IMPROVING THE EFFICIENCY OF PARKING MONITORING SYSTEMS IN JYVÄSKYLÄ, FINLAND

On-street Parking

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Abstract

Jyväskylä is located in Central Finland and is one of the fastest growing cities with a multicultural population. The city is planned by the city council which acts as the governing body. This includes also managing and monitoring most of the on-street parking lots. Currently, the existing monitoring methods that the council uses are somehow porous and inefficient leading to the lack of their full potential.

This thesis aimed to awaken the monitoring bodies to improve parking monitoring methods to arrive at more effective ways of managing the parking lots. This is to ensure that all the users of the city's infrastructures benefit and at the same time to improve traffic safety and enhance the city's image.

In analysing the vitality of the parking monitoring methods, existing control methods were studied and improvements proposed. Also new monitoring methods were studied for implementation. This was conducted through interviews/meetings with parking operators and evaluating their opinions, the use of statistical data of the past three years from the parking operators, field visit to some areas together with the wardens to observe how they work as well as their day to day challenges facing them and getting familiar with the tools and equipment they use.

The study suggests improvements for the existing methods, as well as a few new ones. These include improved fine ticketing machines for easy recording, phone apps, public watch (shifting responsibilities to the public), as well as sensor nodes and readers deployed in the parking lots. The methods will give out several positive results ranging from easing the monitoring exercise, accuracy, to diminishing the rate of cheating, thereafter enhancing an honest society.

Keywords Parking, parking rules, monitoring methods, vehicles
Miscellaneous Sensor networks, Data Reader.

CONTENTS

FIGURES

TABLES

1. INTRODUCTION

1.1   Definition of the Topic

The target of the study was to improve the efficiency of parking monitoring system in Jyväskylä. The study looks on the trend of human behaviours in violating parking rules and suggests improvements to the monitoring methods. The problem of inefficiency in monitoring systems is sensitive due to the fact that the applied methods are either porous or not user friendly. Thus they invite cheating behaviour as well as illegal parking.

It can be stated that there is a need for an improved management of the parking facilities for efficient use i.e. to serve the purpose and to reduce costs of operation while enhancing city image (M. Fishbein and I. Ajzen, 1975). It has to be known that parking fines are not the source of funds to run parking but rather a way to force people to abide to the rules set. Therefore, the most important thing is to make sure that fewer people violate rules unlike now when the number of those who violate rules is in tens of thousands (Offences known to the police, 2014).

In Amsterdam, for example, to indicate the importance of monitoring on-street parking, there is a special van mounted with cameras and a scanner with an automatic registration number recognition interface. Those who violate rules are fined by scooters escorting the van. The method is 98% accurate and the 2% is due to foreign vehicles. This has been made easy because nearly all registration plates of the vehicles are digitised ("European Parking U-Turn page 28).

In Jyväskylä, parking lots can be categorised into public and private. The Jyväskylä City Council runs and manages the public parking lots while the private parking lots are mainly managed by private parking companies/operators. Different types of parking lots are available in Jyväskylä ranging from on-street parking to multi-storeys and underground car parks. Examples of on-street parks can be found in streets like Puistokatu, Yrjönkatu and Tapionkatu, to mention just a few. Underground car parks are found in buildings especially shopping centres and commercial buildings taking Forum, Sokos and Jyväskeskus as examples. Multistorey car parks can be sited in

Sokos and Paviljonki while open yard car parks can be seen in places like Roninmaentie, Kuokkala business centre etc.

1.2 Objectives of the Study

The study on how to improve the efficiency of parking monitoring systems in the city of Jyväskylä covered the following objectives:

1. Reducing the extent of cheating by vehicle users. Cheating is done by adjusting the time reading on the disc and continuing to park after the allowed time is over. This is the most common problem in time-limited parking zones such as near shops, schools and hospitals.

2. Dealing with ''lucky drivers''. These are the drivers who park and do not follow the rules and are not caught and hence walk scot-free.

3. Enhancing the effective use of the parking spaces available since growth of traffic is high compared to the parking lots constructed annually.

4. Reducing the dependency on wardens to monitor parking lots.

5. To reduce conflicts between parking users and wardens when fulfilling their duties, this may at some point rise bribing issues and fights among them.

In order to be able to come out with clear methods on how to solve the monitoring inefficiency issues, the following questions should be well addressed to all the stockholders.

1. Is it true that in time restricted zones (where parking is subject to the provision of parking disc time display), vehicle users do park for a longer time than permitted? What do they do? How do they do it? How often they walk scot-free without being noticed and penalized? If that is the case, then what can be done to reduce/eliminate this cheating behaviour?

2. What are the impacts from parking violations? Can there be other monitoring methods which are more effective than the current to deal with human behaviours?

3. Does the current method have anything to do with the safety of wardens? What about conflicts between parking users and wardens when they meet? Is it possible to reduce this possibility and arrive to a safer and more accurate way of monitoring parking facilities?

4. What is the situation in parking lots where parking is subject to paying and paying is done using park pay machines? Is it convenient all the time? Can there be some changes or improvements?

Therefore, this thesis aims to awaken the monitoring bodies to improve parking monitoring methods to arrive to more effective ways of managing parking lots.

1.3 Jyväskylä City and Jyväskylä City Council

Jyväskylä is the largest city in Central Finland located 270 km north of Helsinki. The estimated population is a bit more than 170,000 inhabitants. (Jyväskylä facts)

FIGURE 1. Facts about Jyväskylä

The City of Jyväskylä alone has a population of 133,000 inhabitants out of which around 47,000 are school children and students. The city centre alone (Kantakaupunki) has the population of close to 26,000 inhabitants. Because of high quality education, Jyväskylä has become the centre of Internationalization and was rated as the second most popular destination to move to in Finland in 2012 (Survey conducted by pollster Taloustutkimus 2012).

The Jyväskylä City Council is the key stakeholder in planning how the city develops. This includes taking care of most of on-street parking which is the major concern in this thesis. The thesis has focused mainly on on-street parking lots monitored by the City Council.

2. PROBLEM STATEMENT

In general, a car spends most of the time (80%-95% of the life time (20-23 hours a day)) parked and each car must have at least two parking locations mainly at home (primary parking) and at the point where one needs to fulfill needs (secondary location) (Litman 2006). In all the scenarios when the car is parked, parking is either paid or free, but sometimes subject to the fulfillment of certain conditions.

