GT-Panama Thesis Series

DISCLAIMER

This document was written by students at the Georgia Institute of Technology as part of the requirements to receive the degree Master of Science in Supply Chain Engineering. This is not a professional consulting report, but rather an attempt by students to explore supply chain issues, generally in a quantitative way that may not have been attempted heretofore. This document has been selected for release because the Georgia Tech Panama Logistics Innovation and Research Center believes that it offers ideas of interest to the community.

Reference in this thesis to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement, recommendation, or favoring by the Georgia Institute of Technology. The views and opinions of the author(s) expressed herein do not state or reflect those of the Institute nor the GT Panama Center, and shall not be used for advertising or product endorsement purposes.

GEORGIA INSTITUTE OF TECHNOLOGY

"TRACKING THE PANAMA CONTAINER TRANSSHIPMENT BY TRUCK"

BY:

JAN CHONG

OSVALDO ORTEGA

ARMANDO RENGIFO

A CAPSTONE PROJECT PRESENTED TO THE FACULTY OF THE SCHOOL OF INDUSTRIAL AND SYSTEMS ENGINEERING.

FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF MASTER OF SCIENCE IN SUPPLY CHAIN ENGINEERING.

ADVISOR: JOHN J. BARTHOLDI III

2014

TABLE OF CONTENTS

1. INTRODUCTION

1.1 DESCRIPTION

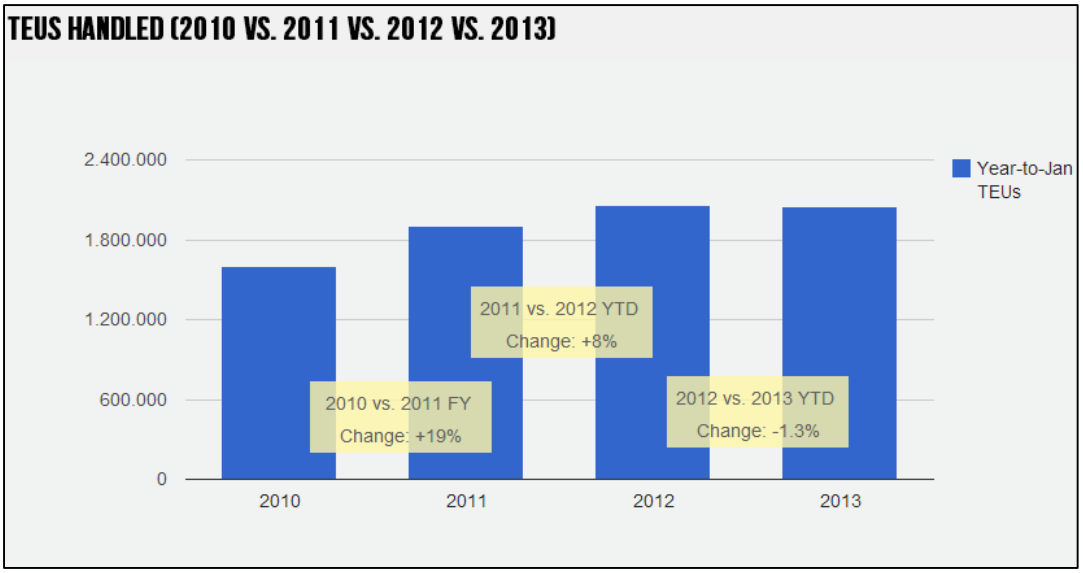
The project consist in an extension of a previous project of the container transshipment operations done by truck from the port of Balboa (Panama) to Manzanillo (Colon). Transshipment consists on the process of moving a container from one vehicle to another and in our case we will be working with ships transshipment, from ships that arrive to the port of Balboa or PSA to ships that sail from the port of Manzanillo, and vice versa.

Our project scope will be the whole transshipment operation from the container load in the truck at arrival port (Manzanillo) up to the container unload at the sailing port (Balboa or PSA). The process is as follows:

1.2 BACKGROUND AND RATIONALE

The Manzanillo International Terminal (MIT), located on the Atlantic Coast, and the Port of Balboa, located on the Pacific Coast, are huge players of the transshipment operations in Panama. The activities in these key seaports represent a significant boost to the Panamanian Economy and the American Region. In fact, the Panamanian maritime industry is the fastest growing sector in the national economy and it represents 20% of the Gross Domestic Product. The high volume of the international traffic is causing a huge challenge in the ports related to the speed of the operations, competitive rates and value added services. The Panamanian seaports are divided into two big groups: State ports and Private ports. The Private ports were created after a process where a private company enters into an agreement to have the exclusive right of manage and invest in a public company. In the other hand, State ports are still operated by the government under the management of the Panama Maritime Authority (AMP). In our study we will be focus in the Private ports of Balboa, Manzanillo and PSA.

In 2013, the container movement in the Panamanian ports decreased 4.3% compared to the previous year, however, the total container movement in units was of 3.9 million (approximately 6.5 million TEUs) were 80% to 90% of their container movement is associated to transshipment processes. From this percentage approximately 1.7% (104 688 TEUs/52 344 containers) is moved by truck. During this period, the Seaports terminals that had the greatest container movement were MIT (1.8 MM units) and Balboa (1.2 MM units), despite the fact that they had a negative growth compared with the 2012.



Manzanillo's TEUs handled (2010-2013) chart

The Port of Singapore Authority (PSA) or Port of Rodman, located in the Pacific side of Panama, is a public company of the Singapore government built by PSA International that provides an important port of call for shipping lines handling container and Ro-Ro cargo. It has a huge growth in the last years and it can be view in the growth of the cargo handling of 53,460 TEU in 2012 to 123,808 in 2013.

We also have to mention one sadly scenario that can highly influenced this study. The majority of transshipment ports of the Pacific and the Atlantic displayed a decrease compared with the first quarter of the last year 2013. Such is the case of Balboa, Pacific , operated by Panama Ports Company (PPC) , which recorded a decrease of 4.1%, although the fall was lower compared to the same period in 2013 when those two months had registered a decline of 17.7%.

The main transshipment port of Panama and Latin America, the port of Balboa, has shown declines in their movements in the last two years.

In the last years, we can see a huge investment resulting from development, expansion, concessions plans and privatization of ports in both oceans. With more of 144 routes in world trade, Panama is on its way to becoming the container trans-shipping center of Latin America and the Caribbean. For example, Panama Ports Company had investments of more than US$1,000 million in both ports (Balboa and Cristobal) to transform them in mega ports in order to increase their capacity to handle approximately 6.5 million TEUs.

Transshipment is originated mainly because of two reasons:

A. Ship uses in these days Post Panamax/Super post Panamax do not fit through the Canal.
B. Some of the loads inside the ship doesn't go to the same destination as the rest, and here is where the importance of this operation is originated.

With that being said our government entity had to implement a complete system of transportation dedicated to transshipment and the main vehicle used is the railroad managed by the Panama Canal railway Company along with the cooperation of Panama Ports Company. The primary role of the railroad is to serve as a transshipment link for container shipments between Pacific and Atlantic seaports. However, the passenger service allows travelers to enjoy a journey through the lush jungles of Panama flanking the scenic Panama Canal.

The Panama Railroad (PCRC) can carry up to a 100 TEUs double stacked per trip, doing up to seven trips per day which give us a total capacity of 700 TEUs. Each trip (47-mile single-line track linking Balboa and Colon) takes about 75 minutes and the loading and unloading of a train at the terminals takes about 2 hours. However, the schedules vary day by day, depending on port operations and demand from shippers that use the PCRC.

The Panama railroad offers many transportation advantages as short travel time, cheapest cost, more security, faster customs clearance process (electronic documentation). On the other hand it is also affected by some disadvantages such as fixed load capacity, no time flexibility for highly time dependent shipments, these means that if you need a container to be transported now by rail you won't be able to make it because the rails usually wait for a full train capacity to move. These two aspect represent a huge problem for many companies, mainly event more critical than transportation cost so an alternative was imperative and this is where the transshipment by truck service born.

It is well know that the cost for the truck transshipment service may even double the price of the rail transportation (approximately $375.00), and that the travel time may not always be the same (variable travel time) but the importance of this service relays on the shipping by demand features which implies that I can send containers whenever is needed and for any capacity required. This represent a huge relive for high container volume movement companies. Beside that with the new technology of tracking devices (GPS, RFID, among others) you can increase the customer satisfaction and feedback about their load movement, plus it allow you to decrease some security risk of the truck transportation.

Besides cost and the variable travel time, the trucking services present another disadvantage which is government holds, which impact the total transshipment process time. This is also a disadvantage for the trucking companies because it limits the daily truck usage.

The Corredor Norte is another important element of the Transshipment Process. It is a modern highway build in 1998 and managed by Empresa Nacional de Autopistas (ENA) through the law 76 of the 2010. ENA is created as a public limited society, where the Panamanian State is the owner of 100% of the capital shares that are under the custody of the Ministry of Economy and Finance, with oversight of the Office of the Comptroller General.

The principal objective of ENA is implement infrastructure optimization processes aimed to improve the performance of the highway and their contribution to the human and economic development of Panama.

