Physical Internet Enabled Transit Centers: Business Modeling and Profitability Assessment

Mémoire

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Résumé

Dans cette recherche, la modélisation d'affaires des centres de transit de l'Internet physique (PI, π) est étudiée dans le but d'aider les gestionnaires de la logistique, les analystes d'affaires et les investisseurs potentiels à avoir une analyse profonde et rapide des principaux aspects d'affaires de ces unités d'affaires. La première partie de cette étude examine les aspects critiques de conception de l'entreprise qu'est un π-transit. Pour atteindre cet objectif, le canevas de modèle d'affaires proposé par Osterwalder et Pigneur (2010) est utilisé pour développer un modèle d'affaires pour cette composante spécifique de l'Internet Physique. La deuxième partie de cette recherche étudie l'effet de l'emplacement sur le modèle d'affaires du π-transit. Un cadre conceptuel est élaboré pour identifier les différents composants affectant le modèle d'affaires d'un π-transit, chacun étant divisé en éléments particuliers. L'impact de la localisation d'un π-transit sur son modèle d'affaires est analysé pour chaque élément à travers un ensemble d'indicateurs. Le modèle est ensuite appliqué pour analyser l'environnement d'affaires pour des sites situés dans les régions métropolitaines. La dernière partie de la recherche étudie l'effet d'un ensemble de facteurs de localisation sur le profit potentiel d'un π-transit. Un modèle analytique est développé et validé par le biais de corrélations et de régressions étant donné un ensemble de données empiriques d'une expérience de simulation à grande échelle.

Abstract

In this research, the business modeling of Physical Internet (PI, π) enabled transit centers is investigated with the goal of helping logistics managers, business analysts and potential investors to have a deep and quick scan over the key business aspects of these business units. The first part of this research investigates critical business aspects of π-transit related to its specific design. To reach this goal, the Business Model Canvas proposed by Osterwalder and Pigneur (2010) is used to develop a business model for this specific Physical Internet component. The second part of this research investigates the effect of location on the π-transit business model. A conceptual framework is elaborated to identify the various components affecting a π-transit's business model, each one being divided into elements. The impact of location on the business model is analyzed for each element through a set of indicators. The framework is then applied for analyzing the business environment of sites located in metropolitan areas. The last part of the research investigates the effect of a set of location factors on the potential for profitability of π-transits. An analytical model is developed and validated through correlation and regression analyses using data from a large-scale simulation experiment.

Contents

Résumé III
Abstract IV
List of Tables VIII
List of Figures IX
Acknowledgements XI
Forward XIII
Chapter 1. Introduction 1
Chapter 2. Literature Review and Research Concepts Overview 4
2.1 Business Model 4
2.2 Business Model Definition 5
2.3 Designing a Business Model 8
2.3.1 Hamel (2000) 8
2.3.2 Rayport and Jaworski (2001) 9
2.3.3 Pateli and Giaglis (2003) 9
2.3.4 Morris *et al*., (2005) 10
2.3.5 Slywotzky *et al.,* (2007) 13
2.3.6 Lindgardt *et al.,* (2009) 14
2.3.7 Yunus *et al.,* (2010) 15
2.3.8 Osterwalder and Pigneur (2010) 16
2.3.9 Caisse and Montreuil (2014) 20
2.4 Business Model Innovation 22
2.5 Factors Affecting a Business Model 25
2.5.1 Business Strategy 26
2.5.2 Business Organization 26
2.5.3 Information and Communication Technology (ICT) 27
2.5.4 Competitive Forces 28
2.5.5 Customer Demand 28
2.5.6 Technological Change 29
2.5.7 Legal Environment 29
2.5.8 Social Environment 30
2.5.9 Business Modelling Summary 30
2.6 Logistics Industry 30

2.6.1 Logistics Mission 31
2.6.2 Logistics Activities 32
2.6.3 Logistics Network (Nodes versus Links) 33
2.6.4 Logistics Network Configuration 34
2.7 Logistics Network Challenges 34
2.8 Physical Internet 35
2.9 Transit Centers 38
2.10 Previous Research on Physical Internet and Business Model Innovation 40
2.11 Literature review and research concepts overview summary 44
Chapter 3. Methodology 45
3.1 Designing Business Models for Physical Internet Transit Centers 46
3.2 Identifying Effective Geographic Location Factors Influencing the Business Model of Physical Internet Enabled Transit Centers and Assessing Their Impacts 46
3.3 The Effect of Location Factors on the Profitability of Physical Internet Enabled Transit Centers 47
3.4 Master Thesis Structure 47
Chapter 4. Designing Business Models for Physical Internet Transit Centers 49
4.1 Introduction 50
4.2 Physical Internet 51
4.2.1 Uni-Modal Physical Internet Transit Center Description 52
4.3 Business Modelling 58
4.4 Π Transit Center and Business Modelling 60
4.4.1 Π-Transit Center Customer Segments 60
4.4.2 Π-Transit Center Value Proposition 62
4.4.3 Π-Transit Center Channels 63
4.4.4 Π-Transit Center Customer Relationships 63
4.4.5 Π-Transit Center Revenue Streams 64
4.4.6 Π-Transit Center Cost Structure 68
4.4.7 Π-Transit Center Key Resources 68
4.4.8 Π-Transit Center Key Partners 68
4.4.9 Π-Transit Center Key Activities 69
4.4.10 Π-Transit Center Business Model Canvas Overview 69
4.5 Π-Transit Center Growth Strategy 70
4.6 Conclusion 71
References 72

Chapter 5. Impact of Geographic Locations on the Business Model of Physical Internet Enabled Transit Centers 74
5.1 Introduction 75
5.2 Literature Review 79
5.2.1 Business Model Concepts 79
5.2.2 Physical Internet Enabled Transits and Business Modelling 80
5.3 Research Context and Methodology 82
5.3.1 Business Characteristics 84
5.3.2 Business Model Axes 84
5.3.3 External Factors 88
5.4 Transit Centers in Metropolitan Area: Comprehensive Business Perspective 93
5.4.1 Business Characteristics 93
5.4.2 Business Model Axes 94
5.4.3 External Factors 96
5.5 Conclusion 102
References 103
Chapter 6. The Effect of Location Factors on the Profitability of Physical Internet Enabled Transit Centers 106
6.1 Approach and Hypotheses 107
6.2 Analytical Model 111
6.3 Determining the Dependent Variable of the Model 112
6.4 Statistical Analyzes 114
6.5 Results and Managerial Implications 115
6.5.1 Supported and Non-Supported Hypotheses 115
6.5.2 Best Predictors of Profit 119
6.6.3 Analytical Model Reorganization 122
6.5.4 Managerial Implications 124
6.6 Predicting Transit Profit: A Summary 125
Chapter 7. Conclusion 126
References 130

List of Tables

Table 2-1: Six questions that underlie a business model (Morris *et al.,* 2005, p. 730) 12
Table 2-2: Growth vector components (Ansoff, 1965, p. 109) 24
Table 2-3: Logistics in 21th century (Coyle *et al*., 2013, p. 38).....31
Table 2-4: The unsustainability symptoms (Montreuil, 2011).....35
Table 2-5: Physical Internet addressing unsustainability symptoms (Montreuil, 2011) 36
Table 2-6: Current and future KPI values for a transport service provider (Meller *et al.,* 2012, p. 15).....42
Table 3-1: Phases, methodologies, and applied methods 45
Table 4-1: Matching Potential Goals and Pricing Strategies for a π-Transit Center...66
Table 4-2: Concepts Underlying Potential Goals and Pricing Strategies for a π-Transit Center 67
Table 5-1: Examples of π-transit's suppliers and customers.....89
Table 5-2: Assessing the impact of location on π-transit business models in a metropolitan area 101
Table 6-1: Research hypotheses 110
Table 6-2: Correlation analysis results 118
Table 6-3: Stepwise regression analysis results 121
Table 6-4: Coefficient and significance of variables.....123

List of Figures

Figure 2-1: Research fundamental concepts 4
Figure 2-2: The business model between the technical and economic domains (Chesbrough and Rosenbloom (2002), p. 536) 7
Figure 2-3: Unpacking the business model (Hamel, 2000, p. 94) 8
Figure 2-4: Components of a business model (Rayport and Jaworski, 2001, p. 71) 9
Figure 2-5: Business Model Components Framework (Pateli and Giaglis (2003), p. 339) 10
Figure 2-6: The dimensions of business design (Slywotzky *et al.,* 2007, p. 12) 14
Figure 2-7: A business model six components (Lindgardt *et al.*, 2009, p. 2) 15
Figure 2-8: The three components of a conventional business model (Yunus *et al.,* (2010), p. 312) 16
Figure 2-9: Osterwalder and Pigneur (2010, p. 44) business model framework 17
Figure 2-10: VAS Triquetra framework for conceptualizing collective endeavors (Caisse and Montreuil, 2014, p. 4) 21
Figure 2-11: Poles, flows, dyads, and faces of the OCCS tetrahedron framework (Caisse and Montreuil, 2014, p. 11) 22
Figure 2-12: Change models (Linder and Cantrell, 2000, p. 13) 23
Figure 2-13: Pricing objectives and strategies (PennState, college of agriculture sciences, 2015) 25
Figure 2-14: The business model's place in the firm (Osterwalder *et al*., 2005, p. 15) 26
Figure 2-15: Logistics management process (Christopher, 2005, p. 15) 32
Figure 2-16: Conceptualizing the logistics network (Simchi-Levi *et al*., 2000, p. 2). 33
Figure 2-17: Logistics Web components (Montreuil, 2009-2012) 38
Figure 2-18: Illustration of hyperconnected semi-trailer truckload transportation across a Mobility Web (Montreuil, 2011) 39
Figure 2-19: Illustrative layout of a π-transit center (Meller *et al.,* 2014) 40
Figure 2-20: Implications of different types of business model innovation strategies for π-Enablers and π-Enabled firms (Montreuil *et al.,* 2012, p. 34) 41

Figure 2-21: Mobility supporting a supply web business model (Hakimi, 2014, p. 68) 43
Figure 4-1: Illustration of an interconnected truckload transportation of trailers across a Mobility Web 52
Figure 4-2: Block Layout for the proposed functional design.....53
Figure 4-3: Overview of the flow of trucks and trailers in a Physical Internet Transit Center 56
Figure 4-4: Final layout of a proposed design (front aerial view).....57
Figure 4-5: π-Transit Center Secondary Customer Segments 62
Figure 4-6: π-Transit Center Customer Relationships based on Channels and Customer Segments 64
Figure 4-7: π-Transit Center Cost Spectrum 68
Figure 4-8: π-Transit Center Business Model Canvas.....69
Figure 5-1: Illustrating interconnected transportation of semi-trailers across a Mobility Web (Source: Montreuil, 2011).....76
Figure 5-2: Illustrative layout of a π-transit center (Meller *et al.,* 2014) 77
Figure 5-3: Example of a π-transit network for the province of Quebec in Canada (Source: Hakimi *et al.,* 2014) 78
Figure 5-4: Logistics Web components (Montreuil, 2009-2012).....81
Figure 5-5: Framework to identify factors affecting π-transit business models and to assess their impact related to location 83
Figure 5-6: Business model axes, elements and indicators 85
Figure 5-7: External factor elements and indicators.....88
Figure 6-1: Methodology used in the third step 108
Figure 6-2: Illustration of the process for profit determination.....114

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Forward

This research has been done during 2013 to 2015 in M.Sc. program in Mechanical Engineering (concentration Industrial Engineering) at Université Laval in Quebec, Canada, under the supervision of Professor Nadia Lehoux and co-supervision of Professor Benoit Montreuil. This research was funded by the Natural Sciences and Engineering Research Council of Canada (NSERC). This thesis encompasses three contributions achieved through active collaboration and help of Professor Nadia Lehoux, Professor Benoit Montreuil, Dr. Driss Hakimi and Mrs. Caroline Cloutier. The results of first two contributions were presented during the first and the second International Physical Internet Conference (IPIC) (2014, 2015), while the third contribution is proposed in this thesis for the first time. Results of this research may be useful for scientists, business analysts and engineers, investors, and logistics service providers to have a deep and quick scan over the key business model aspects of Physical Internet enabled transit centers and to make decisions for investment plans in this business.

Contributions of this research are as follows:

1) Designing business models for Physical Internet transit centers;
2) Identifying effective geographic location factors influencing the business model of Physical Internet enabled transit centers and assessing their impacts;
3) Studying the effect of location factors on the profitability of Physical Internet enabled transit centers.

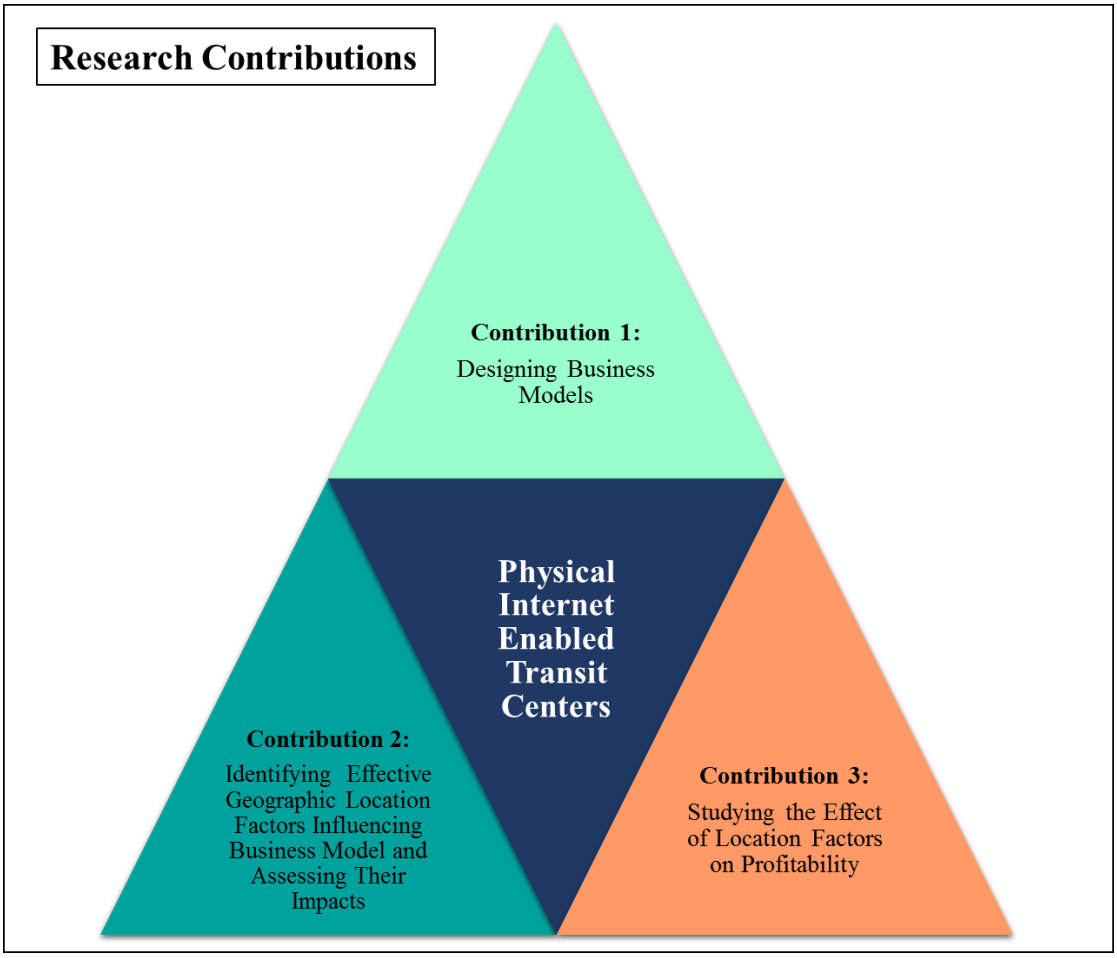

Figure: Research Contribution

Papers currently published that originated from this research are listed below:

1) Oktaei P., N. Lehoux, B. Montreuil (2014): *Designing Business Models for Physical Internet Transit Centers*, Proceedings of 1st International Physical Internet Conference (IPIC 2014), Québec, Canada, 2014/05/28-30;
2) Oktaei P., D. Hakimi., N. Lehoux, B. Montreuil, C. Cloutier (2015): *Impact of Geographic Locations on the Business Model of Physical Internet Enabled Transit Centers,* Proceedings of 2st International Physical Internet Conference (IPIC 2015), Paris, France, 2015/07/6-8.

Chapter 1. Introduction

In today's competitive, economic, and global world, every business should design and improve its business model in order to stay competitive and survive. According to Osterwalder and Pigneur (2010, p.14) "*A business model describes the rationale of how an organization creates, delivers, and captures value*". Designing a business model helps managers in identifying the success and failure factors of their business rapidly, make required decisions, and improve their competitive advantages and performance. It can also guide investors in making the right decisions about their investment plans. As competition is a key component of today's businesses, firms should exploit innovative ideas and dynamically improve their value proposition and performance, in one word, their business model, in order to enable their profitability and sustainable growth in long run.

Focusing on the logistics industry, Montreuil (2011) declared that current logistics networks are economically, environmentally, and socially inefficient and unsustainable. To support his declaration, he mentioned thirteen symptoms of these inefficiencies and proposed the Physical Internet (PI, π) paradigm as a promising solution. According to Montreuil *et al.,* (2012): "*The aim of the Physical Internet (PI) is to universally interconnect logistics networks through world-standard modular containers, interfaces and protocols in order to improve the worldwide efficiency and sustainability of logistics. Basically, the idea is to do in the physical world what was done in the digital world by the Digital Internet".* With the emergence of this revolution in the logistics industry with the Physical Internet Manifesto tackling the challenge of "*transforming the way physical objects are moved, stored, realized, supplied, and used aiming towards greater efficiency and sustainability*" (Montreuil, 2009-2012), actors will have to change their business model and adapt it with new and innovative value propositions to efficiently address this paradigm.

In this research, we focus on designing and improving the business model of a specific type of logistics service provider in a Physical Internet environment known as a Physical Internet transit center in short a π-transit. This key component is responsible for transferring semi-trailers (trailers in short from now on) from one truck to another through a hyperconnected transportation system (Montreuil, 2015). Because transit centers can be located in many potential areas to ensure physical objects movements, they may have to face different customer expectations, resource availabilities, operation costs, technology requirements, etc. Thus in the research project we tried to answer the following three questions related to this challenge:

1) What are the key business model aspects of a Physical Internet enabled transit center?
2) What are the impacts of geographic location on the business model of Physical Internet enabled transit centers?
3) To what extent is the level of profitability of Physical Internet enabled transit centers predictable given a set of geographic location factors?

To answer the first question, a business model was designed based on the Business Model Canvas of Osterwalder and Pingeur (2010). Their Canvas was selected because it is a powerful visual and intuitive tool that provides a comprehensive perspective of a company's business. The tool encompasses nine key components related to customers, offer, infrastructure, and financial viability. Thus in this phase these nine building blocks were analyzed and instantiated for Physical Internet transit centers.

To answer the second question of the research, the impact of geographic location factors on the business model of Physical Internet enabled transit centers was studied. A framework was first developed, encompassing a set of components, elements, and indicators. Potential locations for transit centers were also identified through using a specific network design. The framework was then applied for a predetermined type of transit center location and its indicators assessed. This framework was developed

through reviewing handbooks, articles, and theses related to business performance, business modeling, factors that can affect a business model, etc.

The third question of the research involved studying the level of profit predictability for Physical Internet enabled transits as a function of location, given a set of location factors. Using the defined factors, some hypotheses were developed and an analytical model proposed. Using data sets for each location factor as well as profit for each of the transits, the hypotheses and analytical model were tested and validated through correlation and regression analyzes.

This research aims to help potential business providers and academics in having a deeper perspective over primary aspects of the Physical Internet business world. Academics can also use this research in order to develop similar models for other businesses, while they can change the data sets for other locations and analyze the results. They can also add other location factors such as competition, legal environment, social environment, etc., to the model in order to study their impact on the business model.

This master thesis is organized in seven chapters as follows. The second chapter presents the literature review related to business modeling, logistics industry, and Physical Internet. The third chapter is dedicated to the methodology. The fourth chapter presents the designed business model Canvas for Physical Internet enabled transit centers as an article, published in the proceedings of the First International Physical Internet Conference. The fifth chapter proposes the developed framework to study the impact of geographic location factors on the business model of Physical Internet enabled transit centers and assesses indicators for sites located in Metropolitan area as an article, published in the proceedings of the Second Physical Internet Conference. The sixth chapter indicates the predictability of the level of profit for Physical Internet enabled transit centers in various locations, given a set of location factors. Finally the seventh chapter outlines an overall review, research limits and potential future research directions.

Chapter 2.
Literature Review and Research Concepts Overview

This chapter goes over the fundamental concepts involved in the research. We first review the notion of business modeling, including its concept, goals, and growth strategies. Secondly we study logistics networks, their mission, activities, and configuration. Thirdly we describe the revolutionary Physical Internet paradigm. Fourthly we study the Mobility Web and its role in a Logistics Web. Fifthly and finally we study the transit centers, their value proposition, and their role in a Mobility Web. Figure 2-1 summarizes the fundamental concepts discussed in this section.

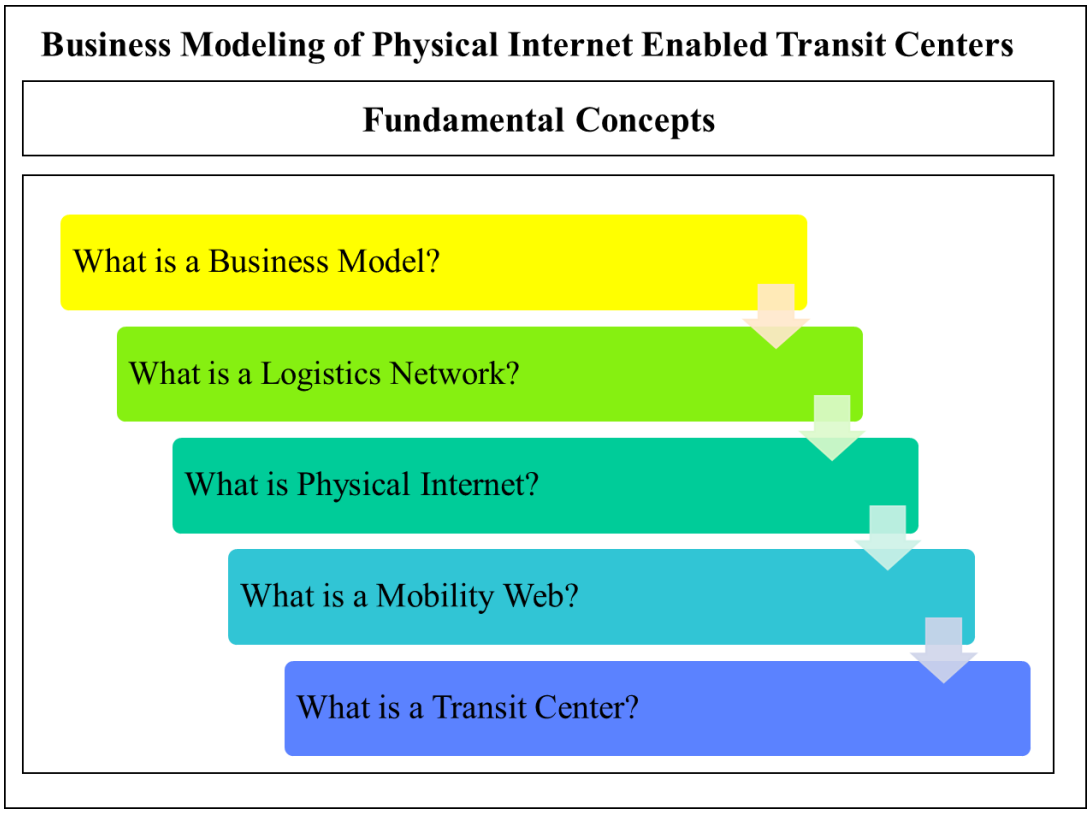

Figure 2-1: Research fundamental concepts

2.1 Business Model

Teece (2010) declared that every business exploits a specific business model that explains the design of creating, delivering, and capturing value. Thus the business

model should be used to identify methods a company uses to: 1) deliver its value, 2) attract customers to pay for its value, and 3) transform customer's payments to profit (Teece, 2010).

The need of how to capture value from providing new products and services, as well as the need of considering how to address customer needs, are increased in the new global environment and a well-designed business model may help firms to increase the innovative ideas (Teece, 2010).

2.2 Business Model Definition

Regardless of 20 years of research in business modeling field, the term "business model" is still a buzzword and its definition and goals are still suffer from fuzziness. According to Shafer *et al*., (2005) and Zott *et al.,* (2010), there is no single definition of the term in the literature. It usually varies according to the domain of studies of the researchers (Zott *et al.*, 2010).

Even though there is not a single definition of what is a business model, distinctive propositions by researchers are provided as follows:

- Timmers (1998): "*An architecture for the product, service and information flows, including a description of the various business actors and their roles; and a description of the potential benefits for the various business actors; and a description of the sources of revenues*";
- Amit and Zott (2001, p. 511): "*A business model depicts the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities*";
- Chesbrough and Rosenbloom (2002, p. 529), as depicted in Figure 2-2: "*A successful business model creates a heuristics logic that connects technical potential with the realization of economic value*";
- Magretta (2002, p. 4): "*Business models, though, are anything but arcane. They are, at heart, stories-stories that explain how enterprises work. A good business model answers Peter Drucker's age-old questions: Who is the customer? And*

what does the customer value? It also answers the fundamental questions every manager must ask: How do we make money in this business? What is the underlying economic logic that explains how we can deliver value to customers at an appropriate cost?";

- Morris *et al.* (2005, p. 727): "*A business model is a concise representation of how an interrelated set of decision variables in the areas of venture strategy, architecture, and economics are addressed to create sustainable competitive advantage in defined markets*". They identified six fundamental components for a business model: value proposition, customer, internal processes/competencies, external positioning, economic model, and personal/investor factors";
- Johnson *et al.,* (2008, p. 52): "*A business model, from our point of view, consists of four interlocking elements that, taken together, create and deliver value"* These elements are: customer value proposition, profit formula, key resources, and key processes;
- Casadesus-Masanell & Ricart (2010, p. 195): "*A business model, we argue, is a reflection of the firm's realized strategy*";
- Osterwalder and Pigneur (2010, p. 14): "*A business model describes the rationale of how an organization creates, delivers, and captures value*";
- Teece (2010, p. 179): "*A business model articulates the logic, the data, and other evidence that support a value proposition for the customer, and a viable structure of revenues and costs for the enterprise delivering that value*";
- Zott *et al.,* (2010, p. 24): "*[…] business model researchers generally adopt a holistic and systemic (as opposed to particularistic and functional) perspective, not just on what businesses do (e.g., what products and services they produce to serve needs in addressable market spaces), but also on how they do it (e.g., how they bridge factor and product markets in serving the needs of customers). The business model perspective thus involves simultaneous consideration of content and process, which explains part of the challenge in defining and operationalizing the construct";*

- George and Bock (2011, p. 99): "*[…] a business model is the design of organizational structures to enact a commercial opportunity*".

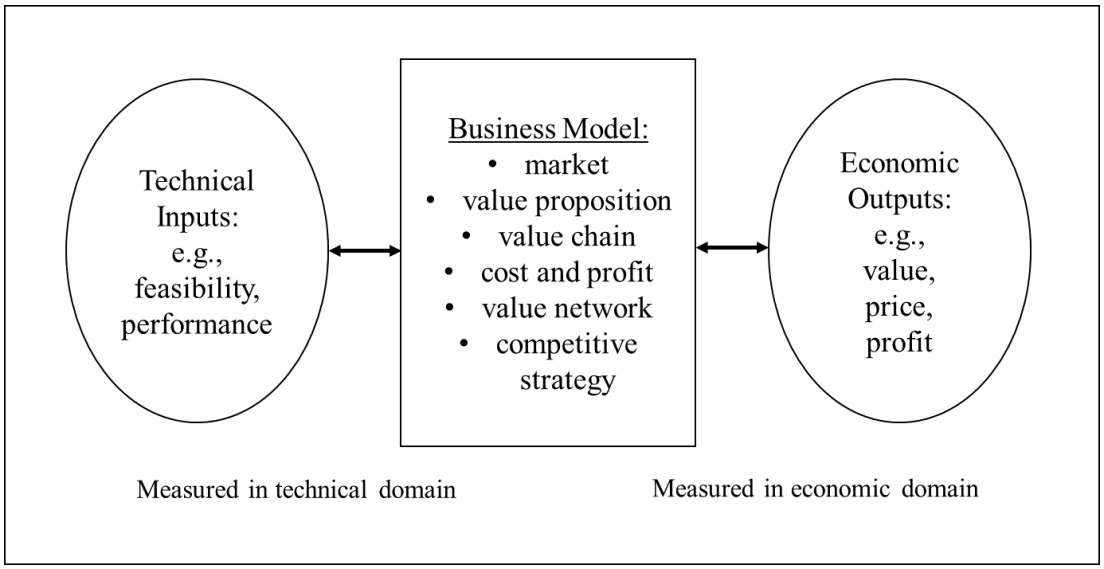

Figure 2-2: The business model between the technical and economic domains (Chesbrough and Rosenbloom (2002), p. 536)

One of the recent research in this context is the work of Caisse and Montreuil (2014). They introduced Polar Business Design as (p.1): " *Polar business design aims to enable entrepreneurs, managers, consultants, researchers, and business students to better tackle model-based analysis, creation, and transformation of businesses, ventures, and, more generically, collective endeavors of any size and purpose. It is based on a systems-thinking approach that builds on a few interrelated core concepts to create holistic visual frameworks. These core concepts act as poles linked by meaningful dyads, flows, and faces arranged in geometric shapes."* In more detail, they declared that: *"Polar business design is a new way to relate concepts to one another in business model literature. It relies on identifying a handful of key concepts called "poles," from which other concepts relevant to business design are derived based on a geometric configuration of interrelationships. Going beyond ontologies and lists of important ideas, this approach helps to visualize and name the interrelations that bind key concepts together*" Their models will be presented further in section 2.3.

Through reviewing the business model definitions, it can be concluded that most of the researchers admit that a business model clarifies the strategies of a firm for creating

value in its targeted market selection as well as addresses the sources of resulting revenues and related costs. In this research, the definition of Osterwalder and Pigneur (2010) is used, since their definition is one of the most recent definitions while covering arguments of other authors.

2.3 Designing a Business Model

To design a business model, researchers and scholars proposed different approaches encompassing various sets of elements. In this sub-section, we will review nine approaches to design a business model. Selected approaches are propositions of further authors: Hamel (2000), Rayport and Jaworski (2001), Pateli and Giaglis (2003), Morris *et al*., (2005), Slywotzky *et al.* (2007), Lindgardt *et al.,* (2009), Yunus *et al.,* (2010), Osterwalder and Pigneur (2010) and Caisse and Montreuil (2014).

2.3.1 Hamel (2000)

Hamel (2000) declared that a business concept is made of four major components: Core Strategy, Strategic Resources, Customer Interface, and Value Network. He linked these four major components through introducing three "bridge" as: customer benefits, configuration of activities and companies boundaries; and identifying four factors to determine the profit potential of the business model: efficiency, uniqueness, fit, and profit boosters. He also introduced a set of subcomponents for each of the four major components (Hamel, 2000). Figure 2-3 introduces his model in detail.

