transport de marchandises. Les propriétaires de plateformes de partage de fret bénéficieraient d'un plus grand nombre de clients servis, ce qui pourrait se traduire par des bénéfices plus importants. Ils pourraient coordonner les arrangements sur le marché du fret de manière plus solide, durable et efficace. Du point de vue des transporteurs, l'amélioration des opérations de fret pourrait se traduire par une minimisation des coûts. Du point de vue des expéditeurs, une plus grande efficacité pourrait être définie par le fait de recevoir des services plus qualifiés. Enfin, d'un point de vue sociétal, l'amélioration de l'efficacité des transports pourrait se traduire par une réduction des impacts environnementaux et des émissions de gaz à effet de serre.

Ce projet de recherche contribue à la littérature dans différents aspects. L'application des différents outils du côté des modèles d'affaires pour construire une start-up dès la base et dès le début. En plus des recommandations pour les nouvelles entreprises qui veulent rentrer dans l'industrie du fret, ont été souligné.

5.4 Limites

L'approche de la méthode des cas uniques est une technique de recherche qualitative axée sur l'analyse détaillée d'un phénomène complexe dans son milieu naturel. Elle offre des avantages comme la richesse des données, la flexibilité et l'applicabilité pratique. Cependant, elle présente des limitations tels que la difficulté de généralisation, la subjectivité et les défis liés à la validation et à la fiabilité de la recherche. Pour améliorer cette méthode, il est nécessaire de résoudre plusieurs

dilemmes et d'adopter des pratiques adéquates. Andersen, Dubois et Lind (2018) introduisent le concept de validation du processus pour les études de marketing interentreprises. Quintão, Andrade et Almeida (2020) proposent des techniques pour renforcer la fiabilité et les différentes formes de validité dans les études de cas. Enfin, Leedy et Ormrod (2010) offrent des critères d'évaluation de la validité et de la fiabilité des études de cas, avec des exemples dans divers domaines et contextes.

Pour évaluer la méthode des cas uniques, on utilise divers critères, dont :

- **Fiabilité** : Elle mesure la cohérence et la stabilité du processus de recherche, et l'absence d'erreurs ou de biais. Pour garantir la fiabilité, le chercheur doit documenter précisément les procédures, utiliser plusieurs sources de preuves et vérifier l'exactitude des données et analyses.
- **Validité de construction** : Ce critère évalue si la recherche mesure et opérationnalise correctement les concepts étudiés. Pour cela, il faut des définitions claires, l'usage de mesures établies et la triangulation des données issues de différentes sources et méthodes.
- **Validité interne** : Elle concerne la capacité de la recherche à établir une relation causale entre les éléments étudiés. Cela nécessite un design de recherche cohérent, la gestion des facteurs confondants et l'utilisation de techniques analytiques adéquates.
- **Validité externe** : Elle indique dans quelle mesure les résultats de la recherche peuvent être généralisés. Pour cela, il faut un échantillon représentatif, l'utilisation de plusieurs cas et la comparaison des résultats avec des théories ou des études existantes.

Dans notre étude de cas sur le développement d'outils multi stratégiques pour les start-ups dans le domaine des transports intelligents de marchandises, nous avons utilisé le cas d'une start-up pour valider et discuter du problème. Malgré l'intention de respecter les critères, des limites ont été notées:

- L'emploi d'un seul cas réduit la capacité de généraliser les résultats. Des recherches futures devraient envisager plusieurs cas pour améliorer la validité externe et la robustesse des résultats.
- L'approche qualitative restreint la quantification et la mesure des variables et résultats. Les recherches ultérieures pourraient intégrer des méthodes mixtes pour combiner qualitatif et quantitatif, améliorant ainsi la fiabilité et la validité de construction.
- Il demeure incertain dans le milieu académique si les stratégies implémentées apportent réellement un avantage aux entreprises en démarrage.

- Le design descriptif et exploratoire limite l'analyse causale du phénomène. Pour améliorer la validité interne, les recherches futures pourraient adopter une approche plus explicative et confirmatoire, permettant de tester des hypothèses et d'établir des relations causales.
- La méthode SWOT, basée sur des évaluations subjectives, repose sur des jugements personnels et des suppositions. Cette approche peut être altérée par les inclinations et les biais des analystes. Elle ne propose ni données chiffrées ni solutions spécifiques pour les problèmes détectés.
- La flexibilité que donne le modèle EFQM-2020 peut rendre difficile l'évaluation et la comparaison des performances entre différentes organisations. La mise en œuvre de ce modèle, ainsi que la conduite d'auto-évaluations régulières, peuvent s'avérer coûteuses et exiger beaucoup de temps.
- Se concentrer excessivement sur le processus d'évaluation peut conduire à négliger les résultats réels et les impacts concrets, en omettant les issues tangibles importants.
- L'analyse des acteurs industriels établis, néglige les petites startups ou les entreprises régionales, qui peuvent offrir des informations uniques.
- Concentration principalement sur les facteurs internes influençant la sélection du modèle DFM, et l'exploration des facteurs externes tels que les conditions économiques et les situations concurrentiels qui peuvent avoir un impact significatif sur l'industrie est limitée.
- Comparativement au contexte du transport urbain, l'information, document, et base de données liées au transport de marchandises sont très limitées et nous n'y avons pas accès.

