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"FUEL TYPE BASED VEHICLE CHOICE"

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1. Introduction

The aim of this paper is to analyse the researches performed so far, concerning the choice of a vehicle according to the fuel type. Among the reasons which make this topic interesting, we recall the following:

a. increasing costs of conventional fuel;
b. development of new fuel types;
c. different fuel efficiency;
d. higher productivity standards, due to crisis of car corporations;
e. Italy's car fleet has a 30% of vehicles that are ten years or older and also by a strong preference towards buying gasoline and diesel fuelled vehicles.

The paper proposes a critical analysis of vehicle choice analysis based on fuel type (e.g. gasoline/diesel, CNG and hybrid).

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A significant number of studies are centred on the consumer. As noted by Achtnicht (2008) the choice depends on the person's age, gender and educational attainment.

Other authors have inquired the actual gap between the efficiency of conventional (diesel/gasoline) and alternative (hybrid) fuels.

The lack of a diffused network of refuelling stations, particularly referring to the CNG (Compressed Natural Gas), has also been highlighted by Achtnicht, Buhler and Hermeling (2009).

Several electrical car market development researches, like Salerno's and Zito's (2004), have stressed its high purchasing price and its maintenance costs.

We will consider, for the different studies, the methodologies used by previous authors in their specific area of research, the results obtained, the critics, and eventually the trends and developments.

2. Analysis method and selection standards

We have chosen a quantitative analysis method, preferred over a qualitative analysis because it allows a greater objectivity in the research results considered.

Previous readings about fuel type based vehicle choice have led to a selection of 20 articles which share some basic characteristics:

- case studies illustration considering electric or hybrid;
- time limited studies (1990 – 2010);
- sample quantity of interviews (at least 200 interviews);
- geographical areas studied.

The table below (tab. 1) shows the researches overview.

Tab. 1 – Researches overview sorted by authors, year, state and attributes.

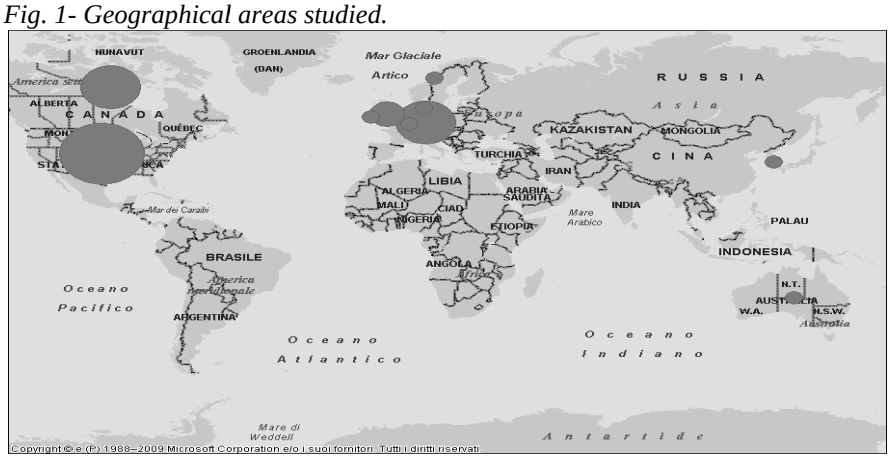
	Authors	**Year**	**State**	**Attributes**
1	Achtnicht	2008	Germany	PP, F, EP, CO2, SSN
2	Achtnicht, Buhler, Hermeling	2008	Germany	PP, MC, EP, CO2, SSN
3	Ahn, Jeong, Kim	2007	South Korea	BT, MC, EP, F
4	Axsen, Mountain, Jaccard	2009	Canada/California	PP, I, EP, FC, F
5	Batley, Toner	2003	Great Britain	PP, R, TS, A, RVY, CO2
6	Batley, Toner, Knight	2004	Great Britain	PP, MC, TS, SSN, CO2, R
7	Brownstone, Bunch, Golob	1994	California	R, TR, SSN, FC, LS, MC
8	Brownstone, Bunch, Train	1999	California	PP, R, TR, RL, F, A, TS, CO2, BT, LS
9	Brownstone, Train	1999	California	PP, R, A, TS, CO2, BT, LS, MC
10	Bunch, Bradley, Golob, Kitamura, Occhiuzzo	1992	California	PP, SSN, R, F, CO2, FC
11	Caulfield , Farrell, McMahon	2010	Ireland	F, I, CO2
12	Dagsvik, Wennemo, Wetterwald, Aaberge	2001	Norway	PP, R, TS, FC
13	Ewing, Sarigollu	1998	Canada	PP, MP, A, R, TR, CO2, CT, MC
14	Greene, Fellow	2001	Tennessee	PP, F, R, MC, A, RL, LS, SSN, BT, FC
15	Hensher, Beck, Rose	2009	Australia	PP, F, I, CO2, FC, EP, BT, CM,
16	Kazimi	1996	California	PP, R, TS, A, FC, F
17	Knockaert	2005	Belgium	EP, PP, MC, PC, F, R, CO2, LS
18	Mabit, Fosgerau	2010	Denmark	PP, MC, R, A, SSN
19	Potoglou, Kanaroglou	2006	Canada	PP, MC, SSN, A, I, CO2
20	Ziegler	2010	Germany	PP, EP, F, CO2, SSN

