

The Kronos Incident - Geospatial Data Analysis

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We were tasked with investigating a fictitious scenario of kidnapping. *GAStech* (GT), a company operating in the city of Abila, in the Island of Kronos, had key executives go missing and authorities suspect an environmental group named *Protectors of Kronos* (POK) played some role in this incident.

Various records for the two weeks leading into the incident were provided so we would investigate and provide an hypothesis to what happened during the incident, and back them with the results of our analysis. We had no data from the day of the incident.

The geospatial data was the core of our investigation, alongside supporting data from credit card purchases and loyalty card uses.

Dataset Description

We were provided four independent data sets, in addition to the geospatial data related to the city of Abila. These dataset likely came from independent sources given that they did not share a common key, and had differences in formatting.

The geospatial data, while sufficient for our study, lacked points of interest (POIs) which are commonly found in other similar geospatial datasets.

cc_df.csv

This is the credit card transaction data, including merchant, date, time and amount spent, alongside the first and last name of the person running who owns the card that was used, 1491 records exist.

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gps.csv

This provides the tracking data for each of the individual corporate vehicles from GT that are assigned to fixed employees. The dataset has a timestamp precise to the second, along with latitude, longitude and the vehicle id, spanning almost 700,000 records.

loyalty_data.csv

This dataset, similar to *cc_df.csv* has the loyalty card uses, with a simple date (no transaction time is present), value, merchant, and first and last names.

car-assignments.csv

This last comma-separated value dataset, is the smallest of the group, and maps the employees to their respective company-owned vehicles, alongside their job title and internal group. A few employees, all truck drivers, do not have a permanent car assigned to them.

Abila.dbf and Kronos_Island.dbf

Kronos_Island.dbf and Abila.ddf are both shape files that can be used with Geospatial programs and GeoPandas. Kronos contained an outline of the Island, while Abila contained a street map of the city of Abila.

Investigation Strategy

The investigation had two main areas to be explored, the geospatial data analysis, working on parsing the files and making them work in tandem with the provided GPS data, and the transactional data. We've explored these two fronts in parallel aiming to have two major tools that would allow us to perform our investigation.

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People Profiler

The People Profiler's purpose is to generate a common key amongst all CSV datasets, extract meaningful information and relation from them, present it to the user, and respond to queries related to shopping habits.

Last but not least, it also runs a simple *LocalOutlierFactor* model on the transactions, attempting to surface seemingly suspicious transactions which may not have been easily identifiable by the main profiler routine.

Most of the queries were simple data frame manipulations, while the most complex queries were translated to *SQL* and performed via *sqldf*.

Here is a sample report from one individual employee, Orham Strum:

- *First name: Orhan*
- *Last name: Strum*
- *Title: SVP/COO*

- *Spending Pattern:*
- *Total spent: 2212.51*
- *Avg spent/day: 158.04*
- *Median purchase: 31.2*
- *Number of purchases: 34*
- *Average purchases/day: 2.43*
- *Top 3 days with most purchases:*
- | | count(*) | date |
|---|----------|------------|
| 0 | 3 | 2014-01-18 |
| 1 | 3 | 2014-01-15 |
| 2 | 3 | 2014-01-13 |

- *Top 15 purchases:*
- | | timestamp | location | price | loyalty |
|---|---------------------|------------------------|--------|---------|
| 0 | 2014-01-12 03:39:00 | Kronos Mart | 277.26 | 0 |
| 1 | 2014-01-18 15:40:00 | Shoppers' Delight | 258.33 | 1 |
| 2 | 2014-01-18 18:59:00 | Albert's Fine Clothing | 226.49 | 1 |
| 3 | 2014-01-19 12:41:00 | Desafio Golf Course | 150.07 | 1 |
| 4 | 2014-01-12 13:32:00 | Ouzeri Elian | 117.22 | 1 |
| 5 | 2014-01-18 13:04:00 | Abila Zacharo | 111.93 | 1 |
| 6 | 2014-01-08 13:21:00 | Ouzeri Elian | 109.73 | 0 |
| 7 | 2014-01-11 19:27:00 | Albert's Fine Clothing | 105.33 | 1 |
| 8 | 2014-01-13 21:27:00 | Hippokampos | 99.63 | 0 |
| 9 | 2014-01-14 12:00:00 | Jack's Magical Beans | 95.70 | 0 |