Unfortunately, the roads doesn't have the required quality of construction and for that reason the full potential of the highway is not reached.

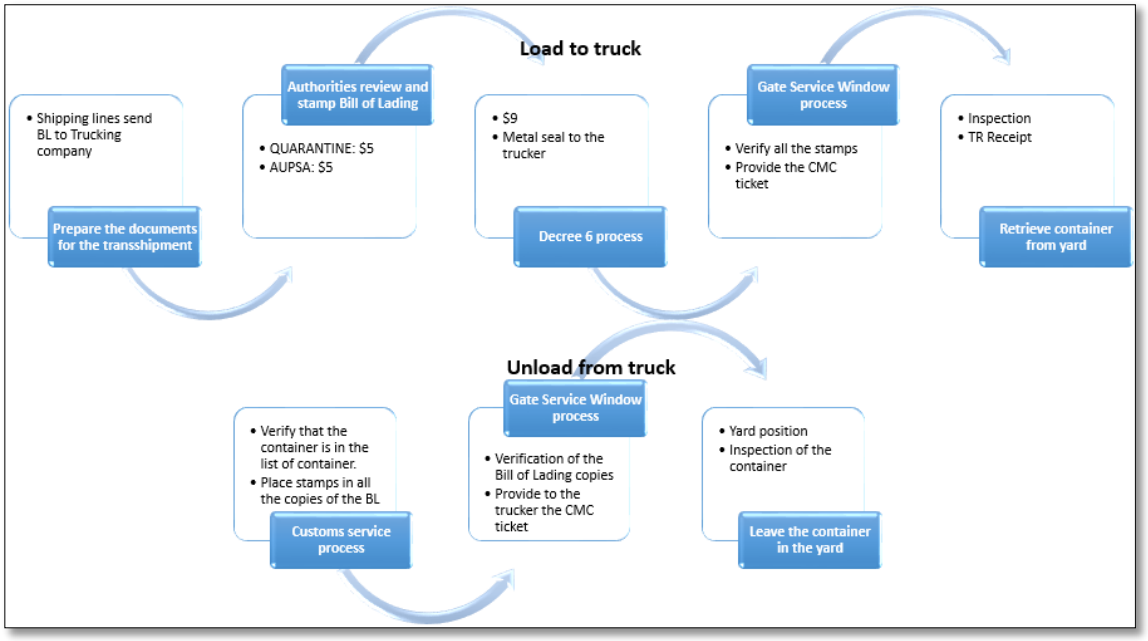
With all that being said, the need for a study of a transshipment by truck process stopped being a "maybe" and became a must in order to determine the areas of opportunity on these highly needed service.

The last year, the Georgia Tech Panama Logistics Innovation and Research Center starts this study, motivated by the fact that actually the trucking industry have huge opportunities of growth as a mode to move containers from port to port. This study will be an extension of this previous study, introducing the utilization of Global positioning systems (GPS) devices that will help us to recreate and model the actual scenario in real time based on an engineering analysis.

1.3 OBJECTIVES:

- **Understand the impact of truck transshipment operation in the supply chain.**
- Determine which are the most time consuming activities in the transshipment operation.
- Collect and analyze the truck transshipment trip information.
- Analyze some alternatives to increase competitiveness of the transshipment by truck operation.

2. CONTAINER TRANSSHIPMENT BY TRUCK PROCESS



Transshipment by truck process flow chart

2.1 FULL CONTAINER TRANSSHIPMENT PROCESS BY TRUCK

- **Load to Truck Process**

The transshipment process starts when the shipping lines send to the trucking company via courier the 10 Bill of Landing or the list of documents needed in the service windows inside the port. The shipping line notifies to the port the need of transshipment approx. 24 hours before the ship arrives. The trucking company will need 5 Bill of lading copies for the port of origin and 5 bill of lading for the port of destination. The port will inform to the shipping line the order in which the containers will be dispatched. The service windows mention previously include:

- **AUPSA**
- **QUARANTINE**
- **CUSTOMS: It opens from 8:00 am to 4:00 pm**

The first service window in the process is the **Quarantine Service Window**. In this window the port will:

1. Request for the phyto/zoosanitary license.
2. Request the charges for plastic seal ($5).
3. Remove the holds in the port system.
4. Place stamps in all the copies of the Bill of Lading.
5. Enter the fumigation arch ($9)

The second service window in the process is the **AUPSA Service Window**. Basically, on this window the port will:

1. Request the transit notice, packing list and copy of sanitary certificate from origin.
2. Request the charges for plastic seal (approx. $5). This seal reduce the risk of a possible contamination.
3. Remove the holds in the port system.
4. Place stamps in all the copies of the Bill of Lading.

Then, the **Customs Service Window** review the Bill of Lading with the stamps provided by Quarantine and AUPSA and begin the **Law 6 or the Decree 6 process**. The D6 form is a Customs form for moving non-nationalized cargo outside the country. Customs will place a stamp in one copy of Bill of Lading and will keep another to fill out the Decree 6 (approx. $9) in order to give a metal seal to the trucker. The Metal seals avoid containers to be opened intentionally through their travel time between the port of origin and the port of destination.

Once this steps are done the trucker will go to the **Gate Service Window.** In this window the port will:

1. Verify all the stamps of the Bill of Lading copies
2. Remove the holds in the port system

3. Provide to the trucker the CMC ticket which contains the container number, yard location, chassis number and the trucker id information.

In this moment the **process of retrieve the container from the yard** starts. This includes:

1. The container retrieval from the yard.
2. A visual container inspection of all the container seals is done.
3. Provide the TR receipt which is a document that guarantees the physical state of the container in Balboa Port.

- **Unload from Truck Process**

Once the trucker moves the container from the origin port, the port of destination will wait for the arrival of the container. The first service window in the process is the **Customs Service Window**. In this window the port will:

1. Verify that the container is in the list of container.
2. Place stamps in all the copies of the Bill of Lading

The second service window in the process is the **Gate Service Window. This process include:**

1. Verification of the Bill of Lading copies
2. Provide to the trucker the CMC ticket which contains the container number, yard location, chassis number and the trucker id information.

The container will go to AUPSA and Quarantine Windows in order to remove all the holds that maintain the system.

Finally, in this moment the **process of leave the container from the yard** starts. This includes:

1. Inspection of the container in order to generate the TR-entry document that the container is in good condition
2. Leave the container in the assigned yard position.

2.2 EMPTY CONTAINER TRANSSHIPMENT PROCESS BY TRUCK

- **Load to Truck Process**

This is an easier and faster process compared with the Full Transshipment Process. It starts when The shipping lines send to the trucking company via courier the Bill of Lading which contains the information/documentation of the port of origin (MIT) and the port of destination (PSA or BALBOA).

The truckers go directly to the gate window in the port of origin to retrieve the exactly position of the empty container.

Finally, the trucker take the container in the yard and leave the port.

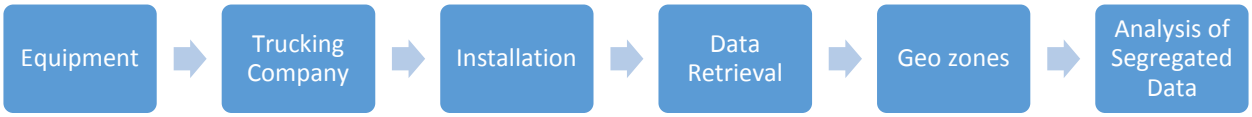
- **Unload from Truck Process**

The **process of leave the container from the yard** starts includes:

1. Inspection of the container in order to generate the TR-entry document that the container is in good condition
2. Leave the container in the assigned yard position.

3. METHODOLOGY

In order to fully track the Panama container Transshipment by truck it was needed to determine which are the most time consuming activities through all the operation. However by analyzing information of all kind of transshipment movement without the truck full detailed report of each one of the movement explained step by step may difficult a clear view of this operation, but due to the versatility provided by the Panamanian hub by combining drops and pick up of containers when arriving to the designated port makes any study of this kind really complex when trying to separate a full trip transshipment operation. Also the lack of cooperation shown by the trucking companies in Panama represent a huge barrier for any kind of study using a scientific method to measure their operations.



Methodology flow chart

For the tracking of transshipment by truck, the utilization of a GPS[1] device on the trucks to gain a full trip visualization and accurate information about the movement of container with its time and location through geo points (latitude and longitude). The ACP (Panama Canal Authority) provided four (4) TETRA radios SEPURA SRG3900[2] with a GPS module.

[1] Global Positioning System
[2] For more information see appendix; The Equipment

Figure 1 SEPURA SRG3900

Every reading will show real time information about the status of each truck through the ACP network which can only be manipulated through a machine inside the ACP building #712 Department of Radios and System, so any data retrieval could only be done in that specific machine for security issues.

Figure 2 Radio and System Department, building#712

The reason why it work this way is because the server manage all communication through the radios, which means confidential information for them. Then we proceed by doing some configurations to the equipment in order to meet a faster installation on the trucks without doing any alterations on the vehicles of the trucking companies.