The quantity of available parking spaces close to the users destination is becoming a challenging issue on one hand while the efficient use of the available parking places is still a nightmare (Litman 2006). It is very difficult to find a free parking space during the day time in all the streets close to the city centre. Worse enough some of the vehicles are parked on a lot for more than the time rule set to be followed prior to parking.

Jyväskylä Regional Development Company Jykes Ltd (Finland HTC) has also written about the growth of city in terms of business and logistics potential towards the year 2020. With its growth as a logistic hub as well as a commercial centre together with other factors (traffic growth rate, the increased growth of population 850 new

inhabitants every year), the need for proper guidance of parking has increased its potential.

Parking operators use wardens to monitor and control parking lots. Parking wardens are also called meter attendants or parking enforcement officers. They are members of the parking control units/agencies responsible for monitoring parking meters, reporting parking offenses as well as issuing tickets/fines for parking violations. (Ouimet L. & Leoutsarakos N. 2004). These wardens work under the umbrella of the parking control authorities and are scattered everywhere around the city. They use cars and sometimes patrol on foot observing those vehicles parked in a way that they violate the parking rules. The violation may be either through not paying, an expired ticket, wrong parking, as well as those who have parked beyond the allowed time limit.

Let us take an example of on- street parking lots scattered in four streets, it takes about 30 minutes or more to check all the cars. By the time the wardens reach the last vehicle parked, some of the already inspected cars will have the parking time expired, but they walk scot-free because the wardens cannot remember and come back as they have a lot still to do and also is not easy to remember. This implies that in terms of performance, the wardens have performed the duties but they have not reached the target (to check the enforcement of the laws).

Furthermore, the warden cannot tell/detect which vehicle has parked for more than the time permitted through the change of time disc display. In some cases during their routine, wardens take photos of parked vehicles and compare the photos with the previous time to see if the vehicles are still parked for a long time or even record the position of the wheels as well as the disc itself. The question here is; how many photos will the wardens have to go through every time they need to inspect the vehicles? This is very tiring. The time extension problem in the parking disc is very common as it is easy to quickly change and display the new time on the disc.

During harsh weather, like heavy rain, storms and snow, the parking wardens' performance definitely drops. For example when it snows for say 3 hours, is it

possible for a warden to scratch all the windscreens of parked vehicles to see if the parking disc/ticket is valid? Can the warden be walking during heavy rain, storm or very hot summer? The answers to these questions show the drawbacks of the current parking monitoring systems. Relying on wardens to monitor parking lots is very inefficient and therefore improved solutions need to be planned and implemented. FIGURES 2 and 3 below illustrate the situation when it is snowing.

FIGURE 2. Signboard showing parking rules and a parked vehicle during bad weather

FIGURE 3. Vehicles parked on On-street parking in Puutarhankatu in Jyväskylä.

One of the good examples of on-street parking lots are those around the JAMK main campus in Jyväskylä within a radius of 500m. Due to scarcity of parking in the campus area during the day, students park their cars in these on-streets parking lots which have a parking limit ranging from 0.5 to 4 hours. When the parking time is over, someone may spend between 25 to 40 minutes to go and change the disc time depending on the location of parking. Also the person cannot concentrate within the last 30 minutes before going to change the disc as all the person's mind will be on a clock to make sure that he/she will not be billed, and hence errors and mistakes occur in whatever he/she was doing. If it is a paid parking, the situation is similar, a user has to walk to recharge the parking. This is an economical problem on one hand, while lost concentration is the psychological torture to the parking user.

3. THEORETICAL BASIS

In everyday life, everything that involves travelling by car will involve parking somewhere. No matter what the purpose of the trip is, be it leisure or business, still someone will need a place where to leave the car. In every location and situation there are different needs when it comes to parking (Litman 2006).

On-street parking is mainly by default and may be subject to terms such as a payment, short time free parking or not allowed to park at all. These are called parking restrictions (Driving School Manual 2010 73-82). Even though parking lots are monitored such that users must adhere to the rules, still monitoring methods are porous and give chances to violation of the rules and regulations set by the governing bodies.

Despite Finland having very strict driving training and rules, still many vehicle users violate rules. Why is this so? The author has compiled the following reasons as to why people violate rules despite well translated parking rules and reasonable parking rates.

1. Lack of knowledge about parking places and parking rules. This mainly affects foreigners who know little about parking rules. As a matter of fact some users forget the rules with time.

2. Disobedience to the set rules. This is from users who just park anywhere provided that the place suits their need at that time and in case they are billed, they don't care, they just pay and business continues,

3. Unawareness of the rules and restrictions. This is because some restrictions change from time to time. It is common to find that certain area was free to park last year but now is subjected to a fee this year. Thus rules need to be transmitted to users via various ways.

4. Users who are in hurry so that they cannot wait to fulfill the parking obligations. These kinds of users exist; it means that someone is in a hurry for the service that they have no time to even read the parking instructions at the entrance to the parking area. To these people, the first priority is the service they are up to. Before the new parking system at the Vantaa airport, someone could leave the car for a week and would just find a fine of 40€

while parking for a week was 60€. This means that someone violated rules just because it is cheaper to be fined than pay for the service.

5. Having no money to pay.
   Some people do not have funds to pay but because they need to visit the place, they park without paying and if they are lucky enough then they walk scot-free.

The study on the inefficiency of parking monitoring methods combines knowledge and understanding from fields/subjects such as Science and Technology, Transportation, Economics, Accounting and Management. Science and Technology can be directly seen in analysing suggested methods in arriving to efficient monitoring of the parking lots. Applying the knowledge of Science and Technology can help to arrive to solutions which are user as well as environmental friendly easing the whole parking chain, while at the same time ensuring less human intervention. The knowledge of economics and management is important in analysing costs, man power as well as accuracy of the current solutions focusing on how we can adjust all the parameters and hence have optimal solutions. The transportation sector is the source of these complications since it is through transportation, that problems involving parking arise. The knowledge is vital because parking patterns can alter the flow of traffic depending on how the vehicles are parked (e.g. diagonal, perpendicular or parallel to the traffic flow) (Chick 1996).

