Report A : Automated car rental

Vilant report. S-72.3510 Product Development of Telecommunication Systems

Viet-Anh Le, Emmi Välimäki, Antti Tuomi, Renaud-Alexandre Pitaval, Aydin KARAER

18/05/2008

In this report, an automated car rental system as an application of the directional RFID is resented. A technical solution is proposed in order to implement the directional RFID capabilities. Finally, the benefits and the market situation are analyzed and a marketing plan is suggested for Vilant.

Table of Contents

List of figures

List of tables

1 Automated car rental

1.1 System description

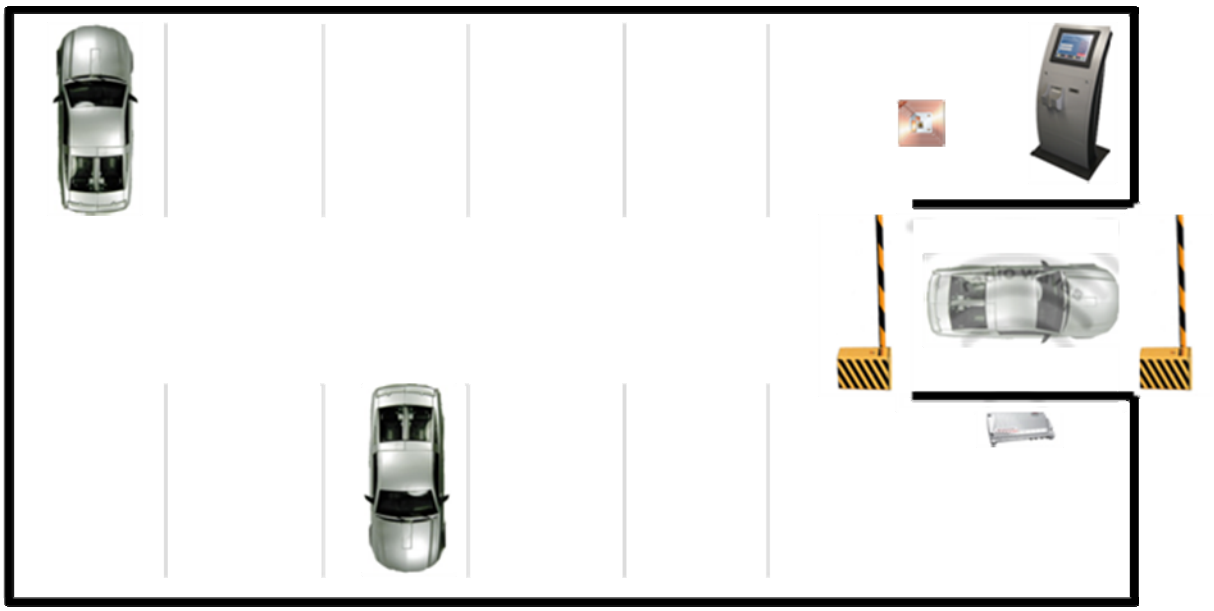

Figure 1 System description

The system is an automated in-vehicle check-out process, with location status management of different rental lots. Customers can rent and return car in different parking lots without any human interaction. Future possible development would be wirelessly transmission vehicle mileage and fuel level.

In order to open the door, start the car, check in/out, the customer must have a HF tag. For regular customers, a PVC laminated card can be used and for temporary customers just a disposable printed tag. The low range of the HF tag is desired for security purpose, the customer is so forced to explicitly show his tag to readers of the car or the gate.

The customer RFID tag must contains information about customer ID, period of validity and the list of car types is authorized to use. A regular customer can have for example, a couple of allowed cars with one year subscription. Regular customers do not need any paperwork and do not have to arrange insurance because all of them are pre-screened and covered automatically. But temporally customer can not yet rent a car without human interaction where checking of driving license and insurance agreement must be done at an office with a tag printer connected to the back office system. The car rental company is free to install or not an office in every parking lot.