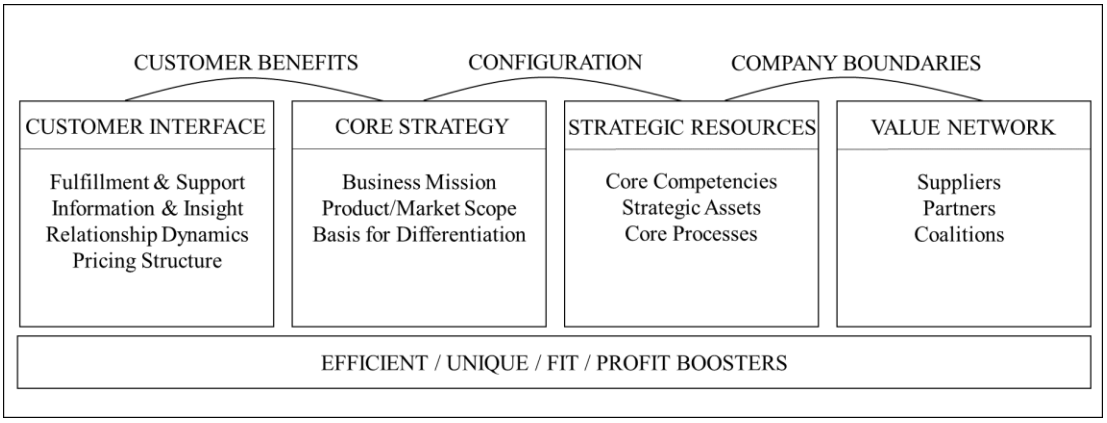

Figure 2-3: Unpacking the business model (Hamel, 2000, p. 94)

2.3.2 Rayport and Jaworski (2001)

Rayport and Jaworski (2001) proposed that a business model needs to cover four main components: a value proposition or a value cluster for targeted customers, a marketspace offering (including product, service, and information), a resource system and a financial model. They investigated each of these components in detail, and also declared that to make decisions about each of these components, it is essential to consider forces that are revealed in the market and the benefits that matter most to customers (Rayport and Jaworski, 2001). Figure 2-4 demonstrates the components that they considered for a business model.

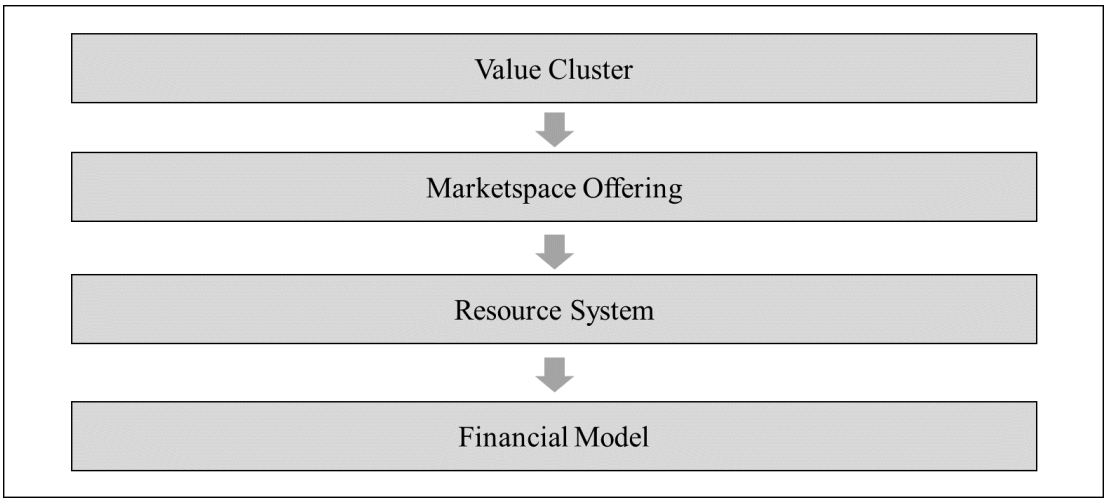

Figure 2-4: Components of a business model (Rayport and Jaworski, 2001, p. 71)

2.3.3 Pateli and Giaglis (2003)

Pateli and Giaglis (2003) proposed a generic framework to synthesize the most addressed components in the literature. They identified two main dimensions in their framework as: the horizontal and the vertical frames. The horizontal frame presents the primary components of a business model: mission (strategic goals), target market (scope and market segment), value proposition (product/service propositions), resources (capabilities, assets), key activities (intra- and inter-organizational processes), cost and revenue model (cost and revenue streams, pricing policy), and value chain/network (alliances and partnerships). The vertical frame indicates business model's main components as well as topics related to wider dimensions of a business and social environment. Examples are: market trends, regulation, technology, etc.

(Pateli and Giaglis, 2003). Figure 2-5 presents the business model framework presented by Pateli and Giaglis (2003).

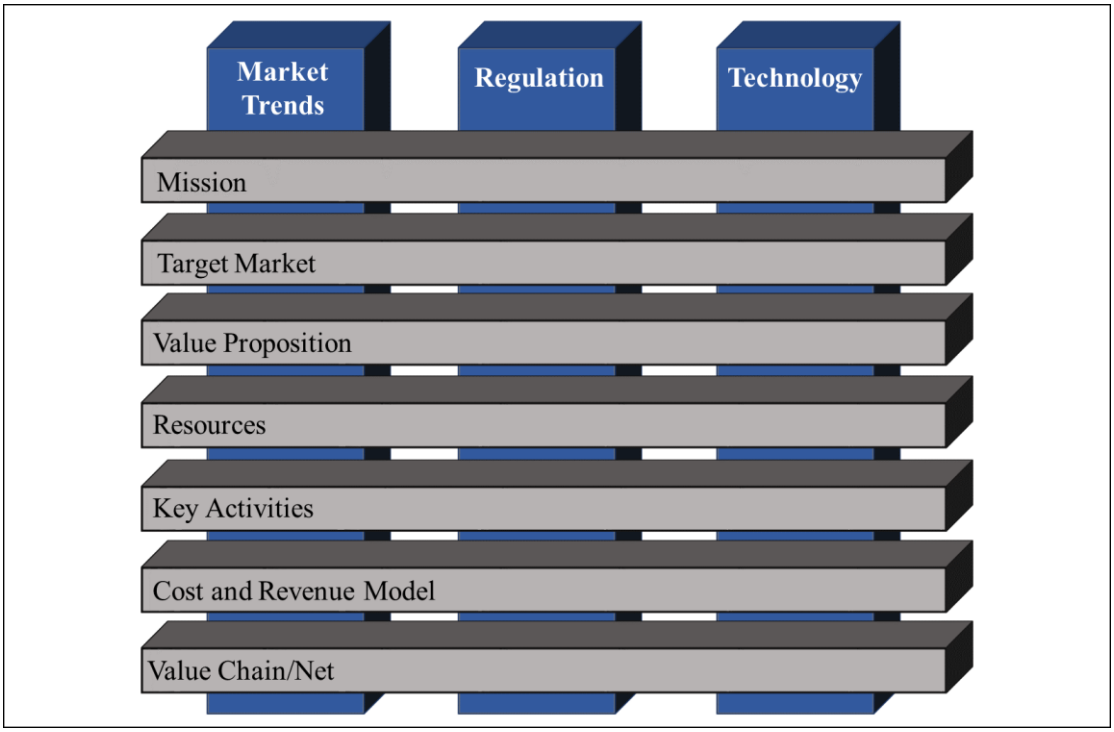

Figure 2-5: Business Model Components Framework (Pateli and Giaglis (2003), p. 339)

2.3.4 Morris *et al*., (2005)

Morris *et al*., (2005) declared that creating a framework that can be exploited by firms in general, while serving the needs of individual entrepreneurs, is a challenge. They proposed a framework encompassing three levels of decision-making and six basic decision areas for each level. The first level, "foundation", encompasses generic and basic decisions that all entrepreneurs must make related to what the business is. This level ensures whether all decisions are consistent. The second level, "proprietary", makes the framework a customizable tool for entrepreneur with the goal of enabling the development of peerless combinations among decision variables that lead toward marketplace advantages. The third level, "rule", addresses the guidelines for managing the execution of the decisions made at the other two levels (Morris *et al.,* 2005).

2.3.4.1 Foundation Level: Identifying Main Components

Morris *et al*., (2005) declared that the right model should address six key questions. These questions were extracted from literature. While most of the literature focuses on value proposition, customers, internal processes and competencies, and the ways companies generate revenue, they added competitive strategy element to these four components to reflect the need of translating core competencies and value propositions into sustainable marketplace positions. Morris *et al.,* (2005, p. 729) in their definition for this level proposed: "*Finally, a useable framework should apply to all types of ventures, reflecting the design considerations necessary to accommodate differing levels of growth, time horizons, resource strategies, and exit vehicles. Thus, the sixth decision area captures growth and time objectives of the entrepreneur.".* Table 2-1 summarizes these six questions.

Table 2-1: Six questions that underlie a business model (Morris *et al.,* 2005, p. 730)

Component 1 (factors related to the offering): How do we create value? (select from each set)
• offering: primarily products/primarily services/heavy mix • offering: standardized/some customization/high customization • offering: broad line/medium breadth/narrow line • offering: deep lines/medium depth/shallow lines • offering: access to product/product itself/product bundled with other firm's product • offering: Internal manufacturing or service delivery/ outsourcing/ licensing/ reselling/ value added reselling • offering: direct distribution/Indirect distribution (if indirect: single or multichannel)
Component 2 (market factors): Who we create value for? (select from each set)
• type of organization: b-to-b/b-to-c/ both • local/regional/national/international • where customer is in value chain: upstream supplier/ downstream supplier/ government/ institutional/ wholesaler/ retailer/ service provider/ final customer • broad or general market/multiple segment/niche market • transactional/relational
Component 3 (internal capability factors): What is our source of competence? (select one or more)
• production/operating systems • selling/marketing • information management/mining/packaging • technology/R&D/creative or innovative capability/intellectual • financial transactions/arbitrage • supply chain management • networking/resource leveraging
Component 4 (competitive strategy factors): How do we competitively position ourselves? (select one or more)
• image of operational excellence/consistency/dependability/speed • product or service quality/selection/features/availability • innovation leadership • low cost/efficiency • intimate customer relationship/experience
Component 5 (economic factors): How we make money? (select from each set)
• pricing and revenue sources: fixed/mixed/flexible • operating leverage: high/medium/low • volumes: high/medium/low • margins: high/medium/low
Component 6 (personal/investor factors): What are our time, scope, and size ambitions? (select one)
• subsistence model • income model • growth model • speculative model

2.3.4.2 Proprietary Level: Creating Unique Combinations

The ability of the entrepreneur to exploit unique and innovative methods for some of the foundation components is the goal of this section. The firm should make decisions about its customers while determining novel approaches for implementing them efficiently. This level is strategic and hard to imitate by competitors (Morris *et al.,* 2005).

2.3.4.3 Rules Level: Establishing Guiding Principles

A basic set of operating rules has to be established in order to ensure that foundation and proprietary components are reflected in current strategic actions (Morris *et al.,* 2005).

2.3.5 Slywotzky *et al.,* (2007)

Slywotzky *et al.* (2007) declared that: "*The scope of a business design refers to the company's activities and its products and service offerings*". They defined the key question for designing a business model as: "*What changes in scope do I need to make to remain customer-relevant, to generate high profits, and to create strategic control?*". They introduced four strategic dimensions to be considered in a business design for a firm as demonstrated in Figure 2-6.

Dimension	Key Issue	Key Questions
1. Customer selection	Which customers do I want to serve?	To which customers can I add real value? Which customers will *allow* me to profit? Which customers do I *not* want to serve?
2. Value Capture	How do I make a profit?	How do I capture, as profit, a portion of the value I created for customers? What is my profit model?
3. Differentiation/ Strategic Control	How do I protect my profit stream?	Why do my chosen customers buy from me? What makes my value proposition unique/differentiated vs. other competitors? What strategies control points can counterbalance customer or competitor power?
4. Scope	What activities do I perform?	What products, services, and solutions do I want to sell? Which activities or functions do I want to perform in-house? Which ones do I want to subcontract, outsource, or work with a business partner to provide?

Figure 2-6: The dimensions of business design (Slywotzky *et al.,* 2007, p. 12)

2.3.6 Lindgardt *et al.,* (2009)

Lindgardt *et al.,* (2009) declared that a business model should encompass two main elements: 1) the value proposition and 2) the operating model, each element encompassing three sub-elements. The value proposition component concerns: *"what are we offering to whom?"*. This component reflects choices along three further dimensions: 1) Target segment(s), addressing questions of "*which customers do we choose to serve? Which of their needs do we seek to address?*"; 2) Product or service offering, addressing the question of "*what are we offering the customers to satisfy their needs?*"; and 3) Revenue model, addressing the question of "*how are we compensated for our offering?*" (Lindgardt *et al.,* 2009).

The operational model aims to define: "*How do we profitably deliver the offering?*". The business's choices in the following three essential areas are captured by this model: 1) Value chain, concerning "*How are we configured to deliver on customer demand? What do we do in-house? What do we outsource?";* 2) Cost model, addressing the question of "*How do we configure our assets and costs to deliver on our value*

proposition profitably?" ; and 3) Organization, indicating "*How do we deploy and develop our people to sustain and enhance our competitive advantage*?" (Lindgardt *et al.,* 2009). Figure 2-7 presents the six components of a business model proposed by Lindgardt *et al.,* (2009).

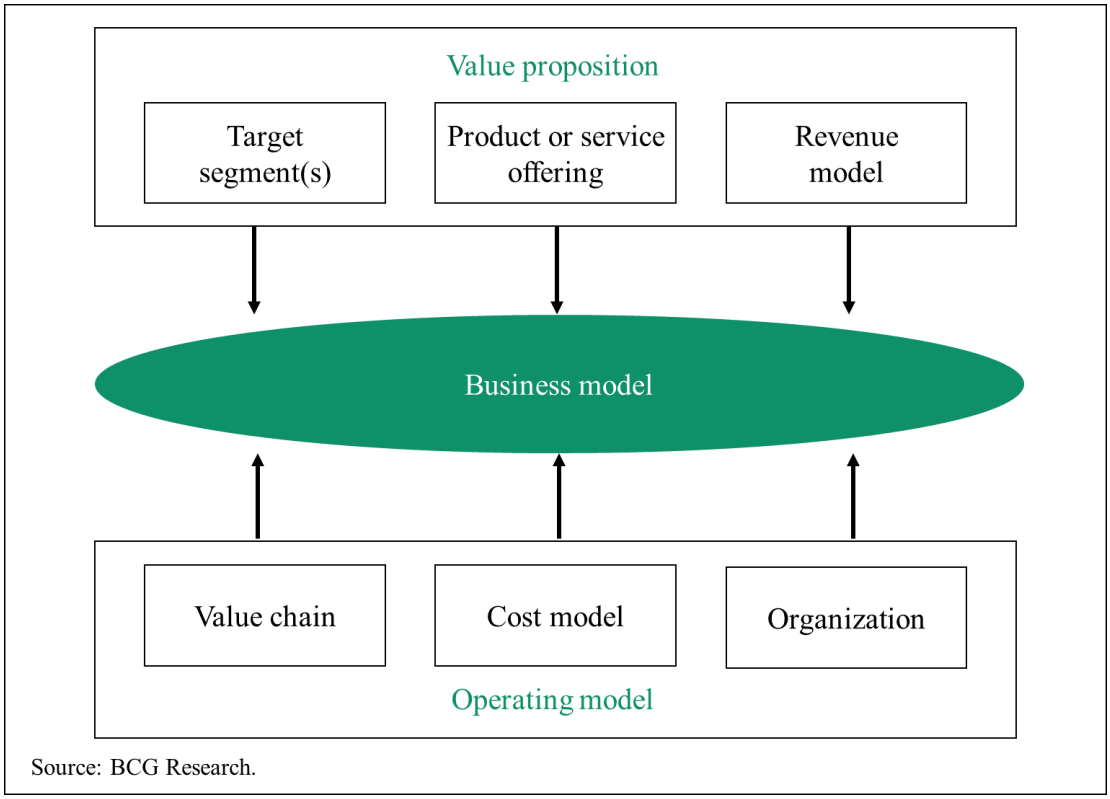

Figure 2-7: A business model six components (Lindgardt *et al.*, 2009, p. 2)

2.3.7 Yunus *et al.,* (2010)

Yunus *et al.,* (2010, p. 312) proposed that: "*The business model concept offers a consistent and integrated picture of a company and the way it generates revenue and profit*.". They believe that new value propositions and new value constellations should be created in a way that results in a positive profit equation. They suggested that a business model encompasses three main components: 1) a value proposition concerning the question of "*who are our customers and what do we offer to them that they value?*"; 2) A value constellation to describe "*how do we deliver this offer to our customers?*", the value proposition and value constellation components having to be matched in order to generate the third component: 3) a positive profit equation that

indicates : "*[...] how value is captured from the revenues generated through the value proposition, and how costs are structured and capital employed in the value constellation.*". Figure 2-8 presents the business model components proposed by Yunus *et al.,* (2010).

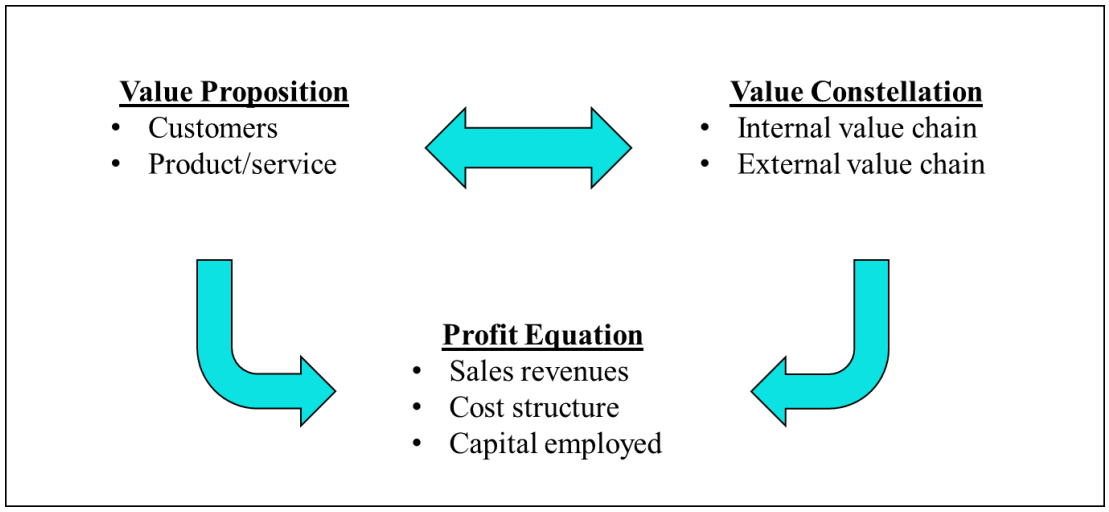

Figure 2-8: The three components of a conventional business model (Yunus *et al.,* (2010), p. 312)

2.3.8 Osterwalder and Pigneur (2010)

Osterwalder and Pigneur (2010) proposed a notion enabling companies to explain the business model of their firms, their competitors, and other companies. They have used and tested their proposition around the world, and many companies such as IBM, Ericsson, Deloitte, and the Public Works and Government Services of Canada are currently using it. They called their proposition a shared language enabling firms to identify the business model or change it in order to create new strategic alternatives. They defined a business model through nine basic building blocks covering four main areas of a business that are: customers, offer, infrastructure, and financial viability. Figure 2-9 presents the nine blocks of their model.

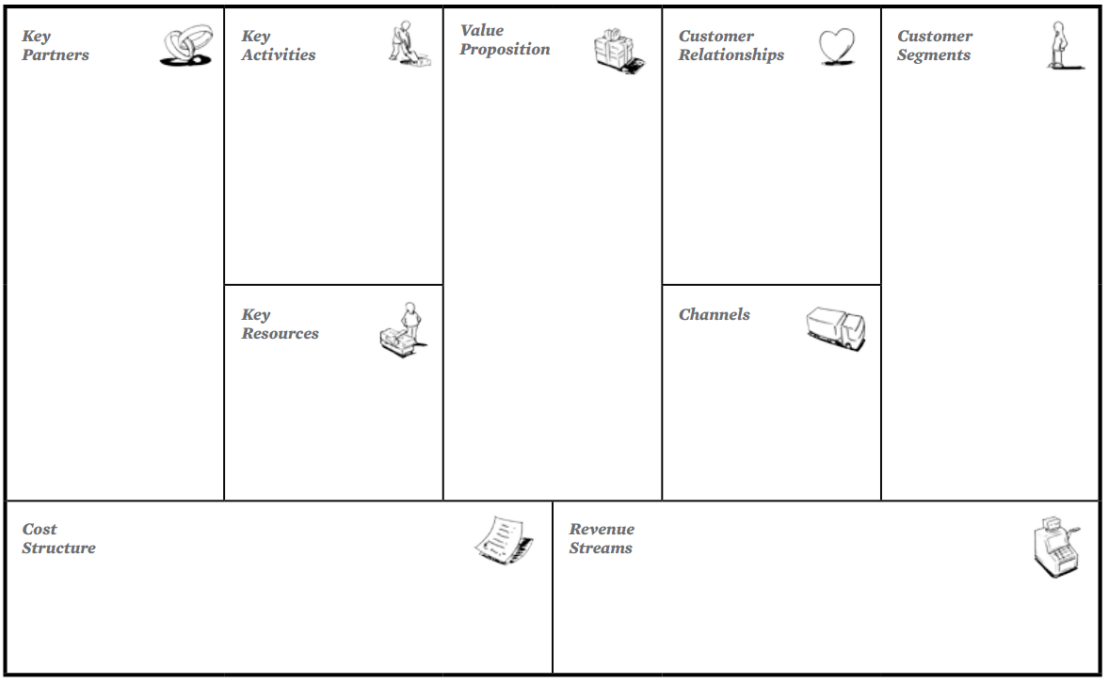

Figure 2-9: Osterwalder and Pigneur (2010, p. 44) business model framework

2.3.8.1 Customer Segment

According to Osterwalder and Pigneur (2010), this block answers the questions: "*For whom are we creating value? Who are our most important customers?*". The group of people or companies that a firm wants to serve is addressed by the customer segments building block. The heart of any business is its customers and business survival depends on the profitable ones. Customers with common needs and behavior or other attributes can be categorized into different groups. This classification helps companies to better satisfy their specific customer segments (Osterwalder and Pigneur, 2010).

2.3.8.2 Value Proposition

According to Osterwalder and Pigneur (2010), this block addresses the questions: "*What value do we deliver to the customer? Which one of our customer's problems are we helping to solve? Which customer needs are we satisfying? What bundles of products and services are we offering to each Customer Segment?*". The aggregation of products and services that creates value for a particular customer segment is addressed in value proposition building block. The reason why a customer selects a

company over other providers is its value proposition. Each value proposition encompasses certain products or services that are proposed by the company to cover its customer segment needs. Proposed value of a firm can be an innovative value, representing a disruptive offer, or be the same value in the existing market with significant added attributes (Osterwalder and Pigneur, 2010).

2.3.8.3 Channel

According to Osterwalder and Pigneur (2010), this block encompasses the following questions: "*Through which Channels do our Customer Segments want to be reached? How are we reaching them now? How are our Channels integrated? Which ones work best? Which ones are most cost-efficient? How are we integrating them with customer routines?*". The ways a company uses to reach its customer segments in order to deliver its value proposition are addressed in the channels building block. Communication, distribution, and sales channels contain company's interface with its customers. Channels can be recognized between direct and indirect ones as well as between owned channels or partner channels (Osterwalder and Pigneur, 2010).

2.3.8.4 Customer Relationships

According to Osterwalder and Pigneur (2010), this block answers to the question of: "*What type of relationship does each of our Customer Segments expect us to establish and maintain with them? Which ones have we established? How costly are they? How are they integrated with the rest of our business model?*". Types of relationships enterprises exploit with specific customer segments are addressed in the customer relationships building block. Range of relationships can vary from personal to automated type. Customer acquisition and retention, as well as sales enhance, can be considered as sources of motivation for establishing customer relationships (Osterwalder and Pigneur, 2010).

2.3.8.5 Revenue Streams

According to Osterwalder and Pigneur (2010), this block concerns the following questions: "*For what value are our customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenues?*". The money a company can earn from each customer segment is addressed in the revenue stream building block. Different pricing policies can be used for each revenue stream (Osterwalder and Pigneur, 2010).

2.3.8.6 Key Resources

According to Osterwalder and Pigneur (2010), this block encompasses the questions: "*What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams?*". Primary resources a firm uses to operate its business processes and make profits are addressed in the key resources building block. Resources will enable companies to generate and propose value, reach the customers and keep relationship with them, while ensuring making money. Each type of business model needs different physical, financial, intellectual, and human resources. A company can own its key resources as well as gain them through its partners (Osterwalder and Pigneur, 2010).

2.3.8.7 Key Activities

According to Osterwalder and Pigneur (2010), this block aims to define: "*What Key Activities do our Value Propositions require? Our Distribution Channels? Customer relationships? Revenue Streams?*". The key tasks a company should perform to operate its business processes and make profit are addressed in the key activities building block. Each business model has different key activities (Osterwalder and Pigneur, 2010).

2.3.8.8 Key Partnerships

According to Osterwalder and Pigneur (2010), this block answers to the question of: "*Who are our Key Partners? Who are our key suppliers? Which Key Resources are we*

acquiring from partners? Which Key Activities do partners perform?". The suppliers and partners that contribute to the success of the business model are addressed in the key partnership building block. Sources of motivation for companies in order to make partnership are: business model optimization, risk reduction, and resource acquisition. These alliances can take multiple forms such as strategic alliances, cooperation, joint venture, buyer-supplier relationships, etc. (Osterwalder and Pigneur, 2010).

2.3.8.9 Cost Structure

According to Osterwalder and Pigneur (2010), this block answers the following questions: "*What are the most important costs inherent in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive?*". All expenses a firm must take into account to provide its value proposition and operate its business model are addressed in the cost structure building block. Obviously, creating and delivering value, as well and keeping relationships with customers, cause costs. To estimate these costs, a firm should first define its key resources, activities, and partners (Osterwalder and Pigneur, 2010).

2.3.9 Caisse and Montreuil (2014)

Caisse and Montreuil (2014) reviewed the findings of business modeling researchers that span from 2000 to 2012 and proposed two polar frameworks for business modeling and design: the three-pole Value-Activity-Stakeholder (VAS) triquetra and the four-pole Offer-Creation-Character-Stakeholder (OCCS) tetrahedron. They declared that business model literature is a mixture of discrete and flexible topics that are called concepts and in order to have a genuine understanding, it is essential to contextualizing these concepts in open interrelated systems. In their paper, they proposed to use "poles", as a small number of root concepts, to catch this complexity as well as employing other concepts, as interrelationships between these root concepts. Their VAS triquetra framework features "flows" from pole to pole and "dyads", as the combination of two poles and the pair of flows that link them. Figure 2-10 demonstrates their VAS triquetra framework.

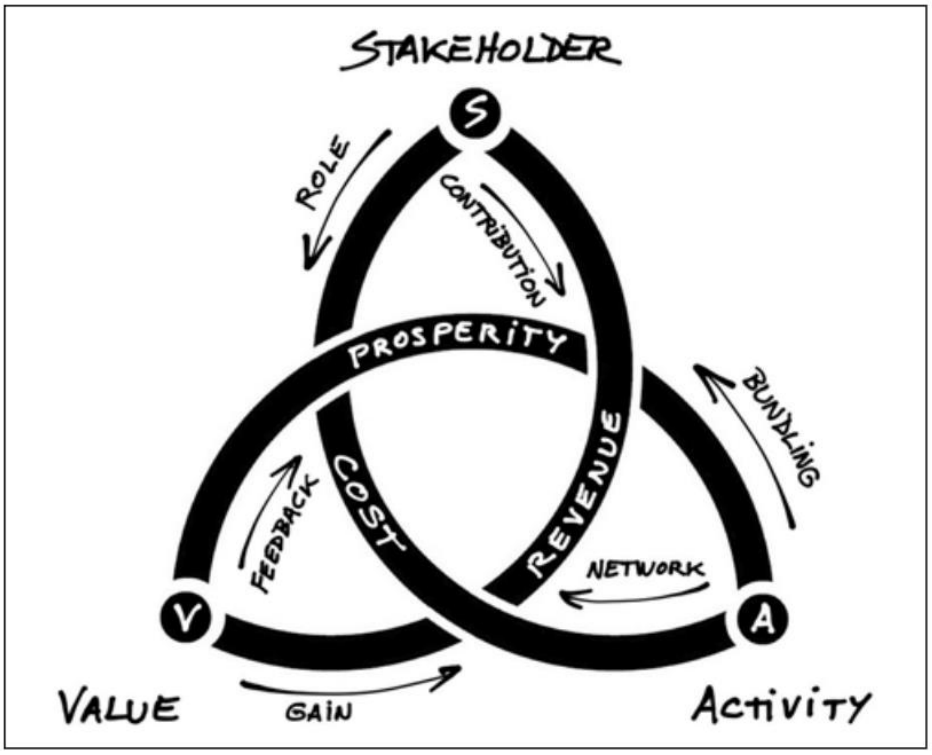

Figure 2-10: VAS Triquetra framework for conceptualizing collective endeavors (Caisse and Montreuil, 2014, p. 4)

Their OCCS tetrahedron framework feature flows, dyads, and faces (combination of three poles, six flows and three dyads). OCCS corresponds to the four poles that are the offer pole, the character pole, the creation pole, and the stakeholder pole. They asserted that the poles, flows, dyads, and faces are concepts that are relevant to current business model literature. Figure 2-11 illustrates their OCCS tetrahedron framework. Montreuil and Caisse (2014) provided the meaning of each feature of the framework as well as their interrelationships.