Figure 3 Machine that was connected to the ACP server

After the equipment was set the next step was to choose a trucking company for the installation of the devices[3]. At the end the trucking company selected for the study was the one that was more willing to cooperate, so then with the help of Bless Truck representative all devices were installed on designated truck. Every week we schedule visits to the Bless Truck yard to see if anything have gone wrong with the equipment.

Figure 4 Bless Trucks

[3] For more detailed information view appendix; Equipment Installation

The reports generated by the Open GTS which is the software use by the ACP were is CSV. So they were all exported into excel files for easiest analysis. The GPS module develop on the radios installed on the truck send signals back to the ACP server every minute so each reading represent a minute. Next step was to set geo zones in order to determine critical areas during the trip were the waiting times were too big. This geo zones were created by setting a conveniently placed geo point and from there drawing a radius until the further one inside each one of this designated zones. Then this radius was placed inside of a formula to calculate distance between geo codes call the Haversine equation[4] so any set of geo point which distance were less than the radius belongs to that specific geo zone. This was especially important to the study because when analysis trip and looking for patterns that could be translated as critical zones. As we know the travel time doesn't change too much from one trip to another so we didn't create geo zones on the route instead we focalize the geo zones where the critical points or trucks stops readings where. In order to segregate the truck stops we took all the reading from the ACP server when the speed were less than 2km per hour as an stop, the reason why we took reading below 2km per hour is that due to the minute by minute transmission if two reading had a movement less than 2km it means that the truck was slightly moved from it position. Also there were times when the speed was around 0.6 km/hr which can be taken as a too slight movement where almost no change in positing have been made from one reading to another.

[4] More detailed information at the appendix; Haversine Equation

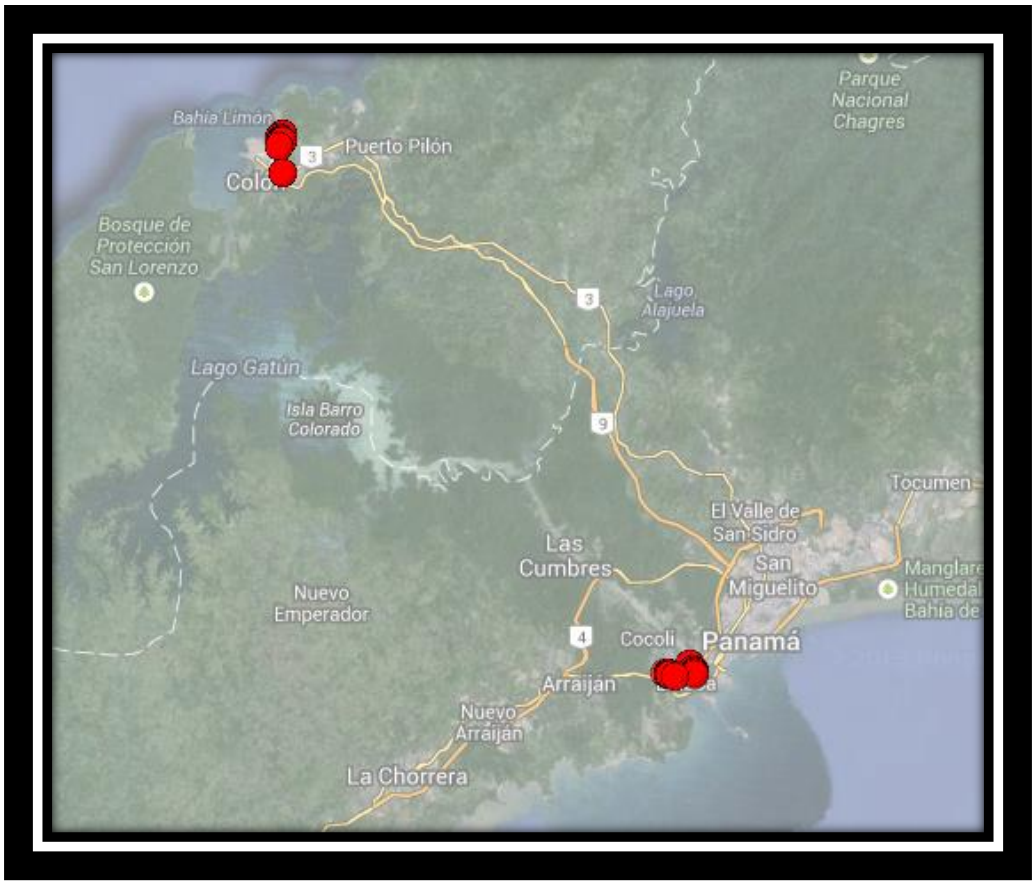


Figure 5 Plotted Stops

Another tool used on the study was the GPS Visualizer[5] which help us to visualize the trips in a more graphical way by plotting the movement of the container inside and outside of the designated critical zones. This tool was too important when trying to separate the paperwork from the upload and download operation at the yard, also to get a general idea of the truck movement inside the port and the traveling route taken when moving loads from Atlantic to Pacific coast.

With all the GPS data information segregated by trip and geo zones it was easy to visualize the critical point during a trucking transshipment. However it wasn't possible due to the policies of all the companies

[5] Adam Schneider, GPS Visualizer. URL; http://www.gpsvisualizer.com/map_input?form=data.

involve on the transshipment operation to have a more closely view of the whole process with a more precise separation at the paperwork on each port (customs, quarantine, etc.).

4. RESEARCH CONSTRAINTS

Before starting with the data analysis and results, it is important to mention all of the constraints/obstacles that were encountered during this project that lead to a smaller data sample for the study and a higher project rush which can imply leaving some details out. Besides that it is also important to point out the lack of importance, attention and/or support from many of the companies and organizations in Panama in regards of academic projects mainly due to the wrong ideology that this won't have any impact on their operations and financial situation at all. Here are the main constraints encountered:

- **No planning or forecast:** trucking companies have no planning or forecast for the transshipment orders, and this is due to a lack of information shared from the shipping line. Quoting interviewed personnel from different trucking companies:
  - Operations Assistant, Bless Trucks: "Unfortunately we don't receive any notification from the shipping line, at most we receive an email notifying us if there is going to be a high volume next month but nothing else".
  - Yard Supervisor, Transportes SOGRI: "We just get called as soon as containers need to be moved, sometimes they call us a day prior, sometimes a lot less".

  In addition, a conversation was held with an Operations Agent from APL[6] who mention that there is no forecast from their own, they may have some preliminary planning just to have an estimate on the volume that will be handled per month, knowing in advance that it is not accurate due to many events that can occurred such as port delays, ship delays, containers lost or left at sailing port, transportation request rejection from customers, among other fortuitous events.

- **Trucking companies and their drivers:** some of the trucking companies in Panama provide the container transshipment service (Bless Trucks, IMO, RODA S.A., InterTrans, SOGRI, etc.) but a few of them were reluctant to provide their help on this type of studies and others had a "not trustable" infrastructure and location so they were disregard from the study.

Figure 6 Trucking company with a not trustable image

Only 1 company, Bless Trucks, which has an acceptable truck fleet, security level and infrastructure, agreed to help out with the project. With this company, 3 main difficulties were encountered:

- **The group of drivers:** who even after a quick education session of the importance of our study, the huge positive impact that it may cause for their economy, and that they were not going to be economically impacted (salary reductions or penalties) by any result of our study, they still performed actions that interrupted the data transmission, e.g. disconnect the device from power source and not reconnecting it, hide the main antenna inside, etc.

Figure 7 Tracking device found hidden inside truck

- **No notification when transshipment order arrives:** for the equipment security, we adopted the rule of installing the equipment at the beginning of the week and/or as soon as there is an upcoming transshipment activity, and then picking it up at the end of the week and/or at the end of the operation. Therefore, knowing already that they have no forecast or planning for the transshipment operations, the company was requested to notify us as soon as they got that notification from the shipping line, but due to their intensive work in those moments they were unable to do so, leading to the loss of many trips for our study.
- **Incorrect trucks selected for equipment installation:** due to the problems encountered with the previous installation rule, a risky methodology of leaving the equipment installed on the trucks was adopted, so no trip would be lost at least from those vehicles but the yard coordinator assigned us few trucks that were scheduled for maintenance or different types of trips such as going to the countryside, without notifying us so this lead to many loss on transshipment trips too.

- **Data format and retrieval:** the equipment provided by the ACP was linked to their radio platform which is used for all their radio network in Panama. Since it is a highly busy platform, the GPS readings of our devices couldn't be more frequent than 1 every minute which may lead to lose some small details on the trips. Besides that we were only able to download data inside the network of the ACP through and authorized

- **Data collection time period:** the time period used to gather data from trucks travels was for only 1 month 1 week due to many activities that were needed to be done prior to start the data collection, as shown in the following Gantt chart.