The car must incorporate an active, secure UHF tag, which contains the car ID. Car battery allows installation of an active tag, which opens future possibility as implementation of a mileage or a fuel control. The cost of an active tag is of course negligible in a car safety system. The car ID must be encoded to avoid that simple reading of it can be used to produce copies. The tag must have a wide range to be readable at the gate; UHF tags have a typical range of 8 meters.

The car door possesses a tag reader connected to the CAN bus. The reader unlocks or not the security system depending of the customer rights recorded on the tag. Car reader checks that the customer has authorization to use this specific car at that time. So, the tag reader must be connected to the clock of the car.

A secure gate must be installed at the entrance of the parking lot. The gate is composed of two physical barriers, the system do not need to have two different ways for cars which get in or get out, the same gate can be used in both case. This reduced the installation cost and is less restrictive for installing small parking lots downtown. The system is thus symmetric and in the following, we denote by first and second barrier in reference to the order that the car meets the barriers independently if it is going in or out of the parking lot. The first barrier ensures that the car will not reverse after the check in/out, but there is no need to have secure system to allow the fence to open if the gate is free, so a simple detector like motion or metal detector is enough to head the opening. If there is already someone in the gate, the first barrier must not open and wait that the gate is free, this is treated by the database. Parking lot gate reads both customer ID and car ID, and checks if the combination is valid. The second barrier opens then, if the information of both car and passenger are compatible and valid in this period of time.

Information is gotten from the gate reader connected to the database and the fences. If it happens that the customer is not allowed to cross the second barrier, different solutions can be apply, the first barrier can simply reopen and let the car go back or alert a security service. The event can be recorded in the database with the time, place, car, and customer involved. If the car rental company desired it, extra surveillance system can be added like video surveillance or permanent security personnel.

1.2 Technical implementation

The system consists of the back-office system and the customer site system. The back-office system includes the database and the asset tracking software. The database can be an ordinary relational database, such as MySQL(1) or PostgreSQL(2). The asset tracking software is used to track the fleet according to the events sent by the customer site system. It is also used to register new customers, new cars, new parking lots etc. This software must either be developed in-house, or it can be outsourced to another company.

When the asset tracking software receives an event from a customer site, for example “car 1 has just passed gate at parking lot 5”, it checks the current location of the car. If the current location is inside the parking lot, then the system recognizes that the car is leaving the parking lot. If the current location was outside, then the system knows that the car is being returned. This can be implemented with a simple finite state machine.

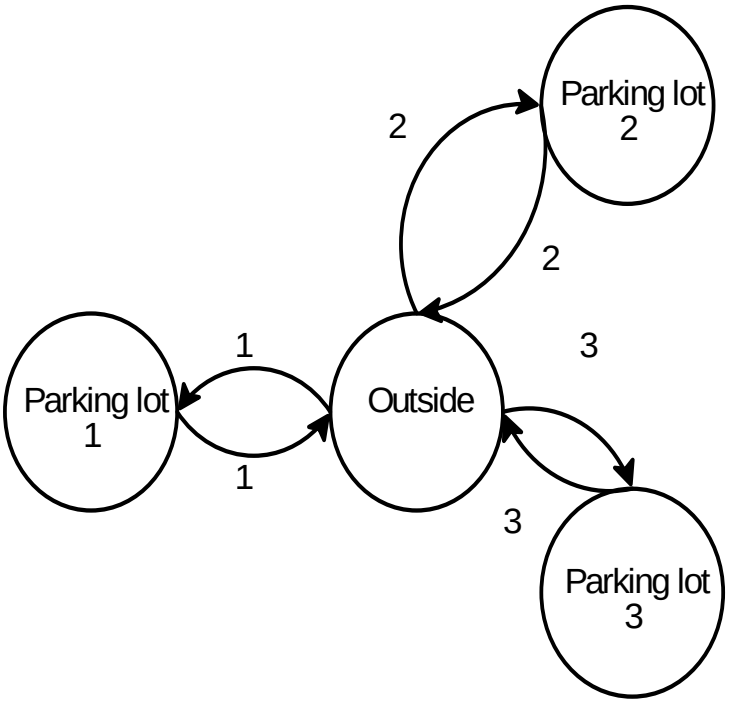

Figure 2 Finite state machine for asset tracking

The system at customer site consists of three subsystems installed at three different locations: At the office, in the cars and at the gate. At the office, there is a RFID tag printer which is used to print temporary RFID tags for customers. When a customer wants to rent a car, he goes to the office, fills all relevant papers (insurance, rental agreement and so on) and he receives a RFID tag. This tag contains data which gives the user access to a certain car in a certain time interval.