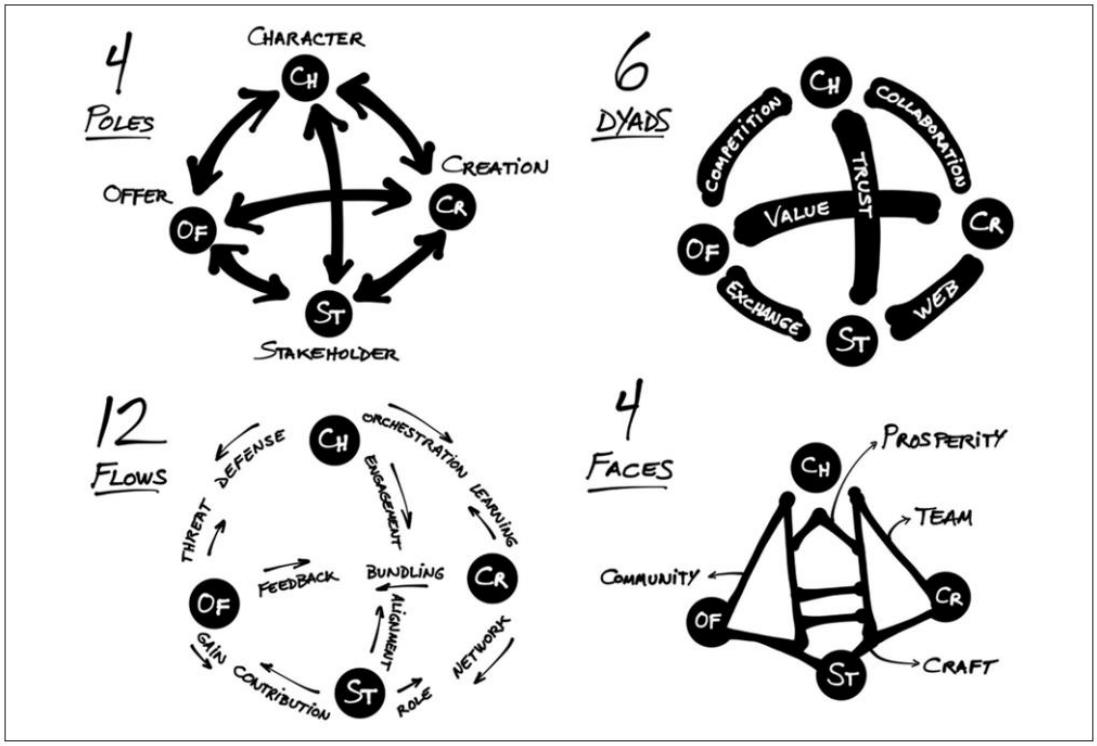

Figure 2-11: Poles, flows, dyads, and faces of the OCCS tetrahedron framework (Caisse and Montreuil, 2014, p. 11)

Through studying the elements of these nine models, most of them are addressing the same basic elements (including the customer segment, mission, value proposition, revenue streams, etc.) while a series of them are more in detail and identify the business key aspects more precisely. The provided models by Caisse and Montreuil (2014) therefore cover all elements proposed by other authors in the literature.

2.4 Business Model Innovation

Regarding the competitive specification of today's world, companies should continuously improve their products and services with innovative ideas and be synchronized with their competitors. According to this issue, they should dynamically change their business model and think about their growth strategy in the long run. In the business modelling literature, various authors have mentioned this issue. For example Linder and Cantrell (2000, p. 10) stated that: "*The business model typology shows business models at a point in time. But most firms' business models are under*

constant pressure to change.". They considered various factors as the source of changes including: innovation in technology, changes in the law, competitor's position, changes in customer's demand, etc. They proposed four types of change models as: realization (i.e., maximize returns from their existing operating logic), renewal (i.e., improve the products and services platforms, brands, cost structure, etc. to generate value,), extension (i.e., cover new ground such as new markets, value chain functions, product and service lines), and journey models (i.e., generate a new business model and never want to use the previous one again). Figure 2-12 illustrates their proposition.

Osterwalder *et al*., (2005, p. 15) also admitted this issue, highlighting that: "*The expression "a company's business model" refers to the way a firm does business. As such, it is a snapshot and description at a specific moment in time.*".

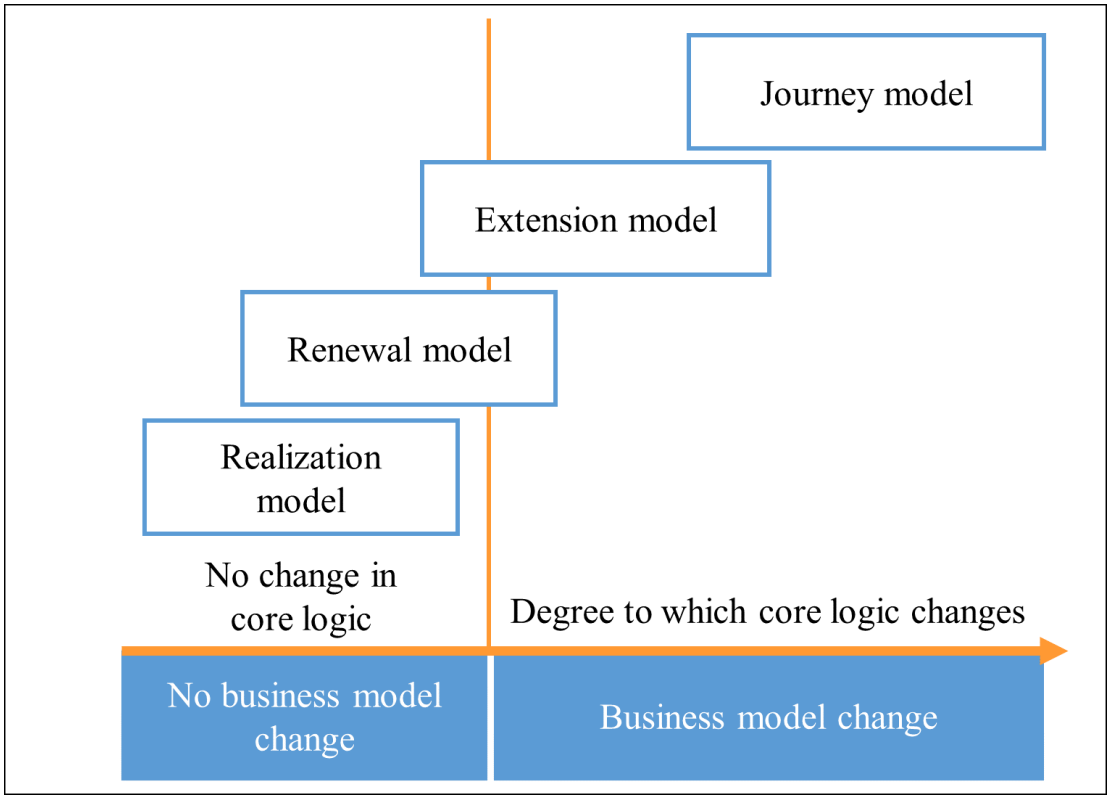

Figure 2-12: Change models (Linder and Cantrell, 2000, p. 13)

Focusing on current and future products and markets for companies, Ansoff (1965) proposed a matrix to help companies to grow based on four different strategies. Table 2-2 presents his matrix.

Table 2-2: Growth vector components (Ansoff, 1965, p. 109)

Product / Mission	**Present**	**New**
Present	Market penetration	Product development
New	Market development	Diversification

According to Ansoff (1965, p. 109-110): "*Market penetration denotes a growth direction through the increase of market share for the present product-markets. In market development new missions are sought for the firm's products. Product development creates new products to replace current ones. Finally diversification is distinctive in the fact that both products and missions are new to the firm.*".

It is also essential to consider a suitable pricing policy associated to the goals and strategies of the firms. According to a study developed by PennState, college of agriculture sciences (2015): "*Pricing is one of the major components of your marketing plan, which is a component of a full business plan. Assigning product prices is a strategic activity. The price you assign will impact how consumers view your product and whether they will purchase it. Price also helps differentiate your product from those of your competitors. However, the price you assign must be in line with your other marketing strategies and the product attributes.*" They reviewed the potential pricing objective and pricing strategies and proposed a diagram (Figure 2-13) to demonstrate the pricing objectives and the strategies that can be used.

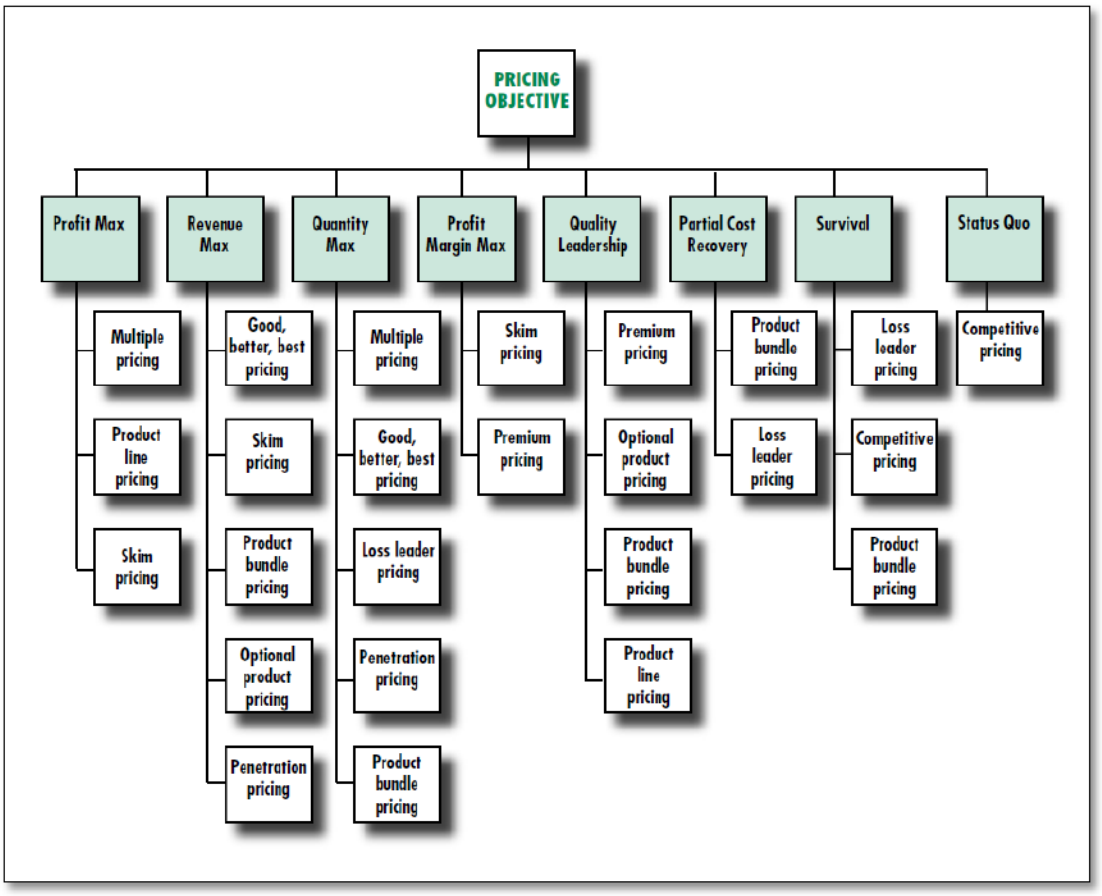

Figure 2-13: Pricing objectives and strategies (PennState, college of agriculture sciences, 2015)

2.5 Factors Affecting a Business Model

When designing a business model, it should be considered that there are many factors that can influence the revenue streams, profit, and in general the business model by itself. In this context, Osterwalder *et al.*, (2005, p. 14) declared that: *"[...] we understand the business model as a building plan that allows designing and realizing the business structure and systems that constitute the operational and physical form the company will take. We call this relation between strategy, organization, and systems the business triangle that is constantly subject to external pressures, like competitive forces, social change, technological change, customer opinion and legal environment."*. Figure 2-14 illustrates Osterwalder *et al.*'s proposition.

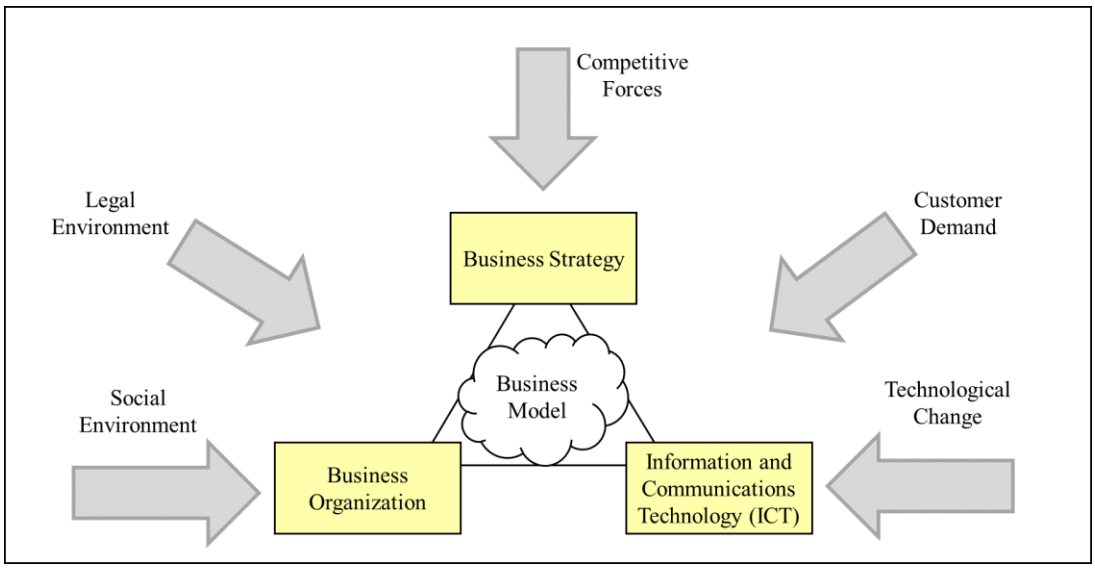

Figure 2-14: The business model's place in the firm (Osterwalder *et al*., 2005, p. 15)

2.5.1 Business Strategy

The business strategy encompasses the formulation methods and implementation procedures a firm chooses to adopt, so as to reach its core value, mission, and vision. There are various strategies that a business can exploit to reach its goals. According to Porter (1980, p. 35): "*In coping with the five competitive forces, there are three potentially successful generic strategic approaches to outperforming other firms in an industry: 1) overall cost leadership, 2) differentiation, and 3) focus*.".

2.5.2 Business Organization

The business structure is one of the first decisions that an owner should make. Each business should adopt legal configuration, defining the participants' rights and liabilities in ownership, the personal liability, and the financial structure of the business, etc. (Kcsourcelink, 2015).

As stated in Kcsourcelink (2015), the organization depends on the vision of business owners regarding the size and nature of their business, the level of control and structure that they want, the level of business's vulnerability to lawsuits, tax implications of the various organizational structures, expected profit or loss of the business, whether or not

the owners need to re-invest earnings into the business, and the need of owners for accessing to cash out of the business for themselves.

Potential types of business structures for a business include sole proprietorship, general partnerships, limited liability partnerships, corporations, and co-operatives (Canada Business Network, 2015). A sole proprietorship structure implies that one person owns the business and sees to its day-to-day responsibilities. The owner is responsible for all business debts and obligations as well as all profits. In this structure, a creditor can make a claim against the owner's personal and business assets to pay off any debt. Partnership structure is appropriated when the owners are interested to have a business with partners without incorporating their business. Financial resources are combined and put into the business, with a partner. Owners can start their business with this structure and prepare specific business agreements for the case of disagreement or dissolution. According to the terms of agreement, profit should be shared among partners. With a limited liability partnership, partners do not take part in business control or management and they are liable for debts. In a corporation structure, the owners consider their business as a legal entity separated from the shareholders, and they are not liable for the debts, obligations, or corporation's acts personally. Finally in a co-operative structure, an association of members own the business, suitable when a group of people or businesses make decision to pool their resources in order to provide access to common needs including product or service delivery, product or service sale, employment, and more (Canada Business Network, 2015).

2.5.3 Information and Communication Technology (ICT)

Gokhe (2015) stated that information and communication technologies (ICT) are the technologies to support activities related to information. Examples of these activities are: gathering, processing, storing, and presenting data, up to collaboration and communication (Gokhe, 2015). ICT defines the role of communication and computers in running a business while improving information management, knowledge management, and transactional speed and reliability. In addition, it can reduce transactional costs.

2.5.4 Competitive Forces

According to Porter (1985, p. 4), "*The first fundamental determinant of a firm's profitability is industrial attractiveness. Competitive strategy must grow out of a sophisticated understanding of the rules of competition that determine an industry's attractiveness. The ultimate aim of competitive strategy is to cope with and, ideally, to change those rules in the firm's favor*". He also stated that in all industries, the rules of competition are involved with five competitive forces: the entry of new competitors, the threat of substitutes, the bargaining power of buyers, the bargaining power of suppliers, and the rivalry among the existing competitors (Porter, 1985). He believes that the ability of a firm to make profit is determined by the cumulative strength of these five forces. In his opinion, the profitability of the industry will be determined by these five forces, since these forces affect prices, costs, and required investment of firms. For example, power of buyers can affect the prices a firm can charge, the suppliers' bargaining power can impact the cost of raw materials, and the threat of entry limits prices and shapes the investment required to discourage entrants (Porter, 1985). According to Porter (1985, p. 5): "*The bargaining power of suppliers determines the costs of raw materials and other inputs"*. He declared that (p. 5): "*Buyer power influences the prices that firms can charge, for example, as does the threat of substitution. The power of buyers can also influence cost and investment, because powerful buyers demand costly service*.". Substitute services are value propositions of other actors and competitors, similar to what the business provides. Competitive rivalry presents current competitors that exist in the area. According to Porter (1985, p. 5): "*The intensity of rivalry influences prices as well as the costs of competing in areas such as plant, product development, advertising, and sales force."*. New entrants are newcomers who are interested in investing in a specific industry and become a potential competitor.

2.5.5 Customer Demand

According to Salvatore and Eugene (2003, p.13): "*The demand schedule for an individual specifies the units of a good or service that the individual is willing and able to purchase at alternative prices during a given period of time. The relationship*

between price and quantity demanded is inverse: more units are purchased at lower prices because of a substitution effect and an income effect". Customers' needs vary through time and businesses should adapt their value propositions to these changes in order to survive and thrive.

2.5.6 Technological Change

According to Singla (2009-10, p. 142): "*Technology includes new methods of production of goods, services, and discovery of new implements. Technological changes make available better methods of production and that makes the optimum use of the raw material possible. The technological changes offer both the possibilities and threats for business. In case a company understands these things well in time it can achieve its objective, otherwise the very existence of the company is threatened."*. The author also mentioned that companies being able to dynamically move with environmental changes will survive. So businesses that use technology to provide their value proposition should synchronize it with dynamic changes in order to stay updated and efficient.

2.5.7 Legal Environment

Meiners *et al*., (2012, p. 22) declared that: "*The modern environment of business means that managers in all firms face a variety of ethical, legal, social, political, and international issues that make business increasingly complex."*. According to Kubasek *et al*., (2012, p. 28): "*The study of the legal environment of business includes the study of legal reasoning, critical thinking skills, and ethical norms; the legal and administrative law processes; selected areas of public and private law; and relevant international law.*" In this context, the idea is to focus on parts of the legal environment that deals with government policies and support. This can be through tax policies, financial support, labor laws, environmental laws, trade restrictions, tariffs, as well as controlling competition and political stability.

2.5.8 Social Environment

According to Jain *et al*., (2009-10, p. 14): "*Business is an integral part of society and both influence each other. It is one of the important non-economic external components of business environment. Socio-cultural environment refers to influence exercised by certain social and cultural factors which are beyond the control of business unit. Such factors include: attitude of people to work, family system, caste system, religion, education, marriage, habits and preferences, languages, urbanisation, customs and traditions, value system, business ethics, social trends, social responsibility of business, etc."* They also admitted social and cultural structure of a society as an element that can affect the type of products, the firm organization, and the value offered. In this context the focus is on societal trends of an area that can affect the level of demand, value proposition, performance, and the level of profitability of the business.

2.5.9 Business Modelling Summary

The previous subsection described the business modeling as well as the factors that can affect it. In order to study the logistics context and in particular the business model of Physical Internet enabled transit centers, the next subsections introduce the fundamental concepts of logistics as well as the Physical Internet paradigm.

2.6 Logistics Industry

There are different terms and descriptions for the term logistics. According to Coyle *et al*., (2013, p. 38-39) : *"Logistics is the process of anticipating customer needs and wants; acquiring the capital, materials, people, technologies, and information necessary to meet those needs and wants; optimizing the goods or service-producing network to fulfill customer requests; and utilizing the network to fulfill customer requests in a timely manner"*. They suggested four subdivisions for logistics as business logistics, military logistics, event logistics, and service logistics. Their definitions are proposed in Table 2-3.

Table 2-3: Logistics in 21th century (Coyle *et al*., 2013, p. 38)

Logistics in 21th century	
Business Logistics	That part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, service, and related information from point of origin to point of consumption in order to meet customer requirements.
Military Logistics	The design and integration of all aspects of support for the operational capability of the military forces (deployed or in garrison) and their equipment to ensure readiness, reliability, and efficiency.
Event logistics	The network of activities, facilities, and personnel required to organize, schedule, and deploy the resources for an event to take place and to efficiently withdraw after the event.
Service logistics	The acquisition, scheduling, and management of the facilities, assets, personnel, and materials to support, and sustain a service operation or business.
Source: Coyle *et al*., (2013, p. 38)	

These four definitions have common characteristics and requirements and can be viewed in a supply chain context. Their primary purpose is on the other hand quite different.

Council of Supply Chain Management Professionals (2015) states that: "*Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements.*".

For Christopher (2005, p. 4), the following definition summarizes the logistics concept: "*Logistics is the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organization and its marketing channels in such a way that current and future profitability are maximized through the cost-effective fulfillment of orders*".

2.6.1 Logistics Mission

A supply chain management philosophy involves being efficient and cost-effective in the whole system. According to Christopher (2005, p. 15): " *[...] the mission of logistics management is to plan and co-ordinate all those activities necessary to achieve desired level of delivered service and quality at lowest possible cost. Logistics*

must therefore be seen as the link between the marketplace and the supply base.”. Simchi-Levi *et al*., (2000, p. 18) in the context of logistics network configuration declared that: “*The objective is to design or reconfigure logistics network so as to minimize annual systemwide costs, including production and purchasing costs, inventory holding costs, facility costs (storage, handling, and fixed costs), and transportation costs, subject to a variety of service level requirements.*”, while Quariguasi Frota Neto *et al.,* (2008, p .195) declared that: “*The objective in the design of logistic networks has changed, therefore, from cost minimization only, to cost and environmental impact minimization.*”.

2.6.2 Logistics Activities

Christopher (2005) indicated that logistics is an organization process starting from the raw materials management and ending with delivering final products. Figure 2-15 illustrates the logistics management process proposed by the author.

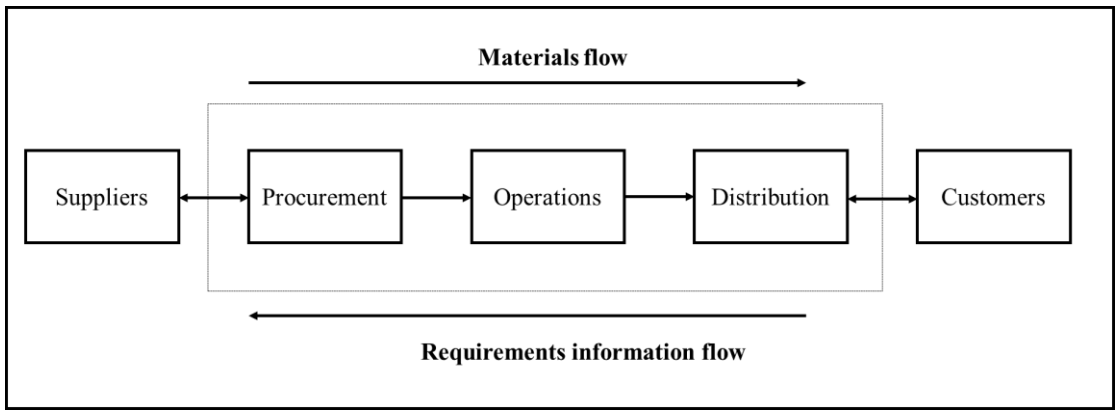

Figure 2-15: Logistics management process (Christopher, 2005, p. 15)

Coyle *et al*., (2013) considered further activities as logistics activities: transportation, warehousing and storage, industrial packaging, materials handling, inventory control, order fulfillment, inventory forecasting, production planning and scheduling, procurement, customer service, facility location, return goods handling, parts and service support, salvage and scrap disposal.

2.6.3 Logistics Network (Nodes versus Links)

A logistics network is made of a set of nodes and links. The term node refers to fixed points addressing manufactures, assembly facilities, and warehouses, while the term link refers to the transportation network that connects nodes in the logistics system. Potential transportation modes are rail, motor, air, ocean, pipeline or their combination. A logistics network can exploit various transportation modes (Coyle *et al.*, 2013). According to Liedtke and Friedrich (2012, p. 1337): "*A logistics network is the set of nodes (for instance, warehouses or transhipment points) and transport connections resulting from and being subject of a planning process of an economic actor or association of actors deciding together.*". Simchi-Levi *et al.,* (2000, p. 17) proposed further definition "*The logistics network consists of suppliers, warehouses, distribution centers, and retail outlets as well as raw materials, work-in-process inventory, and finished products that flow between the facilities*.". Figure 2-16 presents the conceptualization of logistics networks proposed by Simchi-Levi *et al.,* (2000).

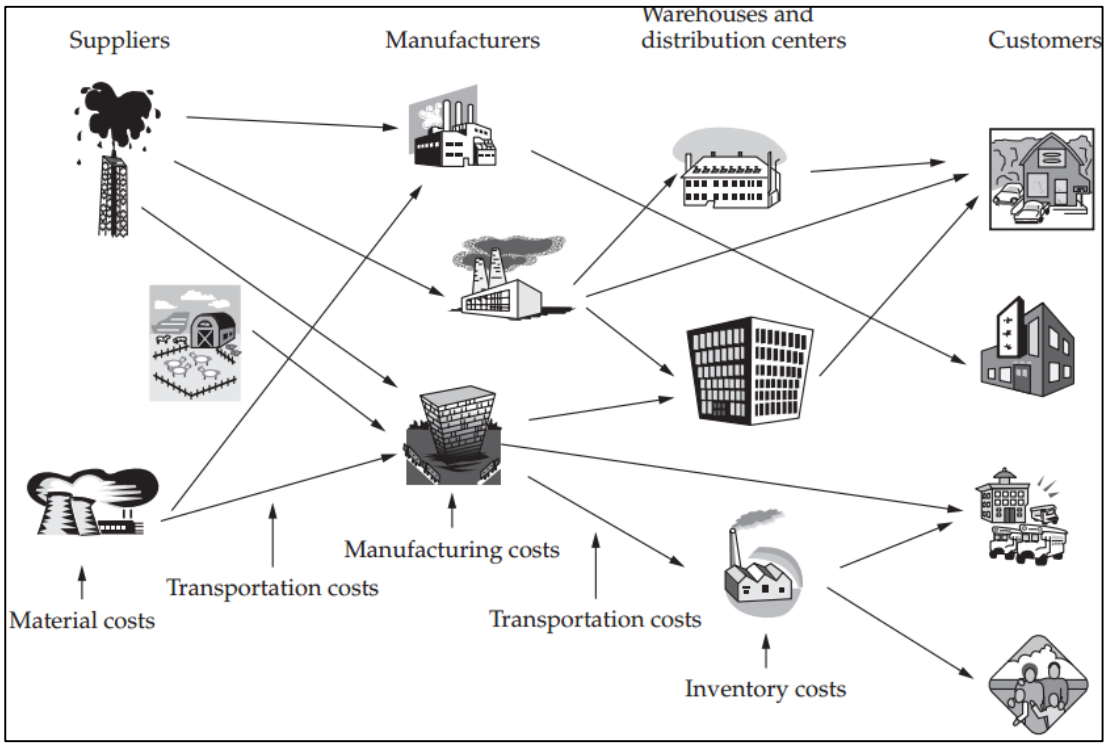

Figure 2-16: Conceptualizing the logistics network (Simchi-Levi *et al*., 2000, p. 2)

The complexity of logistics network can vary based on the number of actors including manufactures, warehouses, etc., as well as the number of logistics transportation modes in the network (Coyle *et al.*, 2013).

2.6.4 Logistics Network Configuration

According to Simchi-Levi *et al.,* (2000), decisions related to designing a logistics network are involved with determining the location of plants, warehouses, and retailers, at a strategic level. The key strategic decisions in this context can be: determining the appropriate number of warehouses, their location, and their size, as well as dedicating the space for products in warehouses. It is a key decision to balance the costs of opening new warehouses and be close to customers (Simchi-Levi *et al.,* 2000). Logistics network configuration is not only about the warehouse location, it also include decisions related to the location of factories, selection of suppliers, selection/location of retailers, areas for temporary stocks, etc., depending on the nature of products as well the type of industry.

2.7 Logistics Network Challenges

Montreuil (2011) declared that in current networks, the ways physical objects are moved, stored, distributed, supplied, and used are socially, environmentally, and economically inefficient and unsustainable. To support his declaration, he addressed thirteen symptoms of these inefficiencies. Table 2-4 summarizes these symptoms.

Table 2-4: The unsustainability symptoms (Montreuil, 2011)

	Unsustainability symptoms	Economical	Environmental	Societal
1	We are shipping air and packaging	●	●	
2	Empty travel is the norm rather than the exception	●	●	
3	Truckers have become the modern cowboys	●		●
4	Products mostly sit idle, stored where unneeded, yet so often unavailable fast where needed	●		●
5	Production and storage facilities are poorly used	●	●	
6	So many products are never sold, never used	●	●	●
7	Products do not reach those who need them the most	●		●
8	Products unnecessarily move, crisscrossing the world	●	●	
9	Fast & reliable intermodal transport is still a dream or a joke	●	●	●
10	Getting products in and out of cities is a nightmare	●	●	●
11	Networks are neither secure nor robust	●		●
12	Smart automation & technology are hard to justify	●		●
13	Innovation is strangled	●	●	●

He introduced the Physical Internet revolutionary paradigm as a solution to these economic, environmental, and social inefficiencies and unsustainability. He declared that from an economic perspective, the Physical Internet goal is to exploit remarkable sources of gains in various components of a Logistics Web. From an environmental perspective, it promises to reduce the global energy consumption and pollution related to logistics, production, and transportation. From a societal perspective, it aims to improve the quality of life for human resources in logistics, production, and transportation, as well as enhancing the overall population by making products available across the world where they are needed (Montreuil, 2011).

2.8 Physical Internet

Montreuil (2011) introduced Physical Internet paradigm as an open global logistics system founded on physical, digital, and operational interconnectivity through encapsulation, interfaces, and protocols. The term “Physical Internet” is a metaphor taken from the Digital Internet, which transmits standard packets of data under the TCP-IP protocols. It proposes to encapsulate products in modular, re-usable and smart

containers to empower any company to handle any other company's products. In this context an open standard set of collaborative and routing protocols are needed to manage modularized containers easier and much more efficiently. Interfaces are another essential parcel in this context in order to ensure reliability, security, transparency, and quality of products through handling and movement processes (Montreuil 2011). Table 2-5 presents a matrix of key Physical Internet characteristics and unsustainability symptoms with the goal of illustrating in which sections Physical Internet contributes significantly to reduce inefficiencies.