Note: the attributes acronyms correspond to legend in the Figure 2.

2.1. Geographical areas studied

The areas where most inquiries have been conducted are: USA (California and Tennessee), Canada and Germany. Less studies have been conducted in Great Britain, Belgium, Norway, South Korea, Australia, Denmark and Ireland. Fig. 1 shows the considered areas, and ranks them according to the number of studies held in each area.

Fig. 1- Geographical areas studied.



2.2. Methodology and models used

Choice models can be of two types: discrete choice model and continuous choice model.

Discrete choice model works on a finite number of possibilities. Continuous choice model is used to describe and to predict the operator's decisions when the choice set consists of an infinite number of possibilities.

Therefore, in our study the discrete model will be used, since the vehicle choice is deeply characterized by present contexts in which choice alternatives are numerable, finite and mutually exclusive.

Among the discrete choice models the solution most widely used, is the multinomial logit model (MNL). In some cases, in order to eliminate restrictions (e.g. IIA) arising from MNL use (Ben-Akiva, Lerman, 1987), the nested multinomial logit model (NMNL) has been adopted.

The discrete choice model data is obtained through surveys conducted using SP data (stated preference).

The stated preference models deduce their behaviour pattern on random utility theory (RUT). Recent researches use jointly the SP/RP interview procedures; in this case the RP data (Revelead Preference) are exploited in the focus groups during the first research phase. In this way the advantages of both techniques are used and overcome their limitations.

The studies data mentioned, are subdivided in:

- SP: 90%
- SP/RP: 10%

2.3. Interviews categories and interviews administration mode

The interviews percentage by category is distributed as following:

- individual: 95%
- household/individual: 5%.

In the group choice case, firstly is taken into consideration the family member's choice interviewed individually and then the group's choice. In this case the group included spouses as a peers group. The administration modes are the following:

- CAPI - computer assisted telephone interview: 25%;
- CATI - computer assisted personal interview (face to face): 20%;
- EMS - electronic mail survey (latest researches): 10%;
- IES - internet electronic survey (latest researches): 20%;
- paper questionnaire: 25%.

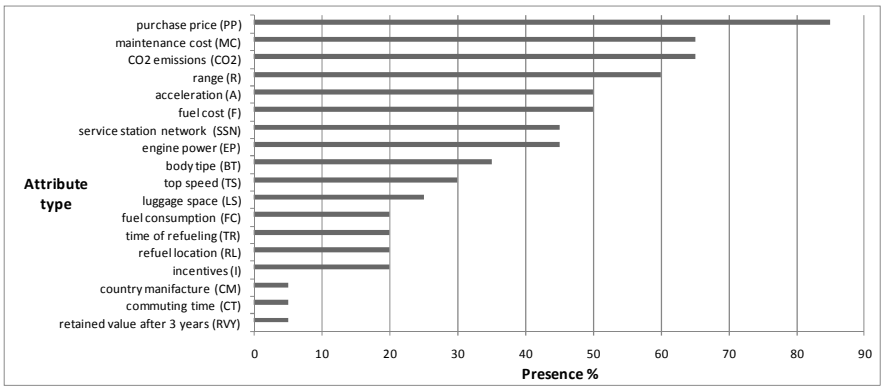
The IES and EMS type of interview are rising in recent researches. This is a result of the internet usage which permits reduction of the research costs.

