# Time use in the city and labor productivity: Distribution patterns of work, transportation and leisure

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**Abstract**

The study examines the patterns of time use in Metropolitan Lima, its deciding factors and the reciprocal influence among times, based on the National Time Use Survey. A typology of working hours in the city is identified, with particular mixtures of time uses, some with efficient time uses and some without, in an urban environment without planned time management. Three main use patterns are recognized: adult workers, women devoted to household chores and single men. It is proven that work time is affected mainly by income level and age, travel time by main occupation, and free time by age. It is confirmed that the population spends time outside of work in activities that do not necessarily imply rest. The individual margins for an optimum time management are narrow. The contrast between the results with the literature on the topic reveals a lot of similarities but also differences.

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**Introduction**

Peru has a population of almost 30.5 million people, of which 31.3% live in Metropolitan Lima. The percentage is the same for Lima in regard to the national labor force: 5,144,100 workers, 31.87% of the Peruvian labor force (National Institute of Statistics and Informatics, INEI, 2013a).

This working population distributes its time daily between work, travel and free time. Several factors contribute to this distribution, but a key starting point is that a fraction of the labor force works at home and the rest outside of it, which allows the first to save precious time in transportation. In summary, every day the entire labor force makes a particular combination of millions of man-hours, transportation and free time, finally reaching 53.58% of the national Gross Domestic Product (GDP) corresponding to Metropolitan Lima (INEI, 2013b), which represents USD 90,618 millions. The 2,794 square kilometer area of Metropolitan Lima is the scene for this dynamic that establishes the combination of productivity and unproductiveness, of idle and active times, of a healthy life or an excess of physical and mental exertion.

Even though Bonifaz (2000) and Calmet & Capurro (2011) have worked on the social value of travel time, most economic studies in Peru on productivity and competitiveness have not taken into account the use or value of time as a key factor in the performance of the

economy and the well-being of society. They have focused on the internal factors of the value chain in companies and industries, disregarding that productivity is also decided in the city layout that houses them and in the relation between the economic, social and cultural factors that enable an optimal or non-optimal distribution between work, travel and free time.

Therefore, this research aims to answer the following questions: What is the distribution of the work, travel and free times of Lima's working population? What are the main factors that influence these time uses? What are the main time use patterns and the groups that follow them? What is the weight of the reciprocal influences between times?


**The problem**

With the economic growth of the 2003-2012 period in Peru, the cost of time is higher, that is why people are ready to allocate a bigger budget to the real possibility of reducing idle times, especially the travel time. Despite this, the time waste rate is relatively high and the combination of times is inefficient for part of the population.

On one hand, work and travel times are different since the first has been regulated and the second not. It was in the first decades of the 20th Century, when the issue of the working hours was apparently resolved limiting them to eight hours per day and then legislating on

the working hours per week. Nonetheless, reality is different in Latin America: the average work week is 42 hours, higher than the European average of 37 hours (CEPAL 2013).

Yamada's study (2005) of working hours in Peru revealed that between 1985 and 2000, we went from an average of 47.5 to 50.1 hours per week in Lima. In 2002, 33.4% of Metropolitan Lima workers worked more than 60 hours a week and 18.5% even worked an average of more than 70 hours. Evidently, the successive economic crises of the 1985-2000 period promoted the increase of work time because the lower the hourly compensation, the longer the work day. The hourly average compensation for men in Metropolitan Lima was reduced by 49% in real terms, which implied an 8.9% increase in the average working hours. Today, the average monthly income in Lima is 515 dollars (INEI, 2014), which makes people work more hours and have multiple jobs. The National Household Survey (ENAHO 2013) registers 16.6% of the labor force having two jobs, a number that is higher among self-employed workers and the informal sector.

The subsequent research by Céspedes (2013) indicated that from 2000 to 2010, the amount of working hours per week had been reduced but was still higher than the Latin American average. The hypothesis suggested was that in periods of productivity gains, such as the one in the last decade, the salary offered per work unit was higher and that caused the substitution of work for free time. This is not automatic because the experience of Asian

countries shows that productivity and salary increases do not necessarily translate into shorter working days (Lee, McCann & Messenger, 2007).

The general problem of transportation in Lima is expressed every day in the perception of its citizens. According to the last Survey *Lima Cómo Vamos* (2014) 67.6% revealed they felt upset with the transportation issue, 25.2% were not satisfied or dissatisfied and only 6.3% were satisfied. All of this in a city where 81% of the population uses public transportation and out of which 43.7% qualified it as bad or very bad. The exception is those who use the Metropolitano bus service or the Electric Train (Metro), who did emphasize their speed by 65% and 72%, respectively. However, 40.3% considered it took more time now to go from one place to another than it did in the previous year, a percentage much higher than the 23.2% of 2012 in comparison to 2011.

Several studies have been conducted in order to quantify the effects of public transportation. The Ministry of Transportation and Communication (MTC, 2013) indicated four problems: the increase of demand for transportation, the overwhelming growth of the supply of transportation, the deficient infrastructure and the insecurity expressed in the frequent car accidents. In the Statistic Yearbook of the MTC (INEI, 2014) the number of vehicles in Lima was calculated at 1,395,576, corresponding to 65.3% of the national total. Considering the 9.5 million inhabitants of the city, Lima has an average of 147 vehicles for

every thousand inhabitants, more than double the average for every thousand inhabitants nationwide.