In every car, there is an active UHF RFID tag and a RFID reader integrated to the CAN bus (or something similar). When a customer wants to enter a car, he shows his tag to the reader. The reader then deciphers the data from the tag and verifies that it gives the customer access to the car at that time. The time is checked to prevent customers from accessing the vehicle after the rental agreement has expired. If the access is granted, the reader unlocks the doors of the car. The car keys are stored inside, and cannot be taken out the car. The active tag requires security features to protect the system against replay attacks. (3)

When the car leaves the parking lot, it passes through two gates. The first gate opens automatically (detecting the car with a pressure plate, motion detector, metal detector…). Between the gates, the customer shows his RFID tag to the reader at the gate. This reader reads both the customer RFID tag, and cars active RFID tag. It then sends a message to the asset tracking software at the back-office, notifying that customer X just passed the gate in car Y. When this event has been registered, the second gate opens. When the customer comes back, the same thing happens – the first gate always opens automatically, and the second gate opens when the event has been registered at the back-office.

Rental company could be worry that regular customer are not controlled before the use of a car. Extra security devices could be installed in this purpose as breathalyzer. It is not also possible to control who is really driving, but as in the traditional renting system, control is just possible at the

picking of the car and it is the responsibility of the customer to do not lend the car or to do not drive after consumption of alcohol or drugs.

The automated return system suppresses the fuel level and damage control. Fuel level can be solved by installation automated system in the car. The control can still be done later and the car will be disabling until then. Operational cost will be still reduced if the entire car lot is control once a day.

The system uses two gates to commit the customer to the transaction. When the customer shows his tag to the reader, he cannot switch to reverse and leave. After he has shown his tag to the reader, he must drive forward and actually enter/leave the parking lot.

The RFID printer at the office and the reader at the gate are connected to the back-office system using GPRS modules. They are cheaper alternative compared to a static infrastructure of cables, and are fast enough for this system.

1.3 Cost estimation

The costs for these items were collected from the internet using common search engines. In reality, they are probably cheaper, because these prices are for single orders.

Resource	Source	Cost
Passive ID tags for regular customers	www.toptunniste.fi	**1,50 €**
Active UHF tags (for cars)	www.rfid-webshop.com	**100,00 €**
RFID Readers for gates	www.rfid-webshop.com	**1 500,00 €**
Asset tracking software	Internal development	**40 000,00 €**
Physical gates	www.fence-it.com	**2 500,00 €**
Networking infrastructure (3*GPRS module)	www.telecom-store.de	**300,00 €**
RFID tag printer	www.rfid-webshop.com	**2 500,00 €**
Tag reader (installed in the car)	www.rfid-webshop.com	**1 500,00 €**
Installation and integration into car bus.	Contract work, approximation	**1 000,00 €**
Enterprise integration	Approximation	**100 000,00 €**
Database server	Approximation	**5 000,00 €**

Table 1 Inventory of required items and price approximations

2 Benefits for the car rental company

For car rental company directional sensing with FRID -system would automate their business. The personnel are no longer needed in the different phase of the car renting process. For a usual car renting case, human intervention is needed in order to verify the customer documents (driving licence, insurance…), to give the key, to provide the customer with the car, to supply the parking lot with the desired car, to verify and update the data concerning the contents of the parking, and to check and clean the cars. The automated car rental solution will provide the car renting company with an automated car retrieve which can result in less personnel for the renting process (only one person is needed for the customer document check before hand and one person needed for regularly planned car checking and cleaning). The automated update of the data based which lead to an efficient inventory is also an attractive quality of the product. Actually, the cost of the components needed for the solution and the maintenance of those will be negligible in comparison to the long term saving resulting of the personnel discharge in the parking lots (Annexes A: techno-economic analysis) and this is without taking into account the time saving which can also result in cutting down cost.