The thesis concentrated on on-street parking run by the Jyväskylä City Council within the radius of 1 km from the city centre including both paid and time limited parking. The area of the study is limited to busy area in Jyväskylä but the implementation can be extended to other areas. Private sectors in the field were involved especially in getting their opinions and trying to suggest the best ways to handle the situation. This is due to the fact that parking monitoring inefficiencies do not concern only the Jyväskylä City Council, but all the stakeholders in the automobile industry as well as city planners.

4. EXISTING MONITORING METHODS OF PARKING LOTS

On-street parking lots can either be free (to some the parking disc is a must) or subject to pay and display. These are run by the City Council and users are allowed to park displaying the correct time of parking. Vehicle users are allowed to park in a time range between 15 minutes to 24 hours having some variations in restrictions from one place to another. In social service areas like markets and hospitals, the parking lots are subject to payments or users are allowed to park for a very short time say, up to 30 minutes.

The common way of parking on on-street parking spaces is the parallel parking, where by vehicles are parked parallel to the flow of traffic one behind the other. In very few places angular or diagonal parking apply. In off-street parking, where cars are parked outside the road area, different methods of parking alternating between parallel, diagonal and angular parking are applied. Off-street parking includes parking lots in building yards, by pass roads, parking lanes and multistorey building garages (McCoy, Ballard and Ramanujam 1990). Multistorey parking spaces are privately owned and they are run by various operators in Jyväskylä like Jyväs Parkki, MKM, APV, etc. These lots use methods like;

Highlight parking: As the name of the system defines, this is simply the vehicle directing technique working so that it uses LED (light emitting diode). Highlight parking (See FIGURE 4 below), helps the driver to know where in the garage there is unoccupied space while the green arrow assists the driver to the spot. Usually, empty spaces have green light while occupied spaces have a red light.(Europe's parking U-Turn: from accommodation to regulation). When multiple parking spaces are available, the arrows will give the driver directions to multiple locations, and it is upon the responsibility of the driver to decide where to park. During peak period, the Highlight Parking will not help the driver to know that there is free parking somewhere but rather, the direction arrow will help the person navigate to the space. Also it is again the responsibility of the driver to know the position of the car after parking.

FIGURE 4. Highlight Parking System in Paviljonki, Jyväskylä

Traffiko: This is based on camera systems and the system detects the parking space occupied and unoccupied). The indication of either the lot is occupied or not is through change in the color of the lamp situated at each lot. More information can be found at https://www.youtube.com/watch?v=R9V1NCC6NPk

Vehicle counter system: With this method, the sign board is displaying where parking lots are open and how may are available (See FIGURE 5 below). It indicates which parking lots have unoccupied spaces and helps drivers to navigate easily instead of going round and round to look for parking spaces which raises the question of pollution as well as congestion (Chrest 2001, 112).

FIGURE 5. Signboard informing drivers the available parking in the city of Jyväskylä

Access gate control: As the method itself suggest, the access to and from the
parking lot is subject to opening of the control gate. Operating mainly by the use of
registration number recognition, permit card recognition or payment at the
entry/exit, this method has also proved to be very successfully in closed areas.
Parking lots at the main hospital in Jyväskylä and most of the multi-storey car parks
use this kind of the system in combination with other methods like Traffiko.

FIGURE 6. Control gates with surveillance device (camera) Paviljonki 1, Jyväskylä

Parking operators work hand in hand to ensure that parking rules are enforced from on/off-street parking, parking yards to parking garages. All these are meant to help users reach their demand of parking and enjoy the service on one hand while enhancing the image of the city. Upon parking, vehicle users must adhere to the following guidelines

- Park within the defined markings
- Park such that entrances/passways are free
- Park and display the valid ticket/permit/disc on a visible place and ensure readability
- Park only within the allowed time.

Parking meter (pay and display): Parking meter, also called a pay and display system, is one of the oldest systems in use though it has undergone a lot of changes before serving to the required level even here in Finland (Chrest et al 2002). There are ticketing machines found adjacent to all parking lots subject to payments prior to parking.

A parking user must pay to these machines or by phone via easy park, get the ticket and display it in a visible place on the windscreen. Three years ago the machines

used were those which accepted only coins and this imposed a big challenge to the user as someone was required to have coins all the time when looking for such kind of parking. Thanks to the technology, now the machines which can take cards as well have been installed hence easing the payment process. These ticketing machines accept bank cards, coins ranging between 0.20, 0.50, 1-2 euro coins as well as bank notes (not many of them accept bank notes), and this has made payment easy in some ways. Pay and display time is mainly between 0800-2000 hours Monday to Friday, 0800-1600 hours on Saturday and after that these lots are free to park. Vehicle users are free to park in these lots free of charge on Sundays as well as public holidays depending on the potential need of parking in that particular zone.

FIGURE 7. Part of EasyPark registration form

In most parking places, the more you park, the less you pay. This directly seems to favor those who park for a long time. Parking zones usually have different rates depending on how potential and close to the city the parking lot is (On-street JyvasParkki).

Parking in the building yards: These parking lots are mainly for the residents of the building and the workers in case of multipurpose buildings. In buildings which are used as office spaces only, parking places are always empty by 1700 hours until the next day around 0700 hours on working days. The parking lots are usually empty throughout the weekends and public holidays.

In residential buildings, signboards displaying the rules governing parking lots are clearly indicated at the entrance to such premises. Even though most residents follow the rules, during weekends and evenings it is common to see vehicles around building areas parked or even blocking necessary walkways. This is dangerous not only to kids and other people around the areas, but also hinders emergency activities like ambulances, fire trucks etc. (Parking Fines and Vehicle Clamping 2014).

Parking for people with special needs are found almost everywhere around the city centre and are rarely fully occupied. Even rules are fair when it comes to a vehicle parked by a person with disability. They have more room to play and can park in many places where other people are not allowed. Parking in these places is subject to provision of disability sign disc on the visible place of the windscreen. Abusing the disabled parking rule attracts a fine. In Finland, there is no special fine for such violation unlike in Amsterdam where parking on such a place causes a fine of up to 150€ (Europe's Parking U-Turn: From accommodation to regulations 2014).

