Revenue Management, Operations Research and Artificial Intelligence:

Tools Application as Support to Decision Makers in Parking Industry.

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Abstract.

The successful application of Revenue Management (RM) to the seat inventory control (SIC) problem of major airlines has made it interesting to consider incorporating revenue management tools in parking industry. The objective of this paper is to motivate studies regarding to the development of methodologies that permit offer solutions for the problem for achieve the maximum revenue in parking facilities doing use of Revenue Management, Operations Research (OR) and Artificial Intelligence (AI) techniques. To accomplish this objective we do a brief summary about all those techniques and some applications in parking industry first, followed by some ideas regarding to development of methodologies in order to reach the maximum revenue considering as relevant include AI techniques as tool qualitative in the demand forecasting and the optimization of pricing.

Keywords: *Revenue Management, Operations Research, Artificial Intelligence, Parking Industry, Optimization, Demand forecasting and Optimization of pricing.*

Resumen.

Revenue Management, Investigación de operaciones e inteligencia artificial: herramientas para la toma de decisiones en la industria de estacionamiento.

El uso acertado del Revenue Management (RM) al problema del control de inventario del asiento (SIC) de líneas aéreas ha motivado interés en considerar incorporar las herramientas de RM en la industria de estacionamiento. El objetivo de este trabajo, es motivar estudios orientados al desarrollo de las metodologías que permitan optimimizar el beneficio en las instalaciones del estacionamiento mediante el uso de técnicas de revenue (RM), investigación de operaciones (O) e inteligencia artificial (AI). Para lograr este objetivo, primero, se desarrolla un breve resumen sobre todas esas técnicas y algunas aplicaciones en la industria del estacionamiento, seguido por algunas ideas orientadas al desarrollo de metodologías para alcanzar máximo beneficio, considerando como relevante la inclusión las técnicas de AI como herramienta cualitativa en el pronóstico de la demanda y la optimización de tarifas.

Palabras clave: revenue management, investigación de operaciones, inteligencia artificial, pronóstico de demanda, optimización de tarifas, industria de estacionamiento

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1. Introduction.

The parking industry can be recognized as one potential application area for Revenue Management (RM), Operations Research (OR) and Artificial Intelligence (AI). Operations research techniques can be applied in order to support decision-makers in parking facilities, in fact Operations Research methods, techniques and tools are applied to the field of Revenue Management and Pricing, and this process can be complemented with Artificial Intelligence systems. To promote the development of methodologies that consider techniques of these disciplines with the purpose of optimize decision make process in parking industry, we are going to summarize and identify possible applications from parking industries and to propose future studies with the objective of identifying news solution methods to parking management.

Revenue Management (RM), is a scientific technique that combines OR, Statistics and Customer Relationship Management (CRM) and categorizes customers into price bands, based on various services. Statistical analysis of past data helps in forecasting demand and establishing the appropriate price bands; then, RM is a combination of market segmentation, forecasting, pricing and other disciplines. RM "is the term used to describe the process of achieving maximum revenue from the sale of perishable assets"[1]. These sophisticated techniques were developed initially for the Airline Industry in the '80s, but more recently are being introduced to other sectors. The principle of RM is to sell the right product to the right customer at the right time and for the right price. "In the parking problem this can be translated to selling the right parking space to the right driver at the right time and for the right price", Rojas and Centeno, 2006.

Though there is no "official definition" of Operations Research (OR), in accordance with OR Britannica Society, it can be described as "a scientific approach to the solution of problems in the management of complex systems". Many analytical methods have evolved, such as: Linear Programming, Non-Linear Programming, Integer Programming, Dynamic Programming, Stochastic Process, Simulation, Networks, Goal Programming, Inventory Control, Forecast, etc.; which have powerful applications to real problems.