Table 2-5: Physical Internet addressing unsustainability symptoms (Montreuil, 2011)

	Unsustainability symptoms	Physical Internet Characteristics												
		1	2	3	4	5	6	7	8	9	10	11	12	13
		Objects encapsulated in world standard modular containers	Universal interconnectivity	Container handling and storage systems	Smart networked containers embedding smart objects	Distributed multi-segment intermodal transport	Unified multi-tier conceptual framework	Open global supply web	Product design for containerization	Product materialization near to point of use	Open performance monitoring and capability certification	Webbed reliability and resilience of networks	Business model innovation	Open infrastructural innovation
1	We are shipping air and packaging	●							●					
2	Empty travel is the norm rather than the exception		●			●								
3	Truckers have become the modern cowboys			●		●								
4	Products mostly sit idle, stored where unneeded, yet so often unavailable fast where needed	●			●			●						
5	Production and storage facilities are poorly used	●	●	●				●	●	●				
6	So many products are never sold, never used							●		●		●	●	
7	Products do not reach those who need them the most		●			●	●	●		●		●		
8	Products unnecessarily move, crisscrossing the world		●		●	●					●			●
9	Fast & reliable intermodal transport is still a dream or a joke	●	●	●	●	●	●				●			●
10	Getting products in and out of cities is a nightmare	●	●		●	●	●	●		●		●		
11	Networks are neither secure nor robust	●	●		●	●		●			●	●		
12	Smart automation & technology are hard to justify	●	●	●	●		●				●		●	●
13	Innovation is strangled	●	●	●	●		●						●	●

According to Montreuil *et al*., (2012), a web can be conceptualized as a set of interconnected actors and networks. In this context a web addresses a set of interconnected physical, digital, human, organizational, and social agents and networks. In Physical Internet, characteristics such as openness, globalism, efficient, and sustainable are allocated to this Web. Openness refers to accessibility, willingness,

and availability of actors and networks for dealing with other entities. Globalism refers to universal worldwide scope and multi scale scope. A Logistics Web can be conceptualized as being composed of five components: a Mobility Web, a Distribution Web, a Realization Web, a Supply Web, and a Service Web (Montreuil *et al.,* 2012).

The Mobility Web is the component responsible for moving physical objects and people from their sources to their destination, through a reliable and efficient multi-modal, multi-segment transportation and handling, and within a global set of open single-modal and multi-modal hubs, transits, ports, roads, and ways, across cities, regions, etc. So this web deals with all activities related to transportation and handling (Montreuil *et al.,* 2012).

The Distribution Web is the component responsible for reliable and efficient distribution of encapsulated physical objects within the myriads of open distribution centers across the world (Montreuil *et al.,* 2012).

The Realization Web is the component responsible for realizing physical objects including all activities dealing with manufacturing, production, assembly, finishing, personalization, retrofitting, etc. This web aims to make and dismantle physical objects from raw materials to final products. This web enables the realization of physical objects in a distributed way, through exploiting open realization centers that are available all around the world (Montreuil *et al.,* 2012).

The Supply Web is the component responsible for supplying physical objects, dealing with acquiring, buying, and securing access to materials, parts, assemblies, products and systems. Examples of key actors in this web are: suppliers, contractors, and providers who are connected through an open platform. These actors uses Mobility, Distribution, and Realization Webs for supplying products and services with the goal of providing fast, efficient, reliable and resilient supply chains (Montreuil *et al.,* 2012).

The Service Web is the component responsible for serving the need of using the physical objects, dealing with accessibility of services provided by, through, and with products and people. This web ensures a collaborative consumption on a worldwide

basis (Montreuil, *et al*., 2012). Figure 2-17 proposed by Montreuil (2009-2012) presents components of the Logistics Web.

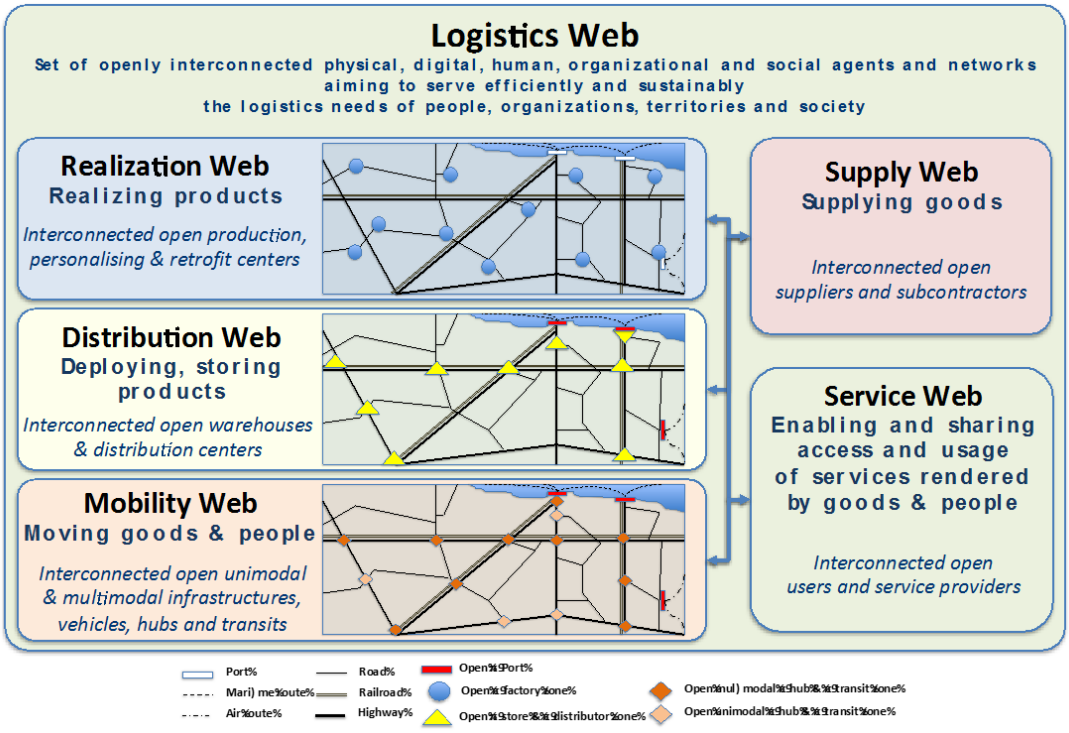

Figure 2-17: Logistics Web components (Montreuil, 2009-2012)

In order to run this PI environment, a set of facilities are required, which in this context are entitled as π-nodes. Examples of these facilities are: transit centers, switches and bridges, hubs, sorters, composers, stores, gateways, etc. (Montreuil *et al.,* 2010).

Because the research focuses on the Mobility Web component, the next section explores the π-transit center, its mission, and design.

2.9 Transit Centers

Figure 2-18 proposed by Montreuil (2011) shows significant results of exploiting π-transit centers, in comparison with the current approach. As it is demonstrated, exploiting a segment by segment delivery, instead of a direct delivery from source to destination, can reduce the delivery time by 50% for a shipment from Quebec to Los Angeles, while improving the productivity of drivers, tractors, and semi-trailers.

Figure 2-18: Illustration of hyperconnected semi-trailer truckload transportation across a Mobility Web (Montreuil, 2011)

According to Meller *et al.,* (2014), a π-transit represents one type of Physical Internet logistics center dealing with asynchronous transfers of semi-trailers from one truck to another. They are amongst the simplest π-centers. Instead of explicitly dealing with modular transport, handling and/or packaging containers (such as in Montreuil *et al.,* 2014), they strictly focus on semi-trailers regardless of what they carry. The three main entities for a π-transit center are tractors, semi-trailers, and drivers. All semi-trailers should leave their specific source and move toward their destinations within a specified time window. A new set of tractor and driver will be assigned to inbound and outbound semi-trailers, when they stop in transit centers (Meller *et al*., 2014).

To have a perspective of the potential layout for a π-transit center, Meller *et al.,* (2014) proposed the design depicted in Figure 2-19. This figure provides a perspective on this site inbound and outbound gateways, its circulation ways, its semi-trailer switching zone, and its buffer zone. Service zone is considered for this facility to improve its eco-friendly design and its care about truckers' quality of life through its service zone.

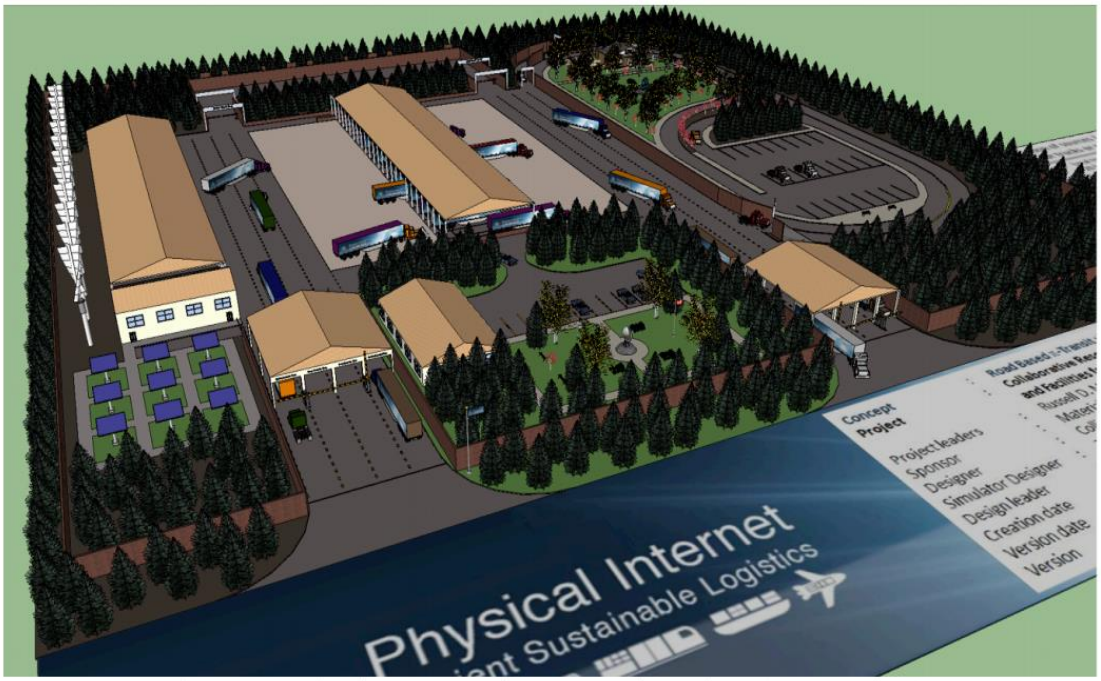

Figure 2-19: Illustrative layout of a π-transit center (Meller *et al.,* 2014)

2.10 Previous Research on Physical Internet and Business Model Innovation

The business modelling challenge related to the Physical Internet paradigm has been studied by Montreuil *et al.* (2012). In their opinion, the Physical Internet will force firms to innovate, mentioning that: *"[…] infrastructure providers will be strongly impacted. The Mobility and Distribution Webs discussed earlier means that transit centres, hubs, distribution centres, and warehouses will be flexible nodes of an elaborate and flexible network that will transform the way cargo, storage, and routing will be done"*. (Montreuil *et al.,* 2012, p. 35). They also mentioned (p. 35): "*In turn, customs agents, insurers, logisticians, and information systems developers will be impacted as new services will become profitable despite a change in intermediation relationships that will provide for real-time optimization."*. Following Linder and Cantrell's model (2000), they analyzed various types of change in business model and declared that in realization type, firms have one option for change, which is to make continuous effort toward efficiency and excellence in operations. In renewal type, firms have to move beyond the limits forced by their value chains. In extension type, firms can increase their products and markets value. And finally for journey type, they

proposed two models for firms to exploit: mash-up and ephemeral models (Montreuil *et al.,* 2012). Figure 2-20 demonstrates their proposition.

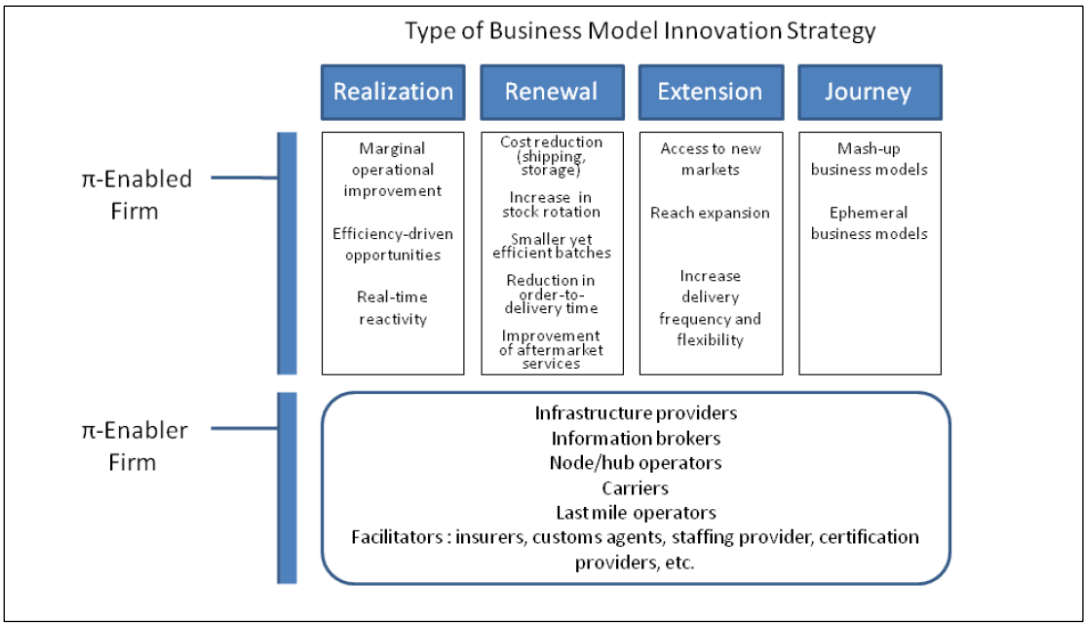

Figure 2-20: Implications of different types of business model innovation strategies for π-Enablers and π-Enabled firms (Montreuil *et al.,* 2012, p. 34)

Meller *et al.,* (2012) developed models in order to quantify the effects of Physical Internet on sustainability and profitability by moving from the current logistics network to a hyperconnected network. Their results demonstrated that the Physical Internet paradigm brings into play a win-win-win business model for shippers, receivers, and transportation service providers through increasing their profit margins as well as reducing environmental footprints. They also mentioned that a hyperconnected logistics network results in strategic impacts on network design, customer service, and driver shortage reduction through reducing driver turnover. They furthermore defined a set of KPIs that stakeholders can use to assess Physical Internet impact. Potential main stakeholders can be consumer packaged goods (CPG) manufactures, retailers, truckloads and less than truckload transportation service providers, and diversified manufacturers/shippers. They summarized KPIs related stakeholders in their research. As an example KPIs related to transportation service providers are illustrated in Table 2-6. (Meller *et al.,* 2012).

Table 2-6: Current and future KPI values for a transport service provider (Meller *et al.,* 2012, p. 15)

KPI		Current	Future	Improvement
Primary	Empty Miles	15%	11%	26% reduction in empty miles by participating in a collaborative network
	Equipment utilization (miles/tractor/week)	2,000	3,500	Nearly a 100% increase due to the use of relay networks that gets drivers home without idling equipment overnight
	Operating cost per mile (basis: total miles)	$1.50	$1.37	9% decrease due to utilizing equipment at a higher rate
	Revenue per mile (basis: billed miles)	$1.85	$1.62	This 12% reduction will be explained further below
Secondary	Driver Turnover	100%	27%	Reduction due to getting drivers home more often in a relay network
	Service (OTD)	95%	98%	Increase to BIC value
	Safety (collisions/1M miles)	2	2	There are advantages and disadvantages to driving in a PI network; a relay network structure may imply more regular work house, which may decrease the collision rate

Hakimi (2014) proposed that combination of various components of a Logistics Web can provide business opportunities. In his research, he analyzed potential combinations for Mobility, Realization, Distribution and Supply Webs and analyzed their potential business model. For example, one of the opportunities that he studied was the mixture of four of the components of Mobility, Supply, Realization and Distribution Webs. He then discussed the Supply, Realization and Distribution web answer questions such as how, where, and when to produce or exploit products as well as tackling how the Mobility Web can help them in moving the products efficiently. He pointed out: "*In this case, companies can build business models that turn around designing products, and setting and managing dynamic supply networks. They may even not own realization and distribution facilities nor manage mobility functions; they will rely on the Physical Internet to produce, transport and distribute their products*." (Hakimi, 2014, p. 68). Figure 2-21 presents his proposition about a Mobility Web supporting a Supply Web business model.

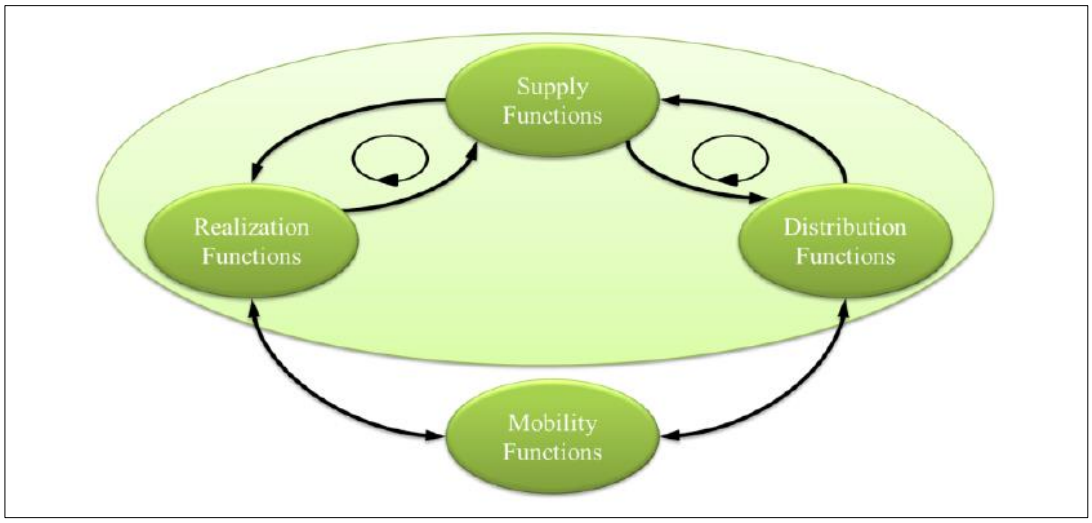

Figure 2-21: Mobility supporting a supply web business model (Hakimi, 2014, p. 68)

Cimon (2014) studied the obstacles in implementing a Physical Internet environment. He declared that to adopt Physical Internet, it is essential to solve its conflicts which are the decentralization, open source nature, and flexibility. He declared that efficient coordination mechanisms (such as markets, auctions, etc.) are essential in implementation process of PI through business model innovation and contracting approaches. He also proposed (p. 6): *"[…] PI business models, IT and individual networks will need to be in sync*". Finally he admitted that the importance of geography in logistics should be considered when implementing this paradigm.

Rouges and Montreuil (2014) worked on crowdsourced delivery, a new approach using technological potential and social trend of sharing and collaboration, to address the increasing customers' expectations. In particular, they studied 18 companies in the crowdsourced delivery industry and proposed a typology of five business models. They then proposed to move toward hyperconnected crowdsourced delivery, following the Physical Internet paradigm, as well as suggesting the crowdsourced route to be considered as an open consolidated segment for all parcels that are moving toward the same next hub, instead of being dedicated to a single exploiter from its source to its destination. They also proposed that crowdsourced delivery should be an alternative solution to create the Mobility Web instead of an isolated industry (Rouges and Montreuil, 2014).

2.11 Literature review and research concepts overview summary

In this chapter we tried to review the fundamental concepts in the context of designing business models, as well as shedding lights on the previous research on Physical Internet, its network design, and its business modeling. Next chapters will exploit these ideas and methods to reach the goal of research.

Chapter 3. Methodology

In order to help investors in making decision whether to invest in Physical Internet enabled transit center's business while guiding academics in key business aspects of this Physical Internet component, a three-phase methodology was followed. It involved:

1) Designing business models for Physical Internet transit centers based on recognized Canvas;
2) Identifying effective geographic location factors that may influence the business model of Physical Internet enabled transit centers and assessing their impacts;
3) Studying the effect of location factors on the profitability of Physical Internet enabled transit centers.

Three different methods were applied for each phase of methodology. Table 3-1 summarizes the phases, methodologies, and applied methods. Each phase is explained with more details in the following subsections.

Table 3-1: Phases, methodologies, and applied methods

Phase	Methodology	Method
Phase 1	Designing business models	• Using Business Model Canvas of Osterwalder and Pigneur (2010)
Phase 2	Identifying effective geographic location factors and assessing their impacts	• Exploiting a framework to identify potential location factors affecting a business model • Using a designed network of transits to identify potential locations for this business
Phase 3	Studying the effect of location factors on the profitability of Physical Internet enabled transit centers.	• Developing a set of hypotheses to identify the potential relationship of location factors (independent variables) and level of profitability (dependent variable) • Using components of a simulation experiment to complete the data sets for the variables • Estimating costs, revenue, and profits to define the dependent variable • Using correlation and regression analyzes to study the relationship between variables

3.1 Designing Business Models for Physical Internet Transit Centers

In order to facilitate forthcoming Physical Internet deployment and in particular, π-transit center implementation, the business modeling challenge was first investigated. More specifically, in this phase we studied strategic aspects of π-transit centers such as what is to be their mission, how they are to add value, what are to be the services they are to commercialize, what are to be their revenue streams, how they are to insure service reliability and to deal with liability in cases of service disruptions, how they are to grow, and how they are to make profits and be viable in the long run.

Among all proposed frameworks for studying business modeling, we focused on the proposition of Osterwalder and Pigneur (2010) "Canvas Business Model" since in comparison to other frameworks, it was relatively comprehensive and easy to apply while covering key essential aspects of a business. We used this tool to analyze the key aspects of π-transits' business models such as customer segments, value proposition, customer relationships, channels, key resources, key partners, key activities, revenue streams, and cost structure. The specific business model developed for a π-transit center based on Osterwalder and Pigneur's Canvas is proposed in chapter 4.

3.2 Identifying Effective Geographic Location Factors Influencing the Business Model of Physical Internet Enabled Transit Centers and Assessing Their Impacts

In order to run the business of π-transits, a network of strategically located π-transits is required. As pointed out in the literature, business unit location choices can affect the value proposition. As a result, it becomes interesting to assess the impact of the geographic location attributes on the π-transit business model. To achieve this goal, a framework was developed, based on some key papers encompassing business performance and business modeling, as well as the work of Osterwalder *et al.,* (2005). They proposed a comprehensive model that related the business model to external factors encompassing competitive forces, customers demand, technological change, legal environment, and social environment in addition to other factors encompassing business strategy, business organization, as well as information and communications

technology. Our framework was thus developed for π-transit centers based on Osterwalder *et al.*'s (2005) model, identifying the various components affecting a π-transit's business model, each one divided into elements. The framework was then used to assess the impact of location on the business model of a transit center, through a set of indicators following a low-to-high scale (i.e., low, medium-to-low, medium, medium-to-high, and high).

3.3 The Effect of Location Factors on the Profitability of Physical Internet Enabled Transit Centers

Hakimi *et al.,* (2014) in their research demonstrated that the implementation and use of a π-transit network promise many advantages, but they did not study the profitability of the individual π-transit according to the geographic location. Assuming that the implementation of the proposed network of π-transits is possible, it is pertinent to estimate the profit of each of these π-transits and understand the impact of the characteristics of the geographic location on their profitability. Thus, this phase proposes a set of hypotheses and an analytical model to help in predicting the profitability of a π-transit based on the characteristics of its geographic location. The simulation inputs and results from the work of Hakimi *et al*. (2014) were used to identify what could be the key geographic location factors that would affect the most the profitability of a π-transit. Based on that, five geographic locational factors were identified, representing the independent variables used in the model to predict the profit of a transit. Fifteen hypotheses were developed around these five factors to study their direct effect on the profit. An analytical model was also developed to identify the best predictors of profit while estimating the value of profit, given a set of values for these effective factors. The hypotheses and the analytical model were validated through correlation and regression analyses.

3.4 Master Thesis Structure

The three phases described below are described with more details in the three following chapters.

Chapter 4 presents the first phase of the research which was proposed as an article titled: "*Designing Business Models for Physical Internet Transit Centers*" in the 1st International Physical Internet Conference (IPIC 2014), Québec, Canada, 2014/05/28-30.

Chapter 5 presents the second phase of the research which was proposed as an article titled: "*Impact of Geographic Locations on the Business Model of Physical Internet Enabled Transit Centers*" in the 2st International Physical Internet Conference (IPIC 2015), Paris, France, 2015/07/6-8.

Chapter 6 presents the third phase of the research related to studying the effect of location factors on the profitability of Physical Internet enabled transit centers.

Chapter 4.
Designing Business Models for Physical Internet Transit Centers

This chapter presents the following paper: Oktaei P., N. Lehoux, B. Montreuil (2014): *Designing Business Models for Physical Internet Transit Centers*, Proceedings of 1st International Physical Internet Conference (IPIC 2014), Québec, Canada, 2014/05/28-30

Designing Business Models for Physical Internet Transit Centers

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Abstract: *The emergence of the holistic concept of the Physical Internet enables transforming the ways physical objects are designed, manufactured, and distributed. The Physical Internet provides a new open and interconnected structure to logistics networks, allowing to reconfigure business models and value creation patterns. As the Physical Internet is being further conceptualized and experimented, it becomes critical to rigorously investigate how its induced new generation of open logistics centers are to be designed and managed. The focus of this paper is to investigate a specific type of Physical Internet logistics centers, termed Transit Centers, from a business design and strategic management perspective. The emphasis is put on their potential business models, by bringing into play a business modeling canvas as a visual tool for envisioning their business operations. The proposed business models address the utility of deploying the Physical Internet to potential service providers of such nodes.*

Keywords: *Strategic Management; Canvas Business Model; Physical Internet; Transit Center; Business Model Design; Interconnected Logistics; Mobility Web*

4.1 Introduction

In today's modern world, logistics networks are yet deemed to be lacking in terms of both efficiency and sustainability from economic, environmental, and social aspects (Montreuil, 2011). The dominant dedication to either one user or one service provider, the emptiness of trucks and containers at departure, and the long travelling times of truck drivers, utterly result in poor asset utilization, low performance, reduced personal life for drivers, and low service levels. The Physical Internet (PI, π), as a solution to this grand challenge, is defined as a global open logistics system founded on physical, digital, and operational interconnectivity, through encapsulation, interfaces, and protocols (Montreuil et al. 2013). It enables the evolution towards interconnected logistics. Users are to exploit it through a Logistics Web, a network of open logistic networks, which can be conceptualized as having five constituents: Mobility Web, Distribution Web, Realization Web, Supply Web, and Service Web, respectively and synergistically devoted to moving, storing, realizing, supplying, and using physical objects.

This paper is to focus on the constituents responsible for good movements (i.e., the Mobility Web), and its open logistics nodes. In particular, our goal is to analyze how such nodes should be designed and managed from a strategic management point of view, in order to facilitate forthcoming Physical Internet deployment. Montreuil *et al.* (2010, 2014), Ballot *et al.* (2014) and Meller *et al.* (2014), have all addressed the physical and operational design of Physical Internet hubs and transit centers. Montreuil *et al.* (2012) have explored Physical Internet induced business model innovation.

To the best of our knowledge, there is no published study that focuses on Physical Internet logistic nodes and their management. So as to contribute toward filling this gap, we strategically study key strategic aspects such as what is to be their mission, how they are to add value, what are to be the services they are to commercialize, what are to be their revenue streams, how they are to insure service reliability and to deal

with liability in cases of service disruptions, how they are to grow, and how they are to make profits and be viable in the long run.

The paper is structured as follows. We first describe the functional design of Physical-Internet Transit Centers, based on the pertinent literature. We next introduce the Business Modeling Canvas of Osterwalder and Pigneur (2010) and use it as a basis for defining the essence of business models for Physical Internet Transit Centers. Third, we address the potential growth strategies for Physical Internet Transit Centers. Finally we provide avenues for further research resulting from our exploratory research.

4.2 Physical Internet

The paradigm-breaking Physical Internet, conceptualized as a metaphor of the Digital Internet, enables the transmission of all products through encapsulation in world-standard, modular, re-usable, and smart π-containers, similarly as moving data through encapsulation in standard packets under TCP-IP protocols (Montreuil, 2011). This standardization allows any firm to handle any other firm's encapsulated products. The Physical Internet is to exploit a new generation of logistics facilities as π-nodes, including π-Hubs, π-Transit Centers, π-Warehouses, π-Distribution Centers, etc. These π-nodes are unique in design and managerial perspectives.

By focusing on π-Transit Centers, Figure 4-1 sourced from Montreuil (2011) shows significant results of exploiting these nodes, in comparison with the current approach: it allows reducing source-to-destination delivery time by 50% for a shipment from Québec City to Los Angeles, unlocking a potential for significant productivity gains for drivers, tractors and semi-trailers.

The following section will explain the process for interconnecting and operating these π-Transit Centers.

Figure 4-1: Illustration of an interconnected truckload transportation of trailers across a Mobility Web

4.2.1 Uni-Modal Physical Internet Transit Center Description

Π-transit centers are among the simplest nodes in the Physical Internet. They are used to transship trailers from one truck to another, in order to facilitate the delivery of trailers from their source to their destination. In particular, π-transit centers are to accommodate three main entities: tractors, semi-trailers, and drivers. Hereafter in this paper, we freely interchange the terms tractor and truck, semi-trailer and trailer, as well as driver and trucker. For a π-transit, a semi-trailer is treated as a single entity, indeed as a black box. It may contain a set of π-containers, but the π-transit will not deal explicitly with these. Each inbound and outbound semi-trailer has to be assigned to a tractor and a driver. All trailers must depart from their original source and reach their final destination within some specified time window. All trailer-truck-trucker (T^3) triads depart from their current location (source, final destination or π-transit) and move toward their next destination (source, final destination or π-transit) according to an agreed upon delivery time window. Truckers' daily driving hour limitations are considered as well as their choices regarding their favorable destination at the end of their workday.

Figure 4-2 sourced from Meller et al. (2012) shows the proposed functional design. Its unique and efficient design is readily observable.