In the last ten years, several efforts have been made to implement a transportation reform, but the progress has not even reached 10% of transportation users. The Metropolitano bus service and the Metro of Lima, still incomplete, have been inaugurated, as well as several bicycle lanes and an old-vehicle scrapping program, which in 2012 only managed to eliminate barely 803 old vehicles (*Lima Cómo Vamos*, 2013). This is indicative of Lima today, horizontal and unplanned: its inhabitants spend a large amount of time in transportation. According to the study by the Japanese International Cooperation Agency (JICA 2013) the number of daily trips in motor vehicles amounts to 16.9 million, with an average of 47.2 minutes in buses, 40.2 in microbuses, 33.4 in the Metropolitano, 31.6 in their own car and 28 in a kind of vans named '*combis'*.

The economic and health cost consequences of traffic congestion were indicated in a report by the Office of the People's Advocate (Defensoría del Pueblo, 2008): loss of man-hours, inefficient use of fuel, deaths in traffic accidents, hospital and health expenses, loss of working days due to illnesses related to pollution, loss of well-being and quality of life, among others. Therefore, urban transportation has an impact on the productivity of companies and society.

The literature indicates as a starting point the Legislative Decree no. 651 from 1991, which promoted transportation management with minimum regulations, allowing free access to urban or interurban transportation routes, free establishment of fares, random access of natural persons or legal entities as service providers and import of used vehicles (Bielich 2010). The model has resulted in the oversupply of urban transportation, traffic congestion, travel time increase and failure to comply with traffic rules in the competition for passengers.

Unfortunately, this poor service encourages the population to acquire their own cars. Furthermore, the economic growth of the 2003-2012 period, has been an incentive for the import of vehicles (Calmet & Capurro 2010). This is evidenced in the fact that between 2005 and 2012, almost 510,000 vehicles were added to Lima's vehicle fleet (MTC 2013), which means an average of 7 inhabitants per vehicle (Webb & Fernández Baca 2013), and without improvements to the 7,582 km of roadways, there are several sections, on which during rush hours, the average speed is below 20 km/h (JICA 2013).

Lima is behind other cities in Latin America in this aspect. According to the Household Survey of the Development Bank of Latin America (CAF 2013), on a scale from 1 to 10, the satisfaction average with the public transportation system is 6.36 in the 18 cities surveyed in 2012; Lima's is 5.6, higher only than La Paz, Arequipa, Sao Paulo and

Cordoba. In regard to speed, the average is 5.1 and Lima is at 4.1, higher only than La Paz, Quito, Caracas and San Cristobal. Punctuality has a higher level of acceptability, 4.7, within a 5.3 average, though it only exceeds Buenos Aires, La Paz, Quito and Caracas. A really important issue is the average travel time from home to the place of the main daily activity, which the same survey collects for the 2008-2012 period. Table 1 shows that Lima have experienced more increase in travel time.

**Table 1. Average Time in Latin American cities (in minutes)**

| City | 2008 | 2009 | 2010 | 2011 | 2012 | Variation: 2008-2012 |
|------|------|------|------|------|------|----------------------|
| Buenos Aires | 34 | 42 | 30 | 28 | 33 | -1 |
| Cordoba | 26 | 27 | 31 | 31 | 35 | 8 |
| La Paz | 33 | 34 | 33 | 33 | 34 | 1 |
| Santa Cruz | 37 | 31 | 32 | 35 | 34 | -4 |
| San Pablo | 45 | 33 | 33 | 33 | 47 | 2 |
| Rio de Janeiro | 34 | 31 | 30 | 28 | 33 | -1 |
| Bogota | 41 | 34 | 35 | 35 | 50 | 9 |
| Medellin | 29 | 23 | 26 | 27 | 30 | 2 |
| Quito | 47 | 42 | 40 | 43 | 51 | 5 |
| Guayaquil | 26 | 26 | 27 | 27 | 32 | 6 |
| Lima | 33 | 31 | 32 | 32 | 40 | 7 |
| Arequipa | 27 | 25 | 28 | 29 | 32 | 5 |
| Montevideo | 32 | 29 | 28 | 31 | 33 | 1 |
| Salto | 22 | 14 | 18 | 20 | 17 | -4 |
| Caracas | 39 | 47 | 34 | 35 | 39 | 0 |
| Maracaibo | 36 | 25 | 29 | 28 | 28 | -8 |

Source: CAF (2013)

Finally, in regard to the variations in free time, the results show that in most of the 15 cities assessed, the main losses produced by urban transportation problems are home activities

and family life. It is important to note that a by no means negligible percentage has to quit working more and therefore does not receive a higher income. In other cities (Caracas, Bogotá, Buenos Aires) this affects even the hours of sleep.