With this directional sensing solution, renting a car would be easier, more flexible, more automated and faster. These features lead to the company's savings in time and personnel expenses and also to better customer satisfaction.

3 Marketing plan

3.1 Target segment

Currently, there are many companies dealing with Car rental businesses in the market. Our target market consists of Car Rental companies, Business Parks such as Innopoli and big international companies which have their own premises for car renting.

3.2 Market situation

Present Market description about the biggest players in the Car Rental Businesses that we aim to have a market share, illustrated that:

Hertz has 1900 locations in US, and 5100 in Europe.

Europcar has 200000 vehicles and 2825 locations in 143 countries.

Budget has 1900 locations, and 26000 employees.

Achievable market shares can be really first-rate, if we manage to have a good marketing plan to meet the customer requirements with a high quality of service.

3.3 Competition analysis

Possible competitors in the market can be classified into two categories.

Service-based competitors are some American companies such as ID System Inc and Activewave have already a similar service since 2005. Promisingly, there are no competitors in Europe and Asia yet, therefore great potential is available in the market.

Facility-based competition can be considered as the alternative methods that would allow the same business case. Those, magnetic cards, sms services, remote control systems or personnel based services can be taken into account as the potential facility-based competitors for our product.

3.4 Marketing strategy

A novel brand name would be used to attract the customers as a facilitator of good Marketing strategy.

A detailed pricing example on the product will be represented with the OPEX and CAPEX analysises in the following sections. Competitive price for a reasonable profit is aimed

Sales and distribution of the product would be achieved via Website, mail or sales representatives with a direct channel that allows manufacturer-to-customer type delivery. Moreover, advertising and promotion strategy would be usage of internet (website), direct mail or tradeshows decided after an annual advertising budget investment. Free samples or product demonstrations would be conducted as a sales promotion. Product launch, special events and maybe a slogan are the key points of publicity.

4 Conclusion

One of the main advantages of the automated car rental case is that it does not need a completely new technical solution in order to be implemented. Namely, Vilant does not need a lot of research and development investment to render this business solution applicable in short term as it required only basic components and the development of software tools.

Concerning the technical aspect of RFID, the security may constitute an important issue. Meanwhile, most of the possible problem aroused from the car retrieving and returning in the parking lots like possible car theft can be solve by using an active RFID tag, multiple gates, and additional security system like camera and movement detection.

The cost of our automated car rental could be a real advantage for Vilant in term of research and development but also it will result in economical advantages for the car rental company which would save money, because of lower salary expenses. Company would also save time and have more accurate data by using this system. When a car is rented or returned to the parking lot, the change would automatically be shown in inventory statistics. In this way, status of inventories would be updated all the time.

Meanwhile, the public opinion about RFID may be a threat for the future development of RFID applications. By reducing the personnel and replacing human intervention in different level of the renting process, the customer will have less human contact and will have to deal most of the time with a machine which may constitute a threat for utilization of the product. Actually, a good marketing plan could ease the adoption of our solution. By starting the introduction of this application in Finland, Vilant has serious advantages because of the open minded attitude of the potential users towards the new technologies. The marketing plan has taken into account the service-based competition as well as the facility-based competition. Namely, the companies proposing similar service are two American companies ID System Inc and Activewave on the market since 2005. However, there is still no competitor in Europe. For the facilities based competition, our team has thought about several existing technology that may be used for the parking lots like the magnetic card, SMS service, or the remote control.

Finally, the result of this analysis is aggregated into the following SWOT – (Strengths, Weaknesses, Opportunities and Threats).