On the other hand, Artificial intelligence (AI) is a branch of computer science and engineering that deals with intelligent behavior, learning, and adaptation in machines. AI divides roughly into two schools of thought: Conventional AI and Computational Intelligence (CI). Conventional AI mostly involves methods now classified as machine learning, characterized by formalism and statistical analysis. This is also known as symbolic AI, logical AI, neat AI and Good Old Fashioned Artificial Intelligence (GOFAI). Methods include: experts systems, case based reasoning, Bayesian networks, behavior based AI, etc. CI involves iterative development or learning. Learning is based on empirical data and is associated with non-symbolic AI, scruffy AI and soft computing. Methods mainly include: neural networks, fuzzy systems, evolutionary computation, etc. AI has been thoughtful in parking industry, mainly in some applications regarding to parking reservation systems. However, there are few contributions to mention about the revenue management and artificial intelligence techniques together. One of them is

1 http://www.revenuemanagement.org.uk/Accesed

that provided by Teodorovic and Lucic in 2003, they proposed that parking reservation system should be coupled with the parking revenue management system in their system named "intelligent" parking space inventory control system, "that is based on the combination of simulation, optimization techniques, and fuzzy logic makes "on line" decisions as to whether to reject or accept a new request for parking". The other one, is that proposed by Grisselle Centeno and Daniel Rojas in 2006, they introduce the concepts about parking revenue management techniques as an input to parking reservation systems, there neural networks are used to predict space availability using data provided by a parking facility. Over again, Teodorovic and Lucic, in 2006, present a paper which discusses basic concepts of the parking reservation system and parking revenue management system, through "intelligent" parking space inventory control system that is based on a combination of fuzzy logic and integer programming techniques. Now, we are interesting in identify another opportunities of application of AI techniques in studies cases about to offers support to decision makers in parking facilities specifically regarding to RM. This work do not pretend offering innovative solution methods to support decision makers in parking management, our objective is motivate future studies that permit the development of several methodologies to reach the maximum RM combining OR and AI techniques and can to compare those in order to achieve improve that existing.

This paper is organized in sections. Section 1, present an introduction about the matter that is treated in the work. Sections 2, 3 and 4, refer to RM, OR and AI Techniques, including a brief summary about those techniques and their applications related to the matter under study. Section 5, provide an overview about some applications of OR, RM and AI, specifically in Parking Industry, based in articles from 2000 until 2007 with the intention of construct a comparative map of application of those techniques in parking industry and identify future application in industry parking in particular. Section 6, brings to a close proposing future studies in accordance with that wrote above. Finally Section 7 summarizes the proposal and leave open door to continue future researches based in the proposed by Centeno and Rojas (2006).

2. Techniques and applications.

2.1. Revenue Management (RM).

Revenue management has gained attention recently as one of the most economically significant and rapidly growing applications of operations research; that is the practice of maximizing revenues and profits through demand forecasting and the optimization of pricing and inventory. In other words, RM is the process of understanding, anticipating and reacting to consumer behavior in order to maximize revenue or profits: by manipulating price, companies can maximize their profits. In the parking problem RM is to selling the right parking space to the right driver at the right time and for the right price.

According to Dusan&Panta and Centeno&Rojas, there are characteristics significant that indicate what revenue management is appropriate to be applied in parking facilities, those are: *Parking facilities offer a service that is perishable:* Parking spaces are a perishable commodity, if a space sits empty, the lost income cannot be made up. *Capacity of the facility is limited:* a parking facility has

a certain number of spaces and more cannot be added without great costs or construction. *Market segmentation:* a parking space can be sold at different price to different customer segments to bear in mind certain factors such as arrival time, time to destination, and price. *Demand for the service varies over time:* demand for parking varies throughout the day. RM can smooth the demand curve by stimulating demand during low demand times and increasing revenue during high demand times. *Parking facilities can sell the service in advance*: often done through reservation systems, to enable forecasting and manipulate demand and pricing. Finally, *the variable costs of the service are low*: the main parking variable costs are for parking attendants and maintenance. If a space is sold that would otherwise have gone empty, then there is additional revenue gained.

There are studies that aim to optimization of demand forecasting or marked segmentation or pricing in parking facilities each one separately and doing use of AI, but the objective is to achieve the better combination that optimize all these at the same time. The AI can be an extraordinary tool that joint to OR, and makes RM one interesting technique for application in the parking industry.

2.2. Operations Research Techniques (OR).

Optimization is one of the fundamentals of Operations Research. In RM techniques, optimization of revenue to refers to the use of OR techniques as support to decision-makers. This paper considers two groups of them. First group involve: linear programming, non-linear programming, integer programming and dynamic programming. In this group, the objective function, which is what is optimized, can be a mathematical expression or it can be a single variable. Examples of some objective functions are revenue, price, cost, etc. Objective functions can be subject to constraints. A constraint is a limitation on the function that is being optimized. Examples of some these are capacity in facilities parking, time, fare, parking regulations, weather, customer behavior, etc.