**Table 2. Activities the population cannot do due to time spent traveling−2009 (in percentage)**

| CITY | More work | Sports | Study | Doctor | Home | Family | Friends | Sleep |
|---|---|---|---|---|---|---|---|---|
| Buenos Aires | 7.8 | 5.8 | 5.8 | 3.0 | 28.8 | 34.8 | 11.3 | 19.5 |
| Cordoba | 1.8 | 2.0 | 2.0 | 0.3 | 18.8 | 23.8 | 0.8 | 8.3 |
| La Paz | 25.7 | 7.9 | 7.7 | 3.7 | 42.1 | 31.2 | 7.2 | 9.2 |
| Santa Cruz | 12.6 | 6.2 | 4.7 | 2.0 | 42.0 | 48.4 | 7.7 | 6.4 |
| San Pablo | 7.5 | 7.5 | 7.0 | 1.8 | 12.3 | 34.5 | 5.8 | 11.5 |
| Rio de Janeiro | 10.3 | 3.3 | 2.8 | 2.5 | 8.8 | 20.5 | 7.3 | 12.8 |
| Bogota | 13.3 | 19.8 | 8.5 | 16.8 | 38.0 | 50.3 | 10.5 | 21.8 |
| Medellin | 6.8 | 11.3 | 5.3 | 3.3 | 17.3 | 24.3 | 12.0 | 12.5 |
| Quito | 19.0 | 6.5 | 4.5 | 4.0 | 38.8 | 50.3 | 8.3 | 8.5 |
| Guayaquil | 7.8 | 2.8 | 0.5 | 0.3 | 22.5 | 34.5 | 11.3 | 5.0 |
| Lima | 14.0 | 6.8 | 4.3 | 3.0 | 29.3 | 23.3 | 4.5 | 3.8 |
| Arequipa | 16.8 | 5.8 | 3.8 | 2.3 | 28.0 | 25.5 | 2.8 | 2.5 |
| Montevideo | 8.5 | 11.9 | 6.7 | 5.0 | 27.1 | 28.9 | 14.7 | 13.4 |
| Caracas | 13.8 | 7.3 | 2.5 | 4.8 | 33.0 | 42.3 | 12.8 | 21.5 |
| Maracaibo | 7.3 | 1.0 | 1.3 | 0.8 | 26.5 | 23.8 | 5.0 | 8.0 |

Source : CAF (2013)

This review of the problem takes us to several preliminary considerations:

a) As the city does not have sound time management, the distribution of time arises as the result of the exchange of options of time use of all the city's actors, without any framework;

b) Thus, by spontaneous agglomeration, a typology of working hours is constituted, each one with specific mixtures of time uses; some sections have an efficient use of time and others not. Each typology has a combination of flexible and fixed times;

c) In this environment, people have very narrow margins for an optimal management of their time; their individual options have high external locus of control or external factors;

d) The urban transportation crisis represents a great factor of unproductivity for people and the economy, as well as the extension of working hours beyond a reasonable limit;

e) Among the tree types of time: work, travel and free time, the latter is the one showing greater flexibility to adapt to the needs of the other two, becoming their reserve time.


**Literature Review**

Gary Becker (1965) was the first to scientifically develop a consumer behavior model that includes time, defined as an essential resource that all people are provided with in the same amount and is consumed simultaneously with the rest of activities. Therefore, unlike other consumer goods, it is characterized by the impossibility of being stored and the need to be transferred from one activity to another. This re-assignment of work and consumer activities will depend on the changes in salaries, additional income, price of goods and productivity. Later on, Karni (1974) proposed that the demand for real monetary balances is

positively related to real value of time. That is, when real value of time is increased due to the increase of productivity or salary, incentives are created to save time in exchange for a higher amount of money.

In the pursuit to develop the value of time, De Serpa (1971) proposed the theory according to which the amount of time one allocates to each activity is a need and a choice, and only the first case has a restriction on the preferences of the consumer, while in the second, the "value of time" does not influence the decision. Its main contribution is that it includes significant non-economic factors to establish the distribution of time and its value, which is never stable. Bonifaz (2000) performed an analysis on the value of free time. Its assessment is based on a ratio between the marginal utility of time in relation to the marginal utility of money, and depends on the variation of income, opportunities to spend and rest, and time available to rest. Finally, for Cervini & Ramírez (2008), time is a crucial component in the cost-benefit analysis: the relevant value for the social evaluation of projects is the one the society is willing to pay for and is not related exclusively to the marginal product of individual work, since work is not the only substitute for travel time. The fact that the individuals are willing to pay for avoiding the time allocated to travel or wait for a service, shows that time is a valuable commodity (Boardman et al, 2001).

Therefore, value of time has become a substantial factor in socio-economic analysis, but almost always referred directly to the work time and indirectly to the travel time required to go to the workplace. It is assumed that the trend is for work time to decrease and free time to increase, due to higher productivity and contemporary culture styles. De Masi (2000) explains that while our ancestors worked almost half their lives, in the current post-industrial society we work only part of our existence thanks to new technologies that allow the increase of free time. But this is not observed automatically in undeveloped societies nor in the Peruvian case.

On the other hand, transportation economics studies the assignment of resources within the transportation industry, emphasizing its difference from other branches of the economics due to the fact that the premise of an instantaneous economy without space does not work. De Rus, Campos & Nombela (2003) present a concrete conclusion: users' time constitutes an input that has to be included in the production function of transportation industry, since it acquires a dimension that sometimes is more important than the monetary cost. This is mainly due to two reasons: first, time spent in traveling is not fixed and the user can choose more than one alternative, whose specific time is also influenced by the decisions of other users; second, transportation is almost always an intermediate consumer good whose use time has to be the least possible because it is a disutility for the consumer.

Previously, Moses & Williamson (1963) had included travel time along with salaries and transportation costs as factors to analyze the public transportation prices. In turn, McFadden (1974) focused on the demand of each type of transportation, concluding that the salary level is a decisive influence, but keeping a correlation with the expectation of travel time. Later, Wardman (2001) said that the sectors with the highest productivity are characterized by having a higher marginal rate of substitution between time and travel cost: in a choice between expensive and speedy routes or cheap and slow routes, the relation between time and money is established by a trade-off between money and the implied value that time has for the individuals. Time saved in traveling is valued fundamentally because it can be destined to other activities and because it avoids the disutility caused by most trips.

