Studying the Effect of Locational Factors on the Profitability of Physical Internet Enabled Transit Centers

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***Abstract* - The Physical Internet paradigm aims to transform the way physical objects are designed, manufactured, and distributed. It exploits a new open and interconnected structure of Logistics Webs which encompasses current production and supply actors as well as new logistics service providers. As Physical Internet is being further conceptualized and experimented, it becomes critical to rigorously investigate how integrating Logistics Webs will influence its stakeholders' business models and their value creation patterns. One of the components of a Logistics Web is the Mobility Web which ensures the movement of physical objects within the global interconnected set of open uni-modal and multi-modal hubs, transit centers, ports, roads, and ways. Transit centers, which are the focus of this research, transship trailers from one truck to another to facilitate their delivery from their source to their destination. The purpose of this contribution is to facilitate the implementation phase of a Mobility Web and more particularly its transit network while helping investors in assessing profitability based on the characteristics of a transit's geographic location. It proposes a model to investigate to what extent profitability of transits is predictable, given a set of geographic locational factors. This model is tested and validated through correlation and regression analyses, given sets of data reflecting the case of the province of Quebec. Results of this research show that six of the fifteen factors studied can be predictors of profit for the transit.**

***Keywords* – Business Modelling, Physical Internet, Transit Centers, Mobility Web, Profitability Assessment.**

1 INTRODUCTION

Introduced by Montreuil (2009-2012, 2011), the Physical Internet (PI, π) paradigm aims to revolutionize the material handling, logistics, and facility design fields. In particular, it exploits open universal interconnectivity through the use of Logistics Webs. A Logistics Web consists of five interconnected Webs respectively devoted to moving, storing, realizing, supplying, and using physical objects, which are: Mobility Web, Distribution Web, Realization Web, Supply Web, and Service Web. Examples of research reporting the potential economic, social, and environmental improvements of this game-changer are Sarraj *et al.*, (2014) and Hakimi *et al.*, (2014), both applying simulation approaches to demonstrate the concept.

In this article, we focus on the Mobility Web which provides a global interconnected set of open uni-modal and multi-modal hubs, transit centers, ports, roads, and ways, to move physical objects from the source to the destination. More specifically, we target the network of transit centers whose role is to transship trailers efficiently and smoothly from one truck to another, so that objects travel from the source to the destination more quickly and efficiently.

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. In a more general way, Montreuil *et al.*, (2012) and Hakimi (2014) explored Physical Internet induced business model innovations. Oktaei *et al.*, (2014) exploited the business model Canvas of Osterwalder and Pigneur (2010) to propose a customized business model Canvas for π-transits. Oktaei *et al.*, (2015) assessed the impact of geographic locations on the business model of π-transits. However, to the best of our knowledge, no previous study has analyzed the transit profitability considering its geographic locational factors.

Therefore in this research, we proposed a set of hypotheses and an analytical model to investigate to what extent profitability of transits is predictable, given a set of geographic locational factors. The following factors and their combinations are considered for each geographic location: 1) the number of local shippers of trailers for the transit *i* (X_{i1}); 2) the number of local receivers of trailers for the transit *i* (X_{i2}); 3) the number of local drivers for the transit *i* (X_{i3}); 4) the estimation of the total number of trailers shipped by local shippers to the transit *i* (X_{i4}); and 5) the estimation of the total number of trailers delivered to local destinations by the transit *i* (X_{i5}). The model is solved using correlation and regression analyses. The data sets for geographic location factors are retrieved directly from input of a transit network simulation developed by Hakimi *et al.*, (2014), while the simulation output is used to estimate transit profit.

Results of the analysis show that certain factors and their combinations could be considered as efficient predictors of profit, such as the estimation of the total number of trailers shipped by local shippers. Transit center owners or investors could use the analytical model proposed in this research, and give value to its effective predictors, in order to estimate the profitability of their business unit.