Parking disc zone: Some of the on-street parking lots in Jyväskylä are time limited and parking is monitored subject to the provision of parking disc at a visible place on the windscreen showing the time of arrival to the parking. These parking places are a few hundred metres from the city centre. The current parking disc has a time set of 30 minutes and top of the hour.

Parking discs are blue plastic cards with a movable twelve-hour dial. The driver sets the arrival time and is then needed to remember the time when the parking permission ends. The maximum duration of stay as well as valid time of the day are clearly indicated on the signs displayed at the entry of the parking zone. With these

facts, it can be accepted that the system works better when the demand is just average (Parking Policies and the Effects on Economy and Mobility, 2005).

Parking fines: Parking fines are tickets given to parking users when caught violating the parking rules or sometimes unnecessary motor idling. These fines are imposed in order to deter and punish those who violate the parking rules and regulations. The parking fines in urban areas is 60€ while in other places it is 40€.

Even though the parking fines given to those who violating the rules is a huge amount of money compared to the cost of parking per day, still the number of parking users who breach the rules is increasing and the community is still far from eliminating the problem. This is true because even after the fine for parking being revised, still there is no change in the trend (Statistics Finland 2014).

FIGURE 8. Warden issuing ticket to vehicle violating parking rules, fined vehicle

5. METHODOLOGIES USED IN THE STUDY

In this study various solutions to arrive to the goals were studied and evaluated in detail waiting for implementation in the near future. Technological solutions as well as improved old ones were part of the struggle to arrive at efficient monitoring of parking in the near future. The study was based on;

- ➢ Studying the existing parking monitoring strategies and how to improve them
- ➢ Finding a cost effective way of monitoring as well as familiarizing the users with the system
- ➢ Observing the economic and social benefits such as change in human behaviour towards the rules set.

To arrive at the clear solution of the questions at hand, the following qualitative and quantitative methods were used (Taylor 2005, 1–7):

- ➢ Interviews/meetings where matters concerning parking monitoring are addressed to monitoring bodies and their opinions evaluated. Traffic Inspectors, Transportation Engineers as well as stakeholders using the facilities form vital figures in arriving to the goals set.
- ➢ Using statistical data about parking trends from parking operators for the past three years. These include fines given, appeal cases, revenue, behaviour of people etc.
- ➢ Field visit to the selected area of concentration and observing the trend. Working together with the wardens to see how they work as well as the day to day challenges facing them.

The major concern in this study was to analyse the inefficiency of the current methods of monitoring on-street car parking lots. Therefore the major materials were the parking lots within the circumference mentioned as well as the vehicles parked in the locations. Using the parked vehicles as part of the study data was the best way, though registration numbers were omitted due to ownership rights. Furthermore, information/data from the operators of the parking lots under study were requested to be used. The experts in the field from Jyväskylä City Council

worked hand in hand to achieve the desired results. Some of the key figures from parking violation for the past 3 years are summarised in TABLE 1 below.

TABLE 1. Parking fine data 2011-2013

Year	2011	2012	2013
Parking fines awarded	28883	27557	27973
Fines paid	27824	26198	26460
Appeal cases	1059	1359	1513

Fine ticketing machines are electronic portable machines used by wardens in performing their day to day activities and recording details of offenders (See FIGURE 8). The machine work so that it has a built in digital camera, memory data to record and store the information as well as the capacity to transfer the data via EDI (Electronic Data Interchange) to a portable printer which gives the hard copy to be given to the offender. The machine can simply be described as 'a portable computer' because of its features and functions. According to the operation information obtained from the traffic inspectors of the Jyväskylä City Council, all the information concerning the parking fines are written manually in the machine. The parking ticket is printed with a portable printer on a weather proof paper.

Upon arrival at the scene of violation, the warden fills all the necessary details such as the registration number, type of the car, reasons for violations, as well as the address where the offence was done. The obtained information is registered on the page that is seen on the machine's screen. When data entry is complete, printing is done on a weather proof paper using a portable hand held printer connected via Bluetooth. The paper on which the fine ticket is printed is very convenient as only details of the car and violation need to be filled. Other necessary information and instructions are on the back of the paper. Details such as the maturity date, the account number of the beneficiary as well as the bill number are on the background of the machine and can only be seen after printing the fine ticket.

Even though a wireless internet connection is possible with the existing equipment, the machines will be connected until 2015. At the moment all the data collected throughout the day are transferred usually at the end of the work shift by placing the hand held machine on a dock. The handheld machines have a touch screen that reacts on pressure (operated by nail or a plastic pen) and a QWERTY keyboard as shown in FIGURE 9 below.

FIGURE 9. Parking fine billing machine (Left) and Printer (Right) used by wardens

Employees of the Jyväskylä City Council directly involved in monitoring the parking lots are shown in TABLE 2 below.

TABLE 2. Employees dealing with parking issues at JCC

Position	Number of employees
Parking Inspectors /wardens	8
Traffic Warden	1
Secretary	1
Manager	1

Working hours per warden is on average 38 hours per week and usually they work in two shifts. Revenues collected annually from fines due to the violation of parking are only €1.4mil. Around €70,000 to €90,000 are lost due to foreign vehicles and others.

The city centre area is described as a no parking zone and because of that it is one of the areas of concentration during monitoring. Even though this is a restricted area but records show that more offences are recorded from this area and surprisingly enough violation occurs during late hours, say from 1600 – 2000.

The monitoring zones are divided into 6, zones 1, 2 and 3 as well as zones A, B and C. Each zone is such that inspectors running zone 1 also runs zone A and this is similar to other zones i.e. 2 runs also B and 3 runs also C. Areas around the city centre are mainly monitored on foot while in areas far from the core, wardens use cars.

6. ANALYSIS OF THE DATA

Parking data from the past three years are very useful when studying the parking violation trend. This is due to the fact that the increment of parking fine from €40 to €60 in urban areas just came into effect three years ago. A €20 increment seemed to be a lot, but unfortunately it can be seen that the parking violation trend has no variation since the change came into effect meaning that people are already feeling very normal about the imposed fines. Looking carefully at the parking fines data, it can be seen that for the past 3 years the variation in trend has been almost negligible.