Second group involve: Simulation, Networks, Goal Programming, Inventory Control, Game Theory and Queuing. Below, we show a brief review regarding some these techniques and its application in parking industry.

Linear programming (LP) considers maximizing a linear objective function subject to linear constraints. LP is an excellent set to initiate because it is the simplest technique to apply even though it may not give the best results. To RM that typical LP objective function is revenue and usual constraints are capacity, demand, and price rationality. An example of the latter is how much types fare assign, in which season and what price sell in order to maximizing revenue in a parking facility.

Non-linear programming (NLP) involves maximizing a linear or non-linear objective function subject to linear or non-linear constraints. Because of the non-linearity, this is significantly harder to perform than LP because the mathematics becomes more complex. In case of RM, frequent objective functions optimized with NLP include revenue too, and constraints include capacity and demand. NLP often applies to bond pricing, spot pricing, and optimizing a fare portfolio agree with customers.

Integer Programming (IP) optimizes a linear equation subject to linear constraint. IP is used when either the objective function result or constraints must be integer values. Somebody might to think of this as a special case of LP, but in reality it is not. The mathematics behind IP

and LP are different; IP is considerably more difficult than LP, in fact, modeling an IP system using LP and then rounding results will produce significant error. Regarding RM, IP applies to scheduling, customer segmentation, and allocation in parking facilities; typical objective functions include revenue, and common constraints include capacity, demand, price rationality, etc.

Dynamic programming (DP) is used for optimizing a variable that depends on future results. The term was originally used in the 1940s by Richard Bellman to describe the process of solving problems where one needs to find the best decisions one after another. Basically, what dynamic programming approach does is that it solves a multi-variable problem by solving a series of single variable problems. This is achieved by tandem projection onto the space of each of the variables. Concerning RM, DP applies to decide, in a parking facility, the quantity of spaces should be made available initially at various price levels or, otherwise, for a certain allocation scheme, find out the optimal pricing levels for example.

Simulation is one of the most powerful analysis tools available to those responsible for the design and operation of complex processes or systems. In parking industry, simulation has become a very powerful tool for the planning, design, and control of parking facilities. Previous research into computer modeling and simulation regarding to parking management has focused on demand estimation techniques. Sometimes, the use of simulation studies has been in association with behavior choice models. Another uses of simulation are about the modeling policies for parking facilities just as: provide carpooling incentives, implement customer segmentation, and sell reserved spaces via a uniform price sealed bid auction, between other.

Networks describe a type of model that is a special case of the more general linear program. The class of network flow programs includes such problems as the transportation problem, the assignment problem, the shortest path problem, the maximum flow problem, the pure minimum cost flow problem, and the generalized minimum cost flow problem. It is an important class because many aspects of actual situations are recognized as networks and the representation of the model is much more compact than the general linear program. When a situation can be entirely modeled as a network, very efficient algorithms exist for the solution of the optimization problem, many times more efficient than LP in the utilization of computer time and space resources. Regarding parking facilities, when a customer may require a space in a parking facility for a sequence of periods weekly or monthly, network capacity control can be used to represent this problem

Goal Programming is a procedure based on LP that allows several goals to be considered instead of just one single objective. It a branch of multiple objective programming, which in turn is a branch of multi-criteria decision analysis (MCDA), also known as multiple-criteria decision making (MCDM). It can be thought of as an extension or generalization of linear programming to handle multiple, normally conflicting objective measures. Each of these measures is given a goal to be achieved. Unwanted deviations from this set of target values are then minimized in an achievement function. This can be a vector or a weighted sum dependent on the goal programming variant used. As satisfaction of the target is deemed

to satisfy the decision maker(s), an underlying satisfying philosophy is assumed.

Inventory Control has as objective determines how to allocate capacity of a resource or a bundle of different resources to different classes of demand so that the expected revenue or profit is maximized. In the parking industry, capacity control can be referred to as space inventory control problems. Its main characteristics are the parking demand is variable over time, parking spaces have daily opportunity to be "sold" (used by drivers), and any parking lot has limited number of parking spaces that can be used by drivers.