The value of travel time was transformed thus in a substantial variable for the determination of time savings of every transportation project. In this way, Senna (1994) was original proposing a method that includes the variability of travel times, and even breaking down the waiting time before the trip. Lastly, Small (2012) tries to fit several factors influencing the valuation of travel time, such as selection of the time of day, aversion to uncertainty, work supply, taxes, scheduling of activities, distribution of the time for household chores and productivity outside of work.

Therefore, the development of quantitative models for the value of time estimation, based on the appraisal of opportunity costs, is understood: people face monetary restrictions which depend directly on the time devoted to production, but travel time exists as an ambiguous factor affecting free and work time, because it is undesired "idle time"..

However, we are also interested in the valuation of free time. Robinson & Godbey (1999) suggest that it provides a better opportunity to look for pleasure, happiness and free expression, distinguishing the real free time in which the person assumes an expressive attitude, from the time devoted to household chores, family and support obligations necessary for existence. They conclude that with the development of a country well used free time increases, which at the same time contributes to future growth. For Souza Júnior (2000), free time should be the moment in which one can decide for oneself without having to submit to the obligation of having to work to live, more related to the use of leisure time for educational and cultural purposes, the attached drive of development of a society. Finally, Hernández-Pozo (2010) focuses on workaholism, understood as addiction to work, and observes that in many cases the intensity and number of working hours are not the result of a free choice, rather a wish to "be better" dismissing leisure time as useless time.

On the contrary, Gomes & Elizalde (2009) indicate leisure has a negative connotation associated to idleness and laziness, a definition influenced by the protestant ethic that

considers it a threat to the capitalist system. Therefore, leisure would represent only a moment of reproduction of the work force, a period in which the person has a freedom that can only be apparent and limited.

Other authors have emphasized the management of free time. Averill (1973) says that the ability to decide among several alternatives is a key element for the reduction of stress. Soon after, Schultz (1974) concluded that the limits of economic growth are not defined by the lack of goods, but by the lack of free time for consumption: by increasing the value of human capital, those satisfactions resulting from an intensive work component become relatively more expensive, thus the value of free time also becomes more expensive; at that point, time for consumption becomes scarce and this causes economic balance. Greenberger et al (1989) talk about the importance of workplaces encouraging the proper use of free time, a deciding factor for productivity and family development, while others (Wang et al, 2010) indicate that managing the time better outside of working hours, contributes to reduce stress and improves productivity.

Free or leisure time appears as an invisible time within the society, but always as a key deciding factor of happiness, and an element contributing to competitiveness and productivity inside and outside of work. The counterpart is a society of long working hours,

little free time and loss of value because of idle time associated to transportation, with the resulting stress, disutility and decrease in productivity.

In short, from Becker's pioneer analysis it arises a branch in scientific literature that studies the optimization of working hours to reach greater productivity, and the minimization of travel time in order to avoid affecting such productivity. A discussion more ideological than methodological has to do with free time, which is seen by most authors as a way to reach happiness, in opposition to others who associate it to laziness. A third group moves away from prescriptive considerations and emphasizes the management of free time through which each person reaches the maximization of their personal usefulness.


**Methodology**

The purpose of the study is to identify the time use in Lima's working population, analyze the factors affecting its distribution and the relationship between work, travel and free time. To that end, it was used the National Survey of Time Use (ENUT), performed in 2010 by the INEI. This survey was taken by people over twelve years old, selected randomly, with a sample size corresponding to a 95% accuracy level, and has 18,412 surveyed people, made up of people from 4,580 households. This study focuses only in Metropolitan Lima, with a sample size of 976 households, made up of a working population over twelve years old.

Based on the aforementioned data, a descriptive analysis of the time use profile by the average Lima inhabitant was performed according to six criteria: gender, age, marital status, main occupation, income level and education level. Next, the model of the multivariate analysis of the multilayer perceptron neural networks was used to establish the influence value of the six socio-demographic factors on the three types of time. The influence of each socio-demographic variable is not linear and its distribution also depends on its interrelation with the other independent variables. Thus, this model was chosen because it facilitates the solution of functions that are not linearly separable, and provides an importance coefficient for each independent variable, whose sum is equal to 1 and out of which we can deduct the percentage influence of each independent variable on the dependent variable.

Generally speaking, the following equation was proposed for the model:

$$T_i = f(\bar{X}, W_{ji})$$

where $T_i$ is the observation i of a type of time, f is a non-lineal function of the $X$ vector of socio-demographic variables and the weighting $W_{ij}$ of the existing connection between observation i and demographic variable j. In addition, the same method was used to

establish the influences between the three types of time, following an equation where $W_{ki}$ expresses the connection of the interrelations between the observations i for each type of time k:

$$T_i = f(W_{ki})$$

The three T dependent variables correspond to work time, travel time and free time, all of them expressed in hours, making clear that the latter includes six subtypes of time: 1) biological needs that include personal hygiene, nourishment and hours of sleep; 2) health care; 3) household chores that includes culinary activities, house cleaning, clothing care and tailoring, repairs, construction and maintenance of the house, child care, care of the household members having a temporary or permanent sickness (disability), household purchases, and management and organization of the home; 4) educational activities; 5) volunteer work that is all the uncompensated work in another home or in some public or private institution; and 6) Family and recreation time which includes time for socializing with family and friends, taking care of orchards, breeding domestic animals and leisure.