This indicates three things: monitoring methods are too common to the rule violators, wardens no more have new tricks to trace those who violate rules, or nobody cares about the fines and the rules. Generally, the expectations were such that because the parking fines went up three years ago, then people would have the feeling of paying a lot for fines instead of just paying coins and parking comfortably. But the situation has been even worse than before (nearly similar figures were recorded in 2011, 2012 and 2013 as seen in TABLE 1 above).

Appeal cases also have been going up each year since 2011. There is a big jump between 2011 (1059) and 2012 (1359) as well as 2013(1513). This indicates that, either people are feeling the pinch of the fine and therefore try to appeal so that they rescue that money, or parking inspectors are giving out fines to the wrong people. Considering the growth rate of the city with at least 850 new inhabitants each year, the authorities need to be attentive on how to stop the act of violating rules.

The amount of lost revenues due to unpaid bills, foreign vehicles as well as lost appeals is close to €100,000. This is quite a lot of money, even though parking fines are NOT the source of income for the city. In comparison with the revenue collected yearly from the parking fines alone, it can be seen that around 7% of the revenue is wasted.

The City Council has an office dealing with parking matters and the organization structure shows that there are 8 inspectors working from 0800 to 2000 hours on weekdays and from 0800 to 1400 hours on Saturdays. The average working hours per week is 38 exchanging shifts when necessary. If this is true, it means that the cost of monitoring parking lots is very low compared just to revenues from the parking fines. Also working with this number of employees, it means that one warden has a very large area to monitor thus increasing the inefficiency. This also increases the possibility of high number of those who violate rules not to be caught.

Fine ticketing machines and printers are modern enough to accomplish the work. Even though they have the ability for an internet connection, currently only Bluetooth is in use. This imposes an obstacle in obtaining vehicle information especially when confused about the usage of the vehicle.

The machines are not weather proof giving it a difficult situation when working say during watery weather. Furthermore, the inability of the machines to read codes makes it difficult to obtain ticket codes from the windscreen especially for the paid parking zones. The ability to read the ticket bar code would help the inspectors during harsh weather.

Taking photos of the parked vehicles in parallel parking can be seen as a solution in dealing with cheating. This is just by comparing the photos taken before and after. Still the question of going through the images is a very tiring process and the degree of effectiveness must be questioned.

7. METHODS TO IMPROVE THE EFFICIENCY OF PARKING MONITORING SYSTEMS

Parking monitoring and management is efficient if available parking spaces are used not only effectively, but also the rules are followed and the intended purpose is served. This includes the description of management strategies and how they can be implemented, at the same time observing their sustainability (Litman 2006). The fact that some of the parking users will use the parking lots for a short time than permitted to accomplish their mission at the destination is neglected in this case. The methods to improve the parking monitoring efficiency are suggested in the following.

7.1 Wireless Sensor Networks for On-Street Parking (WSN)

The world has experienced tremendous changes in the electronics technology. One of the exiting revolutions of electronics use is the incorporation of wireless sensor networks (WSN) in monitoring parking. Several authors including Zhang et al (2013),

Litman (2010) and Asin et al (2013) from various institutions and technology companies have discussed/researched parking monitoring systems using wireless sensor network.

The city authority agrees that there are notorious places when it comes to monitoring. These places include near schools, public institutions and those alternating parking zones as well as no parking zones. Therefore parking operators have to emphasize the use of more modern methods which are more efficient.

What is WSN-Parking?

Wireless Sensor Network is the system comprised of wireless autonomous devices using sensors to detect or monitor certain conditions in a given environment (National Instruments). In this case our environment is the parking lot and conditions to be monitored are the parking rules.

The use of WSN has found applications in many fields including monitoring of parking lots. Various researchers have worked and are still working on various vehicle detecting sensors. The most common examples include an inductive loop, which has several shortfalls including system costs and vulnerability to weather conditions (Hussain, El-Diwany & Hashish 1995). When thinking about the cost of the system and the interference with other devices, it means that the sensors to be deployed should use little power to serve for long enough and this is possible if the sensors are passive (Zhang et al 2013). The sensors can detect the magnetic field of the material and thus will detect the vehicle when entering/leaving the parking bay. Periodically the information will be sent to the router, which then forwards such information to the base station for processing and analysis as illustrated in FIGURE 10 below.

Architecture of the system

As explained above, the system has the following features:
  i.   Sensor nodes deployed on parking lots
  ii.   Cluster to collect data from the sensor nodes. Here is where a camera and other surveillance devices can be mounted

iii.   Gateway that links network of sensors

iv.   Transfer media >> Network say, Wi-Fi

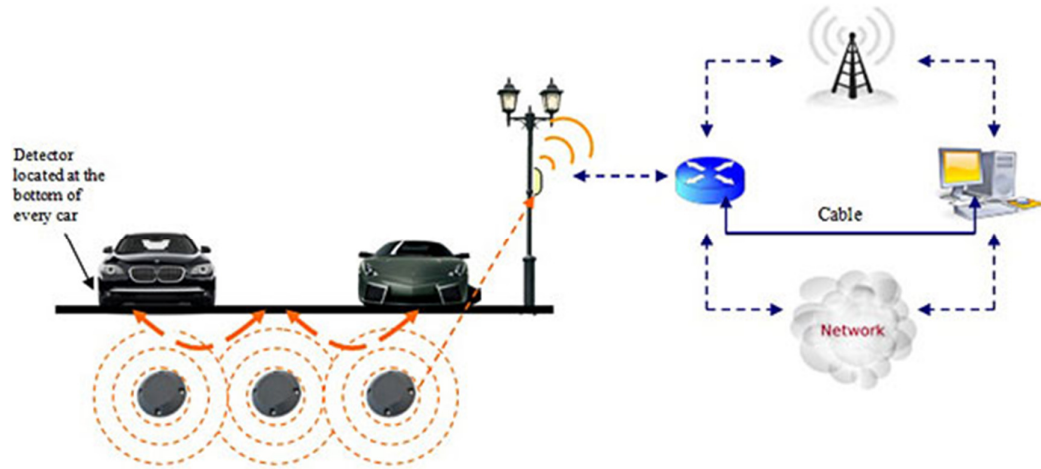v.   Base station (Remote server) for storing, processing and analysing various data.

