# Visual Analysis of Car-hailing Reimbursement Data for Overtime

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**Abstract**

*Compensation management is one of the most important elements of personnel management. One type of compensation is traffic supplementary pay for the overtime employees. Conventional analysis of the traffic reimbursement focuses on the basic financial statistics such as the expenditure trends and rankings among different departments in the company. However, it largely ignores the wellbeing of the individuals and their residential distribution that can help improve the effectiveness of compensation strategies. In this work, we propose a visual analytics system based on a company's traffic reimbursement data for the overtime. It assists the compensation managers in understanding the overtime employees' commuting status and providing more indirect compensation benefits for the employees. A user case confirms the efficacy of our system and experts' feedback also suggests that our approach indeed helps them better tackle the problem of analyzing the car-hailing reimbursement data for the overtime.*

**CCS Concepts**

• ***Human-centered computing*** → *Visualization; Visualization design and evaluation methods;*

## 1. Introduction

As one of the most important elements of personnel management, compensation affects the wellbeing of the individuals in the concerned organization [AA14]. Among the compensation, one common type is the car-hailing supplementary pay for the overtime employees. Analyzing car-hailing reimbursement data is important for the following reasons. First, the trend of the car-hailing reimbursement for the overtime can reflect the car-hailing cash flows, thus facilitating better budget planning. Second, the car-hailing reimbursement data can help the organizations understand the distribution of the employees' residential destinations, thus providing more accessible renting apartments for the employees. Third, the traveling patterns hidden in the car-hailing reimbursement data can help organizations determine appropriate shuffle bus stops and calibrate reasonable bus routes for the overtime employees [FR00, GZFG12, Yan11]. Conventional analysis of car-hailing reimbursement mainly focuses on basic financial statistics [AA14, Kri05, ZKS*19]. In this work, we propose a visual analytics system to help organizations obtain an overview of the car-hailing reimbursement data, evaluate the overtime employees' off-work traffic status, and identify their traveling patterns.

We worked with the financial team from WeBank[†], including a chief director (E.1, male, age: 37), a financial personnel (E.2, male, age: 31) and a human resource personnel (E.3, female, age: 26). Their representative works include reporting the reimbursement cash flow monthly, making future budgets accordingly, and improving the current compensation strategies. The team launched an Excel-like internal financial approval system to facilitate observing the distribution of the current car-hailing reimbursement by dashboard visualizations and obtain a preliminary understanding of the reimbursement flow and overview in a way. However, it fails to support car-hailing data analysis in a more detailed level, thus hard to determine whether the current compensation is effective and more effective strategies can be conducted. To better understand how organizations analyze the car-hailing reimbursement data, the following requirements are proposed: **R.1 Tracking car-hailing reimbursement.** The compensation of car-hailing reimbursement for the overtime only applies to certain conditions, i.e., leaving the company after 9:30 pm. Tracking the car-hailing reimbursement helps reduce the substandard operations. Furthermore, understanding the reimbursement distribution across different departments can facilitate access to the cash flow and future budget planning. **R.2 Understanding residential location of employees.** Providing affordable accommodation is a popular indirect compensation strategy. To achieve this purpose, organization management personnel want to know the residential location of employees and their traffic conditions, thus providing more customized compensation strategies such as setting up new shuttle bus routes or providing new contract departments to accommodate employees. **R.3 Recommending carpooling for the same destinations.** To raise the chance of getting a taxi during peak hours, promote communication between colleagues, and ensure employees' safety, carpooling is highly encouraged. Therefore, recommending carpooling for popular routes and destinations is an appealing request.

† https://www.webank.com/



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**Figure 1:** *(Left) System Overview. (Right) The popular residential areas and the most frequent route from "CC" to "HC" clusters.*

## 2. Data and System Design

We sample employees' car-hailing reimbursement data from WeBank, which ranges from March $1^{st}$, 2019 to June $30^{th}$, 2019. Each record in the car-hailing reimbursement data includes *employee ID*, *departure time*, *arrival time*, *place of origin*, *place of destination* and *payment amount*. Particularly, the place of origin is the location of the company and the places of destination are the employees' residential locations. We estimate the routes from the company to residential destinations using A* algorithm [YLX*10] running on the city's road network data.