Simultaneously, in order to find a joint association between the eight variables of time use (after breaking down the six components of free time), the method of main components and its effective dependency ratio (CDE) was used in the following manner:

$$CDE = 1 - |R|^{1/(p-1)}$$

where R is the correlation matrix and p is the number of variables considered. The result was a CDE = 1-(0.223 (1/7)) = 0.807, which indicates a strong joint linear association between the variables because it is close to 1, and justifies the application of the method of main components to study the structure of the association between these variables. This method is a descriptive multivariate technique which allows extracting relevant information from a group of correlated variables, transforming them into uncorrelated variables, with the purpose of identifying patterns and structures allowing the joint treatment of the observed variables, thus reducing their number, so the importance of each one of them is quantified at the moment of establishing the variability in such data group.

**Results**

One result related to time use distribution shows that for different socio-demographic variables there are different time use profiles (Table 3). According to gender, men work on average more hours and their travel time is also longer. Women have more time outside of work, but they dedicate on average 17.7% of their time to household chores, which is far more than men (7.7%). Women devote more time to health care, since they are in charge of the family care. This confirms the research by Papastefanou & Gruhler (2014), which states that women normally have a less complex time outside of work since they focus on the household. They also devote much more time to volunteer work than men do.

Time use by age group shows that work time increases with age, reaching a ceiling of almost 200 hours per month for people from 45 to 64 years old, and then decreasing to 185 hours in retirement age, which is still a high number. This can be explained by Piekkola & Leijola (2007) research, which states that in countries where the household chores are not shared by men and women, as in Peru, there are more reasons for men to keep working after retirement. Regarding travel time, it is high in more productive age groups (19 to 64 years old). As per family and leisure time, it can be observed that it decreases when passing from youth to adulthood. Time dedicated to household chores increases with age, reaching its highest point between the ages of 30 and 44, with an average of 97 hours per week.

Finally, time devoted to education is only significant in the initial stage of life (12 to 18 years old, 77 hours per week).