- *Average purchase per location (top 10):*
- | | location | avg(price) |
|---|------------------------|------------|
| 0 | Kronos Mart | 277.26 |
| 1 | Shoppers' Delight | 258.33 |
| 2 | Albert's Fine Clothing | 165.91 |
| 3 | Desafio Golf Course | 150.07 |
| 4 | Ouzeri Elian | 113.475 |
| 5 | Abila Zacharo | 111.93 |
| 6 | Hippokampos | 37.34 |
| 7 | Katerina's Café | 33.39 |
| 8 | Guy's Gyros | 33.00 |
| 9 | Jack's Magical Beans | 31.42 |

- *Loyalty Pattern:*
- *Number of loyalty purchases: 22*

- *Top 3 loyalty purchases:*

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- | | <i>timestamp</i> | <i>location</i> | <i>price</i> |
|---|---------------------|------------------------|--------------|
| 0 | 2014-01-18 15:40:00 | Shoppers' Delight | 258.33 |
| 1 | 2014-01-18 18:59:00 | Albert's Fine Clothing | 226.49 |
| 2 | 2014-01-19 12:41:00 | Desafio Golf Course | 150.07 |
- *Suspicious loyalty purchases:*
- *Unmatched!* Day: 2014-01-06 Jack's Magical Beans 7.84
- *Unmatched!* Day: 2014-01-08 Ouzeri Elian 29.73
- *Unmatched!* Day: 2014-01-13 Hippokampos 39.63
- *Unmatched!* Day: 2014-01-14 Jack's Magical Beans 15.7
- *Unmatched!* Day: 2014-01-15 Jack's Magical Beans 4.06
- *Matched!* Day: 2014-01-19 Ouzeri Elian 45.32 w/ Sven Flecha
- *Driving Pattern:*
- *Distance driven:* 212.09km
- *Avg driven/day:* 15.15km
- *Breakdown per day:*
- *Distance driven on day 6 :* 21.88km
- *Distance driven on day 7 :* 16.94km
- *Distance driven on day 8 :* 10.05km
- *Distance driven on day 9 :* 16.38km
- *Distance driven on day 10 :* 16.99km
- *Distance driven on day 11 :* 17.35km (Weekend)
- *Distance driven on day 12 :* 9.41km (Weekend)
- *Distance driven on day 13 :* 18.24km
- *Distance driven on day 14 :* 12.39km
- *Distance driven on day 15 :* 20.58km
- *Distance driven on day 16 :* 17.84km
- *Distance driven on day 17 :* 14.19km
- *Distance driven on day 18 :* 12.98km (Weekend)
- *Distance driven on day 19 :* 6.82km (Weekend)

Mapping Tools

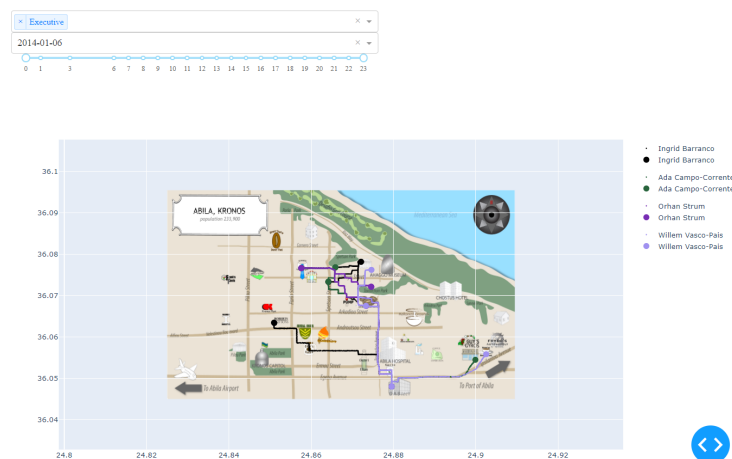
After examining the provided data, we discovered that the Abila Shape data was an exact match with the tourist map. This led us to make the decision to incorporate the GPS file in conjunction with the tourist map for our analysis.