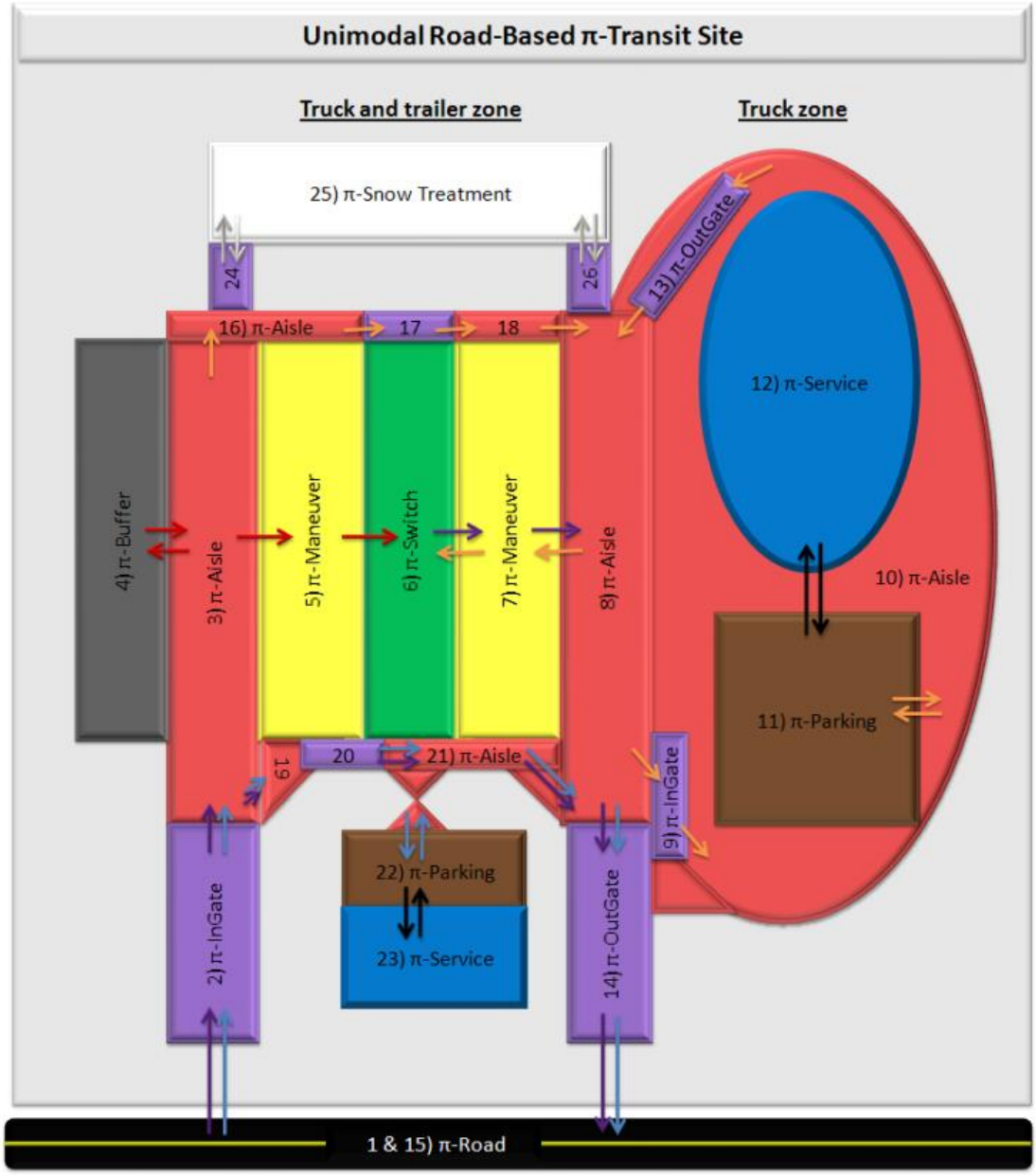

Figure 4-2: Block Layout for the proposed functional design

Π-transit centers are planned and managed using information from each entity involved. This information is recorded in databases, which are manageable by a negotiation protocol under what we call here the π-system. The π-system monitors movements in real time and knows the exact location and state of all trucks, trailers,

and π-nodes at all times. The operational process which is guided through this π-system is as follows**:**

- A T^3 triad signals its intention to visit a π-Transit Center. This triad can arrive from various locations including another π-transit, trucker's home, local pick up or delivery point, or some other π-node.
- Before arrival, the π-system, through the provided information system and databases, gathers information about the capacity of the π-transit, current trailer-truck-driver triads inside the π-transit, potential T^3 triads likely to visit the facility, and their satisfactory routes. Based on this information, it finds the best match between distinct components of T^3 triads, and books a location in the π-transit for further tasks. The location for unhook-hook trailers-trucks is called π-switch.
- After arrival of the T^3 triad near the π-transit, it leaves the π-road and enters to the entrance gate of the π-transit, under the term π-InGate, for a rapid deep-security scan, entrance authorization, and getting a work order. Indeed, the π-system transfers a work order to the truck's dashboard computer. Each work order is obtained by optimizing algorithms to reduce traffic and time wasted. This work order shows every reachable area for the set of T^3 triad in the facility. After the driver acknowledges the work order and confirms its acceptance, the entrance authorization is issued and the blocking barrier is allowed to rise. The π-InGate counts the number of trailers, trucks, and drivers entering the facility. In the case that the π-transit is faced with high load of work, parking for trucks and services for drivers are considered next to the π-InGate to prevent a queue.
- After entrance of the T^3 triad in the π-transit, it moves through provided four-way roads, under the term π-Aisles, to find its booked π-switch bay as specified on its work order. Two scenarios might happen. If the π-switch is full, the set will be headed to the temporary waiting location, called a π-buffer. Otherwise, if the π-switch is free, it will go through a provided place between π-aisles and the π-switch, a space called a π-maneuver, and will enter to its booked π-switch bay. Π-maneuver in between π-aisles and the π-switch is provided to prevent

potential traffics that might happen in π-aisles when a set wants to enter to the π-switch.

- After entrance to the appropriate π-switch bay, the trailer is unhooked from the truck-driver dyad. The unhooked trailer will wait for its next assigned truck-driver dyad, while the available empty truck-driver dyad will leave the π-switch, passing the π-maneuver and, based on its work order, move through π-aisles to find the next determined π-switch to hook the next planned trailer. In the case a T^3 triad enters a wrong π-switch, an alarming system on the truck's dashboard computer announces it and guides the driver to find the accurate one.
- The empty truck-driver dyad next enters a new π-switch and waits until its next trailer is hooked to it. It might take time for the π-system to find the best match between the unhooked trailer and an empty truck-driver dyad with the same intended destination. If the best match is not available, the unhooked trailer is transferred by an employee to the temporary waiting bay, π-buffer, while the empty truck-driver dyad is guided toward the truck zone which provides the π-service and the π-parking. The truck zone has a π-InGate and a π-OutGate to check the sets and count them to inform its free capacity. The π-parking provides places for keeping trucks while π-service provides washroom, restaurant, a small park containing trees, benches, picnic tables, etc., for serving drivers. The empty truck-driver enters to this zone through the π-InGate, passes π-aisle, and enters to the considered π-parking; it will wait in this truck zone until an appropriate trailer will be found by the π-system. When a match is found with a trailer the truck-driver leaves the π-parking, enters to the π-aisle, moves toward the π-OutGate of truck zone, enters to π-aisles of truck and trailer zone, and moves toward the π-switch where the trailer is waiting.
- When a set is matched and the process is done, the new T^3 triad leaves the π-switch, passing the π-maneuver, and moves through π-aisles. Now the new T^3 triad can leave the π-transit through the π-OutGate directly or use truck zone services before leaving. In the case it wants to leave, the T^3 triad will enter to π-OutGate, a security check will be done, the authorization will be issued, the

barrier will rise, and the T^3 triad will leave the π-transit. After a T^3 triad leaves the π-transit, the π-system updates its information and databases.

Figure 4-3 sourced from Meller et al. (2014) presents an overview of the flow of trucks and trailers in a π-transit. Explanations are related to the process inside π-switches.

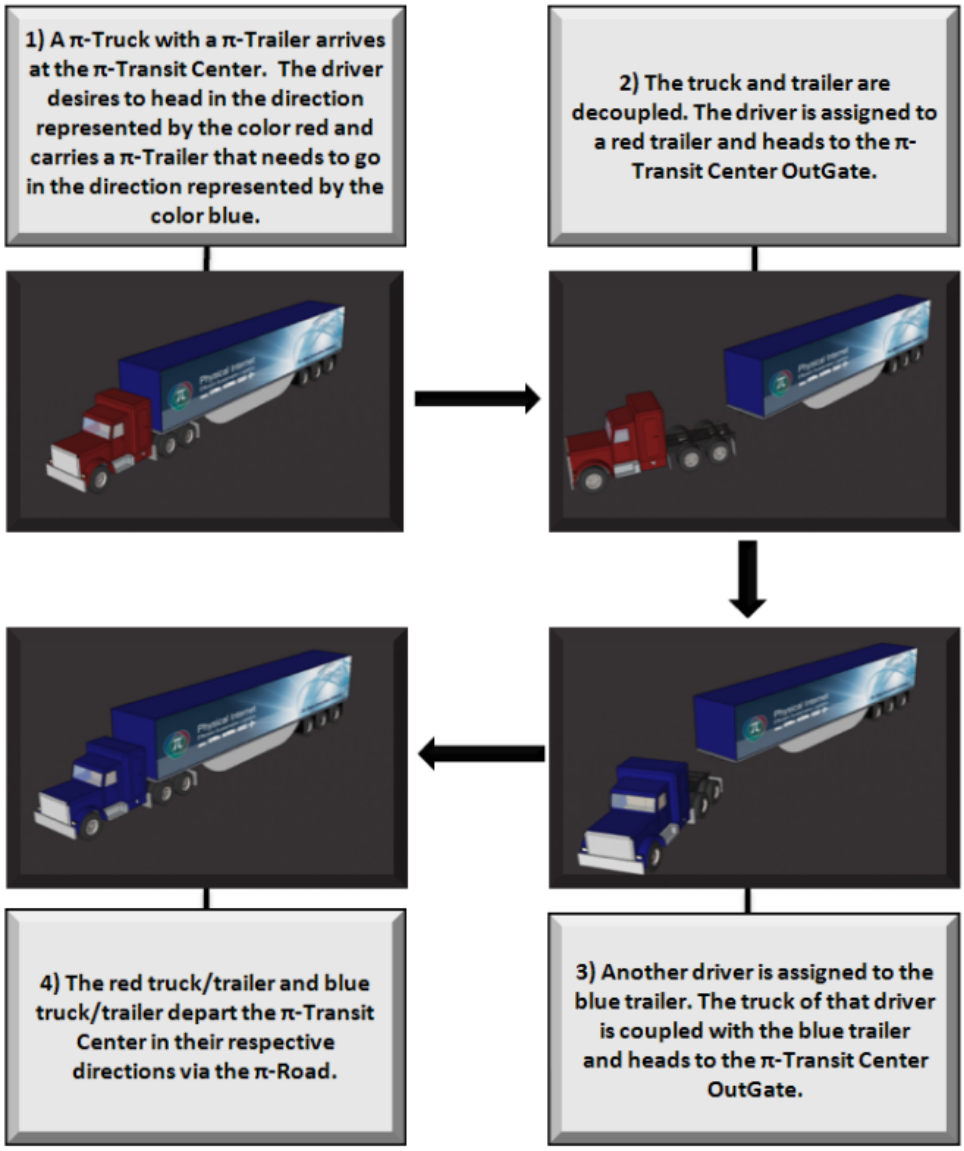

Figure 4-3: Overview of the flow of trucks and trailers in a Physical Internet Transit Center

Figure 4-4 sourced from Meller et al. (2014) shows the final 3D layout of a proposed design (front aerial view). It gives a perspective of the truck zone, the truck and trailer

zone, and the π-gates, which leads to a better realization of the efficiency in the design of the π-transit.

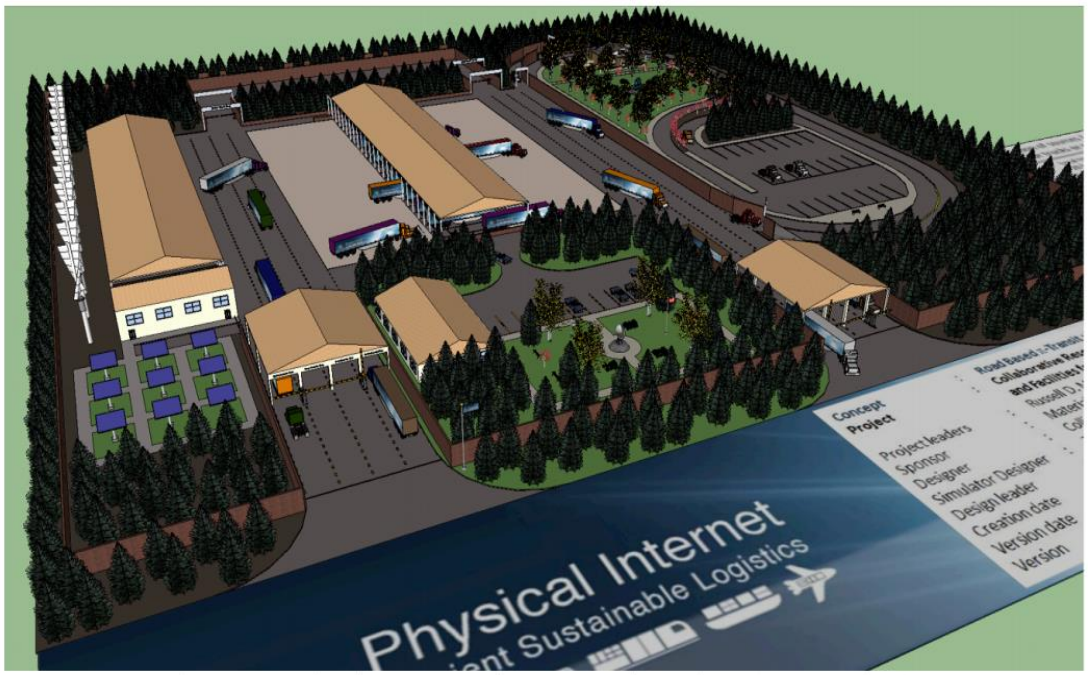

Figure 4-4: Final layout of a proposed design (front aerial view)

The π-transit has two key sets of stakeholders with distinct goals and expectations: its customers and its owners/operators. Customers include transportation service providers (Truck-Driver), transport service brokers (Truck-Driver), and shippers (Trailer). These customers will evaluate the performance of the π-transit based on key potential factors such as:

1) Average processing time inside the π-transit (Trailer-Truck-Driver);
2) Average percentage of departures in preferred or satisfactory direction (Truck-Driver);
3) Average percentage a π-Transit Center is able to manage rushed situations successfully (Trailer).

Π-transit owners/operators are interested in gaining competitive advantage through increasing the π-transit center capacity, attracting new customers, and keeping their current profitable customers through unique services. From a center design perspective, important factors for these stakeholders are:

1) Area of π-transit center;
2) Number of π-gates (In/Out);
3) Number of π-switches;
4) Number of π-parkings for trucks and trailers;
5) Average percentage of time the capacity of π-transit is full and Trucks/Trailers are rejected from entering (Meller *et al.*, 2012).

A better understanding of the functional design of the π-transit center raises the necessity to explore its managerial aspects and to define its innovative business model. The next sections introduce such concepts.

4.3 Business Modelling

A business model is a heuristic logic a firm will use to create value in a competitive environment. Osterwalder and Pigneur (2010) define business models as: "*The rationale of how an organization creates, delivers, and captures value".* Companies that have already designed their business model should also consider the dynamic environment and improve their business model, involving modifications in their value creation patterns (Montreuil et al., 2012). To help managers in defining their business model, Osterwalder and Pigneur (2010) have developed a business model canvas, a powerful visual and intuitive tool that gives a better perspective of company's businesses. The key components embedded by the authors in their canvas include customer segments, value proposition, customer relationships, channels, key resources, key partners, key activities, revenue streams, and cost structure:

- Customer Segments: Profitable customers are centers of attention of businesses and their strategies. Companies will categorize their customers and serve them through various strategies and distinct products and services. Categories of customers are based on their mutual needs, expected behavior, and other attributes. This block therefore addresses various categories of customers, especially the profitable segments a firm wants to focus on.
- Value Proposition: it is the aggregation or bundle of benefits a firm offers to its customers. Proposed value of a firm can be an innovative value, representing a

disruptive offer, or the same value in the existing market with significant added attributes. Value proposition are classified into two categories including qualitative and quantitative values. Qualitative values address customer service and newness, while quantitative values address price, performance, and speed of services. Customers, based on their expectations, give various weights to these values. This block notably addresses the services or products a firm provides.

- Channels: they address the tools and approaches a firm uses to reach its customers and deliver its value to the market. They include sales forces, websites, networking, etc. Firms can reach their customers through their own channels, partners' channels, or a combination of both.
- Customer Relationships: they address various methods a firm uses to contact its customers. Goals out of making these relationships are customer acquisition, customer retention, and sales enhances. A firm might choose multiple types of relationships, from collaboration to automated services, for various segments.
- Revenue Streams: they address cash inflows a firm generates. It can also encompass any new, novel, undiscovered, potentially lucrative, innovative, and creative tools for income generation or a potential exploitation. Revenues can be made in transactional or recurring types. Transactional revenues address incomes from one time customer's payments, while recurring revenues correspond to incomes resulting from customer's ongoing payments.
- Cost Structure: it addresses all expenses a firm must take into account to provide a service or a product. Cost structure can be used in cost-based pricing strategies. Business models can be classified into two categories: value-driven approaches and cost-driven approaches. Cost-driven approaches focus on minimizing costs, while value-driven approaches focus on maximizing delivered values to customers. The spectrum of costs can be classified as strategic, tactical, and operational costs, while another classification can be fixed costs at one end and variable costs at the other end of the spectrum.
- Key Resources: they address any resource a firm uses to operate its business processes and make profit. They can be human resources, tangible resources

(e.g., plant, machineries), intangible resources (e.g., knowledge, brand image), and financial resources. Key resources can be owned or leased from strategic partners.

- Key Partners: partnership is a successful approach to establish business operations between two or more firms, share management and profits, and access to more resources. Through partnerships, firms not only can gain access to various resources, but can also focus on their capabilities and propose unique products or services. This block is to address key partners a firm will choose to work with based on their capabilities;
- Key Activities: they address all the economic, environmental, and social activities a firm carries out to create value for its stakeholders. Activities are to be in line with the mission of the firm and its value proposition.

4.4 Π Transit Center and Business Modelling

Based on Osterwalder and Pigneur's Canvas Business Model (2010), the various business design facets of π-transits will be highlighted and classified into distinct blocks. It will therefore facilitate the analysis of various essential aspects of this type of logistics center, a necessity for superior strategic planning.

4.4.1 Π-Transit Center Customer Segments

A primary classification for the π-transit center customers segregates them into three key segments: transportation service providers (truck-driver providers), transport service brokers (truck-driver providers), and shippers (trailer provider). It is also applicable to categorize these three segments in a secondary classification, based on their usage of π-transit center services over a time span. Such a classification can for example exploit four distinctive segments: elite customers, strategic customers, regular customers, and transactional customers. More specifically:

- Elite customers are the most valuable segment of customers. In a determined time span, for example one month, not only their number of usages is salient, but also they use the π-transit continuously, so they are important loyal

customers for the π-transit center. They are strong contributors to profit for a π-transit center and its owner/operator should plan for significant retention and prioritization strategies to keep them as satisfied customers;

- Strategic customers are the segment with a continuous yet lower usage frequency of the π-transit center over a time span. Their contribution to the profitability of the π-transit center is individually lower than elite customers, but they are loyal to facility and jointly they provide a sure source of profit. As a result, it is essential for the owners/operators to plan for strategies to keep them, especially as they could become future elite customers;
- Regular customers are the segment with the highest collective number of usages but with the lowest individual continuity of usage over a time span. These customers ensure a high load of work, insuring a steady inbound cash flow, so the π-transit center owners/operators should invest on attracting and retaining them;
- Transactional customers correspond to the segment with the lowest number of usages as well as the lowest continuity of usage over a time span. The owners/operators of a π-transit might hesitate to plan for strategies on attracting or keeping them for further work, since they have low share in profitability of the π-transit center; yet these customers can be potential regular, strategic, or elite customers and planning for them may be essential both for profitability and for PI openness integrity. Figure 4-5 illustrates this secondary classification of customers.

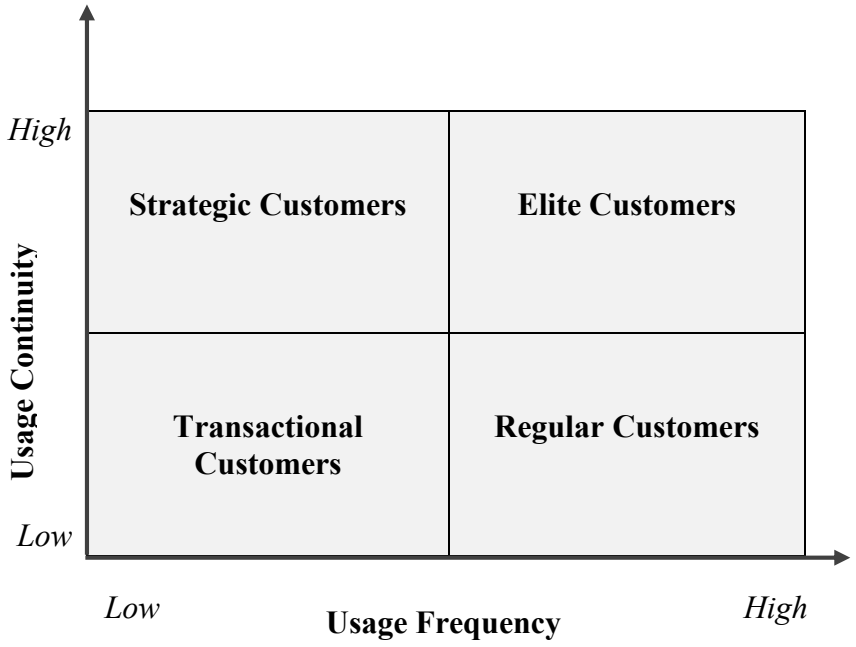

Figure 4-5: π-Transit Center Secondary Customer Segments

4.4.2 Π-Transit Center Value Proposition

The potential portfolio of services offered by a π-transit includes access services, matching services, parking services, resting services and short-term storage services.

- Access service, which is provided by the π-InGate and the π-OutGate of the truck zone and the truck and trailer zone is to address the entrance and exit security checking. It encompasses the initial entrance and final exit authorization, as well as the work order delivering for each set of trailer-truck-driver.
- Matching service is to address finding the best match for sets of trailer-truck-driver through the π-system and performing the physical matching process provided by locations, equipment, and administrative employees.
- Parking service is to address the embedded locations inside a π-Transit Center for trucks according to their needs.
- Resting service is to address embedded washroom, cafeteria/restaurant, and pleasant environment for drivers during their sojourn inside the π-transit center.

- Buffering service is to provide locations (π-buffer) inside the π-transit center, for those trailers waiting to have a well matched truck, for example for up to a few hours. In this case, the trailer would be transferred to a π-buffer by an employee and wait there.
- Storage service is to provide trailer or truck storage space for agreed upon durations, upon explicit customer request.

A π-transit can gain from insuring the quality and reliability of its services, notably through a service guarantee engagement.

4.4.3 Π-Transit Center Channels

A π-transit can reach its customers based on two main channels: indirect services via platforms and direct services via personalized contacts. On one hand, all essential information is provided through a platform and customers from every segment can exploit it. On the other hand, the π-transit might serve more profitable customers through personalized direct contacts, like elite customers who are power poles for the firm or strategic customers who are loyal and provide a stable profit.

In some cases, we can imagine a customer service manager sent to these customers to propose or validate some services. Customers might also not be interested in more formal relationships. However, depending upon on the management philosophy of a specific π-transit center, all four customer segments can be served by both channels.

4.4.4 Π-Transit Center Customer Relationships

A π-transit can exploit various strategies for its relationships with customers. Based on the importance of customer segments, distinct approaches may be used.

For example, elite customers and strategic customers can be served through collaborative relationships. Collaboration in the π-transit center is conceptualized as direct, person-to-person tight relationships, leading to a well-established mutual recognition, more information exchange, and more coherency between proposed services and their needs. It may result in customized services proposition, higher

service level, more loyalty, customer satisfaction, and customer retention in the long-term.

Transactional customers and regular customers could be served through cooperative relationships. Cooperation in the π-transit is defined as one discrete relationship with customers, the latter being served through a platform or via direct relationships on request. It means that the π-transit operator serves these customers through its current superior services, made public on the PI Mobility Web platform, without customizing services for them. Also these segments might not be interested to have more relationships with the π-transit center.

Figure 4-6 shows the summary of potential customer relationships based on channels and customer segments.

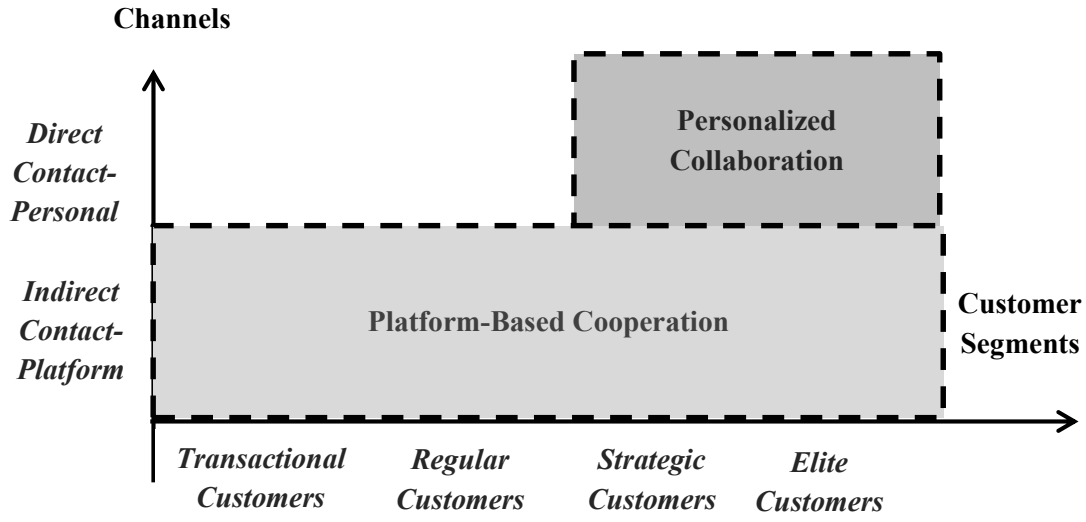

Figure 4-6: π-Transit Center Customer Relationships based on Channels and Customer Segments

4.4.5 Π-Transit Center Revenue Streams

The main revenue streams for a π-transit are through its provided services including access services, matching services, parking services, resting services and buffering services; while subsidiary revenue streams are renting extra capacity and proposing storage services.

The π-transit, based on its goals, objectives, and mission, might exploit various strategies for its services, including pricing strategies. For now, Physical Internet Webs are new and may provide unique non-competitive services, as they are at the first stage of the business life cycle. Nevertheless, when competitors will have their own π-transit, various pricing strategies based on differentiation or cost leadership strategies will become necessary. Table 4-1, inspired from the proposition of PennState, college of agricultural sciences (2015), positions strategic goals versus these potential pricing strategies. Complementarily, Table 4-2 clarifies concepts of various potential strategic goals and pricing strategies.

Table 4-1: Matching Potential Goals and Pricing Strategies for a π-Transit Center

Potential Objective	**Potential Strategies**									
	Multiple Pricing	Service Line Pricing	Skimming Pricing	Good, Better, Best Pricing	Optional Service Pricing	Penetration Pricing	Premium Pricing	Service Bundle Pricing	Loss Leader Pricing	Competitive Pricing
Profit Maximization	✓	✓	✓							
Revenue Maximization			✓	✓	✓	✓		✓		
Quantity Maximization	✓			✓		✓		✓	✓	
Profit-Margin Maximization			✓				✓			
Quality Leadership		✓			✓		✓	✓		
Partial Cost Recovery								✓	✓	
Survival								✓	✓	✓
Status Quo										✓

Table 4-2: Concepts Underlying Potential Goals and Pricing Strategies for a π-Transit Center

Goal	Concept	Strategy	Concept
Profit Maximization	Maximize facility's returns	**Competitive Pricing**	Pricing in the line with competitors for same services
Revenue Maximization	Maximizing revenue from the sale of services	**Good/Better/Best Pricing**	Offering same services with various price levels
Quantity Maximization	Maximizing the number of sold services to follow economies of scale	**Loss Leadership**	Providing one service with low prices Attracting customers for other services and future purchases
Profit Margin Maximization	Maximizing the per unit profit margin of selling a service	**Multiple Pricing**	Pricing per service-usage in the line with prices for more serving Motivating customers to use for greater number
Quality Leadership	Signaling the high quality of service, by a high price	**Optional Service Pricing**	Charging low extra money for optional services
Partial Cost Recovery	Selling services through the lowest cost Exploiting other sources of income for compensating costs	**Penetration Pricing**	Proposing the lowest price for services Attracting/Growing the market share while gaining minimal profit
Survival	Pricing just to stay in business and recover essential costs	**Premium Pricing**	Selling unique/high quality services for buyers less sensitive to prices
Status Quo	Pricing in the line with competitors Maintaining stable levels of profit	**Product/Service Bundle pricing**	Proposing a group of services at a discounted price
-	-	**Product/Service Line pricing**	Selling a range of complementary services together
-	-	**Skimming Pricing**	Setting highest price the same as premium pricing Setting lowest price when competitors enter Setting highest price when no competitor available Increasing prices when demand enhanced Reducing prices when demand decrease

4.4.6 Π-Transit Center Cost Structure

The cost spectrum of π-transits encompasses three main types of expenses as synthesized in Figure 4-7. The top of the spectrum concerns the strategic costs which address initial and less iterative expenses such as initial investments, land costs, sites costs, fixed employee salary costs, fixed management costs, services costs, etc. At the bottom of the spectrum, we can find the operational costs, which address highly iterative day-by-day costs, such as throughput costs and resource utilization costs. In the middle of the spectrum lie tactical costs. They correspond to expenses dependent on π-transit workload such as extra employee hiring costs, extra services costs, extra administrative cost, and extra management costs. In seasons with high workload, a higher number of operators and managers are needed.

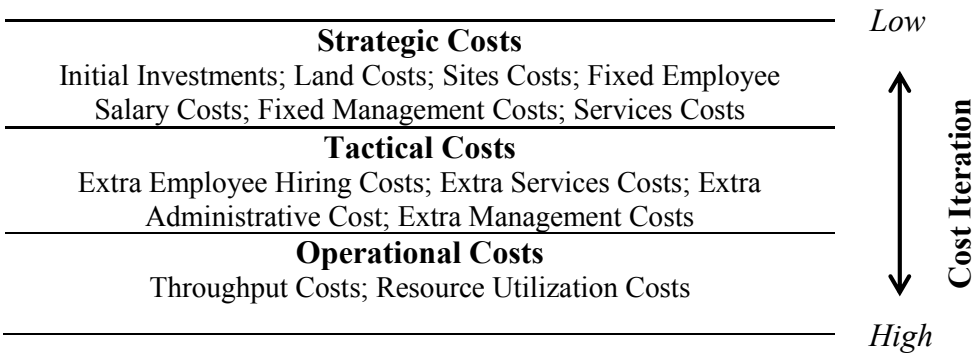

Figure 4-7: π-Transit Center Cost Spectrum

4.4.7 Π-Transit Center Key Resources

In order to exploit a π-transit, a wide range of resources are essential including physical, technological, and technical assets as well as human and financial resources, as was outlined in section 2. A π-transit can thus use various strategies for managing these resources such as partnerships in which companies provide these resources as their exclusive services.

4.4.8 Π-Transit Center Key Partners

The potential partners of a π-Transit Center can notably be technology providers for supplying technological needs; routing service providers for supplying trailers, trucks

and drivers; governments for supporting various facilities or investments; other π-nodes for supplying extra capacity in season with high workload; or other problem solving supports inside Webs. Key customers such as transport service providers and transport service brokers can also be considered as partners as previously explained.

4.4.9 Π-Transit Center Key Activities

The π-transit center is involved with various tasks necessary for providing expected services, with the core activities described in section 2. In particular, based on π-transit center design and goals, these tasks involve accessing services of the π-InGate and the π-OutGate of truck and truck-trailer zones; providing matching services including administrative and managerial tasks; providing parking, resting services, and short-term storage including administrative tasks; monitoring, controlling, and evaluating the π-transit center profitability through cost and performance assessment; and finally motivating human resources toward better performance.