FIGURE 10. Wireless Parking Lot Detection Systems

More information can be found at https://www.youtube.com/watch?v=urWv-_EqS9M

How to deploy on working environment

The first thing to think about is the power of the sensor nodes. The battery of the sensor nodes can provide power to the sensor for up to 5 years. It must be taken into account that after detecting the arriving/leaving vehicle and sending signals to the router and router to the base station, the sensor goes into standby mode until the next time when it needs to awake and give signals again (Wendt & Reindl 2008). In the system configuration, the router is sleeping most of the time. This is because it can be programmed to wake up after a certain time, then it takes the readings from the sensor, communicates with the base station and goes back to sleep. At the base station, data are processed and analysed for various uses. The sensor can be configured such that it can wake up and sleep as needed or within a period of time set depending on the purpose.

This brings the useful application of the idea of monitoring time limited parking lots. The sensor can be set to wake up when detecting the incoming vehicle then sleeps, and wake up again when the allowed time is over. Through the detection of the magnetic fields due to the metallic surfaces of the vehicle, the sensor can also tell if it is still the same vehicle on the same spot or not. If it is the same vehicle it means it has violated the rule but if the magnetic fields have different pattern, it means there is a different vehicle.

When the allowed time to park is over, the sensor will send the signals because it is timely synchronised. Thereafter, either the attendant will come and fine the vehicle or through communication with the central system (base station), the vehicle will be automatically fined. That will be possible by mounting cameras to capture entering/leaving vehicles. Other necessary details for the later method (fining at the base station) will be possible through the records of the vehicle when entering the parking lot. In this way, monitoring of parking will be easier and in a cost effective way, arriving at the purpose of deterring and punishing those vehicles breaking rules.

WSN can also be a key success in case of notorious visitors and residents in different areas, whom happens to park their vehicles near the entrances and walkways in residential areas and hence inconveniencing other users and emergency activities. Delivery and service vehicles will continue to perform their duties without being fined because most of these activities are done during the day and they do not take long. In these areas, time synchronised sensors can also be used to track vehicles parked in these no parking places (Nedap identification System-Vehicle detection 2014).

The projects involving deploying sensor networks are not new, but it is not until recently that the applications of such technology are gaining the popularity. The European Union is funding the smart Santander project (Smart Santander project).

7.2   Phone/Windows Apps

The world has experienced tremendous improvement in the developments electronics. There has been the introduction of various features aimed at easing the way people can get necessary services like improving social lives, developments and empowering people (Global Information Technology Report 2011). The introduction of laptops, tablets, windows phones and android technology has on the other hand brought other exciting moments on how technology can transform lives. Every day there are new apps introduced to users.

Parking is becoming automated and self-controlled, but still services before and after parking need to be user friendly. On a busy shopping day or a discount day in shops around the city, it is normal to see people waiting in what we may call a queue so that they can pay for parking. Taking into consideration variation in weather and time consciousness, it is also the right time to have a system that will not only eliminate the movement to and from the parking meter, but will also shield users from experiencing the outside weather when waiting for their turn to pay.
Taking an example from Helsinki ParkMan (also applied in Denmark and Sweden), the idea can easily be copied to Jyväskylä. The payment can be done direct via the phone apps. The apps can be designed simple and fit for use in many electronic devices with an internet browser.

How does it work?

The parking user opens the webpage and registers or may log in if already have an account. The user will then be directed to the page where there are details for the car or where there is an option to fill new details, and after that the user will be directed to the payment option with account details. The process will be completed by selecting the time the user needs to park and confirming.

The idea can be taken from online accounts like Netbank, S-mobili as well as Elisa, Sonera and DNA online prepaid purchases. The vehicle user will only need to display on a windscreen a card showing ''PAID'' and that's it! In this case the job of the warden continues to be the same, inspecting those not obeying the rules. Whenever doubts about payment arise, the warden can check the validity of the parking user

information by navigating through the system using the registration number of the vehicle.

The app can be such that it is available free of charge to download in all modern phones and the webpage easily accessible even without registration. To discourage paper work as well as the movement to/from the machine, the online method can have discount and this will also encourage people to use it more often.
The system is already in use in many cities around the world including Finland, US, Denmark, Sweden etc. An example of the webpage for such application can be found at http://parkmanworld.com/parkkinappi and FIGURE 11 below shows such a page which is the popular pay method in Helsinki, Finland.
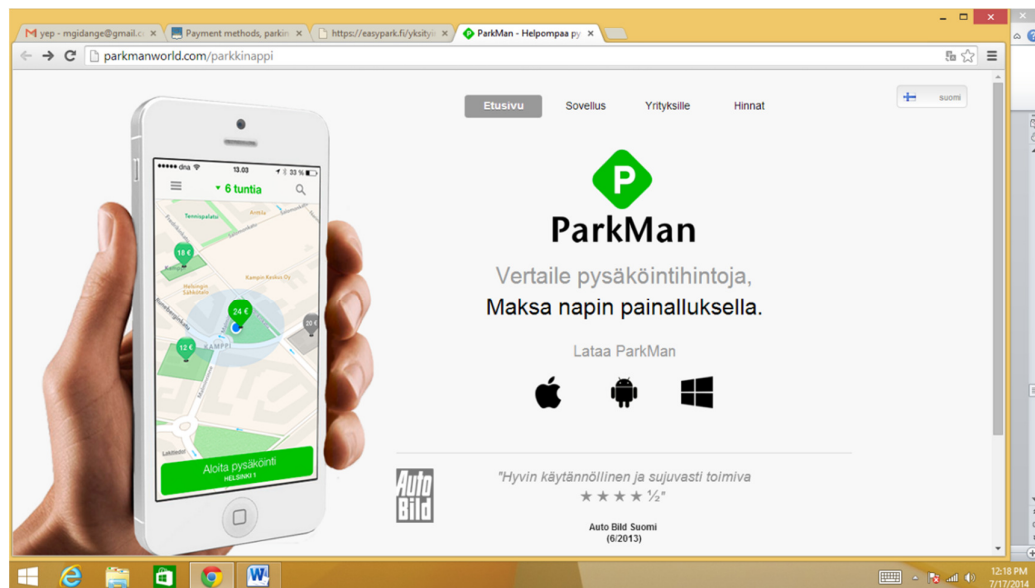

FIGURE 11. An example of pay by phone parking in Helsinki, Finland

Advantages of paying parking via phone/windows apps
  i.   No need for cash/coins or bank cards when making a transaction
  ii.   Safe and convenient especially when you have an account, as it eliminates most of the process
  iii.   Possibility of extending time remotely
  iv.   Eliminates paper work to a great extent

v.   No need to get out of the car and move to and fro the machine to purchase parking time (pay at the comfort and safe place in your car)

vi.   No queue, no exposure to bad weather

vii.   In case someone is fined by mistake (say the parking user forgot to display the card), appealing is easy as it involves only sending the copy of payment to the monitoring office.