Activity	May 12 - 18	May 19 - 25	May 26 - June 1	June 2 - 8	June 9 - 15	June 16 - 22	June 23 - 29	June 30 - July 6	July 7 - 13	July 14 - 20	July 21 - 27	July 28 - 31	August. 1
Getting Started (Establishing work method, Assign groups, Initial scope													
Full Explanation of the project and requirements, initial advisor/student meeting, initial equipment assignment, getting started with the equipment													
Looking for a new equipment for GPS tracking, proposal file elaboration													
Waiting for ACP aproval for SEPURA equipment													
Looking for initial antenna equipment installation method, Picking equipment on ACP, looking for additional rquipment for power source functionality													
Equipment Installation and Starting Data Collection													
Re Scheduling meetings with trucking companies for equipment installation													
Report and presentations elaboration													
Final Presentation and Final Report Deliver													

Project Gantt chart

As Soyoung Iris You mention on her paper titled “Methodology for Tour-Based Truck Demand Modeling”, she collected data for approximately 2 years, and it was done on a more advanced and educated environment, completely different to Panama in culture and infrastructure.

- **Equipment:** thanks to the support of the ACP, 4 tracking devices were loan to be used in the process of gathering data for the study, but after a few time it was realized that 4 devices were just not enough to collect a considerable sample of trips in the small time window that the project is entitled for, almost nothing compared to, mentioning again, the study of Soyoung Iris You.

- **Port policies and restrictions:** there is nothing that can provide a clear view an understanding of the process and locations as a live visit to the different areas involved on the operation such as the paperwork areas, yard areas, steps order, etc. but unfortunately due to the port policies, the truck driver is the only allowed to be in the truck and to enter the port facilities on it, no passengers allowed.

5. DATA ANALYSIS AND RESULTS

Since the change on the scope due to the low volume of movements from the trucking company, 2 complete trips from MIT to PSA and then to Balboa are presented on the next satellite pictures in order to clearly visualize the complete trip of the trucks.

Figure 8 Complete trips MIT-PSA-Balboa

Now, analyzing this 2 trips (Blue and Orange) per steps and areas, the following graphs were elaborated to understand on a numeric point of view what happens in most of the trips.

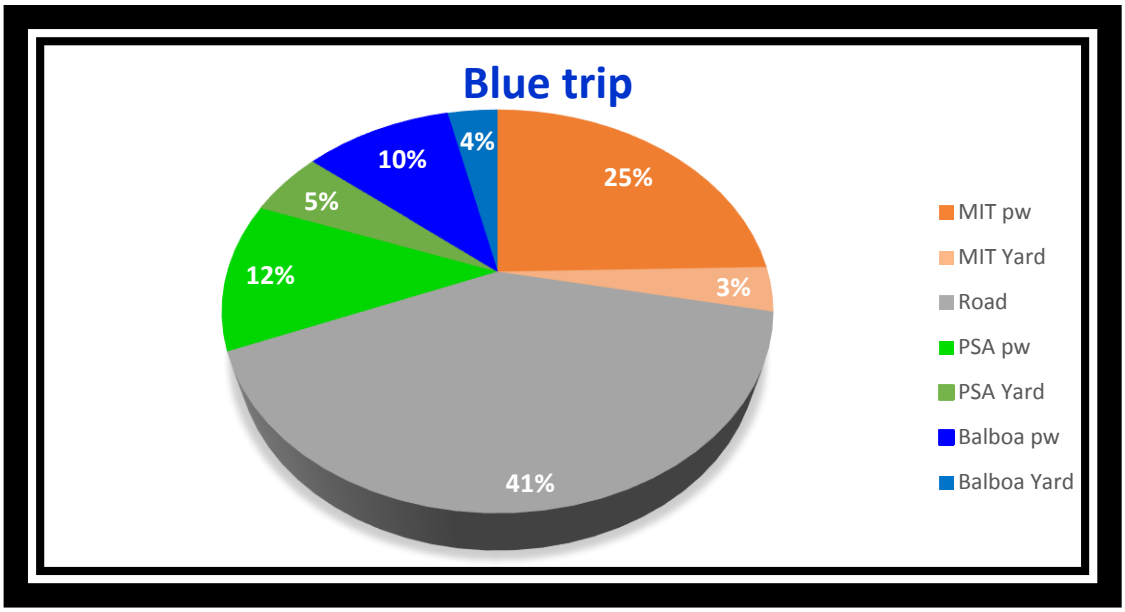


Figure 9 Blue trip time segregation per stage

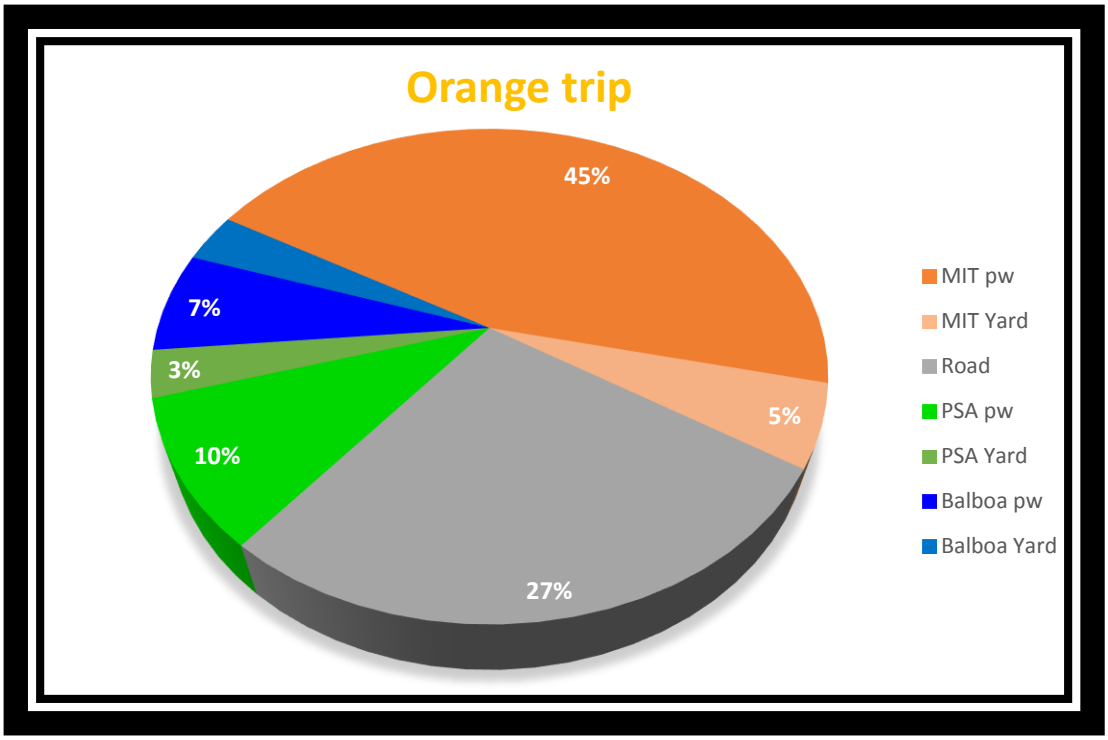


Figure 10 Orange trip time segregation per stage

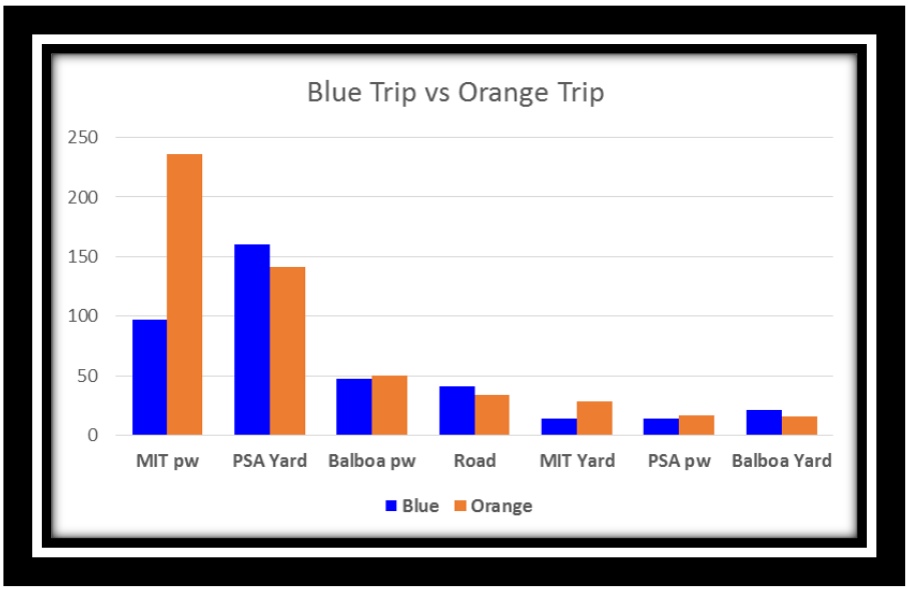


Figure 11 Orange and Blue trip comparison

These segregations were done for the 2 trips, Blue and Orange, that have a total time of 6 hours 34 minutes and 8 hours and 42 minutes, both covering the same distance of 105 km approximately, but why is the time difference if they cover the same distance? The answer is the many stops that the trucks encounter during the whole trip (in this case, the orange trip encountered a wait for approximately 4 hours which was due to a delay of the ship; these type of changes happens every week according to a contact on PSA). With the previous satellite picture we can't visualize where the critical time locations are or areas were the truck stays more time stopped. That can only be visualize with a filtered satellite picture of the stops only like the following one.