4.4.10 Π-Transit Center Business Model Canvas Overview

Figure 4-8 shows an overview of key components of the business model canvas of π-transit centers.

<table>
<tr>
<td rowspan="2">Key Partners
Technology Providers
Transport Service Providers
Transport Service Brokers
Routing Service Providers
Other π-Nodes
Government</td>
<td>Key Activities
Access Tasks
Matching Tasks
Parking Tasks
Resting Tasks
Short-term Storage Tasks
Controlling Tasks</td>
<td rowspan="2">Value Proposition
Access Services
Matching Services
Parking Services
Resting Services
Short-term Storage Services</td>
<td>Customer Relationships
Collaboration Cooperation</td>
<td rowspan="2">Customer Segments
Transportation Service Providers
Transportation Service Brokers
Shippers
Elite Customers
Strategic Customers
Regular Customers
Transactional Customers</td>
</tr>
<tr>
<td>Key Resources
Physical Assets
Technological Assets
Technical Assets
Human Resources
Financial Resources</td>
<td>Channels
Direct Contact-Personal
Indirect Contact-Platform</td>
</tr>
<tr>
<td colspan="2">Cost Structure
Strategic Costs
Tactical Costs
Operational Costs</td>
<td colspan="3">Revenue Streams
Access Services
Matching Services
Parking Services
Resting Services
Short-term Storage Services
Renting Extra Capacity</td>
</tr>
</table>

Figure 4-8: π-Transit Center Business Model Canvas

4.5 Π-Transit Center Growth Strategy

It is essential for π-transit owners/operators to think about growth strategies, whether for a new startup business or an established one, to ensure continuous efficiency and profitability in the long-term.

In general, companies should exploit their opportunities, alleviate their threats, empowering their strength, and obviate their weaknesses. There are various growth strategies available, including market penetration, service development, market development and diversification (e.g. Ansoff, 1965). Market penetration strategy aims to push existing services to their current market segments while market development strategy tries to develop new markets for the current services. Service development strategy aims to develop new products for existing markets while with diversification strategy, new services are developed for new markets.

As mentioned previously, the Physical Internet paradigm is a unique and creative concept. So in the early phases of PI implementation, the exploitation of π-transits may be non-competitive in local markets. Nevertheless, in the long run, as PI implementation builds momentum, they will have to face competitors with similar services. Consequently, in order to keep or grow their market share, they will have to exploit distinct growth strategies. A π-transit center could thus exploit growth strategies as highlighted above.

For example, new services such as π-crossdocking services, π-warehousing services, and π-distribution center services, could be provided, resulting in the attraction of new customers in the current geographical markets. The π-transit center could also enlarge its network or increase its capacity to cover larger geographical markets. Through innovative ideas, up-to-date technologies, greater synchronization with more π-nodes, strategic partnerships and intensive knowledge transfer, π-transit centers could finally ensure their sustainability in the long term.

4.6 Conclusion

As stated at the outset, this paper has aimed to design a comprehensive business model framework for Physical-Internet enabled transit centers. The goal of such a business modeling framework is to address how π-transits should be managed from a service provider's perspective to facilitate their further exploitation.

Using the Business Model Canvas of Osterwalder and Pigneur (2010), various dimensions of these logistics centers have been conceptualized, including their mission, services, customer segments, channels, customer relationships, revenue streams, costs, key resources, key partners, and key activities.

While these π-transit centers are not commercialized yet, their growth strategies have also been investigated since they are another concerning issue. The significant point is that based on the dynamic nature of business environment, these business models should be continuously assessed and modified to bring more value added to their networks.

Limitations of this research are as follows. First, the proposed business model canvas is limited to π-transit centers and their services, while a π-transit center might provide other services to other π-nodes such as π-crossdocking services and π-warehousing services. Second, the π-transit centers can have various business models based on their location. The nature of their locations will lead to demand differentiation, distinct missions, different customer segments, different costs, different resources, different partners, and different revenue streams which affect their competitive advantages and strategies.

Further research is needed to investigate the intricate relationship between the potential business model and the location of a π-transit center. There is also a need for assessing the efficiency of business model variants in dynamic competitive environments through a simulation based assessment. Finally, this research has explored business modeling for one of the simplest types of Physical Internet logistics centers, a π-transit,

opening the way for the investigation of more complex centers such as Physical Internet crossdocking hubs and open distribution centers.

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Chapter 5.
Impact of Geographic Locations on the Business Model of Physical Internet Enabled Transit Centers

This chapter presents the following paper: Oktaei P., D. Hakimi., N. Lehoux, B. Montreuil, C. Cloutier (2015): *Impact of Geographic Locations on the Business Model of Physical Internet Enabled Transit Centers,* Proceedings of the 2st International Physical Internet Conference (IPIC 2015), Paris, France, 2015/07/6-8

Impact of Geographic Locations on the Business Model of Physical Internet Enabled Transit Centers

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Abstract: *The Physical Internet enables transforming the way physical objects are designed, made, supplied, deployed, moved, and used. It exploits a new open and interconnected structure of Logistics Webs, which will necessarily influence the business models of the companies involved. This research focuses on the Mobility Web which is a component of the global Logistics Web in the Physical Internet (PI, π) environment. The Mobility Web ensures the movement of physical objects within a global interconnected set of open uni-modal and multi-modal hubs, transits, ports, roads, and ways. In particular, it uses π-transits to tranship semi-trailers from one truck to another so as to facilitate their delivery from their source to their destination. The geographic location of a Physical Internet enabled transit center can affect its value proposition, indeed its overall business model, and its attractiveness toward investors and stakeholders. Consequently, determining the impact of geographic*

location attributes on the business model of PI enabled transit centers is an essential issue. The goal of this paper is therefore to identify factors that can affect Physical Internet enabled transit center business models and assess their impact according to the location. To reach this goal, a framework is developed and applied to study the business model impacts of locating a π-transit in a metropolitan area.

Keywords: *Business Modeling; Physical Internet; Interconnected Transport; Mobility Web; Transits; Location; Relay; Logistics Facilities*

5.1 Introduction

Interconnected transportation systems have been assessed as more economically, environmentally, and socially efficient. They enable massively open flow consolidation and asset sharing, notably through segment-by-segment delivery of products in relay mode from their source to their destination, instead of the currently dominant dedicated end-to-end direct transportation and hub-and-spoke network based transportation. For example, Sarraj *et al.* (2014) and Hakimi *et al.* (2014) both demonstrated via simulation approaches the benefits of implementing interconnected transportation solutions versus dedicated transport systems.

Interconnected transportation systems are a component of the Physical Internet (PI, π) introduced by Montreuil (2009-2012, 2011) as a solution to the efficiency and sustainability challenges facing today's global logistics. Similarly as the Digital Internet enables a Digital World Wide Web, the Physical Internet enables a global Logistics Web. It can be thought as being composed of a set of interlaced components: a Mobility Web, a Distribution Web, a Realization Web, a Supply Web, and a Service Web, respectively and synergistically devoted to moving, storing, realizing, supplying, and using physical objects. The π-enabled Mobility Web, the underpinning of interconnected transportation systems, deals with moving physical objects and people within a global set of open single-modal and multi-modal hubs, transits, ports, roads, and ways. Figure 5-1 sourced from Montreuil (2011) illustrates an interconnected truckload transportation of trailers across a Mobility Web for a shipment from Quebec City to Los Angeles. This approach allows reducing source-to-destination delivery time

by 50% for a shipment in comparison with the current approach, which can lead to significant productivity gains for drivers, tractors, and semi-trailers.

Figure 5-1: Illustrating interconnected transportation of semi-trailers across a Mobility Web (Source: Montreuil, 2011)

According to Meller *et al.* (2014), a π-transit represents one type of Physical Internet logistics center that, in the context of a Mobility Web, is basically a site for asynchronous transfers of semi-trailers from one truck to another. They are amongst the simplest π-centers. Instead of explicitly dealing with modular transport, handling and/or packaging containers (Montreuil *et al.,* 2015), they strictly focus on semi-trailers without explicit consideration of what they carry. Figure 5-2 proposed by Meller *et al.* (2014) illustrates a potential layout for a π-transit center, providing a perspective on its inbound and outbound gateways, its circulation ways, its semi-trailer switching zone, and its buffer zone, while enhancing its eco-friendly design and its care about truckers' quality of life through its service zone.

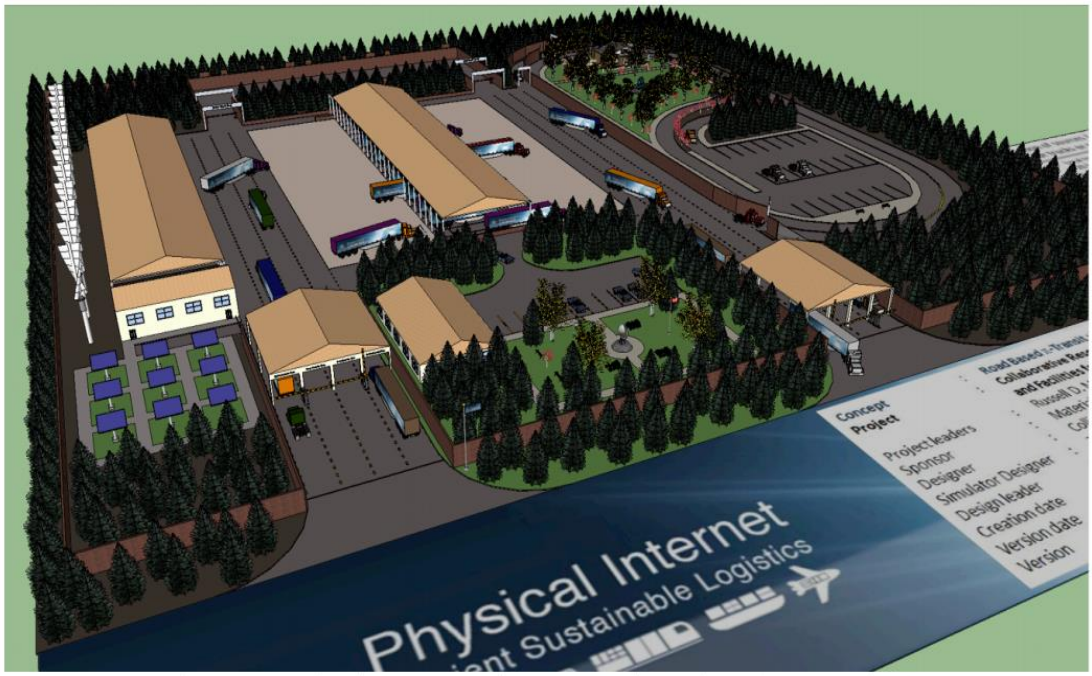

Figure 5-2: Illustrative layout of a π-transit center (Meller *et al.,* 2014)

To support an interconnected semi-trailer transportation through a Mobility Web, a network of numerous strategically distributed π-transits can be built. This network can (1) enable the semi-trailers to travel faster from origin to destination as they do not need to stop while the drivers are taking their mandatory breaks, (2) allow the drivers to improve their productivity and come back home more frequently as they do not need to ensure the entire end-to-end travel of the semi-trailers, and (3) increase the usage and the productivity of trucks (tractors) as they can be used more intensively pulling semi-trailers. Figure 5-3 sourced from Hakimi *et al.* (2014), illustrates an example of a π-transit network for the province of Quebec. In this example, transits were notably placed in metropolitan areas, near the borders to the US and other Canadian provinces, and at key roadway intersections. Transits were then placed strategically across the industrially and commercially active urban and rural areas of the province, inducing maximal inter-transit driving hours of roughly 3.5 hours.

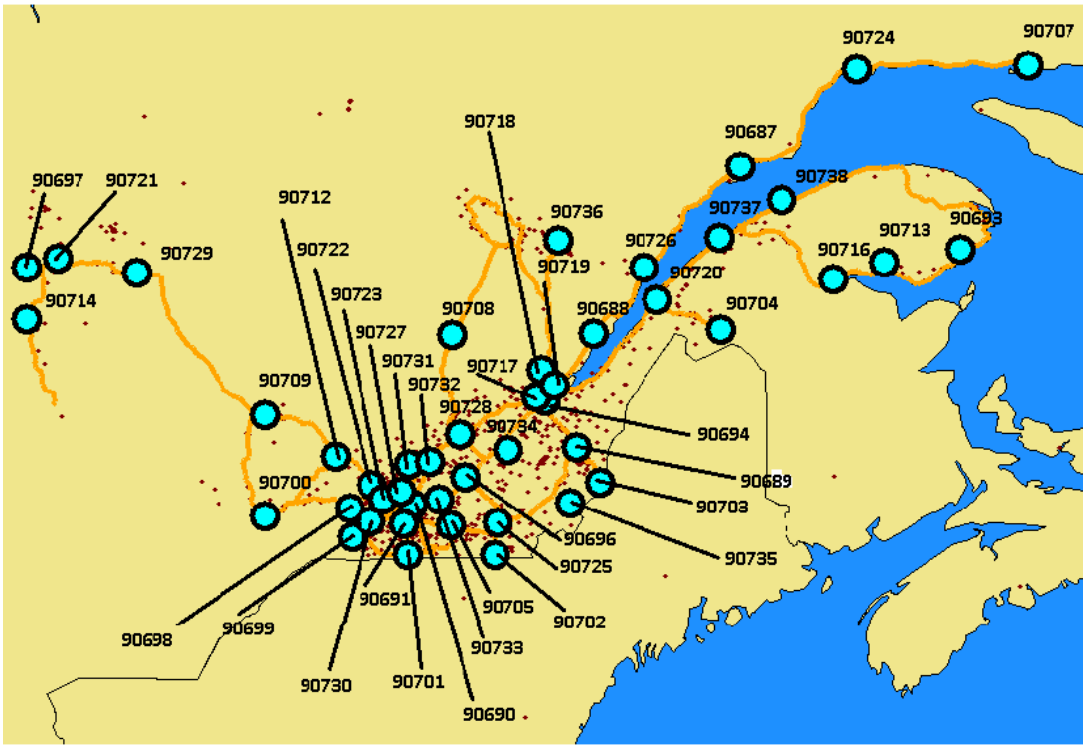

Figure 5-3: Example of a π-transit network for the province of Quebec in Canada (Source: Hakimi *et al.,* 2014)

Note. Blue nodes represent potential locations for Physical Internet enabled transit centers

Since the location of each π-transit will affect its value proposition, and as a result its global business model, as well as its attractiveness toward investors and stakeholders, it becomes important to assess the impact of the geographic location attributes on the π-transit business model. Typical potential locations for π-transits include sites near borders, in metropolitan (metro) areas, in remote areas, and at intersections of ways (such as highways and roadways). As Figure 5-3 shows, there are several transit zones in a metropolitan area such as Montreal and Quebec City, while it is expected that there would often be one transit zone serving a specific rural area.

The goal of this research is to identify factors that can affect π-transit business models and to assess their impact regarding the characteristics of the potential geographic locations of the transit site. To reach the research goal, a framework is developed through reviewing the literature and focusing on Osterwalder *et al*.'s (2005) business model concepts. Our framework encompasses three components that are business characteristics, business model axes, and external factors. These components were

divided into distinct elements, each with a set of indicators to assess the impact of the geographic attributes according to the location of the π-transit. This framework is then applied for π-transits located in a metropolitan area. To the best of our knowledge, this article is the first to consider the impact of the π-transit's location on the business model for the Physical Internet context.

The paper is structured as follows. The second section presents a literature review on business modeling concepts, and previous research on π-transit centers. The third section discusses research context, the applied methodology, and the proposed framework. The fourth section applies the proposed framework for investments in either existing or new π-transits in the metropolitan area as a specific and typical potential geographic location. Finally this paper ends with a conclusion and avenues for further research.

5.2 Literature Review

This section is composed of two main sub-sections in order to present the business model concepts in general as well as previous research regarding the π-transits and their specific business models.

5.2.1 Business Model Concepts

According to Osterwalder and Pigneur (2009, p. 14): "*A business model describes the rationale of how an organization creates, delivers, and captures value.*" Teece (2010) declared that new communications and computing technologies bring into play an open global trading world, which results in a rich pool of choices for customers, leading firms to be more customer centric. Teece (2010, p. 172) stated: "*This new environment has also amplified the need to consider not only how to address customer needs more astutely, but also how to capture value from providing new products and services. Without a well-developed business model, innovators will fail to either deliver - or to capture - value from their innovations.*" Osterwalder and Pigneur (2009, p. 15) affirmed: "*We believe a business model can best be described through nine basic building blocks that show the logic of how a company intends to make money. The nine*

blocks cover the four main areas of a business: customers, offer, infrastructure, and financial viability." In their model, these nine blocks are: customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure. In the context of Physical Internet, Montreuil *et al.* (2012) pointed out the importance of observing the dynamics of the business environment, improving the value creation patterns, and synchronizing the business models with other network members when designing a business model.

Many factors may furthermore affect business model design. According to Porter (1985, p. 4): "*In any industry, whether it is domestic or international or produces a product or a service, the rules of competition are embodied in five competitive forces: the entry of new competitors, the threat of substitutes, the bargaining power of buyers, the bargaining power of suppliers, and the rivalry among the existing competitors. The collective strength of these five competitive forces determines the ability of firms in an industry to earn, on average, rates of return on investment in excess of the cost of capital*." Osterwalder *et al.* (2005, p. 14) proposed: "*[…] we understand the business model as a building plan that allows designing and realizing the business structure and systems that constitute the operational and physical form the company will take. We call this relation between strategy, organization, and systems the business triangle that is constantly subject to external pressures, like competitive forces, social change, technological change, customer opinion and legal environment.*"

5.2.2 Physical Internet Enabled Transits and Business Modelling

The Physical Internet enables a Logistics Web which consists of a Mobility Web, a Distribution Web, a Realization Web, a Supply Web, and a Service Web, respectively and synergistically devoted to moving, storing, realizing, supplying, and using physical objects (Montreuil, 2009-2012, Montreuil *et al.* 2013). Figure 5-4 presents key Logistics Web components.

In this research, we focus on the Mobility Web component responsible for moving goods and people through open uni-modal and multi-modal hubs, transits, ports, roads, and ways. A Mobility Web requires the use of a network of transits for transferring

semi-trailers from one truck to another, on their way from a source to a final destination, to avoid performing the entire distance by a single driver (Meller *et al.* 2012).

Most of the literature around π-transits focuses either on how they can be designed or on their contribution within a Mobility Web to enhance economic, social, and environmental performances of transportation systems. Montreuil *et al.* (2010, 2014), Ballot *et al.* (2014), and Meller *et al.* (2014) have all addressed the physical and operational design of Physical Internet hubs and transit centers.

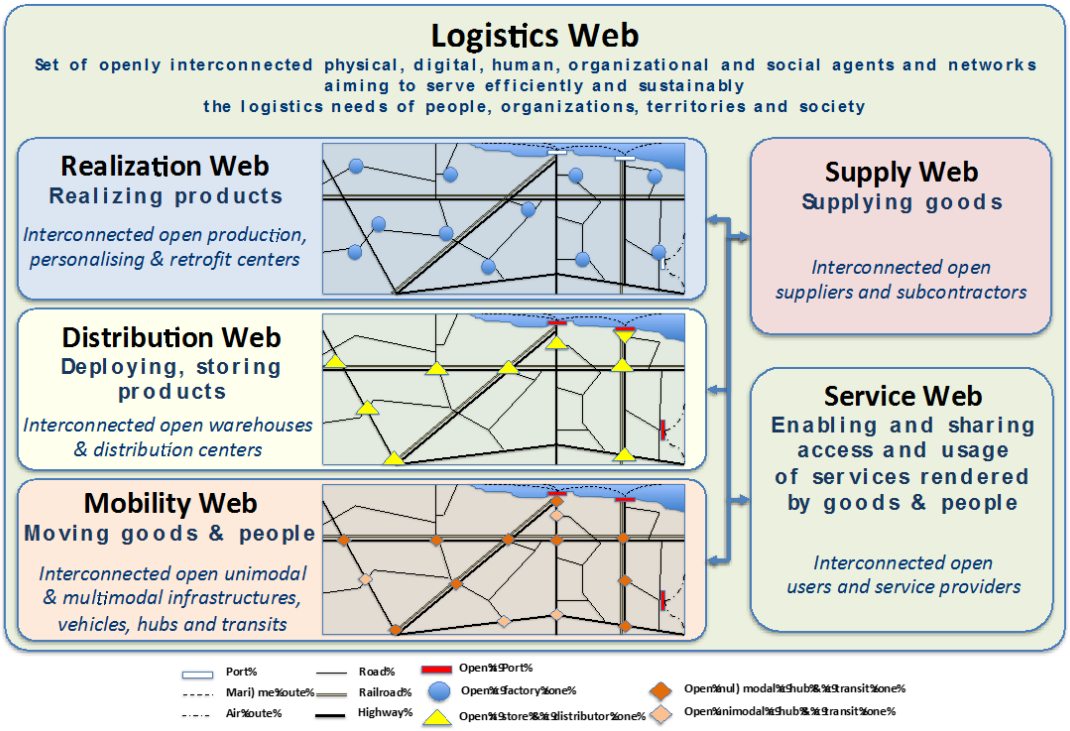

Figure 5-4: Logistics Web components (Montreuil, 2009-2012)

In a more general way, Montreuil *et al.* (2012) and Hakimi (2014) explored Physical Internet induced business model innovations. Oktaei *et al.* (2014) proposed a customized business model Canvas adapted from Osterwalder and Pigneur model (2009) for π-transits.

In the next section, we combine business model and π-transit concepts to demonstrate how the specific location of a π-transit in a Physical Internet environment may influence its business model.

5.3 Research Context and Methodology

As aforementioned, the operational design, the performance, and the business modeling of π-transit centers have been studied in the literature. Nevertheless, to our knowledge the impact of location on the business model of π-transits has not been addressed. In this article, we thus propose a framework to help π-transit investors in having a better perspective of the effect of environmental factors on their business. The framework of this research is obtained through reviewing the literature on business performance, business modeling, internal and external factors affecting business models, and firms' success factors as well as growth strategies. Among this extensive literature, the article of Osterwalder *et al.* (2005) was used as a base since the framework they proposed in their article fits best with our research. Their framework is a comprehensive model as it relates the business model to external factors encompassing competitive forces, customers demand, technological change, legal environment, and social environment in addition to other factors encompassing business strategy, business organization, as well as information and communications technology.

Our framework was thus developed for π-transit centers based on Osterwalder *et al.*'s (2005) model, identifying the various components affecting a π-transit's business model, each one divided into elements. The impact of location on the business model is assessed for each element through a set of indicators, using a low-to-high scale (i.e., low, medium-to-low, medium, medium-to-high, and high). Figure 5-5 summarizes the components and elements of the proposed framework.

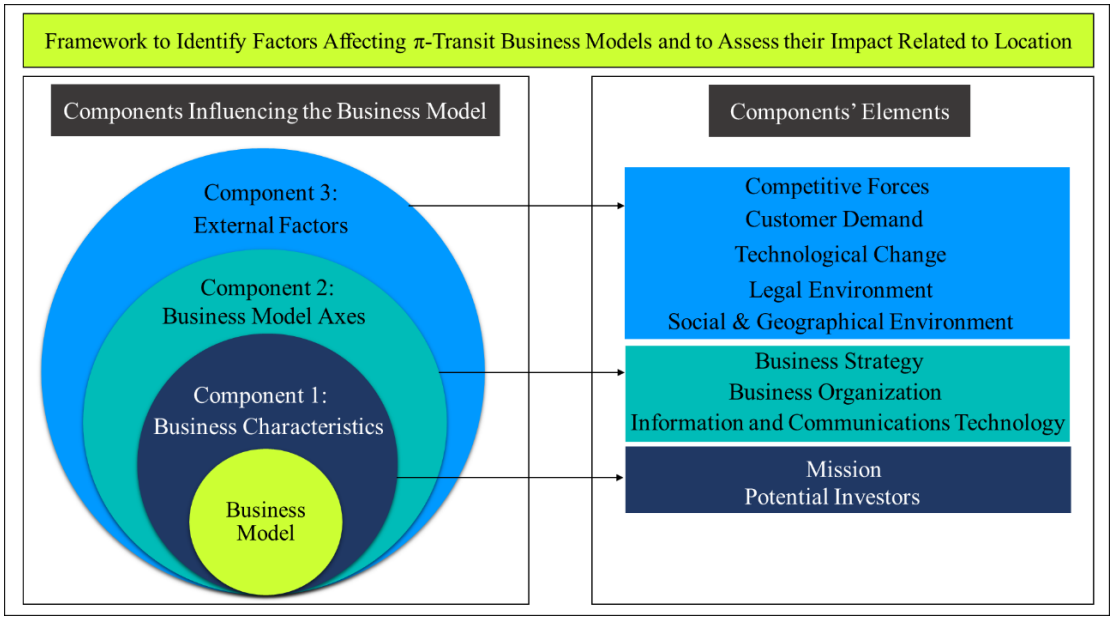

Figure 5-5: Framework to identify factors affecting π-transit business models and to assess their impact related to location

The first component is business characteristics. This component is divided into two elements: mission and potential investors. The mission that a business chooses, as well as the type and accessibility of potential investors, depend on the location and can influence the business model. The second component focuses on the business model axes. This component is divided into three elements: business strategy, business organization, and information and communication technology, as identified in Osterwalder *et al.*'s (2005) model. The third component encompasses the external factors. Several elements for this component are also from Osterwalder *et al.* (2005) model: competitive forces, customer demand, technological change, legal environment, and social environment. To these factors, we added geographic aspects and therefore changed "social environment" to "social and geographical environment" in order to consider more than the mere social aspects of the environment. Then we proposed a set of indicators to each of these external factor elements to assess their impact on the business model.

5.3.1 Business Characteristics

To have a general perspective of the business, the components of the framework relative to business characteristics present the mission and potential investors of π-transits in different locations.

5.3.1.1 Mission

The primary purpose of a business, known as the mission of the company, can vary from one location to another. If we take the example of the Physical Internet context, the mission of a π-transit could be satisfying the high level of demand, facilitating imports and exports, or facilitating transportation in a network respecting limited driving hours for drivers.

5.3.1.2 Potential investors

The presence and type of financial supporters, potential investors and financers, and their number can also be different depending on the location of the business. For example, some cities have a high number of suppliers and customers who could be potential investors, while in other locations the government could be the main investor.

5.3.2 Business Model Axes

The axes of a business present the internal aspects of a business, which are related to its business characteristics and environmental factors. Axes are (1) the business strategy to be adopted by the company, (2) the type of business organization to select, and (3) the impact and role of information and communications technology (ICT) to be evaluated. Figure 5-6 presents the business model axes, elements and indicators.

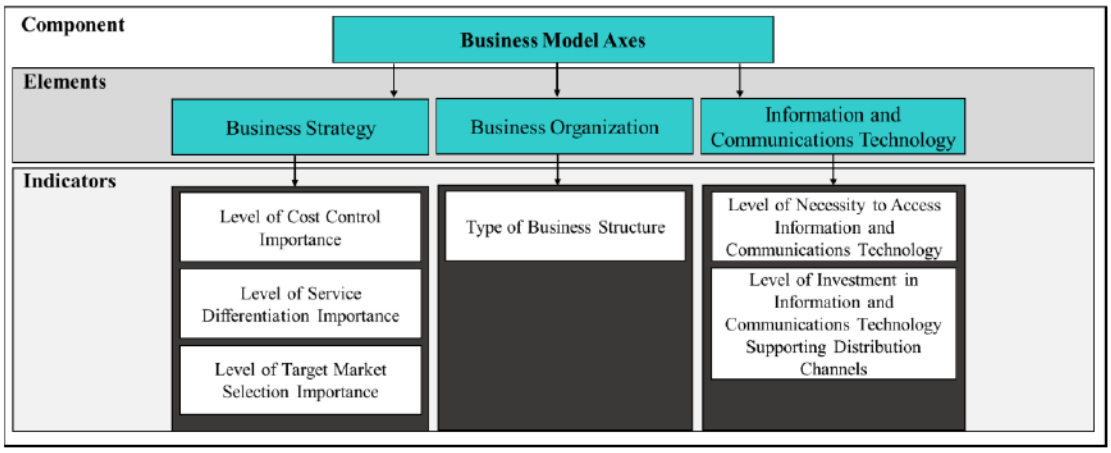

Figure 5-6: Business model axes, elements and indicators

5.3.2.1 Business Strategy

The business strategy encompasses the formulation methods and implementation procedures a firm chooses to adopt so as to reach its core value, mission, and vision. There are various strategies that a business can exploit to reach its goals.

In this research, we focus on the generic strategies stated by Porter (1980, p. 35): "*In coping with the five competitive forces, there are three potentially successful generic strategic approaches to outperforming other firms in an industry: 1) overall cost leadership, 2) differentiation, and 3) focus*." Based on these generic strategies, the indicators chosen to evaluate the impact of location on the business strategy are the firm's level of cost control importance, the level of service differentiation importance, and the level of target market selection importance.

The 'level of cost control importance' indicator measures to what extent it is important for a business to control its costs in its business strategy. This indicator can be ranked through a low-to-high scale for different locations, based on the level of demand, the preferable profit margin the company defines, and the level of competition. The importance of controlling costs is higher in case of low profit margin and aggressive competitive prices (e.g., applying economies of scale to ensure lowest operational costs).

The ‘level of service differentiation importance’ indicator measures to what extent it is important for a business to differentiate its services or products from those offered by competitors. Differentiation can be through accessing a unique advantage on the market such as intellectual property, talented personnel, innovative technologies, or an extra service, which might result in premium final prices for services and products. This indicator can be ranked through a low-to-high scale for different locations, based on the level of demand, the level of competition, the preferable profit margin that companies define, as well as the presence of a pool of customers who are interested in paying premium prices for higher quality services. For a π-transit the key services to offer could concern quick processing time (in and out quickly with a new trailer) and high availability of trailers so the driver would have a good chance of finding a match. Additional services such as a good restaurant, fueling and/or electric charging stations, light maintenance shop, etc., could also be provided. A high value for this indicator demonstrates the importance of providing a differentiated service.

The ‘level of target market selection importance’ indicator estimates to what extent it is important for a business to identify and target a specific market or a set of markets. This indicator can be ranked through a low-to-high scale for different locations, based on the level of demand, the preferable profit margin that the company defines, and the level of competition. When this indicator has a high value, companies must focus on picking their market segments, analyzing their needs, and providing the right value proposition. Companies can always focus on a specific segment of customers (especially profitable ones).

5.3.2.2 Business Organization

The ‘type of business structure’ indicator deals with the legal structure a business chooses to manage the participants’ liabilities in business ownership, the applicable controlling processes, financial structures, etc. The location can influence the type of organization a business selects since the type of and accessibility to potential owners can vary from a location to another. As stated in Kcsourcelink (2015), appropriate organization depends on the vision of business owners regarding the size and nature of

their business, the level of control and structure that they want, the level of business's vulnerability to lawsuits, tax implications of the various organizational structures, expected profit or loss of the business, whether or not the owners need to re-invest earnings into the business, and the need of owners for access to cash out of the business for themselves.

Potential types of business structures for a business include sole proprietorship, general partnerships, limited liability partnerships, corporations, and co-operatives (Canada Business Network, 2015). As these are well known and documented, we do not elaborate further on their nature and their general relative advantages and disadvantages. A π-transit can also exploit these structures.