Strengths	**Weaknesses**
Simple implementation of infrastructure Less cost Automated process Inventory efficiency	less human contact The rental company will need to totally rethink the way it manages logistics
Opportunities	**Threats**
Acceptance of new technology in Finland No competition in the European market	Competitors from US Existing infrastructures and technologies Public acceptance RFID security

Table 2 SWOT analysis

As a conclusion, the automated car rental system is a promising business case for Vilant. There are some risks and threat related to the security of the RFID tags and the public acceptance but that has been the case for other innovative ideas as well. The techno economical analysis and the market situation analysis have shown that automated car rental process will be a profitable solution for the car rental company and a good business case for Vilant.

Bibliography

1. **MySQL AB.** MySQL :: The world's most popular open source database. *MySQL Web site.* [Online] MySQL, May 17, 2008. [Cited: May 17, 2008.] http://www.mysql.com.

2. **PostgreSQL Global Development Group.** PostgreSQL: The world's most advanced open source database. *PostgreSQL Web site.* [Online] PostgreSQL, May 17, 2008. [Cited: May 17, 2008.] http://www.postgresql.org.

3. *The evolution of RFID security.* **Rieback, M. R., Crispo, B. and Tanenbaum, A. S.** 1, s.l. : IEEE, Jan.-March 2006, Pervasive Computing, Vol. 5, pp. 62-69. DOI 10.1109/MPRV.2006.17.

ANNEXE A

Break even analysis for Vilant

By taking into account the resource and implementation cost (table 3), the capital expense for a new customer (table 4), the operational cost (table 5), the initial and the monthly cost (table 6 and table 7), the break even analysis for Vilant is estimated at 11 months.

Resource	Source	Cost
Passive ID tags for regular customers	www.toptunniste.fi	**1,50 €**
Active UHF tags (for cars)	www.rfid-webshop.com	**100,00 €**
RFID Readers for gates	www.rfid-webshop.com	**1 500,00 €**
Asset tracking software	Internal development	**40 000,00 €**
Physical gates	www.fence-it.com	**2 500,00 €**
Networking infrastructure (3*GPRS module)	www.telecom-store.de	**300,00 €**
RFID tag printer	www.rfid-webshop.com	**2 500,00 €**
Tag reader (installed in the car)	www.rfid-webshop.com	**1 500,00 €**
Installation and integration into car bus.	Contract work, approximation	**1 000,00 €**
Enterprise integration	Approximation	**100 000,00 €**
Database server	Approximation	**5 000,00 €**

Table 3 Resource and implementation cost

Initial investment: 45 000 Euros

Resource	Cost per item	Count	Cost
Number of cars	2 600,00 €	200	**520 000,00 €**
Number of parking lots	6 800,00 €	10	**6 810,00 €**
Number of regular customers	1,50 €	250	**251,50 €**
Company size scaling factor	100 000,00 €	0,8	**100 000,80 €**
Total implementation cost			**627 062,30 €**

Table 4 Capital expenses for a typical new customer

Item	Cost per item	Count	Cost
Replaced cars	2 600,00 €	2	**5 200,00 €**
Customer care	1 000,00 €	0,80	**800,00 €**
Equipment maintenance	20,00 €	210	**4 200,00 €**
Total			**10 200,00 €**

Table 5 Operational expenses per month for a typical customer

Item	Cost per item	Count	Cost

Number of cars	2 000,00 €	200	**400 000,00 €**
Number of parking lots	1 000,00 €	10	**10 000,00 €**
Number of regular customers	0,00 €	250	**0,00 €**
Company size scaling factor	50 000,00 €	0,8	**40 000,00 €**
Total			**450 000,00 €**

Table 6 Pricing initial cost

Item	Cost per item	Count	Cost
Number of cars	100,00 €	200	**20 000,00 €**
Car replacements	2 400,00 €	2	**4 800,00 €**
Fixed cost	1 000,00 €	1	**1 000,00 €**
Total			**25 800,00 €**