This paper is structured as follows. Section two encompasses the background, goals and methodology of the research. In methodology sub section, further elements are investigated: 1) identifying geographic locational factors affecting profit; 2) developing hypotheses; and 3) gathering data sets for variables including the process of profit estimation. Section three presents the analytical model. Section four determines the dependent variable of the model. Section five investigates the statistical analysis, while section six provides results and managerial implications including: 1) supported and non-supported hypotheses; 2) best predictors of profit; 3) analytical model reorganization; and 4) managerial implications. The paper is finally ended with a conclusion.

2 RESEARCH BACKGROUND, GOAL, AND METHODOLOGY

This section gives an insight on the background and the context of the research, while stating the research goal and the applied methodology.

2.1 Background

In current transportation systems, a trailer is assigned to a truck-driver combination whose task is to deliver the trailer from its source to its final destination (end-to-end delivery). This type of delivery results in significant inefficiencies since i) the trailer and truck unnecessarily stop when the driver stops for the mandatory breaks; ii) there is a greater chance that most of the return travel will be empty; and iii) when the trailer's travel is very long, the driver spends a lot of time away from home which affects his quality of life and that of his family.

Following the Physical Internet ideas, an alternative to this inefficiency would be to use a network of π-transits to ensure segment by segment delivery instead of end-to-end delivery. During its travel from source to final destination, the trailer visits a series of π-transits where it is transferred between driver-truck combinations. This alternative is expected to offer better economic, environmental, and social results as it can allow: (1) faster delivery of the trailer since the trailer has less chance of stopping to wait for the driver; (2) improved social life for drivers by allowing them to go back home more frequently; and (3) a higher level of productivity for trucks, through more intensive use. Figure 1 from Montreuil's work (2011) shows promising results of exploiting Physical Internet transits as an alternative to the current approach. As it is mentioned in the figure, the alternative solution could reduce source-to-destination delivery time by up to 50% for a shipment from Quebec City to Los Angeles, while ensuring significant productivity gains for drivers, tractors, and semi-trailers.

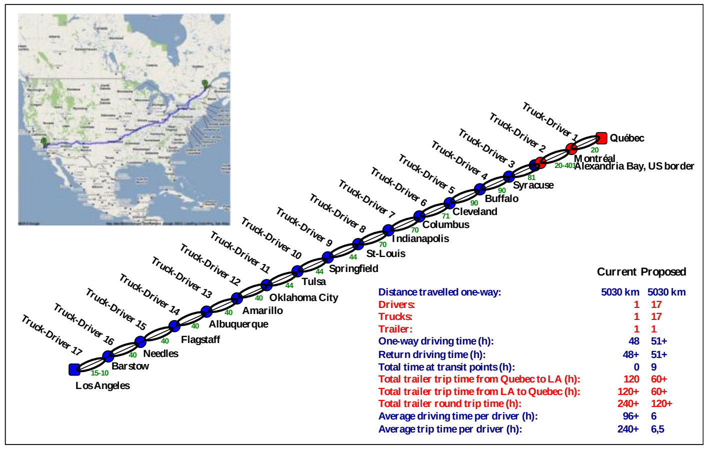

Figure 1. Illustration of an interconnected truckload transportation of trailers across a Mobility Web (Montreuil, 2011)

To support the hypothesis that the use of an open interconnected network of π-transits would lead to better economic, social, and environmental results, Hakimi *et al.*, (2014) used a holistic simulation approach to compare the performance of the current transportation system of the province of Quebec in Canada with a potential interconnected system of π-transits. Their results confirmed the hypothesis of significant sustainable improvement if this type of system would be implemented. In the same context, the result of the simulation-based research of Sarraj *et al.* (2014) also admits the advantages of this alternative solution.

2.2 Research goal

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-transit according to the geographic location. Assuming that the implementation of the proposed network of π-transits is possible, and in order to help potential investors in making their decision, 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. This is especially true knowing that the anticipated profit can vary considerably from one location to another. Thus, this research proposes a model that will help in predicting the profitability of a π-transit based on the characteristics of its geographic location.

2.3 Methodology

In order to facilitate the profitability assessment of a π-transit regarding its geographical location, the steps presented in Figure 2 were followed.