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To further enhance our investigation, we added stop data to the GPS file by identifying entries that had a time lapse of more than 5 minutes until the next stop. We also merged the employee data into the file for a more comprehensive view of the data. Unfortunately, the truck data was missing, so we had to improvise by reviewing the truck routes and credit card purchases to assign trucks based on this information.

We then developed three interactive dashboards using *Plotly Dash* to explore the GPS data in greater detail. The first dashboard allowed us to view the data by name, date, and time. The second dashboard was organized by employment type, date, and time. The third dashboard presented the data by employee and displayed all dates and routes taken.



We also utilized the Local Outlier Factor algorithm to identify stops that were worth investigating in detail. Overall, our investigative approach was successful in identifying important leads and gaining valuable insights into the Kronos Incident. Specifically, this analysis found many late night stops which we further investigated.

Data Preparation

The biggest challenges in preparing the data was dealing with multiple datasets lacking a common key, and timestamp inconsistencies, making it difficult to perform time related queries.

Last names were the first idea developed to standardize a key, but there are instances of multiple employees sharing a last name. The company car ID would work for most employees, but truck drivers lack a fixed ID, those having to be inferred and tracked on a new, separate dataset (*truck-assignments.csv*). First + last name was then chosen to be the common key, being inferred and populated across all data sets.

For timestamp inconsistencies, a full time + date timestamp was developed and standardized across the board, having missing information in this field defaulted to zero.

There was an error in the Abila file that was corrected by removing a single point reference using ArcGIS.

Our Theory

Through analysis of credit card, loyalty card data, we were able to paint a picture of the daily lives of the GT employees. From the data gathered over two weeks, some patterns emerged to give a suggestion to what happened to the missing executives.

From the discrepancies we believe the executives were kidnapped by a group of people working in the security department for the company.

We have evidence to show that this was planned over the two weeks prior along with who is involved. We also found other discrepancies to look into for a thorough investigation.

Data Analysis

Once our tools were mature enough to perform the analysis, we ventured off into analyzing each individual profile, trying to determine what a normal routine in the life of a GT employee was, and find out relevant events, which we could then construct our theory of the kidnapping incident upon.

We will list the daily routine of the employees alongside twelve significant events/deviations from the norm, showing the data backing up our claims, our hypothesis to what is happening, and whether the event could be related or not to the kidnapping incident.

For each event, we will highlight who was involved, what locations did it happen, when, why, and our confidence level.

Daily routines

Employees leave to work between 6 and 8AM, most of them have a favorite coffee shop (Abila seems to be a big coffee consumer, both by the consuming habits and by the fact they have eight different, specialized coffee shops in the small city).

After arriving at work, most leave for lunch around 12PM, some making stops for groceries and alike, finally returning to work around 1PM. After work, employees leave around 5PM, some stopping for small shopping/groceries before returning home.

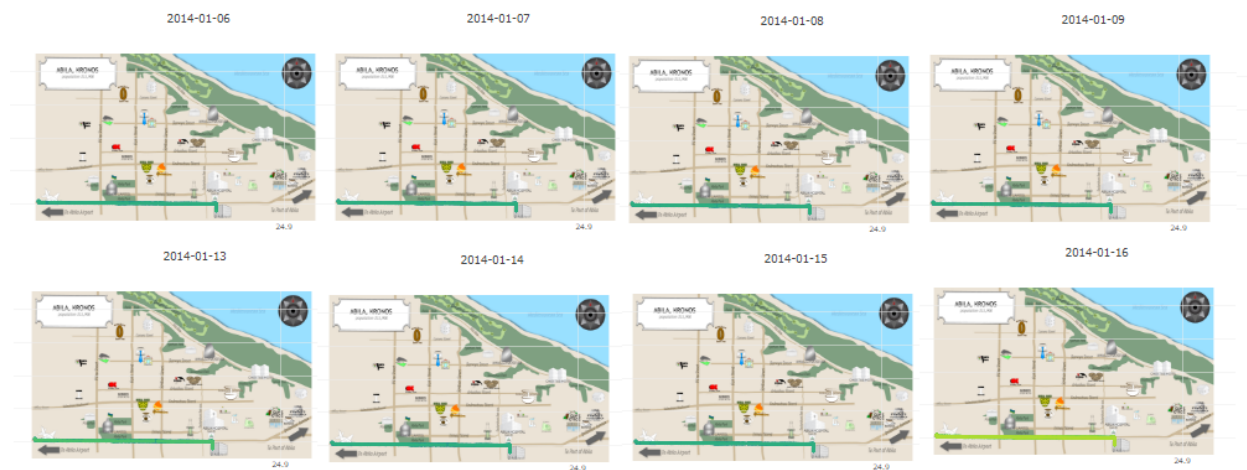
Over the weekend, store visits, lunches out and general recreation seems to be the most popular activities.