Table 7 Pricing monthly cost

Month	Investments	Expenses	Revenues	Cumulative expenses	Cumulative revenues	Cumulative income
0	627 062,30 €	10 200,00 €	475 800,00 €	637 262,30 €	475 800,00 €	**-161 462,30 €**
1	0,00 €	10 200,00 €	25 800,00 €	647 462,30 €	501 600,00 €	**-145 862,30 €**
2	0,00 €	10 200,00 €	25 800,00 €	657 662,30 €	527 400,00 €	**-130 262,30 €**
3	0,00 €	10 200,00 €	25 800,00 €	667 862,30 €	553 200,00 €	**-114 662,30 €**
4	0,00 €	10 200,00 €	25 800,00 €	678 062,30 €	579 000,00 €	**-99 062,30 €**
5	0,00 €	10 200,00 €	25 800,00 €	688 262,30 €	604 800,00 €	**-83 462,30 €**
6	0,00 €	10 200,00 €	25 800,00 €	698 462,30 €	630 600,00 €	**-67 862,30 €**
7	0,00 €	10 200,00 €	25 800,00 €	708 662,30 €	656 400,00 €	**-52 262,30 €**
8	0,00 €	10 200,00 €	25 800,00 €	718 862,30 €	682 200,00 €	**-36 662,30 €**
9	0,00 €	10 200,00 €	25 800,00 €	729 062,30 €	708 000,00 €	**-21 062,30 €**
10	0,00 €	10 200,00 €	25 800,00 €	739 262,30 €	733 800,00 €	**-5 462,30 €**
11	0,00 €	10 200,00 €	25 800,00 €	749 462,30 €	759 600,00 €	**10 137,70 €**
12	0,00 €	10 200,00 €	25 800,00 €	759 662,30 €	785 400,00 €	**25 737,70 €**
13	0,00 €	10 200,00 €	25 800,00 €	769 862,30 €	811 200,00 €	**41 337,70 €**
14	0,00 €	10 200,00 €	25 800,00 €	780 062,30 €	837 000,00 €	**56 937,70 €**
15	0,00 €	10 200,00 €	25 800,00 €	790 262,30 €	862 800,00 €	**72 537,70 €**

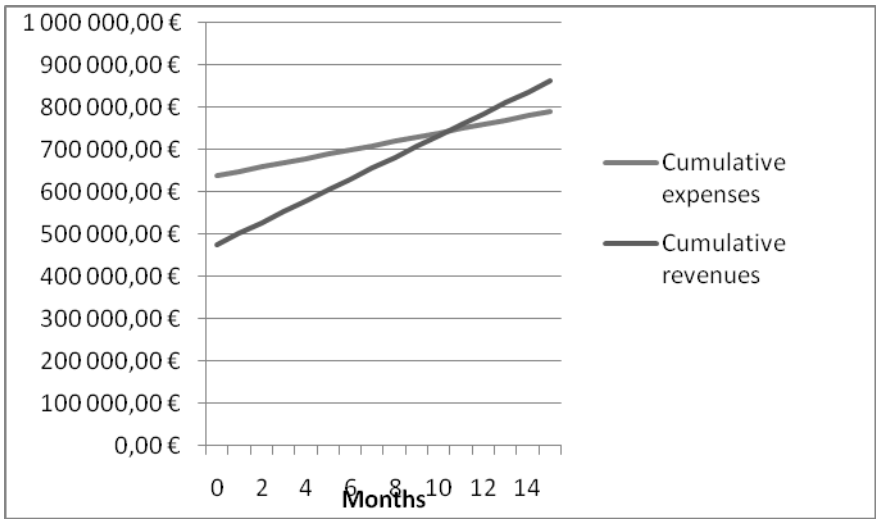

Figure 3 Break even analysis for Vilant

Break even analysis for the car rental company

By taking into account the cost of the material (table 3) and the saving in personnel charge, a break even analysis for the car rental company can be done. The break even is estimated at 13 months.