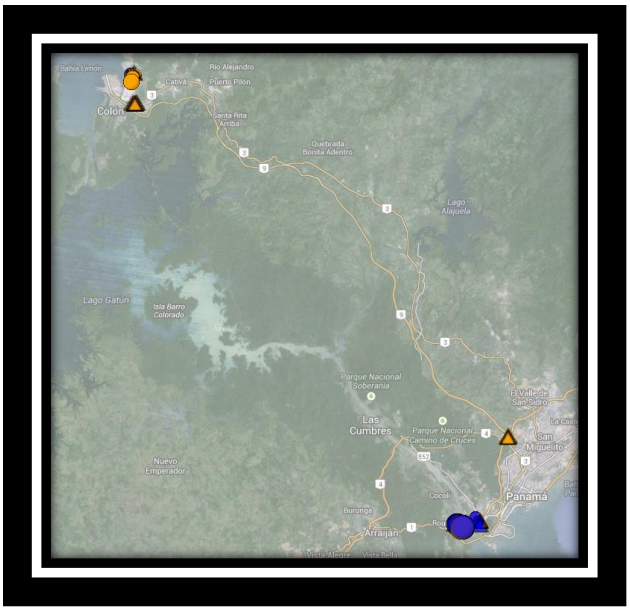


Figure 12 Stops on critical trip locations (Colon and Panama)

With the help of the picture and the support of the percentages graphs we can clearly observe that on these two trip samples the most time consuming areas in total are the **ports**, including the paperwork area and the yard area (load and unload of containers).

The study of the time on the ports needs to be separated in the 2 areas to understand if the main time consumption is due to extended government procedures or due to long port operations with the containers. With the following chart it can be clearly view which are the most time consuming stages on the different ports. It is important to mention that the following chart was done with sample of six trips.

PORT	PAPERWORK (min)	YARD (min)
MIT	83 ±91	20 ±9
PSA	29 ±18	16 ±4
BALBOA	38 ±5	16 ±2

Figure 13 Time in ports calculation and analysis (average and standard variation)

From the chart, we can imply that the paperwork stage takes up to 4 times more than the time in the yard, at least for MIT, and with a higher variation 110% more of the average time. These variations are mainly due to:

- Delays at ports (Customs, Ships, etc.)
- Congestion in ports: it means too many trucks moving inside the port at the same time, causing huge lines and higher waiting time.

Figure 14 Congestion in MIT

- Status of container (Full or empty): according to the interview made to the Operations Assistant from Bless Trucks, the paperwork for an empty container is “almost null” compared to the time that takes to process a full container in both pick-up and delivery process.
- Rain: bad weather conditions such as strong rains may delay quite a bit the operations at the port (not encountered during the study but mentioned by interviewed trucking company personnel: Operations Assistant and few drivers from Bless Trucks).

On the other hand, stating that the waiting time in ports is the most time consuming stage on the trip, is not completely accurate, it would be more accurate to establish that it has a higher variability due to the many facts that affect them and the Road trip stage is depending on the total time on the port could be greater than it but it has a lower variability and is affected by less factors that the port process. In fact as shown on the 2 trip samples shown above, road trip took 27% and 41% of the total time respectively, in this 2 cases it is less than the ports operations but as said before it is not the general rule. An average road trip stage takes 2 hours and 32 minutes with a standard variation of 31 minutes, which is due to:

- Traffic Jam: mainly depends on the hour that passes through certain areas, e.g. Centennial Plaza at 5:00 pm.
- Rain: strong rain periods may trigger a huge decrease on the speed of the truck which is translated in more road time.
- Accidents or Road maintenance.

Figure 15 Strong rain at the Colon-Panama road

There is only one strong bottleneck in the whole road that takes an average of 17 minutes per trip which is pointed on the following satellite picture. After a quick research it was discovered that in this area there is a gas station where at least 60% of the trips encounter this stop.

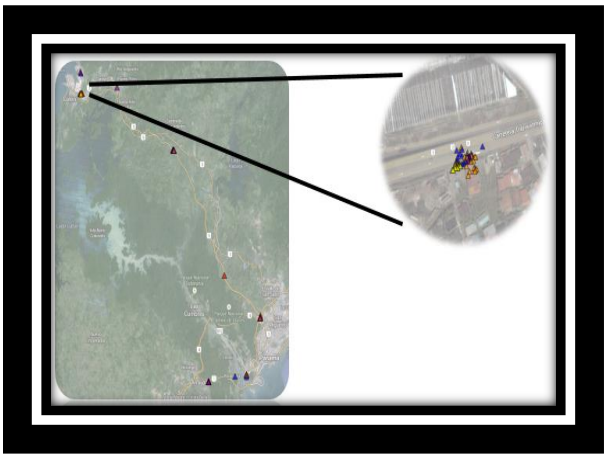


Figure 16 Main road bottleneck satellite picture

Figure 17 Gas station (road trip main bottleneck)

6. IMPLICATIONS

Having a no planning environment is quite a trouble because implies that the operation must be as precise and fast as it could be and having unexpected delays both at the ports and/or on the road may have some serious implications on the whole supply chain operation of the containers involved. In other words, it is a downstream chain effect that ends at the destination port. With that being said let's review this effect: if at the origin port, either at the paperwork or at the yard process, a delay is encountered, it will impact immediately the start time of the road trip which may incurred on traveling during peak hours in Panama where the traffic jam is real heavy and it may increase the regular road trip time 25% or more. In contrast, if the road trip start is delayed or during the haul encounters any of the previously mentioned causes of the road trip variation, it is translated immediately in delivering the container late to the sailing port which may imply:

- Ship sailing without the container: it happens once or twice a month at most
- Orders reprocessing
- Storage costs: Between $50 and $100 per container per day
- Penalties for the carrier and even for the trucking company
- Additional customs expenses to allow the container processing ($10 per hour per agent)

Another scenario is of a truck arriving late for picking up a container it will be automatically translated into late delivery of the required container causing all of the above consequences.

It is also important to mention that having delays on road trips and/or at the ports will also impact directly the trucking company reducing their trucks availability for further activities which reduces their incomes and increases their need for outsourcing many of the orders.

7. CONCLUSION

The transshipment by truck operation mode is a very advantageous way of moving containers as soon as needed thanks to the high availability of trucking companies willing to accomplish every received order, but as we already saw, the stage of moving the container itself comprises a considerable time period in the whole operation with a very low variation probability, it is imperative to address the only stage that can be improved in a short time period which is the port operation stage, in order to create a clear, provable and profitable image of the truck mode of the transshipment operations.

On the other hand, without the alignment and commitment of all entities involved such as customs, carriers, trucking companies, among others, it is almost impossible to improve the whole truck transshipment operation, giving chance to the loss of benefits such as:

- Increased importance and reliability of activities planning/forecast
- Optimized vehicles usage
- Optimized total operation time
- Reduced total operation cost
- Increased resources control (e.g. fuel, labor)
- Increased security

8. RECOMMENDATIONS

It is well known that changing or eliminating policies and/or governmental procedures is very complicated to pursue and even more on a very traditional nation like Panama but it is also well know that the paperwork process at ports needs to be optimized to reduce to the minimum the delays incurred so one quick and simple way to reduce delays on this process without much change to the "traditional method" is to increase the number of personnel in the customs, quarantine and AUPSA offices so more orders can be processed at the same time reducing the wait time and avoiding an unmeasurable increasing congestion. On the other hand, since we live on a technological world a change on the "tradition" can be pursued by implementing an electronic procedure to complete in advance all the paperwork needed at the port so when the driver enters the port only a quick check in must be done at the entrance validating the previously retrieved authorization for picking and/or delivering a container, e.g. implementing and upgrading a platform for all paperwork needed at the port so the drivers will have everything set up in advance and when the truck driver arrives the port entrance only a check in by a bar code reader to the papers would be enough to let him in to complete the operation, this will allow to expedite the process of the container transshipment and any other container movement by completely removing the manual paperwork process.

Being aware that with the current highways network and routes the road trip stage can't be optimized by new route designs, and that efficient traveling windows to avoid peak hours can't be applied on a regular basis due to inexistence of orders forecast, an approach to at least vanish the time spent at the gas station previously mentioned can be pursued by filling all trucks in order to be ready for any order and to plan on having an in-house fuel reserve tank so fuel needed trucks can be refilled and avoid the gas station time.

But again, it is important to remark that none of the possible solutions, that can come out to try to optimize the total transshipment operation time, will succeed unless all entities involved on the operation

from trucking companies up to high government and port authorities get integrated and committed to increase its efficiency.

To make a quick proof about the importance and impact of the optimization on the paperwork process and also of removing the bottleneck of the road trip stage, here we can appreciate a quick simulation with the total time of a truck moving from MIT to PSA for a single operation (picking container in MIT, delivering at PSA, picking again on MIT and delivering at PSA) with the usual 10 hours window that the ports offers their services.