Queuing theory (QT) is the mathematical study of waiting lines (or queues). The theory enables mathematical analysis of several related processes, including arriving at the queue, waiting in the queue, and being served by the server(s) at the front of the queue. The theory permits the derivation and calculation of several performance measures including the average waiting time in the queue or the system, the expected number waiting or receiving service and the probability of encountering the system in certain states, such as empty, full, having an available server or having to wait a certain time to be served. QT is generally considered a branch of operations research because the results are often used when making business decisions about the resources needed to provide service. It is applicable in a wide variety of situations one is transport, in especial in intelligent transportation systems and traffic flow. About RM, QT is used in simulated systems over parking facilities generally when those are below evaluation or design. QT is used joint with simulation in studies about choice behavior or demand estimation.

2.3. Artificial Intelligence.

Artificial Intelligence (AI) can be defined as the study of methods by which a computer can simulate aspects of human intelligence. One objective of AI is the development of systems that can work with natural language, meaning the language that we speak and write as distinct from any programmed computer language. Another is the ability of the computer to search knowledge in a database for the best possible reply to a question, because this has strong parallels with the way that we solve problems ourselves. AI is generally associated with Computer Science, but it has many important links with other fields such as Mathematics, Psychology, Cognition, Biology , among many others.

In parking industry, RM to confront with short of information about its customers and their process of choice, which is to mind, scarce data available to the process of predicting the quantity and specific attributes of parking facilities and spaces needed to satisfy the forecasted demand. That to result in "capacity planning methods do not provide efficient results because most of the time the huge amount of dynamic input data is ignored and not many demand scenarios are considered even though a high uncertainty in the forecasts typically exists", Centeno and Rojas 2006.

The conventional AI to offers tools that permit to preserve several scenarios in knowledge base and decisions making process through of experts systems, case based reasoning, Bayesian networks, systems behavior based AI as agent-based models and knowledge based systems, etc. Furthermore, computational AI to offers tools to permit to emulate the human behavior, just as neural networks, fuzzy

systems, evolutionary computation as genetic algorithms, etc.

The use appropriate of these AI techniques as tools of forecast in RM process can be a step forward to improve the RM applied in parking facilities. Below this paper to presents a brief overview about AI techniques and its applications in parking industry.

Experts Systems (ES) and *Knowledge-based systems* (KBS) frequently are defined as the same tool, but expert systems is reserved for programs whose knowledge base contains the knowledge used by human experts, in difference to knowledge gathered from textbooks or non experts that considerate by knowledge-based systems . On the other hand, experts systems and knowledge-based systems taken together, they represent the most extensive type of AI application. These systems represent the expertise knowledge as data or rules within the computer. These rules and data can be called upon when needed to solve problems. Until now, much research on parking has concentrated on aspects important to policy-making and infrastructure development. However, ES and KBS can be used as tool for studies about parking choices decisions and that can to serve in forecast demand.

Case Based Reasoning (CBR) is able to utilize the specific knowledge of previously experienced regarding to concrete problem situations (cases); a new problem is solved by finding a similar past case, and reusing it in the new problem situation. It is an approach to incremental, sustained learning, since a new experience is retained each time a problem has been solved, making it immediately available for future problems[2]. CBR can be used as tool for studies about parking choices decisions and that can to serve in forecast demand.

Agent-based models (ABM) this modeling approach consist in describe a system from the perspective of its component units, this approach is appropriate for modeling complex systems whose behavior emerges as a result of interactions among the components making up the system. Given that transportation systems display almost all the characteristics of complex systems, ABM is an attracting a lot of attention within the parking industry, applications has been development as simulation models that simulate behavior of every agent (drivers, parking authorities, law enforcement and city government) in order to analyzing parking facilities.

Neural Networks (NNs) are biologically motivated systems consisting of a massively connected network of computational "neurons," organized in layers. By adjusting the weights of the network, NNs can be "trained" to approximate virtually any nonlinear function to a required degree of accuracy. NNs usually are provided with a set of input and output exemplars. A learning algorithm, such as back propagation, would then be used to adjust the weights in the network so that the network would give the desired output, in a type of learning commonly called supervised learning. NNs network can be applied in forecasting about choice decisions in parking facilities.

Fuzzy Systems (FS) are based in Fuzzy Logic, that derived from fuzzy set theory dealing with reasoning that is approximate rather than precisely deduced from classical predicate logic.

2 Aamodt and Plaza, 1994

Fuzzy set membership functions offer a manner to demonstrate that an object can partially fit in to a group. Here it is about that possibility more than probability. In RM for parking facilities an application of FS can be the selection of the best structure of pricing according to forecasted customer demand.