Column1	Column2	Column3	Column4
Savings in personnel costs per parking lot	6000	10	**60000**
Total			**60000**

Table 8

Month	Cost	Savings	Cumulative cost	Cumulative savings	Cumulative total
0	450 000,00 €	60 000,00 €	450 000,00 €	60 000,00 €	**-390 000,00 €**
1	25 800,00 €	60 000,00 €	475 800,00 €	120 000,00 €	**-355 800,00 €**
2	25 800,00 €	60 000,00 €	501 600,00 €	180 000,00 €	**-321 600,00 €**
3	25 800,00 €	60 000,00 €	527 400,00 €	240 000,00 €	**-287 400,00 €**
4	25 800,00 €	60 000,00 €	553 200,00 €	300 000,00 €	**-253 200,00 €**
5	25 800,00 €	60 000,00 €	579 000,00 €	360 000,00 €	**-219 000,00 €**
6	25 800,00 €	60 000,00 €	604 800,00 €	420 000,00 €	**-184 800,00 €**
7	25 800,00 €	60 000,00 €	630 600,00 €	480 000,00 €	**-150 600,00 €**
8	25 800,00 €	60 000,00 €	656 400,00 €	540 000,00 €	**-116 400,00 €**
9	25 800,00 €	60 000,00 €	682 200,00 €	600 000,00 €	**-82 200,00 €**
10	25 800,00 €	60 000,00 €	708 000,00 €	660 000,00 €	**-48 000,00 €**
11	25 800,00 €	60 000,00 €	733 800,00 €	720 000,00 €	**-13 800,00 €**
12	25 800,00 €	60 000,00 €	759 600,00 €	780 000,00 €	**20 400,00 €**
13	25 800,00 €	60 000,00 €	785 400,00 €	840 000,00 €	**54 600,00 €**
14	25 800,00 €	60 000,00 €	811 200,00 €	900 000,00 €	**88 800,00 €**
15	25 800,00 €	60 000,00 €	837 000,00 €	960 000,00 €	**123 000,00 €**
16	25 800,00 €	60 000,00 €	862 800,00 €	1 020 000,00 €	**157 200,00 €**
17	25 800,00 €	60 000,00 €	888 600,00 €	1 080 000,00 €	**191 400,00 €**
18	25 800,00 €	60 000,00	914 400,00 €	1 140 000,00 €	**225 600,00 €**

		€			
		60 000,00			
19	25 800,00 €	€	940 200,00 €	1 200 000,00 €	**259 800,00 €**

Table 9

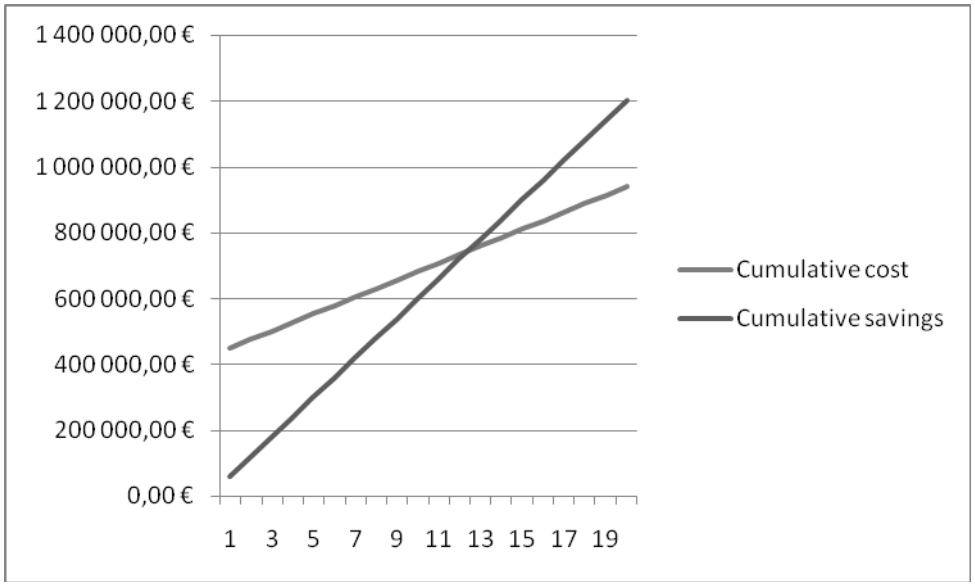

Figure 4 Break even analysis for the car rental company