Trips simulation: Red (Not optimized) and Green (optimized)

It is clearly shown that without the optimization it is not possible to deliver the 2 containers on PSA (using average time measurements) using the same truck but with the optimization applied it is possible to complete both orders plus it still has a time surplus for any unexpected delay on the road. These clearly represents a desirable and important benefit to take in consideration when choosing the transportation mode to complete the transshipment operation.

9. FUTURE CONSIDERATIONS

- Increase data collection time for bigger and more detailed trips samples.

- Increase number of tracking devices and develop methods to avoid transmissions sabotage.

- Motivate integration between entities involved to look for increase on efficiency and volume, and reduced costs.

- Consider new transshipment modes (e.g. by small ships)

10. REFERENCES

- MIT: Manzanillo International Terminal: http://www3.mitpan.com/
- *Excel Formula to calculate distance between 2 latitude, longitude (lat/lon) points (GPS positions)*. Retrieved from BlueMM: http://bluemm.blogspot.com/2007/01/excel-formula-to-calculate-distance.html.
- Georgia Tech Logisticas Innovation & Research Center. *Trucking Transhipment Service.*
- Georgia Tech Logistics Innovation & Research Center. Retrieved from PSA Panama International Terminal: http://logistics.gatech.pa/es/assets/seaports/psa-panama-international-terminal
- Panama Ports Company. Retrieved from Balboa: leading port of Latin America: http://www.ppc.com.pa/balboa.php
- *Ports & Maritime Industries*. Retrieved from Business Panama: http://www.businesspanama.com/investing/opportunities/ports_maritime.php
- *Vision Engineering Group Jordan*. Retrieved from Sepura plc: http://visionengineering.net/index.php?option=com_content&view=article&id=92:sepura-plc&catid=42:partners&Itemid=74
- You, S. I. (2013). *Methodology for Tour-Based Truck Demand Modeling.* Irvine.
- Zhao, E. M. (2011). *GPS Truck Data Performance Measures Program In Washington State.*
- CEPAL. (2012). *Sistemas inteligentes de transporte en la logistica portuaria latinoamericana*.
- Interviews with:
  - *Operations Assistant*, Bless Trucks
  - *Yard Supervisor*, Transportes SOGRI
  - *Operations Agent*, APL

APPENDIX

The Equipment

The equipment used for this project were the SEPURA SRG3900 TETRA mobile ratio.

Talking about the SEPURA Company is a well know English company, supplying telecommunications equipment to more than a hundred (100) countries (Western Europe, Eastern Europe, Middle East, Africa, Asia Pacific, Caribbean and Latin America) and their reputations was confirmed by the BDBOS (the German Federal Agency for Digital Radio of Security Authorities and Organizations) due to their reliable security system and excellent performance. They have been awarded with the ISO9001[1] in 2008 and ISO14001[2] in 2004 certificates for its Management Systems and have the largest range of TETRA radios, supporting every TETA frequency band due to their focus on TETRA technology. For this same reason they are commonly used by public safety (police, firefighter, ambulance, etc.). In fact the ACP[3] address the SEPURA's radios as a precise, reliable and durable equipment.

TETRA stand for Terrestrial Trunked Radio which is an open standard for digital mobile radio communication that allow a two way transceiver, as it's commonly known "walkie talkie". This technology was originally used by the European Union government and public safety agencies. Some of the advantages provide by the TETRA technology over others are:

- The low frequency permits a very long geographic coverage with smaller number of transmitters, which will lower the cost of infrastructure.
- They provide a tight security by using encoded voice encryption algorithms.
- Enable a one to one trunked radio link without the need of a control room operator/dispatcher.
- They are built to not only provide a one to one service but also a one to many and many to many communication, this is really helpful for public safety and professional users.

The SRG3900 model offers adaptability to any vehicle due to the design of the radio who is rated IP67 protection, which means that the device is resistant to dust and water. These devices comes with a GPS module optional for development.

Some other key features apart from their durability, accuracy and the above mentioned advantages provide by the TETRA technology are:

- The 10 watts power connector which comes in handy to these radio because is not that much and won't present any risk for the vehicle where they are installed. In fact thanks to this characteristic we were able to adapt to the power cable of the radios a cigarette lighter connection for faster and easier installation on the trucks.
- The radios provide an easy installation, because as soon as you plug in to the cigarette lighter "in our case" the radio will start transmitting signals to the server.
- Another important feature to mention about these devices is that the radio can be separated from the control console and it will still transmit signal to the main server. In particular it was helpful to the study because the GPS module doesn't need to be operated though the control panel because as soon as the console is plug in to the power it will automatically start sending signal to the server.

Figure 1 SRG3900 control console

The Control console that was not provide by the ACP because it wasn't needed for the GPS module to work.

Usage of these radios at the ACP are basically for internal communication within their personnel and the feature of the GPS module was develop by the department of Radio Systems in order to keep a continues tracking over the locomotive and tugboat drivers. The development of the GPS module on the SRG3900 radios was an initiative of this department using Open GTS software to manage the GPS data of all the vehicles with the radio installed.

Figure 2 Radio and System Department, building#712

It’s important to mention that the department of Radio Systems set a configuration on the GPS signal reports to every 3 minutes in order to avoid saturation of the network that was not only used for this purpose but also for radio communication of their personnel. For the study the 3 minute configuration was too high when trucks were moving inside of critical points like the ports due to the proximity between the yard and the paperwork so three minutes there could be a huge change on position if the truck is moving and also but not less important the stops through all the road trip. These lost data could be a significant source of information to understand the characteristics of the trips for easiest separation of each kind of transshipment done, patterns, critical stops and analyses the route itself, so a request to lower the time between readings was done to the ACP.

The Engineer Jose Manuel from the ACP was the one who decrease the time between reading to one minute and also create a separate login account into the open GTS using the same server but the Open GTS would retrieve the designated equipment into a different logging account for confidentiality issues and easiest data manage. From this account ACP provided full manipulation of GPS data readings and retrieval, however the other features of the software as geo zones creation or manipulation of the surveys were not available for changes.

The ACP had some geo zones created but they were configured to their needs meaning that each one of these places just represent an approximation of the movement when entry and exit a zone. The study needed more detailed zones and for these reason the utilization of the already existing one were not taken into consideration when analyzing the reports issue by the Open GTS software.

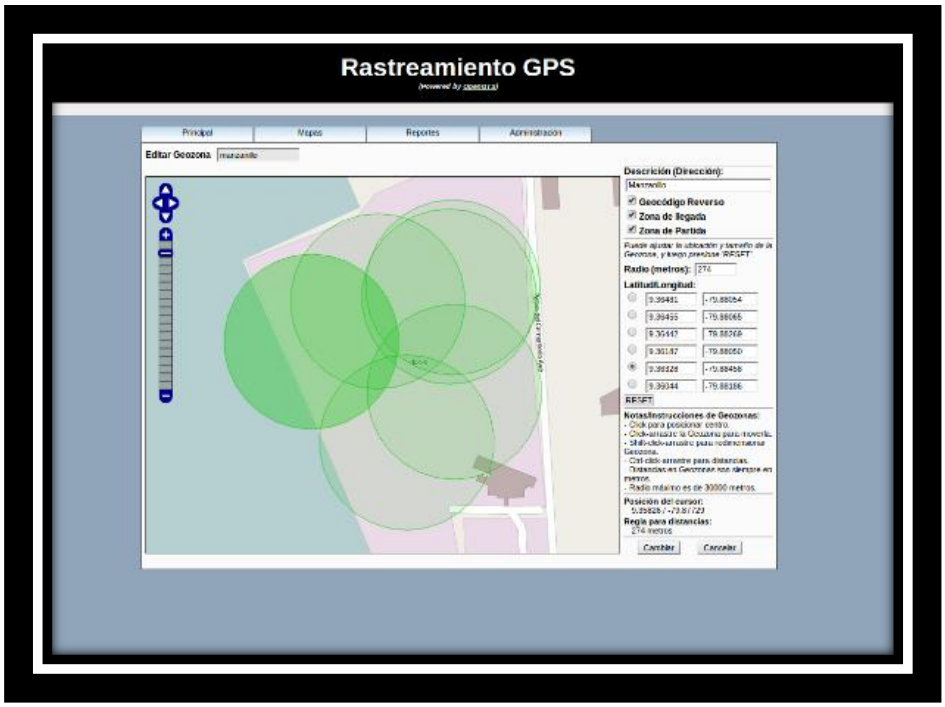


Figure 3 Open GTS geo zones set by the ACP department

Figure 4 the four SRG3900 provided by the ACP

Each box came with the radio SRG3900, the GPS antenna, the power connection and the base to attach the radio to the base of the vehicle in order to avoid strong movement that may cause the disconnection of the cables connected to the radio.

Figure 5 View of the boxes provided by the ACP

The first TETRA antennas that were supposed to be provided to us were long and the base needed to be fixed to the roof of the vehicle with screws-on. This base didn't meet the requirement of the study on the interchangeable installation. Then ACP manage to adapt other antennas with a magnetic base so that they could be easily set on the top of the roof of the vehicles. Normal installation for these antenna was to open a hole on the roof of the vehicle in order to give a strong support so that the antenna stay pointing directly to the sky and provide the best signal at all times. This couldn't be done for the study because with only four equipment and the unscheduled demand an easy interchangeable device was needed.