**Table 3. Allocation of time use per variables (in monthly hours and percentages)**

| TIME | Work | | Travel | | TIME OUTSIDE OF WORK | | | | | | | | | | | | | |
| | | | | | Biological needs | | Health care | | Household chores | | Educational activities | | Volunteer work | | Family and recreational activ. | | Total time outside of work | |
| **GENDER** | | | | | | | | | | | | | | | | | | |
| Man | 209 | 30.7% | 27 | 4.0% | 253 | 37.1% | 2 | 0.2% | 52 | 7.7% | 8 | 1.2% | 3 | 0.5% | 127 | 18.6% | 445 | 65.4% |
| Woman | 167 | 24.2% | 21 | 3.1% | 248 | 36.0% | 4 | 0.5% | 122 | 17.7% | 11 | 1.5% | 8 | 1.2% | 109 | 15.8% | 503 | 72.8% |
| **AGE** | | | | | | | | | | | | | | | | | | |
| 12-18 | 121 | 15.8% | 12 | 1.6% | 273 | 35.9% | 1 | 0.1% | 50 | 6.6% | 77 | 10.1% | 77 | 10.1% | 150 | 19.7% | 629 | 82.6% |
| 19-29 | 188 | 26.9% | 26 | 3.8% | 261 | 37.4% | 2 | 0.2% | 67 | 9.5% | 16 | 2.2% | 16 | 2.2% | 123 | 17.6% | 485 | 69.4% |
| 30-44 | 198 | 28.9% | 25 | 3.7% | 246 | 36.0% | 2 | 0.3% | 97 | 14.2% | 3 | 0.4% | 3 | 0.4% | 109 | 16.0% | 461 | 67.4% |
| 45-64 | 199 | 29.3% | 25 | 3.7% | 244 | 36.0% | 4 | 0.6% | 82 | 12.2% | 2 | 0.3% | 2 | 0.3% | 120 | 17.7% | 455 | 67.1% |
| Over 65 | 185 | 27.5% | 20 | 3.0% | 252 | 37.5% | 5 | 0.7% | 77 | 11.4% | 0 | 0.0% | 0 | 0.0% | 134 | 19.9% | 469 | 69.6% |
| **EDUCATION LEVEL** | | | | | | | | | | | | | | | | | | |
| Without studies | 158 | 22.9% | 24 | 3.5% | 242 | 35.2% | 11 | 1.6% | 124 | 18.0% | 2 | 0.3% | 19 | 2.8% | 108 | 15.7% | 507 | 73.7% |
| Elementary | 186 | 27.2% | 22 | 3.3% | 250 | 36.5% | 6 | 0.9% | 98 | 14.3% | 2 | 0.3% | 8 | 1.2% | 112 | 16.3% | 476 | 69.6% |
| High school | 198 | 28.9% | 24 | 3.5% | 253 | 36.9% | 2 | 0.3% | 78 | 11.4% | 8 | 1.2% | 4 | 0.6% | 118 | 17.3% | 465 | 67.8% |
| Higher technical education | 192 | 28.0% | 28 | 4.0% | 247 | 36.0% | 3 | 0.4% | 85 | 12.4% | 10 | 1.4% | 6 | 0.9% | 116 | 16.9% | 467 | 68.1% |
| Higher education-university | 176 | 25.8% | 25 | 3.7% | 249 | 36.6% | 1 | 0.2% | 75 | 11.0% | 19 | 2.8% | 5 | 0.8% | 131 | 19.3% | 481 | 70.6% |
| Graduate studies | 173 | 25.7% | 32 | 4.8% | 256 | 38.2% | 0 | 0.0% | 41 | 6.1% | 8 | 1.3% | 6 | 0.8% | 155 | 23.1% | 467 | 69.5% |
| **MARITAL STATUS** | | | | | | | | | | | | | | | | | | |
| Domestic partners | 205 | 29.9% | 24 | 3.5% | 249 | 36.5% | 2 | 0.3% | 87 | 12.7% | 3 | 0.4% | 3 | 0.5% | 111 | 16.2% | 455 | 66.6% |
| Separated | 194 | 28.3% | 26 | 3.8% | 249 | 36.5% | 5 | 0.8% | 98 | 14.3% | 2 | 0.3% | 8 | 1.1% | 102 | 15.0% | 465 | 68.0% |
| Married | 196 | 28.5% | 25 | 3.6% | 244 | 35.5% | 2 | 0.3% | 96 | 13.9% | 2 | 0.3% | 7 | 1.0% | 115 | 16.8% | 467 | 68.0% |
| Widowed | 183 | 27.0% | 16 | 2.4% | 246 | 36.2% | 4 | 0.7% | 109 | 16.1% | 2 | 0.2% | 7 | 1.0% | 111 | 16.4% | 479 | 70.7% |
| Divorced | 227 | 32.0% | 38 | 5.3% | 246 | 34.8% | 2 | 0.3% | 71 | 10.1% | 2 | 0.3% | 16 | 2.3% | 107 | 15.1% | 445 | 62.8% |
| Single | 176 | 25.7% | 25 | 3.6% | 259 | 37.8% | 2 | 0.3% | 59 | 8.6% | 24 | 3.5% | 5 | 0.7% | 135 | 19.7% | 485 | 70.8% |
| **MAIN OCCUPATION** | | | | | | | | | | | | | | | | | | |
| Employer | 217 | 31.4% | 14 | 2.1% | 248 | 35.9% | 4 | 0.5% | 73 | 10.6% | 2 | 0.3% | 5 | 0.7% | 128 | 18.6% | 460 | 66.6% |
| Self-employed worker | 190 | 27.6% | 16 | 2.4% | 250 | 36.3% | 2 | 0.4% | 102 | 14.8% | 5 | 0.7% | 7 | 1.1% | 116 | 16.8% | 484 | 70.1% |
| White-collar worker | 185 | 27.1% | 29 | 4.2% | 249 | 36.5% | 3 | 0.4% | 74 | 10.9% | 15 | 2.2% | 5 | 0.7% | 123 | 18.0% | 469 | 68.8% |
| Blue-collar worker | 202 | 29.5% | 30 | 4.5% | 254 | 37.2% | 2 | 0.3% | 63 | 9.3% | 10 | 1.4% | 3 | 0.5% | 119 | 17.4% | 452 | 66.1% |
| Domestic worker | 163 | 23.9% | 29 | 4.2% | 252 | 36.9% | 5 | 0.7% | 112 | 16.4% | 2 | 0.2% | 12 | 1.8% | 108 | 15.8% | 492 | 72.0% |
| **INCOME** | | | | | | | | | | | | | | | | | | |
| < 750 | 163 | 23.9% | 20 | 2.9% | 254 | 37.0% | 3 | 0.4% | 100 | 14.6% | 15 | 2.1% | 8 | 1.1% | 123 | 18.0% | 502 | 73.3% |
| 751-1500 | 214 | 31.3% | 29 | 4.3% | 249 | 36.5% | 2 | 0.3% | 66 | 9.7% | 5 | 0.7% | 4 | 0.5% | 115 | 16.8% | 441 | 64.5% |
| 1501-3000 | 217 | 31.5% | 29 | 4.2% | 247 | 35.9% | 3 | 0.5% | 67 | 9.7% | 4 | 0.5% | 4 | 0.6% | 118 | 17.2% | 444 | 64.4% |
| 3001-4500 | 235 | 35.1% | 19 | 2.8% | 232 | 34.6% | 5 | 0.7% | 57 | 8.5% | 6 | 0.9% | 2 | 0.3% | 115 | 17.2% | 417 | 62.2% |
| > 4500 | 191 | 27.7% | 25 | 3.7% | 260 | 37.7% | 0 | 0.0% | 60 | 8.8% | 6 | 0.8% | 2 | 0.2% | 145 | 21.1% | 474 | 68.7% |

Source : ENUT (2010)

According to the education level, uneducated people spend more time doing household chores, health care and volunteer work. People with high school or higher technical education work more hours. Meanwhile, people with university or graduate studies work

less than the rest and invest more hours in education. Likewise, the higher the education level the more the family and recreation time, following the cultural patterns of the middle class. Concerning travel time, the highest average is for people with a graduate degree (32 hours per month), probably because they need to travel not only to the workplace but also to the education center. Regarding volunteer work, we can mostly see people with no education level.

Related to the marital status variable, divorced people show a quite higher average of working hours and travel time, and also the lowest time average dedicated to household chores. Single people work fewer hours, spend less time doing household chores, and dedicate more time to education, family, and mainly to recreation. They can devote a monthly average of 135 hours to recreation and 24 hours to education, while the other groups can barely spend 3 hours a month on average. Widowed people spend more hours doing household chores, as they might be mainly seniors.

As for the main occupation, employers are the ones who work more hours probably because they dedicate more time to manage their organizations. Moreover, their travel time is the shortest, and they devote less time to household chores, and more time to family and recreation. White-collar workers and blue-collar workers follow them in terms of work time (202 and 185 hours per month, respectively), but their travel time is more than twice as

high. They also devote as little time in household chores as employers, but they spend a few hours a month in education (15 and 10 hours). This is not the case for employers, who usually have their own vehicles, or for self-employed workers, who do not need to move a lot although they work as much as white-collar workers and blue-collar workers, but they register half of the travel time.

