

## Modeling Optimal Time Allocation for Work and Personal Life at The National Level (Case in Lithuania)

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### Abstract

The article deals with the acute phenomenon in the 21st century – the distribution of time for work and personal life. Employed people in the modern society are most frequently faced with problems of work-life conflict. For this reason, this article primarily focuses on determination of optimal time allocation for work and personal life. First, this study analyzes the theoretical aspects of time allocation for work and personal life. Subsequently, a model for optimal time allocation for work and personal life is presented and the research methodology is substantiated. The model is realized by solving the multicriterial (target) optimization problem using weighting coefficients and priority methods and performing sensitivity analysis. This model is composed based on the employed population of Lithuania, but it can be adapted to other countries as well. In this case, the original questionnaire and time diary data should be obtained in the country under investigation. The results of the empirical research carried out showed that the population in Lithuania in 2017 begins to devote more time to personal life compared to 2003. Nevertheless, employed populations do not optimally allocate time between work and private life. For this reason, the article provides recommendations for employed people in Lithuania seeking to balance distribution of time for work and personal life, taking into consideration the current and desired monthly net wages.

**Indexing terms / Keywords:** Time allocation; Working hours; Time spent on personal life; Labor-Leisure model; employed persons.

**Subject Classification:** Economics.

**Type (Method / Approach):** interpretations of scientific literature and previous research; presentation of the empirical study carried out by the authors.

### Introduction

Time is a limited economic resource. Not only is it important to control it, but also to rationally distribute between work and personal life. The distribution of time to work and personal life reflects the behavior of the participants in the labor market, their social habits, differences between market participants, etc.; all of which are important in the analysis of the 21st century labor market issues. In today's society, it can be difficult to balance contradictory goals: the need for self-realization at work, the desire to obtain sufficient wages and enough time to devote to personal life. In such case, it may often be difficult to optimally allocate time between work and personal life. Therefore, it is pertinent to investigate the distribution of time within the employed population and to find the optimal balance between the above mentioned controversial goals.

It is worth noting that the employed population usually seeks to find balance between work and personal life. Nonetheless, there is often an inefficient allocation of time between work and personal life. This kind of situation encourages scientists to continue to discuss time allocation with specific recommendations.

It goes without saying that differences in time distribution between the employed population may depend on personal preferences for work and for private life. In an attempt to balance work and private life, a conflict between work and personal life can be encountered, which may have negative consequences for personal health,

career, personal life, etc. Differences in time distribution may additionally be affected by gender, desired relative pay, etc. Hence, it is relevant to consider the distribution of time between the employed population. For these reasons, the authors of the article conducted an investigation in the case of Lithuania because they identified the lack of recent empirical research on the distribution of these topics in Lithuania.

This article examines the scientific problem – what the content of the phenomenon of day-time distribution is and how it can be modeled.

**Research object:** the economic phenomenon of time allocation for work and personal life.

**Research goal:** to examine the theoretical and practical preconditions for the content and modeling of the time distribution phenomenon of employed population, to empirically verify the optimization of time distribution between work and private life among employed Lithuanians.

**Research aims:** to review the theoretical principles of the time division phenomenon between work and personal life; to ground the methodology used in the research and to provide an optimal model for time allocation for work and personal life; to identify the main aspects of the distribution of time between work and personal life among employed Lithuanians, and to present a concrete empirical study of time distribution and its generalized results.

The research was carried out using comparative analysis of scientific literature, a questionnaire, time diary method, multicriteria (target) optimization, applying weighted coefficients and priority methods, and performing sensitivity analysis.

At the beginning of the article, the theoretical aspects of the phenomenon of time distribution between work and personal life and its modeling are presented. Subsequently, a model for optimizing time distribution and personal life is presented and the methodology used in the study is presented. Finally, the results of the empirical research on the distribution of time for work and personal life and the distribution of wages are presented, which are more comprehensively interpreted and summarized.

### **Theoretical assumptions for modeling time distribution for work and personal life**

Labor-leisure (personal life) modeling describes the behavior of labor supply participants in the labor market, when the time of individuals is divided into two main areas: work and leisure (Fortin et al., 2010; Kabukçuoğlu, Martínez-García, 2016, etc.). In order to correctly understand the theoretical prerequisites of modeling, the basic terms used are explained first.

#### **Working time**

In scientific literature is often defined as paid work time (Aguiar, Hurst, 2007; Manski, 2014, etc.), which can be regulated accordingly, depending on the particular country and / or its belonging to the respective unions (Lee et al., 2007).

#### **Leisure time**

In scientific literature is understood as the other remaining time, i.e., unpaid work time, including various forms of leisure (Douglas, Morris, 2006; Aguiar, Hurst, 2007; Manski, 2014, etc.). Therefore, leisure time includes time spent with family, for social needs, traveling, sports, etc. (Douglas, Morris, 2006). In this case, the concept of leisure is identified in the *broad sense*. According to M. Aguiar, E. Hurst (2007), leisure, as a unison of four categories (entertainment, relaxation, social activity, and active leisure), is defined as leisure in the *narrow sense*. Leisure time can also be understood as the time left from the total time (e.g., the time of day, that is, 24:00 hrs.), minus the time spent on paid and unpaid work (Cavagnoli, 2008).