Figure 6 First base shown by the ACP

Figure 7 TETRA antennas with magnetic base

The radio were given a codename (mula#) which means Truck&number, this was not only written on the top of each radio but also inside of the ACP platform use for GPS tracking.

Figure 8 Specification

Figure 9 GPS antenna

The power connection of the equipment needed to be change in a way it could be easy adapted to the vehicles without the need of doing any direct connection to the battery, but due to the characteristic of the study a more portable way was created by using the cigarette lighter connection of the trucks. This

was the most easiest, faster and reliable way because the led red light on the cigarette lighter connection will show if the radio is receiving power.

Figure 10 Cigar rete lighter adapter

With five (5) repeater located on different point through the canal area it is possible to receive reading from La Chorrera (west of the Panama City), Tocumen Airport (east of the city) and Colon (south of the city). The repeater are located in five mountain Ancon (city of Panama), Gordo, Pelaos (Gamboa), Esperanza (Colon).

Figure 11 The circles represent the coverage of the ACP antennas

The Equipment Installation

For this part of the study first we need to arrange a date of meeting with one of the company interested on the study. All the contacted trucking companies where located in Colon so a schedule was needed in for equipment installation. At the beginning the equipment installation was supposed to be triggered through phone call to see if there was any movement, however this method could never be used due to the characteristic of the transshipment operation in Panama. It occurs at any moment without any planning ahead, instead with help of the representative of Bless Trucks four truck were taken for the

installation of the radios, because all trucks are supposed to be used for transshipment when needed so there were no exclusive trucks designated for the operation.

The four Truck taken for the study:

Figure 12 Mula1/Truck1

Figure 13 Mula2/Truck2

Figure 14 Mula4/Truck4

Figure 15 Mula3/Truck3

Even though the radios were assigned to fixed truck, every week visits were made to the yard in order to inspect the equipment just to make sure everything was going according to the plan and nothing have gone wrong with it. There were also time when looking to the ACP data, it presented that the truck stand

still at the yard through all the week or the signal was lost from a few days which could meaning that something went wrong with the equipment.

Figure 16 Bless Truck Yard

The installation of the equipment was really easy thank to all the configuration done so it wouldn't take more than 10 minutes depending on the availability of the trucks. The first constrain was the fact that all the truck were made of a resistant fiber and not metal, making it impossible to position the TETRA antennas on top of the roof of the Truck as the members of the department advice to do. The solution found was to locate the antennas on the back of the truck where there is part of the body that is made of a metallic alloy.

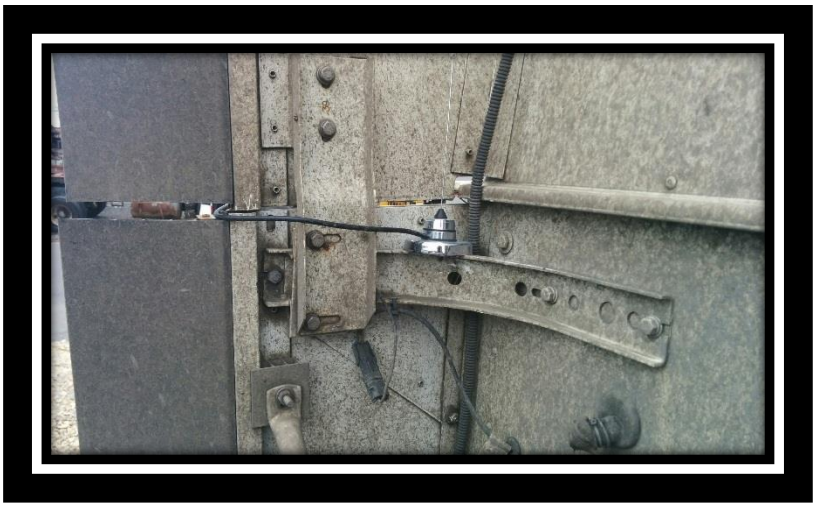


Figure 17 Installation of the TETRA antennas

Then the GPS antennas needed to have a clear view to the sky at all time in order to take at least 3 satellites to start providing GPS location back to the ACP server, however they didn't need to go outside of the vehicles as the TETRA. They were easily located inside of the truck on the dashboard or slicked to the windshield of the truck.

Figure 18 Installation of the GPS antenna

The radio of then is located inside of the truck behind the passenger's sits, which is never use due to company policies so no movement of this sit may never cause the cables to disconnect. First we set the cigarrete lighter connection to see if the red led light turns on which means that there is power going through the cable, after proving that the power source is working we proceed on connecting all the other cables to the radio like the TETRA and GPS antenna.

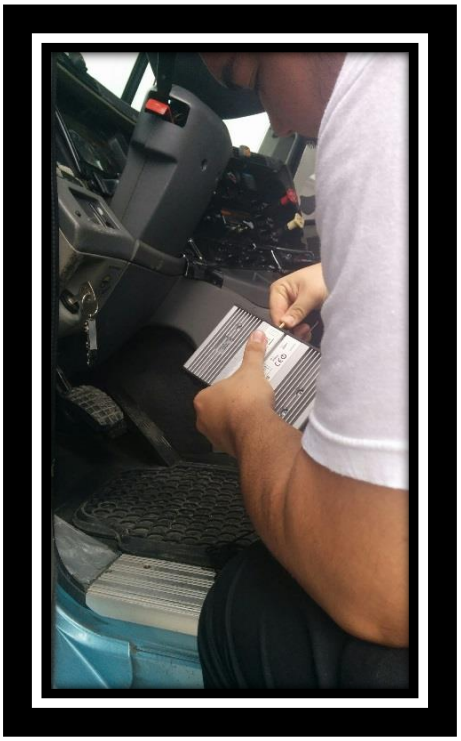


Figure 19 Installation of the Radio

Data Retrieval

All the reading transmitted to the ACP server and them managed by the Open GTS could only be access through a computer at the ACP building# 712 department of Radio and System, so an updated or real time visualization of the movement of the truck through the platform at any time, wasn't possible. An arrangement with a representative of the Department of Radios and System was set every time a data

retrieval or monitoring of the trucks GPS readings was needed. This represent a constrain to the study because if by any change one of the Truck used wasn't moving because it enters maintenance and because the scheduled visits to the ACP once every week were not enough to maintain these issues under consideration many trip suffer these maintenance issue.

The reports were extracted on CSV format with an index, date, time, status, geo point, speed, altitude, odometer and address information.

```
"index","date","time","statusdesc","geopoint","speedh","altitude
","odometer","address"
"1","08/07/2014","09:04:07
PM","............","9.36926/-79.87902","0","0","233","Manzanill
o"
"2","08/07/2014","09:05:07
PM","............","9.36923/-79.87903","0","0","233","Manzanill
o"
"3","08/07/2014","09:06:07
PM","............","9.36922/-79.87901","0","0","233","Manzanill
o"
"4","08/07/2014","09:07:07
PM","............","9.36925/-79.87897","0","0","233","Manzanill
o"
"5","08/07/2014","09:08:07
PM","............","9.36925/-79.87896","0","0","233","Manzanill
o"
"6","08/07/2014","09:09:07
PM","............","9.36927/-79.87898","0","0","233","Manzanill
o"
"7","08/07/2014","09:10:07
PM","............","9.36928/-79.87898","0","0","233","Manzanill
o"
"8","08/07/2014","09:11:07
PM","............","9.36929/-79.87898","0","0","233","Manzanill
o"
"9","08/07/2014","09:12:07
PM","............","9.36929/-79.87897","0","0","233","Manzanill
o"
```