As for the trucks, each individual truck, not tied to one particular driver, seems to have a set route. Both the start and end location at the end of the day is at GT's office. An example day 1/16/14 is shown below for all trucks:

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All these habits were easily inferred in addition by the third mapping tool which showed by individual all daily maps for the two weeks, allowing us to infer daily schedules. For example, truck 104 has a routine of going to and from the airport, as seen below:



Finally, truck assignments are shown in the supporting document: *Trucks.xlsx*

Event I - 10k Auto Supply Purchase

We first noticed this purchase when doing a first pass analysis on the employees profile, and also, this is the transaction with the highest score in the outlier analysis we performed. Employee **Lucas Alcazar** spent exactly 10,000.00 in one transaction, in **Frydo's Auto Supply n' More** on January 13th, at 7h30PM. Not just the individual most expensive transaction of the report, but also being a round number makes it even more suspicious.

Day: 2014-01-13 19:20:00
Location: Frydos Auto Supply n' More
Price: 10000.0

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Day: 2014-01-13 19:30:00

Location: Ouzeri Elian

Price: 28.75

Ten minutes later, another transaction was made by the same employee, at a different business, **Ouzeri Elian**, a few miles away. No car movement was detected between transactions, and our GPS data puts Lucas Alcazar at Ouzeri Elian, not at the auto shop.

A stolen credit card theory could not be supported here as Lucas kept using his card while other suspected fraudulent charges were made. The alternative would be that his card was *cloned*.

At the time of the transaction **Loreto Bodrogi**, **Isia Vann** and **Inga Ferro** were at Frydo's, making one of them the likely culprit for running the fraudulent transaction, not to mention that many employees at an auto supply shop *after* business hours are suspicious. Both the location and the employees warrant further investigation.

More fraudulent transactions were found made by those employees, none of which were high amounts. One interesting fact we found while investigating Lucas' credit card transactions was that **Minke Mies** was found using the cloned cart at **U-Pump** on January 13th at 1h18PM, placing him under suspicion alongside the other 3 employees listed earlier.

Our theory is that the individual transaction was made to leverage financial resources to be used for the kidnappings, while also hiding some POK's tracks by not being traced to individual purchases.

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Event II - Executive's Homes Surveillance



The residences of all four executives who live on the island.

After having four individuals to investigate thoroughly, we started looking at their daily routines and patterns in detail and found a suspicious behavior pattern.

By analyzing all employees' daily routines, we had their home addresses easily referenceable. All executives, except the CEO, live in the north area of Kronos, likely a nicer, upscale neighborhood (supported by the *Ahaggo Museum* and *Albert's Fine Clothing*). The CEO doesn't appear to live in Kronos, but came for a visit on the 17th throughout the 20th, which we will cover in a future, separate event. That leaves us with four executives residing in the city of Abila.

All four residences were surveilled by a **pair of individuals**, on different days, following the same suspicious patterns.

Isia Vann arrived at **Ada Campo's** house at 11PM January 6th and left at 7AM the next morning. **Loreto Bodrogi** arrived at 3AM on the 7th, and left with Isia at the same time.

Both started their days and returned to **Frydo's Auto Supply**, reinforcing our suspicions of this location. We believe that it acts as some form of headquarters for the group.

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On similar occasions, **Loreto** and **Minke Mies** surveilled **Orhan Strum's** house on the night of Jan 8th. **Isia** and **Hennie Osvaldo** surveilled **Willem Vasco's** residence on the night of the 10th Finally, **Minke** and **Hennie** surveilled **Ingrid Barranco's** home on the 13th.