5.3.2.3 Information and Communication Technology (ICT)

Information and communication technologies are the technologies that support activities necessitating certain information to be accomplished efficiently. Examples of these activities are: gathering, processing, storing, and presenting data and, at higher levels, collaboration and communication (Gokhe, 2015). ICT defines the role of communication and computers in running the business of π-transits while helping its providers to improve their information management, knowledge management, as well as transactional speed and reliability. In addition, it can reduce transactional costs.

In this research, indicators of ICT are the level of necessity to access ICT and the level of investment in ICT supporting distribution channels. The 'level of necessity to access ICT' indicator measures to what extent a business needs information or communicational technologies to provide its value proposition. The 'level of investment in ICT supporting distribution channels' indicator measures to what extent a business needs to invest in technological approaches to reach its customers, which can be dependent on the market and competitors' orientation. These two indicators can be ranked through a low-to-high scale, for different locations.

5.3.3 External Factors

External factors are effective environmental aspects surrounding a business model, its axes, and characteristics that cannot be controlled by the firm. The firm should adjust its business model with these factors in mind in order to survive and compete. In this study, elements of external factors are: competitive forces, customer demand, technological change, legal environment, and, social and geographical environment. Figure 5-7 presents external factor elements and indicators.

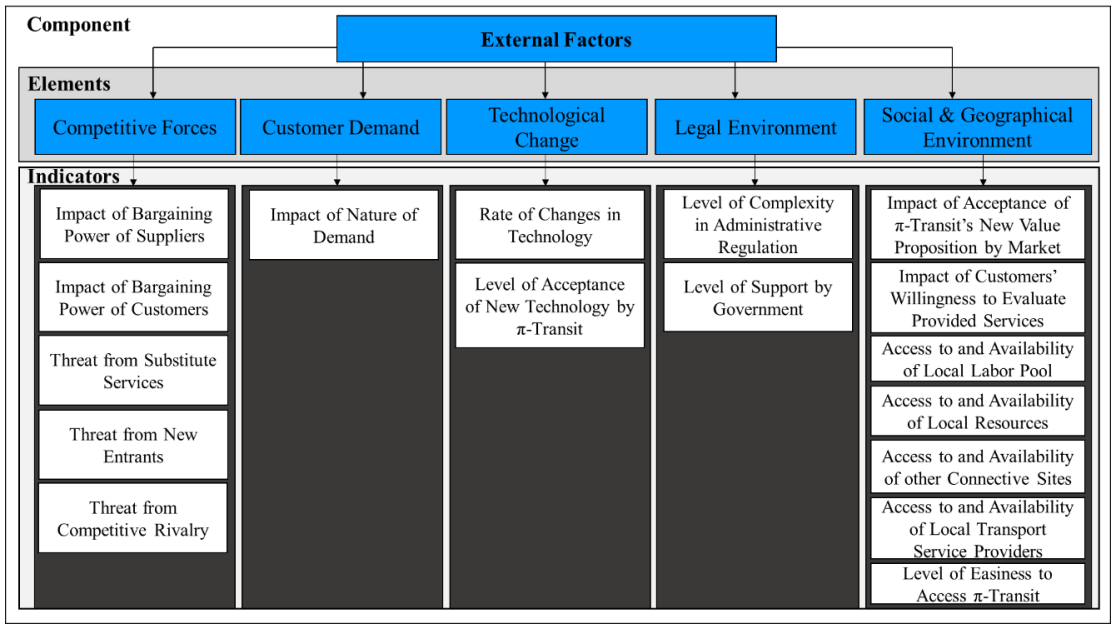

Figure 5-7: External factor elements and indicators

5.3.3.1 Competitive Forces

As aforementioned, Porter (1985) considered five competitive forces that determine the profitability of a company: bargaining power of suppliers, bargaining power of buyers, threat of substitutes, entry of new competitors, and rivalry among existing competitors. In order to consider these forces, the proposed model incorporate the following indicators: the impact of bargaining power of suppliers, the impact of bargaining power of customers, the threat from substitute services, the threat from new entrants, and the threat from competitive rivalry.

According to Porter (1985, p. 5): "*The bargaining power of suppliers determines the costs of raw materials and other inputs.*" In the concept of π-transit, key suppliers are equipment, technology, and maintenance providers, as indicated in Table 5-1. The indicator 'impact of bargaining power of suppliers' measures to what extent their power can affect the level of profitability of the business. This indicator can be ranked through a low-to-high scale for different locations, based on the availability of suppliers and their power and orientation in the industry. A low value is more appropriate when the number of suppliers is high in the area of the business and is expected to affect minimally the profitability of the business because the business can switch to another supplier easily. In the case of a location lacking access to a rich pool of suppliers, the power of available suppliers would be high over the business performance and they might refuse to work with the business or charge higher prices for their unique resources.

Table 5-1: Examples of π-transit's suppliers and customers

Examples of π-Transit's Suppliers and Customers	
Suppliers	**Customers**
Establishment Equipment Providers	Shippers
Technology Service Providers	Receivers
Maintenance Service Providers	Transport Service Providers

According to Porter (1985, p. 5): "*Buyer power influences the prices that firms can charge, for example, as does the threat of substitution. The power of buyers can also influence cost and investment, because powerful buyers demand costly service.*" For π-transits, key customers are shippers, receivers, and transporters, as indicated in Table 5-1. The 'impact of bargaining power of customers' indicator measures to what extent their power can affect the level of profitability of the business. This indicator can be ranked through a low-to-high scale for different locations, based on the availability of customers, their power, and orientation in the industry. A high value is when a powerful group of customers can affect significantly the profitability, by asking for lower prices or switching to other providers (if available). A high number of customers in an area can also be viewed as non-damageable from this perspective because the business can

switch to other customers easily. In the case of lack of access to a rich pool of customers, the business should be much more cautious not to lose its customer.

Substitute services are value propositions of other actors and competitors, similar to what the business provides. A potential substitute service for π-transit's business is the set of transporters offering direct deliveries of products from their sources to their destinations without exploiting relay based transportation. The 'threat from substitute services' indicator measures the threat and effect of substitute services on the level of profitability of the business. This indicator can be ranked through a low-to-high scale for different locations, based on the level of demand, the vulnerability of the business, and the number of potential providers with similar services. A high value is when there are many similar services available in the area. In the case of high demand (i.e., where the level of demand is higher than the offer), the presence of a large number of similar substitute services may also not affect the level of profitability for businesses because even if a customer switches to a substitute provider, the business can maintain its profitability through other customers.

Competitive rivalry presents current competitors that exist in the area. According to Porter (1985, p. 5): "*The intensity of rivalry influences prices as well as the costs of competing in areas such as plant, product development, advertising, and sales force."* The 'threat from competitive rivalry' indicator measures the threat and effect of competitors on the level of profitability of the business. This indicator can also be ranked through a low-to-high scale for different locations, based on the level of demand, the number of potential competitors, and their power and orientation in the market. If the level of demand is higher than the level of offers, the presence of competitors does not affect the level of profitability significantly since all businesses have their own market niche and share, and their environment is running smoothly even though customers are not satisfied by the overall offer.

New entrants are newcomers who are interested in investing in a specific industry and become a potential competitor. The 'threat from new entrant' indicator measures the threat and effect of newcomers on the level of profitability of the business. This

indicator can again be ranked through a low-to-high scale for different locations, based on the level of demand, the vulnerability of the business, and the number of potential interested newcomers. It is expected that in areas with a high level of demand and a high level of profitability, the number of interested newcomers would be higher, but to what extent their presence can affect a business depends on the level of offers in the market. If the level of demand is significantly higher than the level of offers, it is expected that a newcomer would not affect dangerously the level of profitability for current actors. Yet, as mentioned above for competitors, a tightening of the gap between the offer and the demand in the served territory is bound to take place. This is to then make it a market space harder for newcomers to come in. This also makes the successful entry of strong newcomers a threat for existing players as such newcomers are to gain market share to the detriment of current players.

5.3.3.2 Customer Demand

Demand can be seen as the quantity of products or services that customers are interested in purchasing, showing the customers' willingness toward the value proposition and pricing policy of the business. The level of demand therefore depends on the availability of customers and their willingness toward buying the value proposition of the business. Customers' needs vary through time and businesses should adapt their value propositions to these changes in order to survive and thrive. Impact of the nature of demand is the indicator that measures to what extent the level of demand can affect the level of profitability of the business. It can be ranked from low-to-high for different locations, based on the availability of customers, the stability of the demand, the level of competition, and the vulnerability of the business.

5.3.3.3 Technological Change

Technology is prone to dynamic changes and improvement. Businesses that use technology to provide their value proposition should synchronize it with dynamic changes in order to stay updated and efficient. In this research, indicators for technological change are the rate of changes in technology and the level of acceptance of new technologies by π-transits. The 'rate of changes in technology' indicator

measures the level of technological variation and innovative changes in a location. The 'level of acceptance of new technology by π-transits' indicator measures the level of interest of transits to use new and innovative technological products and services. These two indicators can be ranked through from low-to-high for different locations, based on the level of competition in the market of technological products and services, and the willingness of users to use it. It is expected that in competitive markets for technological value propositions, the level of changes and improvement in their products and services would be higher. In addition it is expected that transits in a competitive market would synchronize faster with technological changes.

5.3.3.4 Legal Environment

The legal environment deals with government policies, roles, and support which impact a business. This can be through tax policies, financial support, labor laws, environmental laws, trade restrictions, tariffs, as well as controlling competition and political stability that can affect the level of value proposition, performance, and level of profitability of a business. In this research, indicators of legal environment are the level of complexity in administrative regulation and the level of support by government. The 'level of complexity in administrative regulation' indicator measures the level of governmental legislation on the business. The 'government support' indicator measures the level of governmental supports for the business. These indicators can be ranked through from low-to-high depending on the governmental policy in various areas.

5.3.3.5 Social and Geographical Environment

Social and geographical environment deals with societal trends and location infrastructures of an area that can affect the level of demand, value proposition, performance, and the level of profitability of the business. In this research, indicators of social and geographical environment are the impact of acceptance of π-transits' new value proposition by the market, the impact of customers' willingness to evaluate provided services, the access to and availability of local labor pool, local resources,

other connective sites (not only π-transits), local transport service providers, as well as the level of easiness to access the π-transit.

The 'impact of acceptance of π-transits' new value proposition by the market' indicator measures the effect of the level of customer openness in using new value proposition of π-transit on the business profitability. The 'impact of willingness of customers to evaluate provided services' indicator measures the effect of the level of motivation in customers for sharing their complaints on the level of profitability of the businesses. The 'access and availability of a local labor pool', 'local resources', 'other connective sites', and 'local transport service providers' indicators measure their impact on the level of profitability of the business. The level of easiness to access the π-transit indicator measures to what extent the semi-trailer/truck/driver combination can reach the transit rapidly and easily. These indicators can be ranked through the spectrum of a low to high scale in various areas.

5.4 Transit Centers in Metropolitan Area: Comprehensive Business Perspective

Since π-transit centers facilitate semi-trailer transfers from one truck to another, they can be located in various locations in a global logistics web, such as near borders, in metropolitan areas, in remote areas, at intersections, etc. In this paper, we apply our framework to new or existing π-transit sites located in metropolitan areas to show how location factors could influence the business models. The metropolitan (metro) area was selected because of its high level of demand and competition that provides more issues for analysis. The following sections assess the components, elements, and the impact of indicators of the proposed framework for this location.

5.4.1 Business Characteristics

Sites in metropolitan areas encompass π-transits in or close to large cities with the mission of facilitating the transportation of high flow of semi-trailers crossing, leaving, or entering the city. Different actors of the private sector might have an interest in investing in these π-transit centers because of the expected profit that can be generated

given the importance of the flow that big cities attract. The public sector can also be interested, but may avoid competing with the private sector to encourage investment. However, if the private sector does not take the initiative, the public sector could take the lead because the creation of these metropolitan π-transits is the core around which the rest of the π-transit network will be built. This will also encourage private investors to get involved in the next stages of interconnected transportation implementation.

5.4.2 Business Model Axes

In this section, business strategy, business organization, and information and communication technology as business model axes and their indicators are investigated for π-transit sites in metropolitan areas.

5.4.2.1 Business Strategy - Level of cost control importance

The importance of controlling the cost for the metropolitan π-transits is high since the competition is expected to be high in these locations given the potential that big cities offer. It is important for providers to have a high level of cost control and provide value proposition through lower costs in order to increase their competitive advantages.

5.4.2.2 Business Strategy - Level of service differentiation importance

In the metropolitan area, potential situations are: 1) if the business is satisfied with its market share, then at minimum it must only match the service improvements of its competitors, and 2) if the business wants to gain or avoid losing market share in a competitive environment, then it could opt for service differentiation. However for sites in this location, it is less relevant to adopt a service differentiation strategy since competitors will always try to decrease the gap. So the value of this indicator is low.

5.4.2.3 Business Strategy - Level of target market selection importance

For many π-transits, the pertinent value may be medium-to-low due to their perceived difficulty to design and deliver unique services aimed at specific markets within the metropolitan area. However, providers can focus on a market segment to survive in high competitive environment. π-Transits can try to differentiate their value proposition

for special segments of customers through a focus on a service differentiation strategy if they can access unique resources and customers who are not sensitive to premium prices. For example, they can offer particular and unique values to their more profitable customer segments. This can be true given the high demand but it is still risky to adopt this strategy in these areas.

5.4.2.4 Business Organization – Type of business structure

Given the highly competitive environment and the large number of actors such as transport companies, transport service brokers, and various suppliers, the metropolitan π-transits should be motivated toward making limited liability partnerships, corporations, and co-operatives, even though special circumstances may lead them toward other structures. The prime target structures may allow them to use highly adaptive high-service solutions, giving them an edge over the competition. The structures vary in their characteristics, yet they all offer openness and attractiveness of the business to investors and/or partners, easing their way in and out as the mutual interests evolve.

5.4.2.5 Information and Communication Technology (ICT) – Level of necessity to access ICT

Since the flow of semi-trailers will be important in the metropolitan area, a high level of access and use of the latest versions of appropriate ICT solutions is critical to stay competitive and to ensure the required efficiency, speed, and security of semi-trailer transhipment.

5.4.2.6 Information and Communication Technology (ICT) – Level of investment in ICT supporting distribution channels

A certain level of ICT supporting the distribution channels to stay easily accessible to advanced customers is required. For example, if the competitors relay on a transportation e-market place to assign trailers to transporter, the company must insure the same service and have the ICT platform that supports it. However, since the ICT platform is to detail the characteristics of the transit centers (i.e. location, pricing,

capacity, etc.), the level of investment in ICT supporting distribution channels is medium-to-low.

5.4.3 External Factors

In this section competitive forces, customer demand, technological change, legal environment, social and geographical environment, and their indicators are investigated for sites in metropolitan areas.

5.4.3.1 Competitive Forces – Impact of bargaining power of suppliers

Access to a rich pool of suppliers (see Table 5-1) in the metropolitan area reduces the power of these stakeholders over businesses. Businesses can more easily switch to other suppliers in a metropolitan area, which results in a low impact of bargaining power for suppliers. However we assume that the π-transit business does not rely on a day-to-day supply to provide its services, so close proximity of suppliers is not necessary since distant suppliers would be willing to deliver products or services sporadically.

5.4.3.2 Competitive Forces – Impact of bargaining power of customers

Since the number of competitors is expected to be high in the metropolitan area, the bargaining power of customers (see Table 5-1) will be high as they can easily use another π-transit.

5.4.3.3 Competitive Forces – Threat from substitute services

The early battleground will indeed be between non-π-players and π-players attempting to collectively establish an efficient interconnected semi-trailer transportation system. Assuming PI gradually takes over, then the threat from currently known substitutes will be low. However, there may be a new, yet unknown, generation of π-enabled services that may threaten the use of π-transits in metropolitan areas in the future.

5.4.3.4 Competitive Forces – Threat from new entrants

The value of this indicator depends on the saturation of the market in the metropolitan area. If the demand is higher than the offer, generally, the impact of this threat is low. If the offer meets or surpasses the demand, the threat is high. For example, in the early interconnected era, the threat would be lower, growing as more players want to be part of the game, then decreasing as the set of game players stabilizes, giving the perception that the metropolitan area is well covered, and staying at that level until the performance of current players degrades relative to the customers' expectations or when a new player arrives.

5.4.3.5 Competitive Forces – Threat from competitive rivalry

It is expected that in the metropolitan area, the number of competitors would be high. The threat from a rival depends on the saturation of the market. Assuming an already existing balance between rivals, continuous efforts to decrease the gap, and the low possibility to adopt a service differentiation strategy, then the value of this indicator would be medium-to-low. However if the level of demand is getting lower than the level of offers and/or competitors want to compete for market share, then their threat would be high.

5.4.3.6 Customer Demand – Impact of the nature of demand

In the metropolitan area, the demand is expected to be high so the business can always have a certain level of demand which makes the impact of this indicator less pertinent. Nevertheless variation of demand throughout the year (e.g., peak of demand for some seasons) should be considered, moving the value of the indicator higher. The value of this indicator could therefore be considered as medium-to-low.

5.4.3.7 Technological Change – Rate of changes in technology

The number of technological service providers can be high in these locations, which results in a competitive market for their value proposition. This leads toward a more extensive and faster rate of changes in technology, as the technological providers compete and try to keep their competitive advantages. The real challenge may be the

desire of some technological service providers, notably the information, communication, and decision automation and support players, to take over the value space, considering their contribution and platform as the core, and wanting to put the π-transit centers in a lower value-perceived position in the market. This is similar to the emerging situation in the automotive industry, between the car manufacturer giants on one side and the automotive-savvy ICT giants on the other side, in a brain vs. body dominance. Such a situation may never arise for π-transits, yet it is important for it to be known as a potential.

5.4.3.8 Technological Change – Level of acceptance of new technology by π-Transit

Based on the high level of competition in the metropolitan area, it is expected that π-transit owners need to synchronize quickly and dynamically with technological changes, in order to improve their competitive advantages. The value for this indicator is thus expected to be high.

5.4.3.9 Legal Environment – Level of complexity in administrative regulation

In the early interconnected era, urban regulatory bodies can have huge influence relative to adoption rates through incentive and/or enforcing regulatory policies, so the indicator is bound to be high in the early era. When business environment in a metropolitan area is running smoothly with a stable and high demand, the level of intervention and regulation of government will be limited. However, regulation regarding the control of pollution, noise, and congestion will be enforced, especially in the urban populated areas. Therefore, the value of this indicator would be medium-to-high.

5.4.3.10 Legal Environment – Level of support by government

Since the business environment in the metropolitan area will be attractive to investors, public support will be limited to prevent discrimination among actors. So the value for this indicator is expected to be low. However, it is possible that some incentives be provided if political authorities determine that public investments in transits are a priority as they have an important positive economic, social, and environmental impact.

5.4.3.11 Social and Geographical Environment – Impact of acceptance of π-Transits' new value proposition by the market

Early on, customers in metropolitan areas are bound to be quite interested in trying new and innovative interconnected transportation value propositions. Thus, the level of accepting new value proposition by the market can be high. However, the impact of this acceptance on the business model will be low unless the company can achieve a service differentiation strategy.

5.4.3.12 Social and Geographical Environment – Impact of customers' willingness to evaluate provided services

One of the elements on which customers will base their decision to choose a π-transit center will be reputation. In the Physical Internet, widespread open monitoring and diffusion of performance as well as performance ranking by service users are core characteristics to be considered (Montreuil 2009-2012; Montreuil, 2011). This is to be also core for the focused interconnected semi-trailer transportation. Thus, the impact of this indicator is high and the company must adopt a strategy of continuous high service performance while encouraging all its customers to make their evaluations so that its ranking reflects its real performance.

5.4.3.13 Social and Geographical Environment – Access to and availability of local labor pool

It is expected that the level of access to and availability of a rich and educated labor pool would be high in this location even though a π-transit is not a labor-intensive business.

5.4.3.14 Social and Geographical Environment – Access to and availability of local resources

It is expected that the level of access to and availability of local resources would be high in this location. In general, the metropolitan area has a high level of access to fundamental tangible and intangible resources including financial, human, and physical resources.

5.4.3.15 Social and Geographical Environment – Access to and availability of other connective sites

It is expected that π-logistics sites within a metropolitan region will be in contact with several other sites. For example, the relationships with π-hubs dealing with open consolidation and transhipment of modular containers may prove very important to π-transits. Filled up trailers may be transferred from a π-hub to a π-transit in case there is a temporary lack of driver/truck availability at the π-hub. Therefore the value of this indicator is medium-to-high.

5.4.3.16 Social and Geographical Environment – Access to and availability of local transport service providers

It is expected that the level of access to and availability of various local transport service providers will be high in a metro area.

5.4.3.17 Social and Geographical Environment – Level of easiness to access the π-Transit

It is expected that the level of congestion in main highways, especially in peak hours of the day, be high in the area. Yet it may depend on the specific location selected, since some locations have better access to secondary less prone to blockage from congestion. Therefore the value for this indicator is medium-to-low.

Table 5-2 summarizes the assessment of the impact of location on π-transit business models in a metropolitan area.

Table 5-2: Assessing the impact of location on π-transit business models in a metropolitan area

Assessing the Impact of Location on π-Transit Business Models in a Metropolitan Area			
Components	Elements	Indicators	Assessment
Business Characteristics	Mission		Facilitate the transit of high flow
	Potential Investors		Private and public sectors
Business Model Axes	Business Strategy	Level of cost control importance	High
		Level of service differentiation importance	Low
		Level of target market selection importance	Medium-to-low
	Business Organization	Type of business structure	Limited liability partnerships, corporations and co-operatives
	Information and Communications Technology (ICT)	Level of necessity to access information and communications technology	High
		Level of investment in information and communications technology supporting distribution channels	Medium-to-low
External Factors	Competitive Forces	Impact of bargaining power of suppliers	Low
		Impact of bargaining power of customers	High
		Threat from substitute services	Low
		Threat from new entrants	If the demand is higher than the offer, then low If the offer meets of surpasses the demand, then high
		Threat from competitive rivalry	Medium-to-low
	Customer Demand	Impact of nature of the demand	Medium-to-low
	Technological Change	Rate of changes in technology	High
		Level of acceptance of new technology by π-transit	High
	Legal Environment	Level of complexity in administrative regulation	Medium-to-high
		Level of support by government	Low
	Social and Geographical Environment	Impact of acceptance of π-transits' new value proposition by the market	Low
		Impact of customers' willingness to evaluate provided services	High
		Access to and availability of local labor pool	High
		Access to and availability of local resources	High
		Access to and availability of other connective sites	Medium-to-high
		Access to and availability of local transport service providers	High
		Level of easiness to access the π-transit	Medium-to-low

As summarized in Table 5-2, business owners of π-transit sites in metropolitan areas should allocate a high value to the strategies related to cost control. They can run their business through limited liability partnership, corporation or co-operative, since there is a rich pool of investors available. ICT would also play an important role to manage and gain profit. The level of technological changes is expected to be high, so businesses in this area should synchronize fast with new technology in order to compete and survive. Customers have a high power on business, since level of competition is high and they can switch to other providers. Furthermore it should be considered that customer reviews about the business performance will play an important role in the

reputation of the site. A rich pool of labor, resources, and transport service providers should finally be expected as well as an access to several other sites. On the other hand, metropolitan areas may involve difficulties in arriving to the transit during peak hours of the day.

5.5 Conclusion

In this research, we identify factors that can affect π-transit business models and assess their impact according to the location for the Physical Internet context, based on a proposed framework. This framework encompasses three key components of the business environment, which are the business characteristics, the business model axes, and the external factors. It also allocates a set of indicators to each component's element and measure their effect on the value proposition, business model, and attractiveness toward investors and stakeholders. The metropolitan area was then selected to demonstrate how this specific location influences the business model. This exercise showed that applying the framework would help π-transit business analysts and investors in obtaining a more comprehensive overview of their business for a potential location.

In future steps, the business environment of other potential locations (i.e. sites near borders, in remote areas, and at highway intersections) for this business could be studied. Furthermore, studies could be focused on π-transit businesses deciding to operate a network of π-transits in selected locations across territories rather than operating a single π-transit. There are many other such avenues as businesses focused on π-logistics centers may also decide to operate multiple types of such centers, such as a network encompassing geographically distributed π-transits, π-hubs, and π-DCs. They may also decide to combine the functionalities of multiple types of π-logistics centers in multi-service π-logistics complexes, and operate networks of such complexes and more focused centers. The current work, with its focus on π-transit business models and location, can be considered as a first step in exploring the business vs. location issues in the Physical Internet logistics-center business ecosystem.

From another perspective, even though the proposed framework introduced in Figure 5-5 and exploited in this research was designed for π-transits as a key focus, it is quite generic in its essence. It may prove useful for other types of Physical Internet centers and businesses, and potentially wider beyond the scope of the Physical Internet. Validating such a potentiality is beyond the scope of this paper, yet indeed a promising avenue for further research.

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Chapter 6.
The Effect of Location Factors on the Profitability of Physical Internet Enabled Transit Centers

The previous chapters have investigated the business model for Physical Internet enabled transit centers as well as the geographical factors having an impact on its performance. Nevertheless, the impact on profitability of π-transits has not been addressed yet. Furthermore, while Hakimi *et al.,* (2014) demonstrated that the implementation and use of a π-transit network promises many advantages, they did not study the profitability of the individual π-transits according to their geographic location.

Assuming that the implementation of a network of π-transits is possible, and in order to help potential investors in making their decisions, it is pertinent to estimate the profitability of specific π-transits and understand the impact of the characteristics of the geographic location on the profitability. This is especially true knowing that the anticipated profit can vary considerably from one location to another.

Thus, in this research, we propose a model that will help in predicting the profitability of a π-transit based on the characteristics of its geographic location. In particular, we propose a set of hypotheses and an analytical model for investigating to what extent profitability of transits is predictable, given a set of geographic location factors.

The model is tested and validated using correlation and regression analyzes. The data sets for geographic location factors are retrieved directly from input of a transit network simulation developed by Hakimi *et al.,* (2014) for an experiment centered on the Province of Quebec in Canada, while the simulation output is used to estimate transit profit.

First section of this chapter defines the approach and hypotheses. Second section is dedicated to analytical model. Third section determines the dependent variable of the model. Fourth section conducts statistical analyzes which are correlation and regression

analyses were then conducted, to study the relationships between the expected profit of π-transits and the characteristics of their geographic location, leading to some managerial insights Fifth section provides the results and managerial implications. Sixth section provides a summary of this chapter.

6.1 Approach and Hypotheses

As depicted in Figure 6-1, to assess profitability of a transit center regarding its location, we first analyzed the simulation experiment results of Hakimi *et al.* (2014) to identify what could be the key geographic location factors that would affect the most the transit business unit. We observed that the flow of trailers and the number of drivers were different from one location to another, involving potential revenue streams that would also probably vary from one point to another. Based on that, five geographic location factors were identified, representing the independent variables used in the model to predict the profit (Y_i) of a transit *i*:

(1) Number of local shippers of trailers for the transit (X_{i1})
   - Corresponds in the case to the number of Quebec-based companies in the π-transit's area that have the potential to send trailers.

(2) Number of local receivers of trailers for the transit (X_{i2})
   - Corresponds in the case to the number of Quebec-based companies in the π-transit's area that have the potential to receive trailers.

(3) Number of local drivers for the transit (X_{i3})
   - In the case, the driver's address is used to calculate the closest π-transit, which becomes his local π-transit. These drivers are the π-transit's local drivers.

(4) Number of trailers to be shipped by local shippers to the transit (X_{i4})
   - Corresponds in the case to an estimation of the number of trailers the π-transit can receive from all companies in its area during the considered horizon.

(5) Number of trailers to be delivered to a local destination by the transit (X_{i5})

- Corresponds in the case to an estimation of the number of trailers the π-transit can deliver to the companies in its area during the considered horizon.

In the second step, a set of hypotheses was formulated regarding the potential relationships between the profit and each of the five geographic factors and on the combined effect of all possible pairs of these factors, as summarized in Table 6-1. A logarithmic function transformation was applied to normalize the distribution of data (the transformation will be detailed in the statistical analysis section).

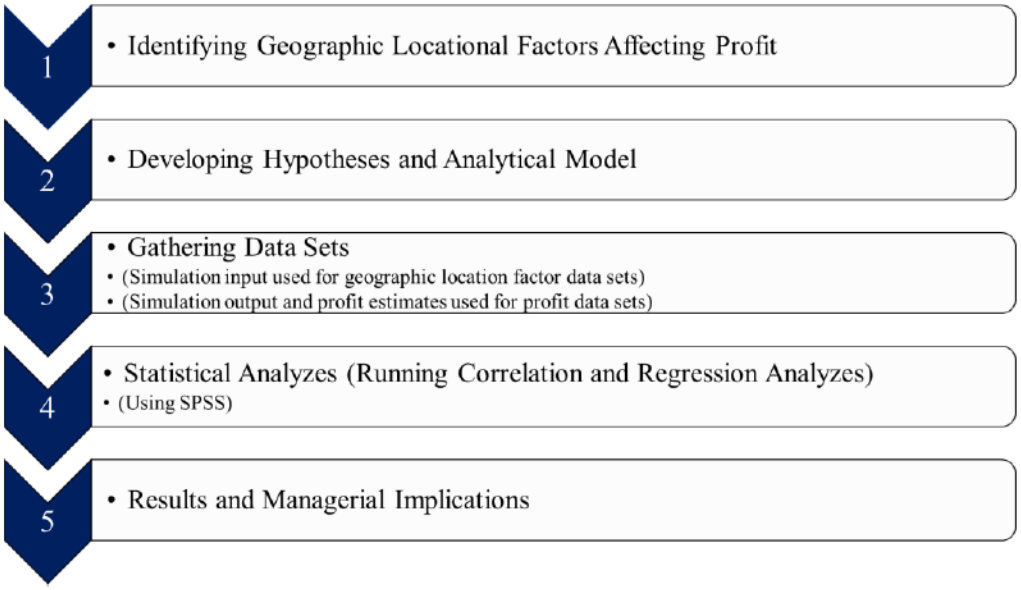

Figure 6-1: Methodology used in the third step

An analytical model was developed, based on the approach detailed in Hair Jr. *et al.*, (2010), to validate these potential relationships. The model will be explained in detail in the following section.

In the third step, data sets for geographic location factors and profit estimation were gathered, using input and output of the simulation experiments from Hakimi *et al.* (2015) simulation, for the case of the province of Quebec. The simulation based study considered a total of 46 π-transit zones distributed around the main cities of the province of Quebec, at major highway and roadway intersections, near maritime and air ports, and near the main borders with the United States and the neighboring

Canadian provinces. Figure 5-3 shows the π-transit network of the simulation used in the context of this project.

Through their simulation experiments, Hakimi *et al.* (2014, 2015) also kept track of the dynamic state of drivers, trucks, trailers if any, sources, destinations, driving times, travel times, travel distances, time of departure, time of arrival, and if the source was a π-transit, the durations that the truck and trailer spent in the π-transit, in detail through each simulation run.

