Study of Social Organization for the Use of Firewood Heating in Zones Where Polluting Material is Generated in the City of Temuco, Araucanía Region, Chile

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Abstract. Temuco, capital of the Araucania Region of Chile, presents the highest indices of pollution by smoke from wood-burning heating stoves in the country, specifically during the southern winter. Firewood combustion is the cheapest heating fuel available to the population of Temuco, and has resulted in considerable contamination in the city. There has been an increase in the city’s population, while the winter months from April to September have been growing colder. The problem affects the whole population, and especially children and the elderly. The pollution indices present serious levels. The evening and night are the worst times to be outside, due to both poor visibility and the toxicity of the environment. This situation is a social problem which has not been fully investigated. More seriously still, the people of Temuco do not display particular concern about their collective health or about protecting the environment from the smoke produced by wood-burning stoves. In view of this serious problem, the present article proposes a strategic design for information and social organisation by sectors in the city’s residential districts, in order to generate awareness and communication in the community. The strategic guidelines are drawn with special emphasis on visual communication, in both printed and digital format, in order to organise social groups of people motivated to solve the pollution problem. The central object of this proposal is to offer a strategic model able to generate collective awareness to support and help the city’s housing estates and residential zones. Connection between community members, empathy and social assistance will be basic aspects for the functioning of the strategy when it is applied. Finally the proposal contemplates social organisation in pursuit of the common good: protecting the local environment, improving people’s quality of life, and promoting social coexistence in housing estates and communities affected by the problem of pollution by smoke from wood-burning stoves.

1. Introduction
The present article presents an analysis of a social problem arising from pollution in the city of Temuco, Araucanía Region, Chile. The pollution is generated by heating stoves and the indiscriminate use of firewood in wood-burning stoves in and around the city. The case study is set in Temuco, the capital of the region, and includes various residential zones and sectors such as closed housing estates.

The research question refers to knowledge among the better-off population of Temuco about the current pollution problem and their willingness to make the necessary changes. The hypothesis is that by implementing effective communication strategies it will be possible to clear up the mistaken
conceptions of the population about the existing pollution and motivate substantial changes in a
segment that has been little studied in contemporary scientific literature.

Finally, we propose a visual organisation strategy, based on the contents of information design for
communication with the sectors involved in the research problem.

2. Case study: City of Temuco, Araucanía Region, Chile.
The Araucanía Region covers an area of 31,842.30 km², equivalent to 4.2% of Chilean territory.
According to the 2017 Census, the population is 957,224 inhabitants with a density of 30.06
inhabitants per square kilometre. The regional capital is Temuco, with a population of 245,347
inhabitants, of whom 232,528 (94.8%) live in urban zones and 12,819 (5.2%) in rural areas. [7]

Temuco is a municipal district and city in southern Chile, capital of the province of Cautín and the
Araucanía Region. It was founded as a fort in 1881 by Manuel Recabarren, principally due to its
strategic location in the central valley. It lies 619 kilometres south of Santiago, capital of Chile, in a
straight line, and 675 by road. [7]

The city limits include one of the most emblematic protected natural spaces of the region, the Cerro
Ñielol Natural Monument (located only ten blocks away from the main square), where vestiges can be
seen of the original forests of the central valley of the Araucanía Region.

The main economic activities of the region are based on farming of traditional crops; however the
participation and importance of forestry and tourism have increased, the latter particularly in resorts
like Pucón and Villarrica.

The geographical space of the region comprises the Andes Range, the pre-cordillera, the central
valley, the Coastal Range and the littoral plains of the Pacific coast, with a wealth of flora and fauna
typical of the wet temperate zones of southern Chile. Temuco lies at 300 m.a.s.l. in the centre of the
region, of which it is the economic and urban hub.