2.4. Choice attributes considered

The researches are characterized by a specific set of attributes which expresses the considered alternative. Most of the studies rely on classical variables: purchase price, maintenance cost, CO2, fuel cost. But new variables begin to appear, unconsidered so far: refuel location, commuting time, luggage space and engine power.

Fig. 2 shows the attributes presence in the selected case studies.

Fig. 2 – Presence of choice attributes considered in case studies.



Most of the considered attributes have a clear meaning, but some of these (recently introduced in the researches) need an explanation and a measurement method description:

- service station network: in Fig. 2 the two measurement methods have been matched (the measurement based on the percentage of alternative fuel stations than normal ones, with the measurement based on the refuelling stations distance from the departure place);
- refuel location: refuelling place (home or refuelling station);
- commuting time: time for commuting. It varies according to feeding (the electrical vehicle can take the preferential lanes);
- engine power: measured in HP (horse power) or capacity;
- incentives: measured in terms of road tax lower price or vehicle lower purchasing price.

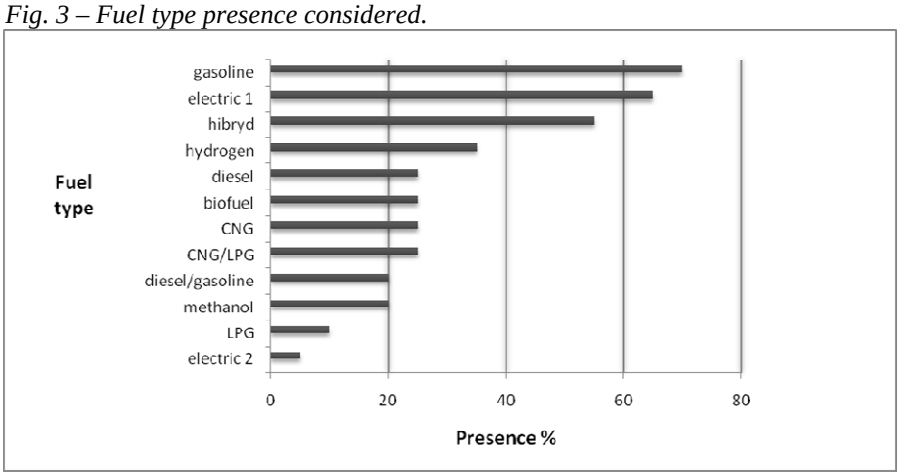
2.5. Fuel type studied

Considering the fuel type in each research, the maximum number is 7. On average, the researches consider 4 alternative fuels. The most common are gasoline, electrical 1 and hybrid. Fig. 3 shows the fuel type presence percentage in the researches. There is a description of some fuel types usage and meaning:

- electrical 1: electrical energy generated by batteries;
- electrical 2 (fuel cell): the cell allows to produce electricity directly from some substances: typically hydrogen and oxygen, without heat combustion;

- hybrid: it means an electric engine mixed with a heat engine, not a flex heat engine;
- methanol: currently used in sport competitions. A possible choice in some researches as one of the AFVs (alternative fuel vehicle).

Fig. 3 – Fuel type presence considered.



Note: LPG (liquid propane gas)

3. Conclusions

This research summarises the studies about the vehicle choice in the last 20 years, focusing on methodological aspects considered as fundamental: the choice attributes, the fuel type and the sample quantity.

The analysis shows that some relevant attributes have not been deepened yet, for example:

- fuel consumption: significant in this historical period due to indiscriminate increases of traditional fuels prices;
- network diffusion of alternative fuels service station: this is one of the clean fuel vehicles greatest barrier;
- commuting time: time to cover the work/home distance. The home/university or home/school distance can be added to the meaning of this attribute. The work/home distance becomes relevant in a group choice such as the household one.

4. Future research

Future research will be developed from the following points:

- accurate examination of group choice within the household because the vehicle choice often concern more than two individuals;
- elaborate a survey, since unexplored aspects, which finds innovative solutions in order to encourage the alternative fuel purchase. We must also remember that a vehicular fleet such as the Italian one has a strong impact on CO2 emissions: incentive strategies to purchase have to encourage the fleet renewal, because the European goals that we have subscribed are pressing.

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