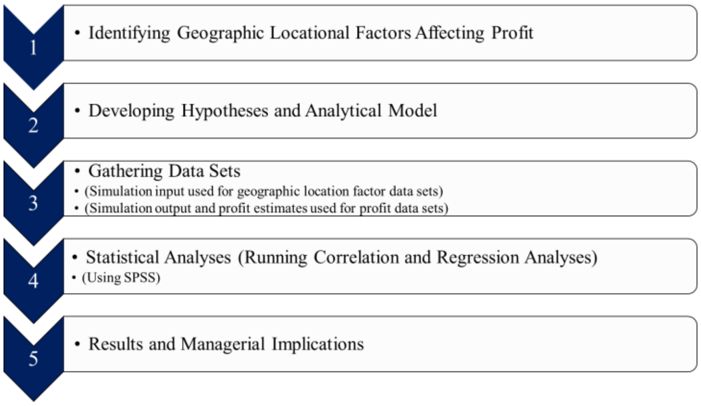

Figure 2. Steps of research

In the first step, we looked at Hakimi *et al.*'s simulation results to identify what could be the key geographic locational factors that would affect the most the profitability of a π-transit. 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 locational factors were identified, representing the independent variables used in the model to predict the profit (Y_i) of a transit *i*:

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

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

(3) The number of local drivers for the transit (X_{i3}) - 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) The estimation of the total number of trailers shipped by local shippers to the transit (X_{i4}) – Corresponds to an estimation of the number of trailers the π-transit can receive from all companies in its area during the considered horizon.

(5) The estimation of the total number of trailers delivered to a local destination by the transit (X_{i5}) – Corresponds 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 or the combined effect of all possible pairs of these factors. A logarithmic function (LN) transformation was applied to normalize the distribution of data (the transformation will be detailed in section five.)

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.

Table 1 summarizes the hypotheses.

Table 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 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 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 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 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 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 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

	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 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 shipped by local shippers to the transit, and the estimation of its total number of trailers delivered to local destinations by the transit $(LN(X_{i4}) \times LN(X_{i5}))$; and its profit $LN(Y_i)$.

In the third step, data sets for geographic location factors and profit estimation were gathered using input and output of a simulation developed by Hakimi *et al.*, (2014) for the case of the province of Quebec. The simulation 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 at the main border crossing zones to the United States and the neighboring Canadian provinces. Figure 3 shows the π-transit network of the simulation used in the context of this project.

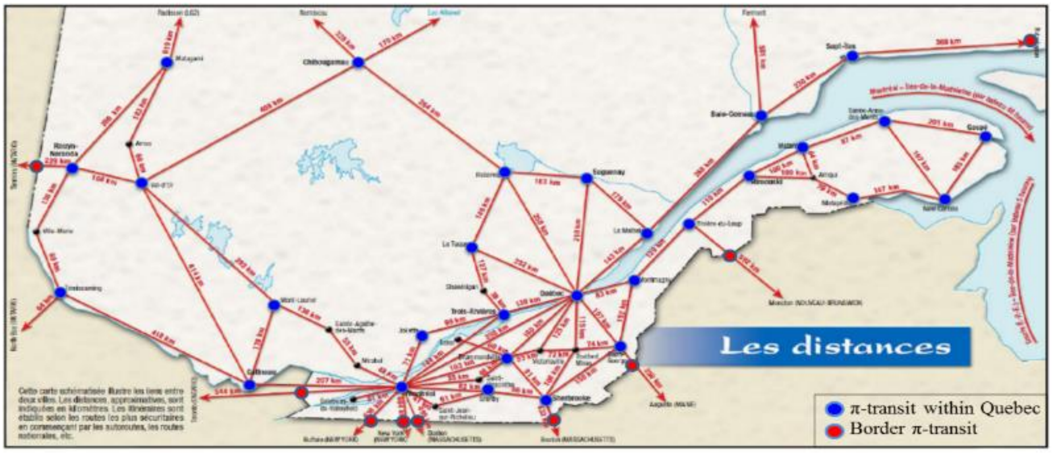

Figure 3. Mobility Web network design and potential location of π-transits [1]