Genetic Algorithms (GAs) are stochastic algorithms whose search methods are based on the principle of survival of the fittest. The procedure starts with a randomly generated initial population of individuals, where each individual or chromosome represents a potential solution to the problem under consideration. Each solution is evaluated to give some measure of its "fitness." A new population is then formed by selecting the more fit individuals. Some members of this new population undergo alterations by means of genetic operations to form new solutions. This process of evaluation, selection, and alteration is repeated for a number of iterations (generations in GA terminology). After some number of generations, it is expected that the algorithm "converges" to a near-optimum solution. GA can be used in problem solving and optimization as comparison of different forecast combination techniques for the application of RM forecasting for parking industry. Another application can be minimize the walking distance of drivers between the parking lot and the destination on the basis of meeting the parking demand in the planning area.

2.4. Applications OR, RM and AI in Parking Industries: an overview.

To our knowledge, there is little work on applications of revenue management in parking facilities which were named above. In fact, a recent overview presented by Wen-Chyuan et.al. in January, 2007, suggest that the application of RM in other industries is promising, however, in spite of they reviewed 221 articles; they do not include none development regarding to revenue management applied in parking industry; neither, they considerate parking industry as area especially interesting in apply RM.

Nevertheless, several modeling frameworks have been applied to analyze parking problems. Some approaches about to optimization techniques, specifically OR, and another about AI. Below, we presented the Table 1 with some examples of these applications with the intention of illustrate that.

Table **1.** ➤➤
Examples of Applications OR, AI an RM in Parking Industry.[3]

				Revenue Management			Operations Research												Artificial Intelligence							
No.	Author	Year	Title	Policy	Choice Behaviour	Pricing	Linear Programming	Non-Linear Programming	Integer Programming	Dynamic Programming	Simulation	Sthocastic Process	Networks	Goal Programming	Inventory Control	Forecast	Game Theory	Queuing	Experts Systems	case based reasoning	Bayesian networks	Agent-based models	knowledge based systems	Neural Networks	Fuzzy Systems	Genetic Algorithms
1	Waterson B.J.- Hounsell N.B.- Chatterjee K.	2001	Quantifying The Potential Savings In Travel Time Resulting From Parking Guidance Systems - A Simulation Case Study		✓						✓		✓													
2	Donohue, George - Cannon, Stephen et,al	2002	Optimization Of Resource Distribution In The George Mason University Parking System	✓		✓					✓															
3	Teodorovic, Dusan - Lucic, Panta	2002	Parking Space Inventory Control: An Artificial Intelligence Approach		✓						✓	✓			✓										✓	
4	Dell'Orco, Mauro - Ottomanelli, Michele - Sassanelli, Domenico	2003	Modelling uncertainty in parking choice behaviour		✓				✓																✓	
5	Dell'Orco, Mauro - Teodorovic, Dusan - Zambetta, Michele	2003	An Artificial Intelligence Approach for Parking Facilities Management			✓																✓				
6	Muromachi, Yasunori	2003	Inter-Relationship Between Route and Parking Location Choice Behavior in Downtown		✓											✓		✓								
7	Sattayhatewa, P. - Smith, R. Jr.	2003	Development of Parking Choice Models for Special Events		✓		✓						✓													
8	Griffioen -Young, H.J.W. Janssen - D.J.C. van Amelsfoort - J.J.	2004	The Psychology of Parking		✓	✓																				✓
9	Hess, H. - Polak, J.	2004	Mixed logit estimation of parking type choice		✓											✓										
10	Centeno, Grisselle - Rojas, Daniel	2006	Revenue Management Techniques Applied to the Parking Industry		✓	✓										✓								✓		
11	Hollander, Yaron - Prashker, Joseph - Mahalel, David	2006	Determining the Desired Amount of Parking Using Game Theory	✓													✓									
12	Teodorovic, Dusan - Lucic, Panta	2006	Intelligent parking systems		✓				✓																✓	

In regard to table above, make decisions about policy has been faced with simulation (2) and game theory (11); studies in relation to choice behavior has been developed with Linear Programming (7), Integer Programming (4), Simulation (1) and (3), Stochastic Process (3), Networks (1), Inventory Control (3), Forecast (6) and Queuing (6) regarding to OR techniques; concerning to AI techniques; Neural Networks (10), Fuzzy Systems (3), (4) and (12) and Genetic Algorithms (8). Finally, pricing has been analyzed applying simulation (2) and forecast (10) OR techniques; and Agent-based models (5), Neural Networks (10) and Genetic Algorithms (8); regarding to AI techniques.