(Pay by Phone Parking: The only change you'll need)

The problem is that, mobile phone apps need a wide range of users in order to be commercially viable. Moreover, the data modification is also difficult to open. These can be tackled through proper introduction of the system to the society. The society will not just learn new things by heart, no, but rather through introduction and familiarisation. The more the method is exposed to the users, the more it will gain popularity.

7.3   Improving Machines Used By Wardens to Issue Fines

The machines used by wardens at the moment to perform their activities have most of the important features and some of the information are standardised. They are capable also of operating with an internet connection. The future use of internet will improve the efficiency but has nothing to do with the cost saving strategy. The application of this will only mean easing the work done by the wardens. Since the amount of money collected from fines alone each year is a huge sum, then it will be a good move to the advanced machines for the smooth operations of the exercise. Even though everything seems working properly, but sometimes it is important to go along with the technology growth.

7.4   Public Watch

This is the method where by monitoring responsibilities are moved to the public and therefore normal people play a role of the parking attendant. This includes all stakeholders from parking users to the pedestrians. The public watch will not be a new monitoring method to come in use. The same method is used in Britain under the name of Flash Park.

Implementing the public watch is easiest and to author's opinion, is the most effective method of monitoring those who violate not only the parking rules but also the traffic rules. Despite now where the police or parking attendant has to patrol personally for those who violate rules, in public watch, as the name itself suggest, it means everyone in the society is obliged to make sure others also follow the rules. The method will gain popularity by getting support from smart phones. And this does not need much initial cost because electronics technology has grown to the level that more people own if not smart phones then at least a camera phone.

The parking operators will have only the task of developing a web application page with important information about the vehicle, kind of violation and location of violation. When an individual wants to report violation, he/she will open the page and fill necessary information including a photo attachment(s). Upon completion, the form will be submitted automatically to the central system where fine ticket will be automatically printed, bearing addresses of the vehicle owner. Later, the office workers will have only a job of posting the fine ticket with say, 30 day pay period (FlashPark- parking enforcement made easy).

It has to be clearly known that the aim of parking fines is not to collect revenue by the parking operators but rather to remind those who finds it difficult to observe and follow the rules that wherever and whenever you are breaking the rules then someone is watching you. In the beginning the system will be feared by people but as the aim is to deter, slowly the society will accept the changes and consequently arriving to the society where by rules are followed hence improving image of the city as well as city authorities.

As stated earlier, this monitoring system is not new and it has been in use in UK since the end of 2010 to replace the then existing clamping system. The clamping system was such that, apart from causing a lot of troubles to the vehicle users it meant also that the parking lot will not be used by someone else until unclamping is done. With flash park, private land owners do register for the service, but taking into considerations the importance of the public interest, in the public watch method it

will be such that if the person who caught the vehicle breaking the rules needs a bonus (commission) from the fine paid then one has to leave/write his/her necessary details but otherwise the system may not require registration to submit the offence.

The system will to great extent eliminate the need for parking attendants simply because each driver and each citizen act as a watch dog to whoever violates rules. The great benefit of the system will be so that even if the operators will keep the same number of wardens, but accuracy will increase and there is 99% possibility of whoever violates the rule to be caught and penalised accordingly.

When implementing the public watch, there will be two things to consider, one being breaching the rules in the right place and the second being breaching the rules in the wrong places. This is simply because in residential areas people park the vehicles the right way but in wrong places. It is common during weekends and evenings to find vehicles parked near building entrances sometimes blocking pedestrian's access. This has effect not only to building residents but rather to safety issues such as ambulance operations, fire trucks and other emergency service activities. Therefore those who park vehicles in a wrong place or where is not allowed to park will be considered different to those who park at the right parking place. The latter being not observing the rules governing parking at that particular place say, not paid, or exceeded parking time. Even though the latter is preventing others from using the parking by the rules but at least is not blocking or interfering with other traffic. To these, normal parking fines may apply. Those vehicle users parking at the no parking zones and therefore imposing threats to other traffic have to be punished different or even pay more.

Upon submission of the parking offence, the page will clearly indicate if the place is allowed to park or is outside the parking zone and the person violating the rules will be fined accordingly. Strong evidence displayed by photos taken will make the system more accurate and with few complains. In case users are not pleased by the punishment, appeal will always be open for further prosecution. Strong evidences

will set the offender free from punishment. The system has to manage multiple entries in case more than one person is trying to report the same vehicle.

In UK most landlords have appreciated the FLASHPARK system as it is easy to use and has wiped out most of the inconveniences.

Below are quoted appreciations from people who have used FLASHPARK in UK

*"Very happy with the service, it acts as a very good deterrent and it's very easy to take action when someone has parked on our property without permission. It has definitely solved our parking problems." (*Craig Swatton, Landowner, Greenhither)

*"A very good idea much less confrontation and very flexible" (*Michael Rose Winchester Investments)

Advantages of Public Watch
i. Shifts the control to the public
ii. Enhances safety because everyone watches the other
iii. Burden to attendants is reduced by 75%
iv. Same registration number can be fined again and again if continues to break rules. This has to be made such that if is on the same parking address/street; a new fine ticket can be given after every one hour.

Disadvantage;

The method may bring in conflict between individuals especially at the scene of violation.

7.5 Introducing Parking Fines Based On Income

The idea behind the improvement of parking monitoring efficiency in Jyväskylä as well as Finland in has many objectives, but one of them is to ensure that people abide to the laws and rules governing parking permission. Despite the increment of fines from €40 to €60 two years ago, still has made no great changes to the behaviour of people (Statistics Finland 2014). It is high time now to move to the new system exactly like the one used by the police to fine those who violates the rules such as over speeding, unnecessary idling, shoplifting etc. on which the fine is based on the income of the offender. The aim of the fines will always remain the same; to deter and to punish.