Figure 20 Example of the raw data retrieve

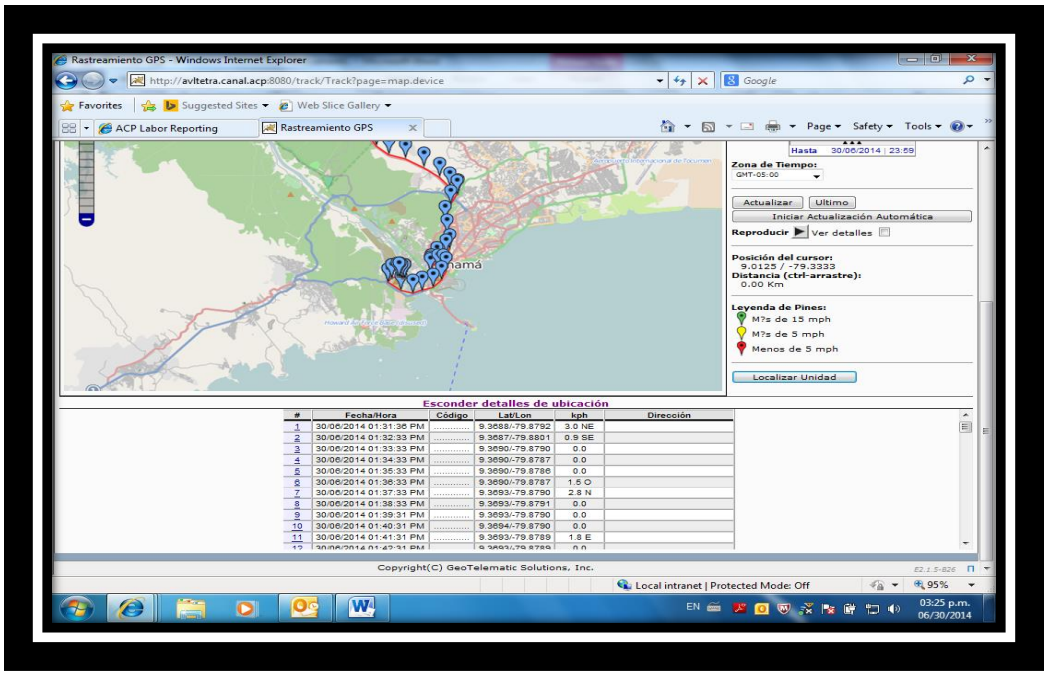


Figure 21 Example fo the platform Open GTS

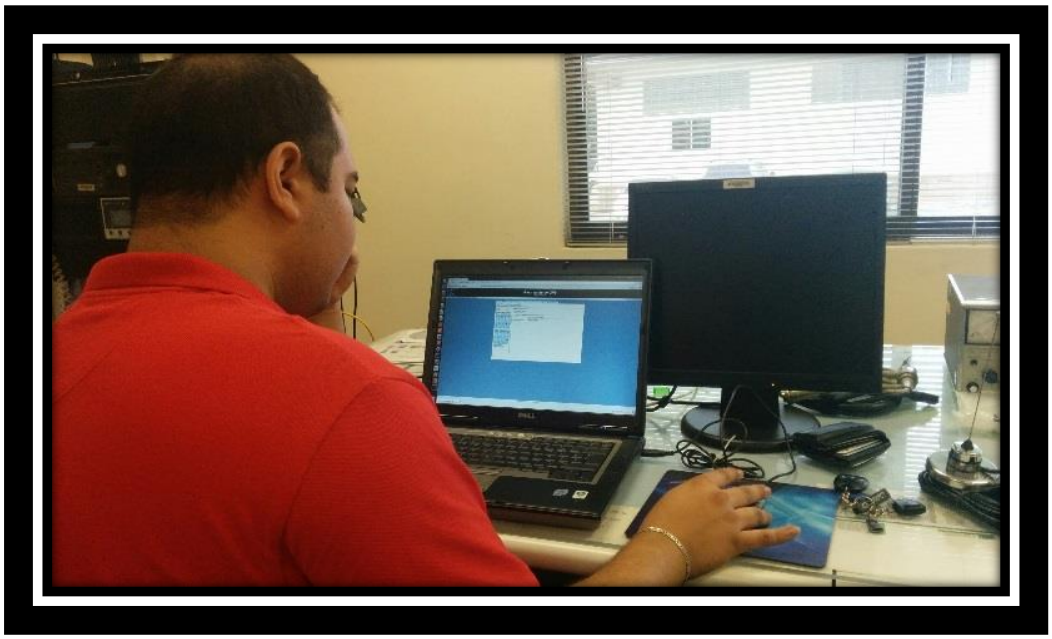


Figure 22 Retrieving data from the ACP server through the only authorized machine

Creation of the Geo Zones

The Open GTS software provided geo zones arrange by the ACP department of Radios and System, even though this help to identify an approximation of the movement of the trip for the study it was needed a more accurate geo zones in order to clearly separate the internal zones inside the port.

For these operation there were chosen convenient geo point on every critical area that present a huge amount of reading over the same location through different location. Most of these points fall under the places set before hands as the places where is more likely to have a long waiting time (ports).

The first geo point set was the Bless yard, because due to the fact that the study was done through one company it was import to set start and finish line in order to easiest separation of the trips.

The point 9.36906, -79.87882 was the geo point used to set the first geo zone with a radio of 70 meters. The radio of the geo zone was set by looking at all the readings and finding the maximum scatter point of a truck at the yard.

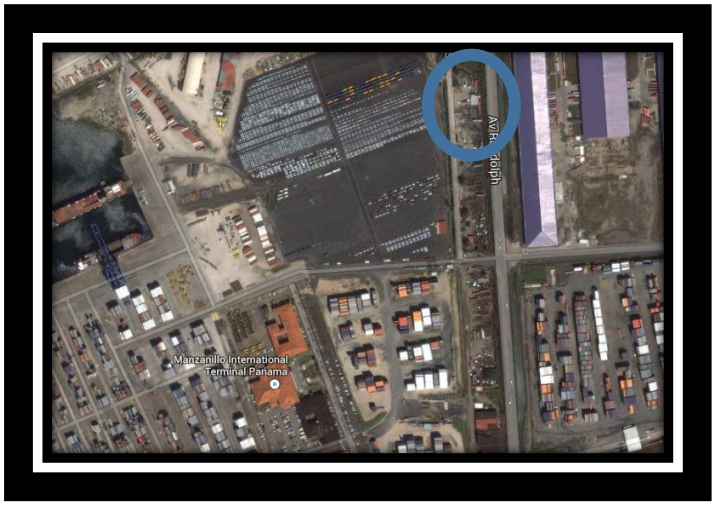


Figure 24 Bless Truck location

It is a fact that the error of the GPS module on the truck could be up to ten point, however this was not always true because how clear the sky is an important characteristic for this to be through and in Colon raining or just a cloudy day is a normal set any time of the day. There is also another case seen at the Bless yard, when all the trucks stays at the yard due to slow volume of shipment the area designated for parking wasn't enough for all the fleet so sometimes the truck were parked a little bit further from normal readings at the Bless yard, almost as if there weren't inside. However none of these event affect the study because the yard is only to make it easier for us to set the starting and the finish point of the study, so the waiting and the slight movement wasn't took into account. As it can be visualize on figure XX the Bless yard is really close to the MIT yard but thanks to the fact that the piece of yard close to Bless is use for parking of vehicles that comes into the port through Ro-Ro ships meaning that in case of a transshipment operation no truck should ever go to this zone.

Then there are the Port that were taken into consideration for the study; Manzanillo International Terminal (Atlantic), PSA International Terminal (Pacific), Balboa Port (Pacific). This three port, due to the scope of the project were separated into paper work and the yard. This separation was possible through the study of the report retrieved at the ACP which shows a pattern of a truck on standby at the entrance of the port and them moving to the yard, but also the representative of Bless draw a layout of Manzanillo Port and explained the approximate

location of the entities inside the port. With this we corroborate and saw that the pattern shown by the GPS reading where closely related to the draw and the explanation given by Bless.

For MIT paperwork we use the geo point 9.364899, -79.880137 with a radio of 250 mts, MIT yard was separated into three due to the size; yard(1) 9.36396, -79.88374 with 218mts, yard(2) 9.35989, -79.88193 with 218mts, yard(3) 9.35643,-79.88129 with 121mts. Another reason why the yard was divided into three was to the fact that the Colon Free Zone is connected to the yard(3).

Figure 25 MIT; blue is paperwork, yellow is yard and green is the Colon free Zone

For the Pacific coast we have Balboa and PSA these two port are in front of each other. The difference in size of these two port is notorious but also the fact that the transshipment through train is been monopolize by the Balboa port on the Pacific coast due to the proximity. It is shown on the movement given by the reading that demonstrate that most of the transshipment done during these month of low volume where from MIT to PSA.

Figure 26 Pacific Ports

The PSA International Terminal was easier to set than the other ports thank to the layout it has a clear separation of the yards and the paperwork. For the paperwork we set the geo points 8.9575, -79.58015 with a radio of 150mts and the yard with the geo points 8.95533, -79.57636 with radio of 180mts. Another thing to take into consideration is that between the yard and the entrance of the Port there is a street connecting them so it helped when the zone creation was made.

Figure 27 PSA Port; blue is paperwork and green yard

Then by last the most troublesome one due to the low volume and almost none complete transshipment trip to the Balboa Port. The setting of the paperwork and yard was done through the assumption we made by studying the trips. The paperwork geo point 8.95895, -79.56065 with a radio of 150mts and the yard geo point 8.9629, -7956403 with a radio of 430mts.

Figure 28 Balboa Port; the green represent the paperwork and the blue he yard

There were some zones on the port that weren't include on the geo zones. First on the lower left of the port is located the place where Ro-Ro ship download cars and also the workshop, so it's less probably to see a transshipment to go that way.

Haversine Equation

This was the equation used to calculate the distance between the convenient geo point set in order to evaluate all points near to see if they enter on the radius already set for the specific geo zone. Really

simple equation that would give spherical distance between two latitude and longitude. This distance doesn't take into consideration hills, or mountains.

We use an excel formula for this equation where R= radius of the Earth in meters

ACOS(COS(RADIANS(90-LatA))*COS(RADIANS(90-LatB))+SIN(RADIANS(90-LatA))*SIN(RADIANS(90-LatB))*COS(RADIANS(LongA-LongB)))*R.