In 2006, Centeno and Rojas (6), proposed a methodology that consider revenue management process applied to the parking problem, this work to include revenue management techniques as an input to parking reservation systems in order to improve that. This proposal will be used as base for develop the last section because we considerate that as interesting to explore in detail in order to achieve improve that.

3. Future studies proposed.

In 1998, Peter van der Waerden et.al., presented a paper which discussed the effects of changing the parking situation in the surrounding of shopping centers on consumers store choice behavior. To get insight into these effects a hierarchical logit model of parking lot and store choice behavior was estimated and

3 Made by authors.

validated. In that paper they concluded that "especially the model does not perform very well on predicting parking lot choice." This and other cases to suggest looking for other methods for forecast choice behavior. It know that humans being have interesting approaches to problem-solving, based on abstract thought, high-level deliberative reasoning and pattern recognition; in this way, the AI can help us to represent this process by recreating it, then potentially enabling us to emulate the human behavior when is to face of choice problem. By reason of we suggest continuing the research about RM in parking industry following the approach used by Centeno and Rojas (2006), and use AI techniques for forecast driver's behavior, so discontinuous change in mode choice behavior can be considerate and forecast will not depend on the continuity of historical data and time series.

In order to motivate studies about the combination of techniques to improve the methodology proposed by Centeno and Rojas, we ask the following research question: Can be applied AI techniques and OR techniques together to improve RM in parking facilities? This question can derivate another direct questions: Can AI be a technique a suitable tool to predict parking availability, demand or driver's behavior in parking facilities and show superiority to traditional regression models? How can OR be compliment of AI to achieve an optimal methodology to apply RM in parking facilities?

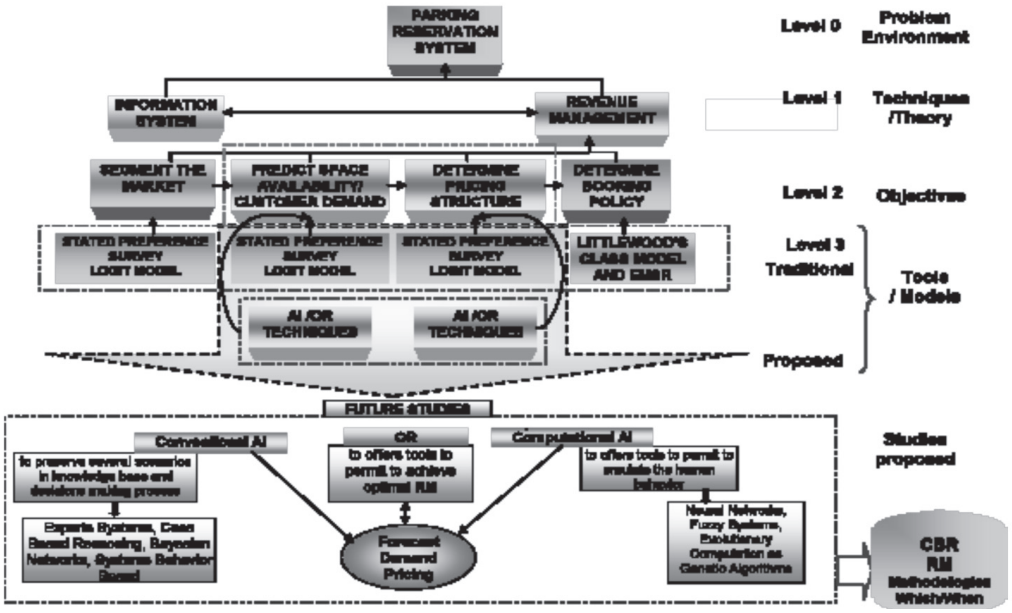
Those questions only can be answered after of develop a set of research projects whose aims are apply several combinations of AI techniques and OR techniques in order to compare the effectiveness of each one and determine the better combination of techniques to achieve the optimal revenue and can offer improve to the methodology mentonated. Due to we would like to motivate develop of those project through of suggest idea about that.