Table 6-1: Research hypotheses

Research Hypotheses	
Index	**Hypothesis**
H_1	For a given transit *i*, there is a significant correlation between its number of local shippers of trailers $LN(X_{i1})$ and its profit $LN(Y_i)$
H_2	For a given transit *i*, there is a significant correlation between its number of local receivers of trailers $LN(X_{i2})$ and its profit $LN(Y_i)$
H_3	For a given transit *i*, there is a significant correlation between its number of local drivers $LN(X_{i3})$ and its profit $LN(Y_i)$
H_4	For a given transit *i*, there is a significant correlation between the estimation of its total number of trailers to be shipped by local shippers to the transit $LN(X_{i4})$ and its profit $LN(Y_i)$
H_5	For a given transit *i*, there is a significant correlation between the estimation of its total number of trailers to be delivered to local destinations by the transit $LN(X_{i5})$ and its profit $LN(Y_i)$
H_6	For a given transit *i*, there is a significant correlation between the combination of its number of local shippers of trailers and its number of local receivers of trailers $((LN(X_{i1}) \times LN(X_{i2}))$ and its profit $LN(Y_i)$
H_7	For a given transit *i*, there is a significant correlation between the combination of its number of local shippers of trailers and its number of local drivers $((LN(X_{i1}) \times LN(X_{i3}))$ and its profit $LN(Y_i)$
H_8	For a given transit *i*, there is a significant correlation between the combination of its number of local shippers of trailers and the estimation of its total number of trailers to be shipped by local shippers to the transit $((LN(X_{i1}) \times LN(X_{i4}))$ and its profit $LN(Y_i)$
H_9	For a given transit *i*, there is a significant correlation between the combination of its number of local shippers of trailers and the estimation of its total number of trailers to be delivered to local destinations by the transit $((LN(X_{i1}) \times LN(X_{i5}))$ and its profit $LN(Y_i)$
H_{10}	For a given transit *i*, there is a significant correlation between the combination of its number of local receivers of trailers and its number of local drivers $((LN(X_{i2}) \times LN(X_{i3}))$ and its profit $LN(Y_i)$
H_{11}	For a given transit *i*, there is a significant correlation between the combination of its number of local receivers of trailers and the estimation of its total number of trailers to be shipped by local shippers to the transit $(LN(X_{i2}) \times LN(X_{i4}))$ and its profit $LN(Y_i)$
H_{12}	For a given transit *i*, there is a significant correlation between the combination of its number of local receivers of trailers and the estimation of its total number of trailers to be delivered to local destinations by the transit $((LN(X_{i2}) \times LN(X_{i5}))$ and its profit $LN(Y_i)$
H_{13}	For a given transit *i*, there is a significant correlation between the combination of its number of local drivers and the estimation of its total number of trailers to be shipped by local shippers to the transit $((LN(X_{i3}) \times LN(X_{i4}))$; and its profit $LN(Y_i)$
H_{14}	For a given transit *i*, there is a significant correlation between the combination of its number of local drivers and the estimation of its total number of trailers to be delivered to local destinations by the transit $((LN(X_{i3}) \times LN(X_{i5}))$; and its profit $LN(Y_i)$

H_{15}	For a given transit *i*, there is a significant correlation between the combination of the estimation of its total number of trailers to be shipped by local shippers to the transit, and the estimation of its total number of trailers to be delivered to local destinations by the transit ($LN(X_{i4}) \times LN(X_{i5})$); and its profit $LN(Y_i)$.

Among the data sets used to build their simulation, Hakimi et al. (2014, 2015) obtained shipping (X_{i1}) and receiving (X_{i2}) sites information via ICRIQ's database (version 2012) of Quebec-based manufacturers, wholesalers, and industrial-related service companies (www.icriq.com). The available data gave information about the number of companies per city and sector of activity. The number of local drivers (X_{i3}) was obtained using capacity-setting simulation runs (see Hakimi *et al.,* (2015) for details).

The estimation of the total number of trailers to be shipped by local shippers to the transit (X_{i4}) and the estimation of the total number of trailers to be delivered to local destinations by the transit (X_{i5}) were estimated using two data sources. The first is Quebec Transports (2007) providing estimates of the flow of semi-trailers within the province and the flow in and out between the province, other provinces and the US. The second is Quebec Transports (1999) which is a census of the number of trucks travelling per fifteen minutes on key segments of the main highways in Quebec.

In addition, as the ICRIQ database provides the range of size, revenue, number of workers, etc., of each company, it allowed the estimated assignment of the generated volume of demand to specific shippers and receivers.

The different sets of collected data were also used to estimate transit profit, explained in detail in section 6.4.

6.2 Analytical Model

This section presents the analytical model used to study the profitability of π-transits based on the characteristics of their geographic location. The X_{i1}, X_{i2}, X_{i3}, X_{i4} and X_{i5} defined earlier are integral part of the model, as well as the following elements:

- Y_i: Profit of a π-transit *i*;
- b_j: Coefficient of variables (*j*=1,2, … , 15);

- LN: Logarithmic function.

The model is defined through equation 6.1 as follows:

$$LN(Y_i) = b_0 + b_1(LN(X_{i1})) + b_2(LN(X_{i2})) + b_3(LN(X_{i3})) + b_4(LN(X_{i4})) + b_5(LN(X_{i5})) + b_6(LN(X_{i1}) \times LN(X_{i2})) + b_7(LN(X_{i1}) \times LN(X_{i3})) + b_8\big(LN(X_{i1}) \times LN(X_{i4})\big) + b_9(LN(X_{i1}) \times LN(X_{i5})) + b_{10}\big(LN(X_{i2}) \times LN(X_{i3})\big) + b_{11}\big(LN(X_{i2}) \times LN(X_{i4})\big) + b_{12}\big(LN(X_{i2}) \times LN(X_{i5})\big) + b_{13}\big(LN(X_{i3}) \times LN(X_{i4})\big) + b_{14}\big(LN(X_{i3}) \times LN(X_{i5})\big) + b_{15}(LN(X_{i4}) \times LN(X_{i5}))$$

(6.1)

Equation 6.1 estimates the profitability of the π-transit, based on a set of data of location factors as described previously.

6.3 Determining the Dependent Variable of the Model

While the independent variables considered in the analysis could directly be extracted from the simulation, the dependent variable, which is in our case the profit (Y_i) of each π-transit, had to be calculated. It was obtained by subtracting the total cost (C_i) of a π-transit from its generated total revenue (R_i), according to Equation 6.2:

$$Y_i = R_i - C_i \tag{6.2}$$

The total cost (C_i) incurred by a π-transit during the simulated horizon is a combination of the depreciation cost (C_{Di}) of the facility over the considered horizon and the operational costs (C_{Oi}), as shown in Equation 6.3.

$$C_i = C_{Di} + C_{Oi} \tag{6.3}$$

The depreciation cost smoothes over the depreciation period the cost of building the

facility and the interest paid for a potential loan acquired to build it. The cost of building the facility has been estimated by taking into consideration the cost of all contributing elements such as the price of buying and resurfacing the land, the price of building and equipping different parts of the transit such as the transshipment zones, the gateways and the wait-and-rest areas. The operational cost has been estimated by analyzing the simulated daily activities and their induced costs such as personnel salaries, maintenance, electricity, information and communication technologies.

The estimated revenue per transit (*i*) per trailer (*k*) (R_{ik}) is calculated through equation 6.4;

$$R_{ik} = C_{ik} \times (1 + (p_i)) \quad (6.4)$$

Where:

C_{ik}: Cost induced by trailer k in transit i;

p_i: Targeted profit margin for transit i.

The cost per trailer per transit (C_{ik}) is estimated through equation (6.5):

$$C_{ik} = C_i / N_i \quad (6.5)$$

Where:

C_i: Total cost of transit *i* (C_i);

N_i: Total number of trailers received by transit *i*.

The targeted profit margin (p_i) has been estimated assuming a weighted average cost of capital of 20 percent.

The expected revenue per transit (*i*) per trailer (*k*) (R_{ik}) is coming from the fees received for two kinds of services: (1) incoming trailers and (2) drivers who were assigned a trailer in the π-transit. Hence the charging price (p_i) for each of these services is equivalent to half of R_{ik} (6.6).

$$P_i = R_{ik}/2 \quad (6.6)$$

The total revenue is obtained by multiplying the charging price (P_i) of each two services by the total number of received trailers by transit i (N_i) (6.7).

$$R_i = 2 \times (P_i \times N_i) \quad (6.7)$$

Figure 6-2 summarizes the process that was used to determine a π-transit's profit.

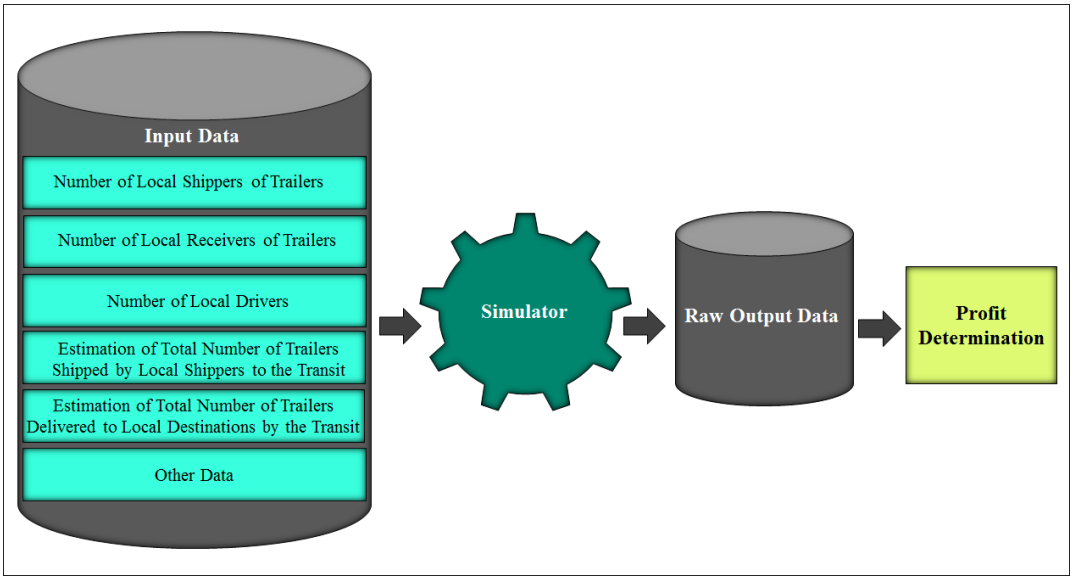

Figure 6-2: Illustration of the process for profit determination

6.4 Statistical Analyzes

A total of 184 observations where exploited, stemming from 46 transits in each of four simulated scenarios. The scenarios reduced the driver pool from its original 100% computed through the capacity-setting simulation runs, down to 90%, 80%, and 70% (see Hakimi *et al.,* (2014, 2015) for more details).

Based on these observations, correlation and stepwise regression analyses were applied to assess the hypotheses and solve the proposed analytical model (6.1). Using correlation analysis allowed to verify if our hypotheses were supported. The stepwise regression analysis was exploited to identify which independent variables would help in predicting the profitability of a π-transit regarding its geographical location. SPSS software package 20 was the tool used to conduct these analyses.

According to Poole and O'Farrell (1970), there is a set of assumptions that must be validated before running a regression analysis, including the linearity of the relationships between variables, the normality of the distributions for the variables, multicolinearity, homoscedasticity, and auto-correlation.

Analysis revealed that the distribution of data sets for independent and dependent variables skewed to the right. A logarithmic function transformation was therefore applied to normalize the distribution of data. Next the data sets were standardized and prerequisites were checked.

Hypotheses H_9 and H_{11} were rejected and removed from the model because both in H_9 and in H_{11}, independent variables were highly correlated (i.e., multicolinearity problem).

6.5 Results and Managerial Implications

The results of the research are presented in three different sub-sections. The first sub-section introduces the accepted and rejected hypotheses of Table 6-1, based on the correlation analysis. The second sub-section identifies the potential geographic factors capable to predicting profit, using a stepwise regression analysis. The third sub-section proposes the value for the coefficients (b_i) of geographic location factors and their combinations to use in Equation 1 so as to estimate the profit for a transit, given values for the geographic location factors. This section concludes with managerial insights.

6.5.1 Supported and Non-Supported Hypotheses

When using a correlation analysis, the strength of a linear relationship between independent and dependent variables can be estimated based on Pearson's correlation coefficient r, ranging from -1 to +1. A correlation coefficient close to +1 and -1 respectively correspond to extreme positive and negative relationship between the variables (Hair Jr. *et al.*, 2010). Furthermore, when considering a significance level of 1%, the p-value (The level of marginal significance within a statistical hypothesis test)

for the related variable, conceptualized as a rejection point, has to be lower than 0.01 to accept a hypothesis.

Considering the fact that to accept a hypothesis, the p-value should be smaller than 0.01 (assuming a significance level of 1%) results of the correlation analysis in this research demonstrated that the correlation coefficient of all variables are accepted except for the following four variables:

1) Combination of the number of local shippers of trailers for the transit *i* and the number of local drivers for the transit *i* ($LN(X_{i1}) \times LN(X_{i3})$);

2) Combination of the number of local receivers of trailer for transit *i* and the number of local drivers for the transit *i* (($LN(X_{i2}) \times LN(X_{i3})$);

3) Combination of the number of local driver for the transit *i* and the estimation of the number of trailers to be shipped by local shippers to transit *i* (($LN(X_{i3}) \times LN(X_{i4})$);

4) Combination of the number of local drivers for transit *i* and the estimation of the total number of trailers to be delivered to a local destination by transit *i* (($LN(X_{i3}) \times LN(X_{i5})$).

If we look for example at the first combination expressed in H_7, it would mean that for a given transit *i*, there is no significant correlation between the combination of its number of local shippers of trailers and its number of local drivers (($LN(X_{i1}) \times LN(X_{i3})$) and its profit $LN(Y_i)$. This is the same idea for combinations of variables expressed in hypothesis H_{10}, H_{13}, and H_{14}. As a result, hypotheses H_7, H_{10}, H_{13}, and H_{14}, related to these variables, were rejected.

The accepted hypotheses based on the correlation analysis are presented in Table 6-2. As it can be observed, the p-value for accepted hypotheses is smaller than 0.01 (significance level of 1%), which admits a significant relationship between independent and dependent variables. Knowing that a higher correlation coefficient involves a

higher significance of linear relationship between the variables and the profit, results in highlighting the strong relationship existing between the estimation of the total number of trailers to be shipped by local shippers to the transit ($LN(X_{i4})$ and profit $LN(Y_i)$, as well as between the number of local receivers of trailers for the transit ($LN(X_{i2})$ and profit $LN(Y_i)$. The sequence of importance of the linear relationships between all considered factors is given in Table 6-2.

Table 6-2: Correlation analysis results

Correlation-Table		LN(Yi)	LN (Xi4)	LN(Xi2)	LN(Xi5)	LN(Xi1)	LN(Xi4)×LN(Xi5)	LN(Xi1)×LN(Xi4)	LN(Xi1)×LN(Xi2)	LN(Xi2)×LN(Xi5)	LN(Xi3)
LN(Yi)	Pearson correlation	1	.667	.565	.539	.513	.372	.332	.262	.244	.239
	Sig.1 (tailed)	.	.000	.000	.000	.000	.000	.000	.000	.000	.001
	N (Sample Number	184	184	184	184	184	184	184	184	184	184
Note:	Pearson correlation indicates the correlation coefficient (r value)										
	Sig. 1 (tailed) indicates the p-value associated with the correlation										
	N indicates the number of cases that were studied in the correlation										
	LN indicates the logarithmic transformation										

According to Table 6-2, the sequence of importance of linear relationships between factors is as follows, from most to least significance:

1) (($LN(X_{i4})$ (r=0.667, P=0.000)),

2) (($LN(X_{i2})$ (r=0.565, P=0.000)),

3) (($LN(X_{i5})$ (r=0.539, P=0.000)),

4) (($LN(X_{i1})$ (r=0.513, P=0.000)),

5) ($LN(X_{i4}) \times LN(X_{i5})$ (r=0.372, P=0.000)),

6) (($LN(X_{i1}) \times LN(X_{i4})$ (r=0.332, P=0.000)),

7) (($LN(X_{i1}) \times LN(X_{i2})$ (r=0.262, P=0.000)),

8) (($LN(X_{i2}) \times LN(X_{i5})$ (r=0.244, P=0.000)), and

9) (($LN(X_{i3})$ (r=0.239, P=0.001)).

6.5.2 Best Predictors of Profit

In this sub-section, we show the results obtained from conducting a stepwise regression in order to identify which variables could be efficient predictors for the profit of a transit. According to methods explained in Hair Jr. *et al.,'s* (2010), variables are selected for their inclusion in the regression model. It first starts by selecting the best predictor for the dependent variable, and then additional independent variables are selected and added to the regression model based on their incremental explanatory power that they can add to the model. Independent variables are added to the model as long as their partial correlation coefficients are statistically significant. If the predictive power of independent variables drops to a non-significant level by adding another independent variable, then they may be removed from the model (Hair Jr. *et al.,* 2010). The stepwise procedure of the SPSS software was used to select the variables based on their ability to contribute in the overall estimation.

It is expected that the variable with the highest level of correlation coefficient would be the first to compose the analytical model. Consequently, as the estimation of total number of trailers to be shipped by local shippers to the transit *i* ($LN(X_{i4})$) has the highest value of r (i.e., r=0.667) and a p-value within an acceptable interval (i.e., P=0.000<0.01), it is anticipated that this variable would enter into the model first.

The results, summarized in Table 6-3, indicate the best predictors of profit for a transit, according to the statistical analysis conducted. It encompasses:

1) Estimation of the total number of trailers to be shipped by local shippers to the transit *i* $LN(X_{i4})$;

2) Combination of the estimation of the total number of trailers to be shipped by local shippers to the transit *i* and the estimation of the total number of trailers to be delivered to a local destination by transit *i* ($LN(X_{i4}) \times LN(X_{i5})$);

3) Number of local receivers of trailers for transit *i* $LN(X_{i2})$;

4) Combination of the number of local shippers of trailers for transit *i* and the estimation of the total number of trailers to be shipped by local shippers to transit *i* (($LN(X_{i1}) \times LN(X_{i4})$);

5) Combination of the number of local drivers for transit *i* and the estimation of the total number of trailers to be shipped by local shippers to transit *i* (($LN(X_{i3}) \times LN(X_{i4})$);

6) Combination of the number of local shippers of trailers for transit *i* and the number of local receivers of trailers for transit *i* (($LN(X_{i1}) \times LN(X_{i2})$).

As best predictors, these variables improved the model's R^2 to 0.682, which confirms the fitness of the model. It means that the model explains 68.2% of the variability of the dependent variable around its mean. In addition, no auto-correlation problem was detected according to the Durbin Watson test (i.e., value of 1.787 within the acceptable interval of (1.5, 2)).

Table 6-3: Stepwise regression analysis results

Model Summary[g]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.667[a]	.445	.442	.5482713	
2	.766[b]	.586	.582	.4745647	
3	.790[c]	.624	.617	.4538781	
4	.804[d]	.646	.638	.4415990	
5	.821[e]	.673	.664	.4251321	
6	.826[f]	.682	.671	.4207541	1.787

a. Predictors: (Constant), LN(Xi4)
b. Predictors: (Constant), LN(Xi4), LN(Xi4)×LN(Xi5)
c. Predictors: (Constant), LN(Xi4), LN(Xi4)×LN(Xi5), LN(Xi2)
d. Predictors: (Constant), LN(Xi4), LN(Xi4)×LN(Xi5), LN(Xi2), LN(Xi1)×LN(Xi4)
e. Predictors: (Constant), LN(Xi4), LN(Xi4)×LN(Xi5), LN(Xi2), LN(Xi1)×LN(Xi4), LN(Xi3)×LN(Xi4)
f. Predictors: (Constant), LN(Xi4), LN(Xi4)×LN(Xi5), LN(Xi2), LN(Xi1)×LN(Xi4), LN(Xi3)×LN(Xi4),
g. Dependent Variable: LN(Yi)

Note: R indicates the square root of R square
R square indicates the proportion of variance in the dependent variable predictable by independent variable
Adjusted R. Square indicates a modified verison of R square adjusted for the number of predictors in the model
Std. Error of the estimate indicates the standard deviation of the error term
Durbin-Watson indicates the test of detecting auto-correlation problem
LN indicates the logarithmic transformation

6.6.3 Analytical Model Reorganization

This section proposes a table of coefficients to include in Equation 1 so as to estimate the value of profit, given a predictor dataset. Table 6-4 notably enables to compare the importance of predictors. The "unstandardized coefficients" column provides the value of coefficients (b_j) while the "standardized coefficients" column shows the importance of the predictors. The higher the standardized coefficient, the higher the importance of the predictor. The Variance Inflation Factors (VIF) investigates whether multicolinearity problems exist between predictors.

Based on the results of Table 6-4, Equation 6.1 can be instantiated as Equation 6.8 so as to estimate a transit center profit given a set of geographic location factors:

$$LN(Y_i) = -0.247 + 0.139\ (LN(X_{i2})) + 0.4\ (LN(X_{i4})) + 0.083\ (LN(X_{i1}) \times LN(X_{i2})) + 0.243\ \big(LN(X_{i1}) \times LN(X_{i4})\big) - 0.261\ \big(LN(X_{i3}) \times LN(X_{i4})\big) + 0.174\ (LN(X_{i4}) \times LN(X_{i5})) \quad (6.8)$$

As illustrated in Table 6-4, the "standardized coefficient" column helps to compare the predictors' importance. For example, the independent variable $LN(X_{i4})$ has the highest parameter among the predictors, confirming that the estimation of the total number of trailers to be shipped by local shippers to transit has higher importance in predicting profit in comparison to other predictors. Results also show that there is no multicolinearity problem among the current predictors, as tolerance value for all variables of Table 6-4 are higher than 0.2.

Table 6-4: Coefficient and significance of variables

Coefficients[a]								
		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-.247	.042		-5.854	.000		
	LN(Xi4)	.400	.042	.545	9.407	.000	.536	1.866
	LN(Xi4)×LN(Xi5)	.174	.036	.258	4.896	.000	.647	1.545
	LN(Xi2)	.139	.043	.189	3.203	.002	.515	1.943
	LN(Xi1)×LN(Xi4)	.243	.055	.322	4.445	.000	.343	2.915
	LN(Xi3)×LN(Xi4)	-.261	.059	-.283	-4.405	.000	.435	2.300
	LN(Xi1)×LN(Xi2)	.083	.038	.126	2.173	.031	.538	1.860
a. Dependent Variable: LN(Yi)								

Note: Constant indicates the intercept for the equation
B indicates standardized coefficients and the value for bj of the Equation 1
Std. Error indicates the standard errors associated with the coefficients
Beta indicates the standardized coefficients
t and Sig. represent t value and 2 tailed p-value to test whether a given coefficient is significatly different from 0
Tolerance and Variance Inflation Factors (VIF) indicate test of detecting multicollinearity problem

6.5.4 Managerial Implications

Based on the different obtained using statistical analysis, it is expected that in an area where the number of companies that the transit send trailers for them is higher, the profit level be high for it since based on the Equation 8 the profit increases as the value of this predictor increases. It can also be interpreted that as the number of companies in the area increases, the level of selling services increases and it results in more profits as assets are better utilized.

In the areas where the number of trailers that a transit is to receive is higher (the demand for a transit), the profit level be higher, since based on Equation 8 the profit increases as the value of this predictor increases. It can be also interpreted that higher levels of flow result in higher level of selling services, higher level of responded demand, more satisfied customers, higher service level, and consequently more profits.

Another insight is that in the areas where higher is the number of companies sending trailers to the transit or the number of companies receiving trailers from the transit, the level of profit is expected to be higher since based on Equation 8 the profit increases as the level of predictors in related combination increases. It can be also interpreted that the higher number of users in the area results in more flow for the transit and consequently higher level of profit.

It should be considered that the areas the number of companies who send their trailers to the transit is high or the level of trailers that a transit receives is high (demand), the profit level would be high since based on Equation 8 the profit increases as the level of predictors in related combination increases. It can be also interpreted that the higher number of companies in the area will provide higher level of flow for the transit, which result in higher level of service selling and consequently higher level of profit.

As yet another insight, results also indicate that in areas where the number of drivers or the number of trailers the transit receives are high, the profit level reduces since based on Equation 8 the sign for this value is negative, which means profit decreases as the value of predictors in related combination increases. It can be interpreted that if

in a transit location, the number of drivers is low, while the number of received trailers is high, it means that there are not enough drivers available; or where drivers are available adequately while no trailer for them to take, the profit level is reduced (it highlights the fact that finally customers (trailer senders/receivers or drivers) are not satisfied, since their demand is not responded efficiently).

Finally it is also expected that in the areas where the number of trailers that a transit is to send and receive are high, the profit be high since based the Equation 8 the level of profit increases as the value of predictors in related combination increases. It can be interpreted that the higher level of flow for transit (get in or get out) provides higher level of services sells, higher service level, and consequently higher level of profit.

6.6 Predicting Transit Profit: A Summary

The goal of this phase of the research was to investigate the predictors of profitability of transits, given a set of geographic location factors. To reach this goal, a set of potential geographic location factors that could affect the profit were identified. Using these factors and their combined effects, a set of hypotheses and an analytical model were developed. The hypotheses and model were tested through correlation and regression analysis, given a data set exploited from a simulation developed by Hakimi *et al*., (2014). Results of correlation analysis helped in identifying those geographic location factors, or their combination, that could have a significant relationship with profit, while results of the regression analysis helped in instantiating the proposed analytical model in order to estimate profit of a transit based on its predictors' values. This phase also proposed managerial insights.

Chapter 7. Conclusion

Business modeling is a method exploited by firms to define and optimize how they are to create, deliver, and capture value. It notably helps managers and owners to recognize their business strength and weaknesses rapidly, make better decisions, and improve their global performance. Innovation in proposed value and dynamic synchronization of the business model with market, competitors, and other environmental factors, is a pivotal factor toward success. Therefore an eminent business model can ensure sustainable success in the long run.

Recently a revolutionary paradigm entitled as the "Physical Internet" was introduced in the logistics industry with the goal of solving the grand challenge of current logistics networks in terms of economic, environmental, and social inefficiency and unsustainability. As expressed in the Physical Internet manifesto, the aim is: "*transforming the way physical objects are moved, stored, realized, supplied, and used aiming towards greater efficiency and sustainability*" (Montreuil, 2009-2012). The goal of Physical Internet, which is founded on physical, digital and operational interconnectivity, is to universally and openly interconnect logistics network through exploiting world-standard modular containers, interfaces and protocols, in order to move toward higher levels of efficiency and sustainability.

The Physical Internet enables various actors of a Logistics Web consisting of a Mobility Web, a Distribution Web, a Realization Web, a Supply Web, and a Service Web respectively and synergistically devoted to moving, storing, realizing, supplying, and using physical objects. So exploiting this innovative solution leads current actors and players to change their business model and synchronize their standards, rules, and propositions.

Focusing on the Mobility Web, the component responsible for moving goods and people through its open nodes, the goal of this research was to enable creating sound, comprehensive and innovative business models for Physical Internet enabled transit

center, while identifying the geographical factors affecting its profitability and performance. To reach this goal, a three-phase methodology was followed.

The first phase focused on designing a generic business model framework for transit centers. It used as a tool the business model canvas proposed by Osterwalder and Pigneur (2010). The designed business model framework addresses the key partners, key activities, value proposition, customer relationships, customer segments, key resources, key channels, cost structure, and revenue streams of a transit center business, declining options relative to each facet.

The in-depth design work of the first phase was rich in contributions toward understanding and helping design transit centers. For example, their value proposition is essentially a smart combination of access, matching, parking, rest and short-term storage services. Their targeted customer segments can include shippers, transport service providers, and transport service brokers. Their potential partners include transport service providers, transport service brokers, government, suppliers, as well as other transit centers and hubs.

The second phase investigated the impact of geographic location factors on the transit center business model. To accomplish this phase, a framework was developed consisting of a set of components, elements, and indicators. Identifying the potential locations for transit centers through exploiting a specific network design, this framework was then applied for a specific type of transit center location and its indicators were assessed. The framework was developed through a rich review of literature.

In the second phase, by scanning the assessments of the framework for a metropolitan area, it was concluded that metropolitan transit centers should put significant emphasis on their cost control strategies, their business structure, and their exploitation of ICT. In metro areas, the level of technological change is expected to be high, which forces transit center businesses to synchronize rapidly with new value propositions of technological service providers. Taking into consideration that metropolitan customers

have access to a rich pool of transit service providers, they can have more switching behavior which admits their high power over the business, and also their reviews are expected to play a key role on a metro transit center reputation.

The third phase studied the level of profit predictability of a Physical Internet enabled transit in various locations, taking into consideration a set of location factors. Carrying out this phase, a set of location factors were identified, a set of hypotheses formulated, and an analytical model developed. A set of data and profit values were then used to validate the hypothesis as well as the model. Identified location factors were: the number of local shippers of trailers for the transit, the number of local receivers of trailers for the transit, the number of local drivers for the transit, the estimation of the total number of trailers to be shipped by local shippers to the transit, and the estimation of the total number of trailers to be delivered to local destinations by the transit.

Results from the third phase indicate that best predictors of profit are (1) the estimation of the total number of trailers shipped by local shippers to the transit, (2) the combination of the estimation of the total number of trailers to be shipped by local shippers to the transit and the estimation of the total number of trailers to be delivered to a local destination by the transit, (3) number of local receivers of trailers for the transit, (4) the combination of the number of local shippers of trailers for the transit and the estimation of the total number of trailers shipped by local shippers to the transit, and (5) the combination of the number of local drivers for the transit and the estimation of the total number of trailers shipped by local shippers to the transit with a negative effect, (6) the combination of the number of local shippers of trailers for the transit and the number of local receivers of trailers for the transit. In this context, the importance of the estimation of total number of trailers shipped by local shipper is higher and it can affect the level of profitability more than the other factors. Result of this part also helps to have an equation from geographic locations factors in order to estimate the profit value.

Limitations of this research provide potent avenues for further research. As an example, in this exploratory work, the proposed transit center business model framework is

treated as a stand-alone self-centric business. This leads to its value proposition options being limited to the services that can be provided at its site. The framework could be extended by considering for example that a π-transit center might provide other transit-focused services to other π-nodes such as neighboring π-crossdocking hubs and π-warehouses. Another such research avenue could be to assess the efficiency of the business model of a transit center in a dynamic competitive environment through a simulation based experimental assessment.

Further research could focus on performing for other Physical Internet logistics nodes (e.g. π-hubs or π-DCs) the type of research conducted here.

Moreover it could be interesting to investigate the case where a business aim to design, manage, and operate a network of π-transits in selected locations across territories is managed rather than a single one the case where multiple types of such centers are operated. This orientation could be extended to businesses aiming for a network encompassing geographically distributed π-transits, π-hubs and π-DCs. Businesses may also be interested to combine the functionalities of multiple types of π-logistics centers in multi-service π-logistics complexes.

Finally, focusing on this paper's third phase on profit predictability, further research could be aimed at taking a more comprehensive perspective over factors influencing the profit of π-nodes, including other factors such as the competition, legal environment, social environment and technological change. Ideally, a comprehensive methodology would be available for holistic business model design for businesses aiming to be players in offering logistics services through Physical Internet logistics facilities, and this methodology would be instrumented through a rich hyperconnected design, simulation and optimization platform.

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