Each row of Figure 1(A) displays the department name, the total amount of the reimbursements, the total number of the reimbursements, and the average amount of each reimbursement (R.1). The Figure 1(C) employs two-layer linked timelines to support both coarse-grained and fine-grained time selections. By interacting with the two timelines, analysts could select a subset of the reimbursement with a certain time period. The interaction results are then displayed in Figure 1(H). Each point of Figure 1(B) represents a reimbursement record. We employ four features including distance and direction from the company to the employee's residence, departure time, and arrival time to represent one car-hailing reimbursement record. We leverage t-SNE to obtain the two-dimensional embedding. Figure 1(D) gives analysts an intuitive understanding of the employees' residential destination and traffic status (R.2), with the yellow circles indicating the locations of the employees' traffic destinations and the heat map layer showing the density of the residential locations. The red paths present the recommended trajectories of the car-hailing reimbursement, with blue cars on the trajectories simulating the real-time movements. To understand the traffic flow of employees for the overtime, we use a density-based clustering algorithm called Mean Shift [CM02] to obtain the clusters of employees' residential locations. The black-filled circles represent the clusters. Particularly, the clusters with the white border are defined as "Home-Center"(or "HC") clusters and the one with the red border is called "Company-Center"(or "CC") cluster. To further identify the frequency of each traffic destination, we use Figure 1(F) with each segment representing a destination (i.e., the red ring represents the "CC" while the other rings represent the "HC") and the angle of each ring represents time. The time range is from 8pm to 7am of the next day. The lines between the rings indicate reimbursements from the "CC" to the "HC" cluster. The starting and ending positions of the lines indicate the starting and ending time from the "CC" to the "HC", respectively. By clicking on a "HC" ring, detailed information would be shown between the "CC" and the selected "HC" in Figure 1(G). The two timelines in Figure 1(E) show the "CC" and the "HC" (R.3), respectively, with each line representing one car-hailing reimbursement record. The line position on the axis represents the starting/ending time of a specific car-hailing record. Analysts can further brush to select a specific time range for observation. From Figure 1(D2), we identified that about half of the employees live within 5 kilometers to the company and almost all employees live within 20 kilometers to the company. There are a lot of car-hailing from the company to "HC 1", and the most popular residential areas for the employees are "Zone A" and "Zone B". The yellow routes in Figure 1 occupy half of the entire reimbursement records, indicating that the company should set up a shuttle bus route in order to alleviate the longer car-hailing waiting time for employees.

## 3. Discussion and Limitation

We conduct a user-centric design process and deliberately select familiar visual metaphors to help the experts quickly familiarize themselves with our visual designs. The experts commented that designing a shuttle bus route is traditionally based on examination of employees' residential locations. Our system can well identify the employees' gathering residential locations and extract the spatiotemporal characteristics of employees' car-hailing patterns. Furthermore, car-hailing demand awareness can be also extended to help design shuttles for other types of commuters. Our work has some limitations. First, we only leverage limited data for car-hailing reimbursement analysis and ignore factors such as the current shuttle bus routes and the average coverage of the shuttle buses. Second, recommending carpooling for employees with similar car-hailing behaviors may introduce potential privacy issues that should be further avoided. Third, we only provide suggestions for establishing or adjusting shuttle bus routes and carpooling, which does not substantially resolve the car-hailing issues for employees.

## 4. Conclusion and Future Work

In this paper, we propose a visual analytics approach to understanding the car-hailing reimbursement data of the overtime employees. It provides an overview of company's employees' reimbursement records and facilitates recommendation of shuttle bus routes and carpooling. Case studies and feedback confirm the efficacy of our system. In the future, we shall consider more factors to comprehensively review the current car-hailing compensation strategies.

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