It is worth noting that all suspects work for the security department. Some of them work with perimeter control. We believe that these employees were investigating the executives' houses' perimeters in order to assess the possibility of kidnapping over the night.

Event III - Existence of Safehouses



Safehouse locations.



One example of a trip to a safehouse, performed while avoiding main ways.

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As we had employees which we were thoroughly investigating, **Minke Mies, Isia Vann, Loreto Brodogi, Hennie Osvaldo** and **Inga Ferro**, we noticed another peculiar movement pattern, which seems to indicate the presence of **five individual safehouses** in the city of Abila.

These houses were visited by the five employees being investigated, at different days and times of the day, but most of them **during their lunch breaks**. Some of those visits were individual, while others had at most two employees meeting up.

Our geospatial data did not have POIs, so we were able to deduce that they are safehouses as there were no credit card transactions in the period they were seen at these locations, and by the fact that **no other employee** is seen at these particular positions.

We assume that these locations are **secret**. We noticed that when visiting these locations, the trips in and out were taken using secondary streets, likely to avoid being seen by the general public.

It is possible that by visiting these locations during their lunch breaks, they were performing dry-runs of possible runs to the houses, after kidnapping the executives. There is a coincidental number of houses matching the number of executives

Minke Mies, Isia Vann, Loreto Bodrogi, Hennie Osvaldo and **Inga Ferro**, our suspects, are the employees seen at the safehouse locations. It is also worth mentioning that three out of five of the locations are close to Frydo's.

Event IV - Lucas Alcazar Late Office Visits

Employee Lucas Alcazar, who works at the IT Helpdesk, is seen on multiple occasions heading to GASTech during suspicious hours, outside his regular work schedule (or what we assume it to be).

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His normal work schedule revolves around leaving his residence, NW of Hallowed Grounds (coffee shop) at around 7h15AM, stopping for a coffee and going to work. Sometimes going out for small shopping during lunch break and heading back home around 5h30PM.

However, on multiple occasions, Lucas can be seen going to the office at unusual times:

- 1/6 he goes to the office at 22h15, returns the next morning 1/7 at 1h.
- 1/8 Lucas again returns to the office at 21h30 and leaves 23h50 of the same day.
- 1/15 again he heads to the office at around 22h45, and leaves on 1/16 shortly after midnight.
- 1/7 he heads back to the office at 20h30 and leaves 22h40

Being part of the IT helpdesk, it may be that he went back to assist other users, however, no other employees are seen at GT during this time. We assume that part of his responsibilities may deal with production systems and these visits are work related. We've investigated Lucas' thoroughly and found no reason to suspect him.

Event V - GASTech CEO Visit to Abila

Sten Sanjorge Jr., the President and CEO of GASTech is not seen in Abila during the days preceding the kidnapping, until the morning of January 17th, when he is first seen leaving *Chostus Hotel* in the morning period.

We assume Sten either flew in an helicopter from the mainland to the Hotel (we can assume it has a heliport, and the island is located in the Mediterranean Sea, making an helicopter trip from the continent feasible) or he simply flew in to the airport, took a cab to the hotel the night before.

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He has no credit card transactions before his arrival, meaning that the transactions captured in the report are for the island alone and would not cover transactions made outside its territory.

The whereabouts of Sten in the days before his arrival remain a mystery. No suspicious individuals are found stopping at the hotel, either before or after Sten's arrival.

Event VI - Evening Gathering on 1/10/14

On the evening of Friday, January 10th, a group consisting of employees from the Engineering and IT teams assembled at the residence of Lars Azada. The attendees included Lucas Alcazar, Felix Balas, Isak Baza, Linnea Bergen, Isande Borrasca, Nils Calixto, Axel Cazas, Gustav Cazar, Lidelse Dedos, Birgitta Frente, Vira Frente, Adra Nubarron, Marin Onda, and Brand Tempestad.

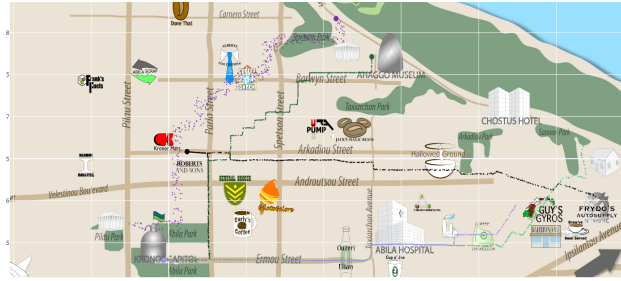


Considering that this gathering took place after work hours, it is probable that it was a social event, possibly an after-work party. Notably, the event occurred at the residence of Lars Azada, suggesting that he may have been the host or organizer of the gathering.