Concerning the income variable, people with an income above 1,500 dollars work fewer hours than low-income people, the latter being the ones who waste more time traveling. On the other hand, the group with incomes ranging from 1,000 to 1,500 dollars works more hours, while those earning less than the minimum wage (250 dollars) work fewer hours, probably because they have part-time jobs. People earning high incomes have more flexible work schedules, so they can enjoy more time with family and friends.

In order to measure the influence of the six demographic factors on the three types of time, we carried out the multivariate analysis of artificial neural networks, identifying which variables influence work time, travel time and free time, standardizing the importance of such independent variables. Table 4 summarizes this influence matrix.

**Table 4. Coefficient of socio-demographic variables importance**

| INDEPENDENT VARIABLES | DEPENDENT VARIABLES | | |
|---|---|---|---|
| | Work time | Travel time | Time outside of work |
| Gender | 10.9% | 9.4% | 13.6% |
| Age | 25.0% | 14.0% | 24.8% |
| Highest level of education achieved | 15.4% | 16.0% | 11.8% |
| Marital status | 14.1% | 10.8% | 11.6% |
| Main occupation | 9.5% | 32.4% | 19.7% |
| Income level | 25.0% | 17.4% | 18.5% |

It can be noted that work time is mainly affected by the income level and age, which account for 50% of the combined influence. This is in line with the previous results showing that work time increases with age up to a point where it decreases, and people work more hours when they earn a low salary between 600 and 1,500 dollars.

Regarding the travel time, the most important deciding factor is the main occupation (32.4% of influence), because it usually determines if people will move or not, or at which time they will do it. Income level is fairly important (17.4%) because it defines the type of transportation to be used, while education level (16%) and age (14%) have an influence since they often explain the income level.

Finally, regarding free time, age is the most significant factor (24.8%), since pre-employment stage or post-employment stage means more free time. This issue was studied by Baxter (2011) and her conclusions are barely different from the results presented here. Type of occupation is relevant for the same reasons as in the case of travel time, while income increases the alternatives for leisure. It should be clear that variables do not involve

an intertemporal substitution since the three times are limited to a certain number of hours according to the measurement period, in this case monthly.

The method of main components permitted to identify three groups in the working population from Lima in relation to time use. They are represented in Graph 1. Proximity of time variables expresses the correlation among them, while the distance from the central point expresses the weight of each one.

**Figure 1. Result of the method of main components**
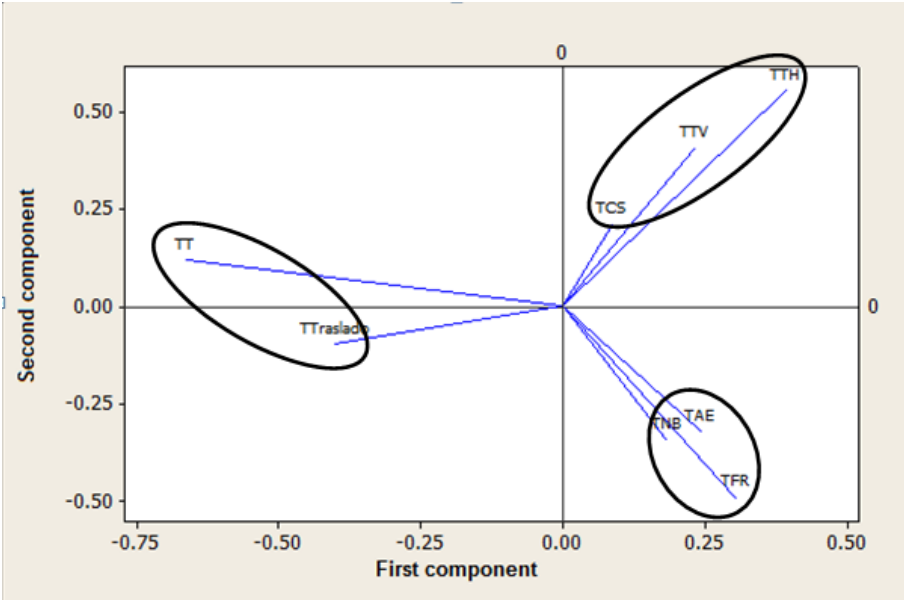


Note: TT = Work time; TTraslado = Travel time; TNB = Time for biological needs; TCS = Time for health care; TTH = Time for household chores; TAE = Time for educational activities; TTV = Time for volunteer work; TFR = Family and recreational time.

The first group represents 54.67% of the sample, and is characterized by prioritizing work time, which has a direct relation to the travel time to the workplace. More than 70% of the participants in this group are men, most of which (41%) are between 30 and 44 years old, with a similar participation of married people and partners, around 30% each. Moreover, 56% have only high school education and a little more than a half earns an income ranging from 250 to 500 dollars per month. Almost two thirds of them are white-collar and blue-collar workers. It can be inferred that this group is composed of men supporting a family with children and/or teenagers. The average income level is in line with education level and indicates that people within this group do not have time for other activities and are subject to a barely flexible schedule because they are dependent workers.

The second group representing 21.1% of the sample is composed mainly of women (81%) and people earning at most the minimum salary of 250 dollars (64%). The interesting aspect is the positive relation among time spent at home, volunteer work, and health care. This is due to the fact that they are women who work part-time or every other day. These are activities generally performed by low-income women within the Lima family pattern.

The third group, 24.2% of the sample, includes 57% of single people, 63% of men, and 61% of people earning up to 500 dollars; more than 40% are white-collar workers with high school education only. This group gives priority to family relations and recreational

activities, as well as to educational activities and biological needs. However, they cannot choose from a broad range of activities due to their low income. As most of the participants are single, it is deduced that they are under the age of 30 (31.7% are between 19 and 29 years old), which is a sector focused on education.