The simulation tool also kept track of the 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. Among the data sets used to build their simulation, the authors 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 considered as equivalent to the number of transporters and obtained using capacity-setting simulation mode (see Hakimi *et al.*, (2015) for all the details). The estimation of the total number of trailers shipped by local shippers to the transit (X_{i4}) and the estimation of the total number of trailers delivered to local destinations by the transit (X_{i5}) were estimated using two data sources: Quebec Transports (2007) which estimates the flow of trailers within the province and the flow in and out between the province, other provinces, and the US, and Quebec Transports (1999) which is a census of the number of trucks travelling per fifteen minutes on the main highways of the province. In addition, the ICRIQ database indicating the range of size, revenue, number of workers, etc. of each company, it allowed the assignment of the generated volume of demand to specific shippers and receivers. The different data collected were also used to estimate transit profit, explained in detail in the following section.

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.

3 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 following variables were used:

- *i*: π-transit index;
- X_{i1}: The number of local shippers of trailers for transit *i*;
- X_{i2}: The number of local receivers of trailers for transit *i*;
- X_{i3}: The number of local drivers for transit *i*;
- X_{i4}: The estimation of the total number of trailers shipped by local shippers to transit *i*;
- X_{i5}: The estimation of the total number of trailers delivered to a local destination by transit *i*;
- Y_i: Profit of a π-transit *i*;
- b_j: Coefficient of variables (*j*=1,2, … , 15);
- LN: Logarithmic function.

[1] The layer of the π-transit network added on the map of distances between regions produced by the Service de la géomatique of Quebec Government (2010)

Equation 1 introducing profit estimation for π-transits is as follows:

$$LN(Y_i) = b_0 + b_1(LN(X_{i1})) + b_2(LN(X_{i2})) + b_3(LN(X_{i3})) + b_4(LN(X_{i4})) + b_5(LN(X_{i5})) + b_6(LN(X_{i1}) \times LN(X_{i2})) + b_7(LN(X_{i1}) \times LN(X_{i3})) + b_8\left(LN(X_{i1}) \times LN(X_{i4})\right) + b_9(LN(X_{i1}) \times LN(X_{i5})) + b_{10}\left(LN(X_{i2}) \times LN(X_{i3})\right) + b_{11}\left(LN(X_{i2}) \times LN(X_{i4})\right) + b_{12}\left(LN(X_{i2}) \times LN(X_{i5})\right) + b_{13}\left(LN(X_{i3}) \times LN(X_{i4})\right) + b_{14}\left(LN(X_{i3}) \times LN(X_{i5})\right) + b_{15}(LN(X_{i4}) \times LN(X_{i5})) \quad (1)$$

It encompasses a series of geographic locational factors that may influence the profitability of transits including the number of local shippers of trailers for transit *i*; the number of local receivers of trailers for transit *i;* the number of local drivers for transit *i*; the estimation of the total number of trailers shipped by local shippers to transit *i*; the estimation of the total number of trailers delivered to a local destination by transit *i*; as well as the combination of these factors.

4 Determining the dependent variable of the model

While the independent variables considered in the model could directly be extracted from the simulation (e.g., number of local receivers, number of drivers, etc.), 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 2.

$$Y_i = R_i - C_i \quad (2)$$

The total cost (C_i) acquired by a π-transit during the horizon of the analysis 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 3.

$$C_i = C_{Di} + C_{Oi} \quad (3)$$

The depreciation cost includes the cost of building the facility and the interest paid for a potential loan acquired to build it. The cost of building the facility takes 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, the wait and rest areas, etc. The operational cost is generated by daily activities and includes costs related to personnel salaries, maintenance, electricity, information and communication technologies, etc.
As shown in Equation 4, the expected revenue per transit (*i*) per trailer (*k*) (R_{ik}) is calculated using the cost per unit pricing policy. This expected revenue (R_{ik}) is the cost per trailer (C_{ik}) to which the profit margin (p_i) is added.

$$R_{ik} = C_{ik} \times (1 + (p_i)) \quad (4)$$

The cost per trailer per transit (C_{ik}) is obtained by dividing the total cost of the transit (C_i) by the total number of trailers received by transit *i* (N_i) (Equation 5).

$$C_{ik} = C_i / N_i \quad (5)$$

The profit margin (p_i) is obtained 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 (Pi) for each of these services is equivalent to half of R_{ik} (Equation 6).

$$P_i = R_{ik}/2 \quad (6)$$

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) (Equation 7).

$$R_i = 2 \times (P_i \times N_i) \quad (7)$$

Figure 4 summarizes the process that was used to determine a π-transit's profit.