5.5 Recherches futures

Les recherches futures devraient viser à englober un échantillon plus complet de participants et à prendre en compte un éventail plus large d'entreprises, généraliser davantage les résultats et à développer des tableaux de bord de décision stratégique systématiques pour les plates-formes de fret intelligentes afin de tester et d'analyser les opportunités de création de valeur dans un environnement axé sur la durabilité et la technologie. Tout en examinant également l'influence des facteurs externes sur la perspective du rapprochement numérique du fret. De plus, des recherches plus approfondies sur l'impact des modèles DFM sur la durabilité environnementale, y compris les

stratégies de réduction de l'empreinte carbone, seront cruciales alors que l'industrie est confrontée à des préoccupations croissantes concernant son impact écologique. L'évaluation des initiatives respectueuses de l'environnement et de leur impact sur l'efficacité opérationnelle pourrait être un domaine d'intérêt prioritaire.

Une modélisation et simulation basée sur des agents pour un modèle DFM, pourraient être réalisées et mises en œuvre. Cela pourrait permettre aux nouvelles entreprises de comprendre comment elles peuvent modéliser ces systèmes, comment ils fonctionnent pendant la phase de modélisation et de simulation, et quels résultats elles peuvent obtenir. Ceci donnerait un réalisme au modèle et la possibilité d'explorer les facteurs environnementaux dynamiques, en effectuant des analyses comparatives des plates-formes DFM.

Nous présentons également la Figure 5.1 où nous observons qu'à la figure originale du cadre d'outils appliqués Figure 1.2, nous avons ajouté la recherche future dans la base, où la modélisation à base d'agent d'un système DFM, échantillon plus complet d'entreprises analysé ainsi que l'impact des modèles DFM sur la durabilité environnementale pourraient être effectués.

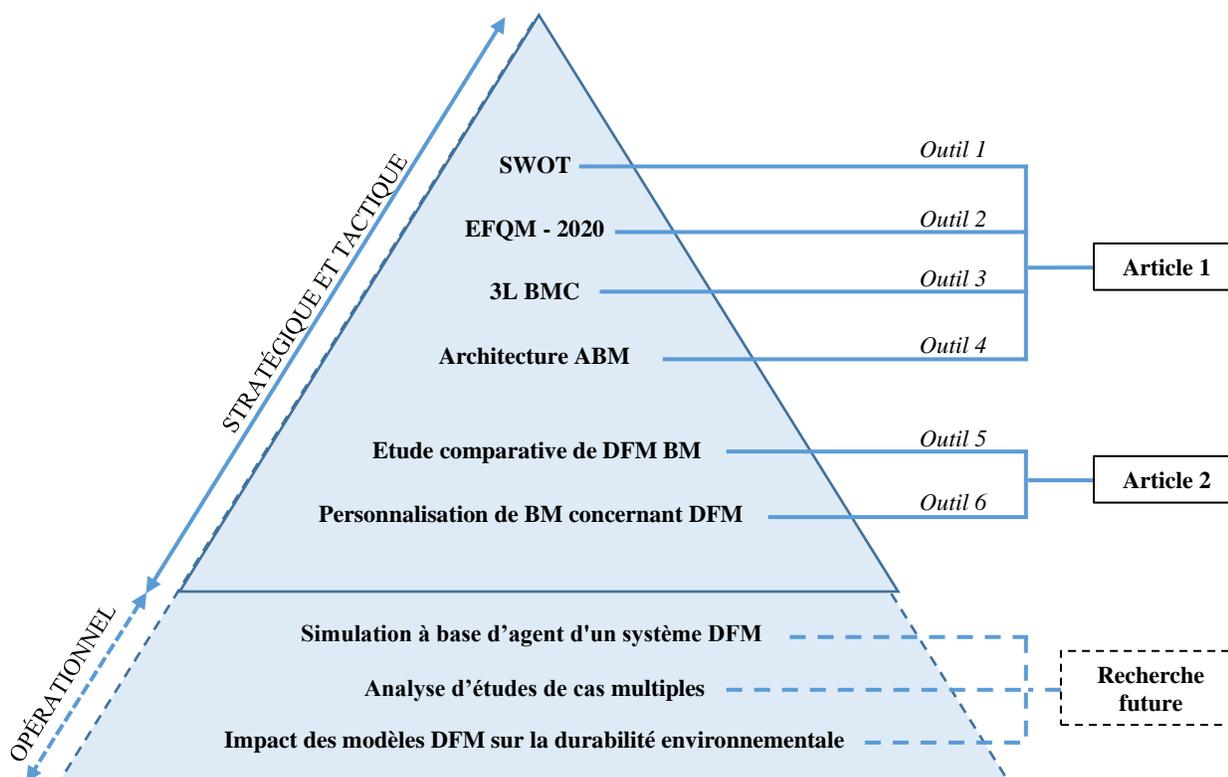


Figure 5.1 Cadre d'outils appliqués et recherches futures

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