Finally, the neural network model was applied once more to determine the influence among the three types of time. There is a mutual and strong influence between the work time and the time outside of work, to the point that any extension in one affects the other. Nevertheless, the relation between the work time and the travel time (to and from) is not equal. The work time affects the travel time more, since more work involves more transportation. However, travel time has less influence on work time, which is the most inflexible and conditions more the other one, but is less conditioned by it. Influence of free time on travel time is greater than the other way around, showing that people with more time outside of work do not need much travel time. Graph 2 tries to explain these interrelations.

**Figure 2. Influence between the types of time with standardized weights**
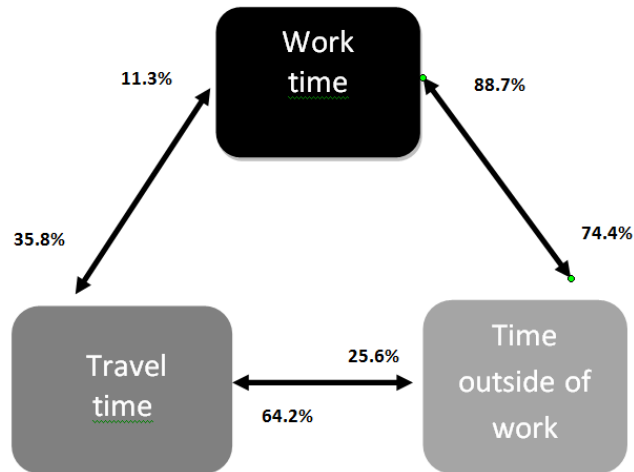


## Discussion

Comparing our results with the literature, the different number of hours devoted to each type of activity reflects how factors force or encourage people to distribute time among activities as explained Becker (1965). Even though our findings reveal that less income involves more work, and more work involves more transportation, this does not necessarily confirm Karni's theory of propensity towards time saving in return for greater income, since in Lima it is applicable only up to certain income levels. Once people reach a certain amount of income, they prefer to use it during their free time instead of saving time to earn more. In such case, we are closer to De Serpa's (1971) theory, since this allocation of time is a need and a choice. For people in Lima, when 1,500 dollars are surpassed, choice wins

over need. Regarding this issue, Eriksson & Ortega (2011) developed a hypothesis that coincides closely with the aforementioned: economic incentives have a substitution effect on white-collar workers since they encourage them to work more, but at the same time, they have a discretion effect because they help them organize their schedules better, fulfilling their tasks in less time and having more free time if they have more money to enjoy it. Hjeds (2007) and Anxo & Carlin (2004) reached a similar conclusion: reduced income tends to increase household chores as a compensation mechanism, particularly by women.

To a certain extent, we have agreed with Small (2012) in the formulation of a model that includes the factors affecting travel time; however, we have found other factors, mainly the type of work (dependent or independent) as the one with the highest weight. It should be noted that considering type of work, individuals can choose their travel schedule, and therefore, how long they will take depending on traffic congestion of a particular moment of the day, while income level influences the choice of vehicle to be used: with their own car they can avoid the most congested routes.In any case, travel time in Lima has a lower influence on the other two

On the other hand, this study considers different forms of time outside of work that do not necessarily imply resting (e.g. education, household chores and volunteer work). According

to this, free time in which people take an expressive attitude in Lima would really scarce. The question is whether workers from Lima uses their free time to achieve interior freedom through educational and cultural activities, or as Averill (1973) stated, whether they are managing their free time inappropriately. The results contradict Robinson & Godbey's (1999) thesis: family and recreational activities, which are free time in the strict sense, always mean 23% less than total time. The population spends their time outside of work in satisfying basic needs considered as part of the "useful leisure".Over 50% of the sample is within what Hernández-Pozo (2010) would call "workaholism", and the other 25% −due to their low income and limited economic opportunities− should limit themselves to their homes, and at a lower extent, to volunteer work and their health.

Schultz's (1974) hypothesis about the fact that an improvement of human capital will lead to a shortage and rise in the price of consumption time is evidently true to Lima up to some extent, since the higher the education, the more the recreation time. However, it is worth mentioning that there is a major cultural difference with northern hemisphere countries, which have a more homogeneous pattern of free time use in all their social classes. Nonetheless, the balance between work time and free time is achieved every time the education level grows up to some extent, and then, it goes down, though not abruptly.

In brief, a worker in Lima only partially follows behavior patterns similar to other parts of the world. This can be observed in the weight that work time has in relation to travel time and free time, influence that does not work the other way round. There is a major percentage of individuals who are not prone to leisure activities, entertainment or education as part of their social reality. Limitations of type of work and education, partially determining income, are important when distributing time. Travel time is also significant because apart from the delay caused, it generates a stress component whose duration goes beyond the travel time (Bonke & Gerstoff, 2007). This indicates that society rejects leisure as a valuable time for personal fulfillment. Chapela (2013) concluded, limitations lead to focusing on specific activities.

Are we free to escape from the "iron cage" of deciding factors of time uses found? Fisher & Layte (2004) proposed through the analysis of a group of people's diaries that life quality deteriorates when social patterns, institutions, or structures force individuals to use their time in a particular way. That happens in Lima, where the problem is not only the bad management of public transportation −that certainly contributes to an inefficient allocation of time− but also the external factors that impoverish people's time management. Public policies in this regard are hidden and as Cullen (1978) said, reality makes the population form habits that suboptimize their behavior in view of restrictions.

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