2.1. Climate of the city of Temuco
The city has a rainy, temperate ocean climate with mediterranean influence, typical of Chile's central
valley. The mean annual temperature is 11°C, with mean maximum in the hottest month of 22°C, and
mean minimum in the coldest month of 3°C. The southern winter is defined as June to September,
however in this zone it is considered to run approximately from April to October based on the thermal
sensation. [4]

Thus the "cold" season lasts for around seven months, and the population depends on heating
systems to get through this period. Apart from being cold, the area is also rainy, with annual
precipitation of around 1150 mm, concentrated in the months of May to October.

The above indicates that Temuco and its region are generally cold, with temperature troughs below
0°C in the night and early hours of the morning.

3. Study references
Temuco is the capital of the Araucanía Region, the region with the highest poverty indices in Chile.
This is an important factor for the purposes of the present investigation.

In 2015, the data of the National Socio-economic Characterization Survey (CASEN) showed that
the Araucanía Region presented the highest percentage of people living below the poverty line in
Chile. This diagnosis is corroborated by both income data and multidimensional measurement. While
income data report a level of 23.6% of the population living in poverty, multidimensional
measurement indicates a rate of 29.2%. [7]

These indicators reveal a situation which must form the starting point of this study, since the
cheapest form of heating for the population of Temuco is by burning firewood. This problem is
present not only in poor sectors but also in better-off areas, since it is a long-standing custom in
southern Chile. Firewood heating is a practice which goes back to the customs of the indigenous
peoples who inhabited the region, dating back many centuries.
South of 38°S, more than 80% of urban households and almost 100% of rural households consume firewood, which is probably between 4 and 7 times cheaper than other energy sources. The principal uses are for cooking and heating. The mean consumption of firewood in the residential sector is more than 500,000 cubic metres per year. [4]

In view of these data, the present investigation is directed towards the better-off sectors of the city's population, in levels C1a, C1b and C2 of the Chilean socio-economic scale. Poor segments have already received state assistance, through subsidised improvement of the thermal insulation of the foundations of their houses, installation of pellet stoves and replacement of windows with double-glazing units, under the Atmospheric Decontamination Plan (PDA). [8]

In this scenario, any number of paths have been proposed to design educational and organisational responses to reduce the consumption of firewood. The population of Temuco is not sufficiently informed about the social impacts on the population; the better-off people in particular, who could use other energy sources for heating, continue to use firewood in their stoves and fireplaces.

It is essential to communicate true, easily-understood information to these sectors to persuade them to reorganise their heating decisions. Education is proposed from the angle of information design, either through texts or infographics, to reach this segment of society in Temuco.

4. Methodology
This work uses a case study to analyse the information available to the C1a, C1b and C2 population of Temuco concerning the pollution caused by firewood combustion, for example: what heating options are available in the country, use restriction timetables, emergency periods, consumption and cost.

The data were constructed through semi-structured interviews and case follow-ups in four middle-class residential sectors of Temuco: Barrio Inglés, Puerta de Alcalá, Los Pablos and Portal de la Frontera.

A sample of 20 cases was selected from the sectors named, out of a universe of 100 families who use heating systems fuelled by firewood combustion.

The main object of the study was to discover the conditions which lead the C1a, C1b and C2 population segment in Temuco to take and maintain the decision to use firewood to heat their homes.

5. Results
The study was carried out between April and August, during the winter, and specifically in spaces with the highest wood-smoke pollution in the city. The effects of pollution can be seen in these sectors.

In general, the majority of the cases interviewed stated that they used firewood for heating their homes, with more than 80% opting for this solution because of the quality of the heat produced. The interviewees invoked a cultural aspect to explain their decision: that this is a custom maintained from previous generations, the countryside and the areas inhabited by indigenous peoples and colonial settlers who used firewood from their forests for heating.

Firewood heating is said to be ‘better’ than other kinds, for example gas and paraffin which generate humidity in the spaces where they are used. The interviewees state that firewood is incomparable in its effects and the sensation of warmth, and that people also use it for drying clothes inside their homes.

They also say that this type of heating is cheaper to run; because these are well-off sectors of the city, the people do not qualify for subsidies for thermal insulation improvements, let alone for replacement of their heating systems by a non-polluting method.