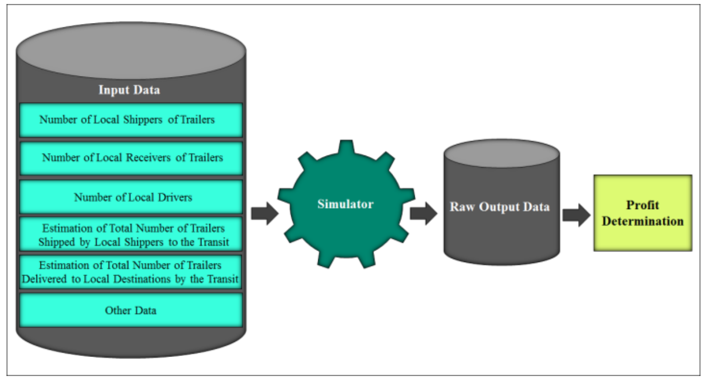

Figure 4. Illustration of the profit determination process

5 Statistical analysis

Using a total of 184 observations (i.e., 46 transits for the cases where 100%, 90%, 80%, and 70% of the drivers in each transit area were available, see Hakimi *et al.*, (2014) for more details), correlation and stepwise regression analysis were applied to the hypotheses and proposed analytical model (Equation 1). The idea of using correlation analysis was to verify if our hypotheses were supported while a 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 are a sets of assumptions that must be validated before running a regression analysis, including the linearity of relationship between variables, the normality of the variables distribution, multicollinearity, homoscedasticity, and auto-correlation. We therefore checked all these prerequisites. 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. 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., multicollinearity problem).

6 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 1, based on a correlation analysis. The second sub-section identifies the potential geographic factors capable to predicting profit, using a stepwise regression analysis. The third sub-section is allocated to propose the coefficients of geographic location factors and their combinations (b_i) to use in Equation 1 so as to estimate the exact value of profit for a transit, given value to geographic location factors. This section concludes with some managerial insights.

6.1 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 a correlation coefficient (i.e., Pearson's r), ranged from -1 to +1. A correlation coefficient close to +1 shows a positive relationship between the variables while a correlation coefficient close to -1 shows that an increase in one variable will result in a decrease in another one. Furthermore, when considering a significance level of 1%, the p-value (i.e., 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.

Results of the correlation analysis in this research demonstrated that the correlation coefficient of all variables are accepted with a significance level of 1%, except for further 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 drivers for the transit *i* and the estimation of the number of trailers shipped by local shippers to transit *i* ($(LN(X_{i3}) \times LN(X_{i4}))$, and 4) the number of local drivers for transit *i* and the estimation of the total number of trailers 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 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 variable. Knowing that a higher correlation coefficient involves a higher significance of linear relationship between the variables and the profit, results highlight the strong relationship existing between the estimation of the total number of trailers 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 relationship between all the factors considered is also given in Table 2.

Table 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 2, the sequence of importance of linear relationships between factors are:

1) The estimation of the total number of trailers shipped by local shippers to transit *i*; and transit profit ($(LN(X_{i4})$ (r=0.667, P=0.000));
2) The number of local receivers of trailers for transit *i*; and transit profit ($(LN(X_{i2})$ (r=0.565, P=0.000));
3) The estimation of the total number of trailers delivered to a local destination by transit *i*; and transit profit ($(LN(X_{i5})$ (r=0.539, P=0.000));
4) The number of local shippers of trailers for transit *i*; and transit profit ($(LN(X_{i1})$ (r=0.513, P=0.000));
5) The combination of the estimation of the total number of trailers shipped by local shippers to transit *i* and the estimation of the total number of trailers delivered to a local destination by transit *i*; and transit profit ($LN(X_{i4}) \times LN(X_{i5})$ (r=0.372, P=0.000));
6) The combination of the number of local shippers of trailers for transit *i* and the estimation of the total number of trailers shipped by local shippers to transit *i*; and transit profit ($(LN(X_{i1}) \times LN(X_{i4})$ (r=0.332, P=0.000));
7) The combination of the number of local shippers of trailers for transit *i* and the number of local receivers of trailers for transit *i*; and transit profit ($(LN(X_{i1}) \times LN(X_{i2})$ (r=0.262, P=0.000));
8) The combination of the number of local receivers of trailers for transit *i* and the estimation of the total number of trailers delivered to a local destination by transit *i*; and transit profit ($(LN(X_{i2}) \times LN(X_{i5})$ (r=0.244, P=0.000)); and
9) The number of local drivers for transit *i*; and transit profit ($(LN(X_{i3})$ (r=0.239, P=0.001)).

6.2 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). SPSS software in stepwise procedure selects the variables based on their ability to contribute in the overall prediction.

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 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 3, indicate the best predictors of profit for a transit, according to the statistical analysis conducted. It encompasses: 1) the estimation of the total number of trailers shipped by local shippers to the transit i $LN(X_{i4})$; 2) the combination of the estimation of the total number of trailers shipped by local shippers to the transit i and the estimation of the total number of trailers delivered to a local destination by transit i ($LN(X_{i4}) \times LN(X_{i5})$); 3) the number of local receivers of trailers for transit i $LN(X_{i2})$; 4) the combination of the number of local shippers of trailers for transit i and the estimation of the total number of trailers shipped by local shippers to transit i (($LN(X_{i1}) \times LN(X_{i4})$); 5) the combination of the number of local drivers for transit i and the estimation of the total number of trailers shipped by local shippers to transit i (($LN(X_{i3}) \times LN(X_{i4})$); and then 6) the 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 R square of the model 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 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), LN(Xi1)×LN(Xi2)
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

6.3 Analytical model reorganization

In this section, a table of coefficients (Table 4) to include in Equation 1 is proposed, so as to estimate the value of profit, given a set of data to predictors. Table 4 also enables to compare the importance of predictors. The column "unstandardized coefficients" provides the value of coefficients (b_j) while the column "standardized coefficients" 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 multicollinearity problem exists between predictors.

Table 4. Coefficient and significance of variables

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			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

Based on the results of Table 4, Equation 1 can be reorganized, leading to Equation 8, to estimate the exact value of profit given a set of geographic location factors.

$$LN(Y_i) = -0.247 + 0.139\,(LN(X_{i2})) + 0.4\,(LN(X_{i4})) + 0.083\,(LN(X_{i1}) \times LN(X_{i2})) + 0.243\,\big(LN(X_{i1}) \times LN(X_{i4})\big) - 0.261\,\big(LN(X_{i3}) \times LN(X_{i4})\big) + 0.174\,(LN(X_{i4}) \times LN(X_{i5})) \quad (8)$$

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

6.4 Managerial implication

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

It can also be concluded that in the areas where the number of trailers received by a transit is high (i.e., the demand for a transit), the profit level will be high since based on Equation 8, the profit increases as the value of this predictor increases. In the same manner, a higher level of flow results in a higher level of selling services and consequently more profits.

It should be considered that in 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.

Results also indicates that in areas that 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 are low, while the number of received trailers are high, (we do not have driver) or there are drivers available and there is no trailer to take, the profit level reduces (as customers are not satisfied and their demand is not responded).

7 CONCLUSION

For a Physical Internet environment, the goal of this research was to investigate the predictors of profitability of π-transits, given a set of geographic locational 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 locational factors, or their combination, that could have a significant relationship with profit, while results of the regression analysis helped in reorganizing the proposed analytical model in order to estimate the exact profit value of a transit regarding its predictors' values.

This research may help investors interested in investing in this business to assess transit profitability based on the characteristics of the business' geographic location. Using the model, they could estimate the level of profit for their transit based on a set of geographic locational factors.

In further research, other locational factors such as the competition, the legal and social environment, technological changes, etc., could be added to the model and their effect on profitability analyzed.

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