Event VII - Lunch Gathering on 1/18

During lunch hours on 1/18, a gathering was witnessed at the premises of Kronos Capital, involving employees from the Security and Engineering Departments. Attendees of this meeting included Kanon Herrero, Loreto Bodrigi, Edvard Vann, Elsa Orilla, and Adra Nubarron.

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Of particular interest is the fact that Loreto Bodrogi made a stop at Kronos Mart before arriving at the Capital. Moreover, it has been observed that Adra Nubarron had no GPS movement from the Capital until the following day. It may be necessary to conduct further investigation to determine the cause of this event.

Event VIII - Executive Golfing

On January 12th, the executives of the company went golfing.



Additionally, on the 19th, the CEO and executives went golfing again.



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Event XI - Affair

From the GPS tracking data, it seems probable that Isande Borrasca (SVP/CFO) and Brand Tempestad (Drill Technician) are having an affair. They have been observed meeting at the Chostus Hotel during lunch hours on several occasions, including January 8th, 10th, 14th, and 17th.

This pattern of behavior suggests the possibility of an ongoing romantic relationship between them. It is noteworthy that they only appear to be seen together at the hotel, and the fact that they hold different positions may indicate that they are attempting to conceal their relationship.

Event X - Relationship

According to the transaction data, there is evidence to suggest that Elsa Orilla (Drill Technician) and Kanon Herrero (Badging Office) are in a romantic relationship. It has been observed that they have been meeting for lunch every day and sharing vehicles. Elsa drove on January 9th, 14th, and 17th, while Kanon drove on January 6th, 7th, 8th, 10th, 13th, 15th, and 16th.

Notably, Kanon typically paid for these outings using a loyalty card, which may indicate that he has a greater financial stake in the relationship. Based on these findings, it can be inferred that Elsa and Kanon are likely dating.

Event XI - Truck Purchase Patterns

According to the available GPS data, it seems that the trucks followed their usual routes, frequently traveling to and from the GASTech headquarters along established paths.

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Nevertheless, it is important to highlight that while credit card and loyalty purchasing data was available at most stops, not all stops were associated with this information. In certain instances, multiple stops made by the same truck did not have any linked purchase data.

Therefore, further inquiry may be required to ascertain the cause of these inconsistencies and determine whether they hold any significance in the overall investigation.

Event XII - Irene Nant Inconsistent on 1/10/14

Irene Nant was responsible for driving truck 107, which followed its regular route and included a stop at Carlyle Chemical. However, on January 10th, 2019, it was observed that someone else was driving the truck assigned to her.

Despite this, Irene was seen making a purchase at Carlyle Chemical on the same day. It is significant to note that truck 107 was located near Carlyle Chemical at the same time, driven by Claudio Hawelon.

These observations raise the possibility that Irene may have traveled with Claudio or was involved with the truck in some capacity on that day.

Conclusions and Recommendations

Based on our investigation, we have gathered evidence that leads us to suspect five employees: **Minke Mies, Loreto Bodrogi, Isia Vann, Hennie Osvaldo, and Inga Ferro**. We have reason to believe that they have visited and test-drove vehicles from work to various safe houses during work hours.

Additionally, we have conducted surveys on the houses of all four GT executives who reside on the island. We have discovered that the suspects have used a cloned card to raise funds of up to \$10,000, which was utilized during the previous weeks.

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Furthermore, we have observed that the suspects often drive around side streets when visiting suspicious places and consistently meet at the Auto Supply shop. It is also noteworthy that all five employees work in the security department and are assumed to have advanced surveillance training.

In light of these findings, we recommend conducting further investigations into the possible safe houses, as well as screening the past histories of these employees to understand how they were able to coordinate and get hired. We believe that these additional measures will provide valuable insights into the Kronos Incident and aid in bringing those responsible to justice.