So the economic aspect is also important for this sector. It may be noted, however, that in a few specific cases the interviewees said that they had changed their heating systems according to their needs.
As shown in Figure 1, firewood continues to be the most widely used heating source in the study segment; this segment is relatively well-off with monthly family income of approximately US$ 4,000 or more. [9]

The 18% who replied “Other” use a central heating system with a gas, pellet or oil-fired boiler.

The segment interviewed relates quality with the sensation produced by the effect of firewood heating, associated with their local culture. According to some of the statements made by interviewees, the heat produced by firewood is dry, it does not produce humidity, so there is no condensation inside the houses leading to the proliferation of fungi due to excess humidity and the accumulation of water.

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Low cost is an important aspect in the study, since firewood is still the cheapest option available in Temuco. The study population is not sufficiently informed about the effect that it produces, and that the cost of the other options does not differ so widely from what they have.

This population sector lacks information about the other heating options, for example gas, oil, pellets and paraffin. The cost differences are not very great, and the gap in market value is reducing as firewood has become more expensive, coming closer to the “other” options.

72% of the interviewees said that they were committed to helping to decontaminate their city, as they feel a need to contribute and above all they recognise that in winter the city is completely full of smoke generated by firewood heating. This makes it impossible to play outdoor sports, reduces visibility in the streets and promotes respiratory diseases which are harmful to people's health.

There is also a small segment that is not interested in contributing; they are not even interested in the issue and have no wish to stop using firewood for heating.

The percentage of interviewees who gave a positive response is encouraging. This is reflected in their age range, mainly young couples with families who are interested in helping and contributing to their city.

6. Conclusions
In conclusion, we can say that the results of the study were encouraging, since the responses showed that this segment is interested in helping to decontaminate the city. They were keen to generate ideas, including carrying out campaigns to improve air quality.

Those interested in contributing indicated that they were not fully informed on the cost of each option for heating in the regional market, which was why they maintain that firewood is the cheapest option for them. This shows that education is fundamental: direct communication with guaranteed information about what is happening in the city, indicating heating options, commercial values, and the health and environmental impacts.

Most of the interviewees showed interest in the issue, especially young couples who wanted to pass on environmental values to their children. On this basis the strategy design can be carried out; the different age ranges studied need to be addressed, from children aged under 12 to elderly people.

Finally, the strategy proposed below will seek to design a concept which appeals to the emotions, for a family segment appropriate to the residential sectors studied, in order to educate and communicate with the population, giving them the necessary information to achieve an improvement in air quality in Temuco.

![Figure 4](source: Own preparation.)
7. **Object**

In response to the research problem, we propose to design a strategy to reduce the consumption of firewood in the better-off sectors of the city through visual communication; also to seek sustainable and/or ecological heating options in the study sector, so as to inform people about the regional and national supply of these alternatives.

The basis of the strategy will be information design and it will respond to the wishes of the segment as expressed in the results of the study.

We propose to design infographic material with heating options and information on sustainability in the city, cost and consumption comparisons, and a report on the current situation in the city during periods of declared emergencies. Wind and water power and photovoltaic systems available in the regional market for heating uses are some of the examples suggested for the infographics proposal.

The communication concept will seek to appeal to people's emotions through their social conscience about what is happening with pollution in the city, quoting examples of the harmful effects for children, adults and the elderly.

The information design will be based on the socio-economic segments interviewed in the study, the geographical space and the location (using educational maps). The design will use full, linear synthesis in order to achieve rapid, simple communication for all age bands.

![Figure 5. Design of prototype infographic material. Source: Own preparation.](image-url)
There will also be information on the time restrictions for firewood heating which have been imposed in Temuco. There is no time restriction on firewood heating for the study segment as it was assumed that they already used other methods.

Finally, the strategy proposes organising communication for the selected zones, covering education and social awareness, care of the environment, healthy life, sport and the use of recreation areas in public spaces. Infographics will be the tool used for didactic communication of the problem and possible solutions to improve the situation. The proposal is for the use of digital design through social media, and a possible printed prototype for the elderly.

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