Using similar or more advanced parking fine ticketing machines, it means that the machine upon recording the registration number, the machine will communicate with the central server by recording the registration number of the particular vehicle, it will also obtain income details of the victim and other important parameters of the car as required in the ticket. Upon printing the fine ticket, other parameters will be omitted and only those details for the car and the amount of fine will be shown in the paper including payment details.

To make the improvement and adapt to the system easily, the normal parking fines rates (€60 for urban areas and €40 for other areas) will continue to be in effect. The current parking fine for urban areas (€60) will remain as the minimum parking fine in these areas and also will be used for vehicles with more than one owner as well as companies vehicles (Not privately owned). This parking fine will be for those whose monthly income when multiplied by a certain percent index (say 12%) will not exceed €60. Therefore, an individual with monthly income of say €719 will pay a fine in urban area of

€719*12% = €87.48

Even though the introduction of this system will be unfair to others, but it will help to shape the community especially for migrants enhancing Finland to remain the honest society through abiding to the rules. Low income people often by making simple mistakes they are fined and feel the impact of such fines while people whose income are high they just pay it and go on with their routine. In other words we can say that the system only helps to further the gap between the rich and the poor. Moreover, people with high status in the society should set a good example to the rest. Often low income people have fewer legal choices while the rich have no limitations but still some choose the illegal act anyway (Refer rich men fined in Finland, Switzerland and USA) because of bleaching driving rules.

When parking fines are proportional, it is fair to the entire system and prevents the system from being exploited by the rich on one hand and the system exploiting the poor on the other. This will not end completely the problem but will generate more

revenue which will help in developing the community and at the same time building a more honest society. Even stubborn people will have to think about this careful. Having a fine say of €34,500 just by violating the parking rule that you would have paid only €2 say! The lesson learned by those who park in bike lanes, pedestrian walkways, back yards where not permitted, handicaps lots as well as those who park without paying and park longer than required, disproportionately represented by expensive cars, people with a sense of entitlement, or those who would just find the fine (€60) to be like paying for parking. Make it hurt proportionately. What do you think (Wfloyd 2012)?

On the other hand one might think that obtaining the income records will not be easy and will be in interference of personal/private matter. Yes, it is true that private matters are interfered, but by breaking the rules it means that the offender is interfering with the matter of many people for personal interest. These records can be obtained from tax office. Again one might think that the vehicle was not used by the owner, YES, that is true but it is the owner who is responsible for whatever happens to the vehicle. This means that the vehicle owner must always be keen to whoever is handling the vehicle to. Authorities do not need to worry because worry drives off confidence leading to little achievement at the end.

8. EXPECTED OUTCOMES

The implementation of the proposed monitoring methods will ensure that now and in future the following are achieved;

 i. Benefiting pedestrians, cyclists, public transport passengers as well as other drivers by reducing the amount of offences from inconsiderate users

 ii. The flow of traffic and road safety will be improved through proper dealing with those who violate rules

 iii. Improving the city environment and enhancing the city's image also to outsiders

 iv. Reducing unnecessary movement of vehicles in the city because whoever violates the rules will be severely punished.

The improved parking monitoring systems will adapt to technology hence easing the work. There will be no need to trace and push people to abide to rules easing the tiring job of the wardens. By creating a mobile interface, the user will be able to select the desired parking duration and the need to queue to pay for parking or run from where you are to extend your parking time will be eliminated.

During the early days of implementation, the system will probably encounter a lot of criticism from people due to confusion, but as people are given time to learn, a stage will reached where people will get used to the system and be comfortable with it. Long term benefits to operators will be lowering the costs for wardens and their necessary materials/equipment and tools they use when performing their duties.

9. CONCLUSION AND RECOMMENDATIONS

9.1   Conclusion

Parking has been and will continue to be something that affects everybody in the society ranging from street dwellers, short term visitors, as well as traffic and law officers. Meanwhile, the monitoring methods have proved to be porous and therefore a need for improvements has become necessary not only at present moment but also in the future. This study has found that using the proposed improved methods there will be a range of benefits from increased revenues to improved security as well as customer satisfaction. The proper collaboration between management bodies and other stakeholders, as well as the advanced control systems using simple and reliable technologies will drive monitoring stresses out of our way.

By deploying systems which are more effective than the existing ones, vehicles violating rules will be easily detected through the automatic detection of parked vehicles as well as the societal responsibility.

With more challenges coming from conflicts with aggressive customers and changes in weather conditions, it is necessary that the authorities introduce better but technologically simple methods to attract more people to abide to the rules. The use of sensor networks as well as higher fines for bigger figures will not only drive stresses out of operators' employees, but also will force people to remain on the line.

9.2   Recommendations

As the car ownership is growing, the demand for parking will also grow. Most of cities in Europe and developing countries are already suffering from the issues that already have been outlined in the materials. This means that it is always important to learn from the mistakes/experience of other places as well as to update the methods in use by measuring their efficiency.

Parking spaces near higher learning institutions such as JAMK and Jyväskylän Yliopisto, especially the time limited parking spaces which oblige to a use parking disc need more attention. Introduction of sensors for detecting the presence/movement of a vehicle at a particular space can start on these lots to eliminate the tiring job of wardens. This can go hand in hand with the erection of surveillance systems in those places with the aim also of improving safety.

Legislative bodies should give local authorities and the public power to exercise the enforcement more contrary to the present moment where the society/public has little to contribute to efficient parking. This could be done mainly through direct reporting the offences. Parking should also be more expensive for on-street parking than off-street parking to encourage people to use the latter.

Park and ride facilities can be introduced, but this will work better where there is a shortage of central parking (which is not the case in Jyväskylä) but our case is about monitoring the parking lots to arrive at the efficient use of them.

Upon implementation, the project should be made sustainable by evaluating its effectiveness from time to time, and this will help the governing bodies to have

more ideas for future development. The proposed solutions are not rigid and they can change depending on the circumstances and the time of applications, and therefore the doors should stay open to welcome more ideas with similar aims.

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