First, it knows that demand forecasting in RM have been studied using statistics methods traditional; however, more recently use AI techniques, or qualitative methods, in forecasting is more frequently; overall when behavior human is a characteristic determining in decision making as in parking facilities.

Among, the technique more used by demand forecasting is Neural Network. Due to it is necessary board another AI tools and considerate that in the methodology proposed by Rojas and Centeno (2006) in order to evaluate results from each different tools and identify which is the best and when each one should be applied.

The Figure 1, presents the general problem description and overview to provide solutions to the parking problem used by Rojas and Centeno, 2006, after level 3, we include the approach of specific interest in this paper. At the top level of the methodology is the parking reservation system, with two entrances an information system that allows parkers to reserve a parking space in advance and the results of the revenue management process applied to the parking problem. First, market segmentation would be studied through a parking behavior/choice survey supported in AI and OR techniques. The objective of market segmentation is to determine if drivers are willing to pay higher fares under certain factors such as arrival time, time to destination, and price. After drivers have been segmented, we propose in the next step to predict parking space availability through of conventional AI (Experts Systems,

Figure **1.** ➤➤
Methodology proposed by Rojas and Centeno, 2006 with proposal auditioned. Some modifications were made by the authors.



Case Based Reasoning, Bayesian Networks or Systems Behavior Based) as an alternative to other traditional forecasting. The results of the prediction model are extremely useful since they would be used as an input later to optimally allocate available parking spaces supported in OR techniques. Revenue management theory states that a parking space could be sold at different fare rates. The goal is determine the price difference that would influence drivers to change their parking choice. This would be studied through parking behavior/choice models based on computational AI (Neural Networks, Fuzzy Systems, Evolutionary Computation as Genetic Algorithms) in order to emulate the human behavior. Finally, these results and the ones obtained from the prediction model would be used to determine how many parking spaces should be reserved for each drivers segment in order to achieve the maximum revenue, doing use of OR techniques or Evolutionary Computation as Genetic Algorithms. Finally, we can compare the results obtained with application of each one AI tools applied for forecast and to use a Case Based Knowledge CBR for choosing forecasting techniques proper according study case.

4. Conclusion.

The diagram above show the AI techniques that can be applied as forecast tools over possible areas considered as relevant in this paper as parking availability, demand or driver's behavior. The proposal is select a study case about parking facilities and apply RM taking as forecast tools someone AI techniques, in some cases combine that with OR techniques and to store the results in a CBR in order offer a tool of selecting the best methodology by RM in parking facilities according to specific suitcases.

The approach proposed consider to use traditional techniques by *market segmentation,*

pricing and booking, the variation will be present by *predict space availability and forecast demand*, in which AI techniques will be applied as forecast tool. The research methodology to use is that proposed by Centeno and Rojas in 2006 where they concluded that Neural Networks offered good forecast measured; now, the purpose is look for better AI techniques in forecast about parking facilities when the main objective is to reach the maximum revenue supported in OR techniques. Over this base, this paper aim to motivate the follow studies.

To develop a number of methodologies based in different scenarios, in different infrastructure of parking facilities and supported in different forecast combinations of AI techniques joint OR techniques for the application of RM forecasting for parking facilities.

To develop a framework of an intelligent advisor assistant that permit to preserve the results of the methodologies developed above in a CBR in order to compare and to identify which is better on each one particular scenario, then to store these outcomes and finally, can suggest when apply a determined tools combination and to be sure of achieve optimal revenue in a specific parking facility.

We proposed a Case-Based Reasoning (CBR) it is an intelligent-systems method that emulate an analyst who works by matching new parking problems to "cases" from a historical database and then adapting successful solutions from the past to current situations, taking advantage of previous researches. Organizations as diverse as IBM, VISA International, Volkswagen, and NASA have already made use of CBR in applications such as customer support, quality assurance, aircraft maintenance, process planning, and decision support, and many more applications.

The way is so long, just we should to go over it and recognize what the use of AI has enormous potential for handling the complexities of RM because of its abilities in complex problem solving, reasoning, perception, planning and analysis of extensive data are 'knowledge based' software packages that reflect the expertise in the area of the application and these type of systems have extensive capacity in dealing with non-numeric, qualitative data. Great advances have taken place in the development of such systems within OR in order for capacity constrained to answer the question of profit optimization. Due to AI and OR are natural bases in which RM can develop and improve through the foundation principles of OR, in particular parking industry.

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