Another leisure time breakdown is provided by X. Wei et al. (2009). Scientists divide free time into three groups: leisure for learning; necessary leisure time (for relaxation, house work, etc.); nice leisure (for traveling, for fun, for sports, etc.). Another one by O. Hawrylyshyn (1977) who suggests that daytime should be divided into four main areas: biological needs (sleep, personal care); work (paid labor market); productive activities (house work, caring for children, learning); leisure activities (entertainment, recreation). Although there is a wide range of leisure-time interpretations in scientific literature, this research study considers **leisure time** phenomenon *in the context of the labor-leisure (personal life) model* in the broad sense.

Thus, the time of day can be divided into time spent for work and personal life as indicated by E. J. Douglas, R. J. Morris (2006), G. Yaniv (2011), S. E. Forris (2015) and other authors. Such division of the time of day into two main parts: the time spent on work and personal life is chosen for the research to be presented in the article. Thus, **time spent on personal life** is understood as the time allocated to all activities, except for paid work. In this case, the concept of time spent on personal life is identical to the interpretation of leisure time in the broad sense.

Having reviewed the main concepts, it is expedient to introduce more widely the model of labor-leisure (personal life) and related aspects. It should be emphasized that in the context of this model leisure is understood in the broad sense and the concept of personal life can be used as a synonym.

The basic idea of the labor-leisure (personal life) model relates to the rational individual's desire to maximize the benefits in choosing two products: work and consumption (Sendi, Brouwer, 2004; Myck, Reed, 2006; Dagsvik et al. 2012; Manski, 2014, etc.). In this case, an employed person seeks to choose the best possible time allocation option between work and leisure time (personal life).

The labor-leisure (personal life) model is based on budget, time, and environmental constraints. *The budget constraint* identifies person's financial capabilities, where two types of income - work and non-work related income can be obtained (Becker, 1965). This condition in the labor-leisure (personal life) model is important because a person, taking into account available and desired income, can make appropriate decisions regarding the allocation of time for work and personal life.

It should be emphasized that not only the budget but also the time is limited. *The time constraint* defines the aspect of time constraints, where time can be appropriately allocated to two main areas - work and other non-work-related activities (personal life; Becker, 1965). All of this is important in the labor-leisure (personal life) model, as employed people who do not allocate time between work and private life optimally, experience a conflict of work / personal life. This phenomenon can be named as negative. According to the International Labor Office (2011), the conflict between work and personal life has a negative impact on personal career, work quality, employee health, personal relationships, etc. Additionally, S. H. Laeeque (2014), investigating the case of the Pakistan banking sector, also finds that conflict between work and personal life negatively affects person's productivity and personal career opportunities.

*The environmental constraint* refers to the production of economical / non-economic goods based on knowledge, skills, physical and mental skills (e.g., housekeeping, childcare, etc.; Staudigel, 2012). In other words, dedicating time to one good, sleeping for example, affects the functioning of the other goods, for example, work. Understandably, sleep time will often depend on personal preferences. Consequently, the need to restrict environmental conditions in the labor-leisure (personal life) model is based on the person's ability to distribute time between work and personal life, taking into account personal, physical, and mental capabilities.

Although the labor-leisure (personal life) model is geared towards maximizing the benefits of time-sharing between work and private life, while respecting budget, time and environmental constraints, in practice, the effectiveness of such a model depends on the type of the person, his / her priorities.

According to E. J. Douglas, R. J. Morris (2006), S. C. M. Gatapia, R. A. Dorado (2016), at least three types of individuals can be distinguished. Individuals who seek to maximize the time spent on their private life minimizing

the time spent on work – they are understood as *individuals who prioritize personal life*. Another extreme is those *who prefer work (workaholics)*, who are addicted to work and spend many hours at work, do their best to achieve the best results, yet experiencing the negative consequences of workaholism, namely in personal life: physical and psychological health problems (Yaniv, 2011; Bakker et al., 2013, etc.) and the results of the organization (Clark et al., 2016). An intermediate option can be defined as *a person who seeks to balance work and private life*. Such a person seeks work-life balance. S. Holly, A. Mohnen (2012) defines work-life balance as the need to combine work and personal life time.

Hence, the optimal allocation of time between work and personal life, allows employed people to avoid the negative consequences of work-life imbalance both at work and in personal life.

**Time use studies.** Scientists (e.g., Alesina et al., 2006; Aguiar, Hurst, 2007; Caragea, 2009; Fortin et al., 2010; Krueger, Mueller, 2012; Colella; Van Soest, 2013; Hamermesh, Stancanelli, 2015; Jankiewicz, 2015; Ryu, 2016; Sappleton, Lourenco, 2016, etc.) analyze the phenomenon of time allocation for work and personal life in various aspects. S. Rätzel (2009), G. Yaniv (2011) and other authors emphasize the lack of research in economic distribution of time at theoretical and empirical levels. For example, the Harmonized European Time Use Survey (here in after referred to as HETUS) is a time use survey between 15 European countries during 1998–2006. Although S. Mrkić (2008) points out that time distribution statistics in countries should be updated at least every five years, but this recommendation is violated in Lithuania. The latest HETUS study in Lithuania was carried out in 2003. Consequently, the strategy for updating the consistent data on the distribution of time is not always followed, and the case in Lithuania is an example. All this points to a lack of new time distribution statistics.

The lack of time distribution research can be explained by four facts about time allocation research, which are highlighted by P. Sendi, W. Brouwer (2004), S. Mrkić (2008) and other authors:

- 1) time allocation studies are described as complex;
- 2) time allocation studies are time-consuming;
- 3) the implementation of time distribution studies involves a large amount of knowledge;
- 4) time allocation studies are receptive to human potential resources.

Despite these facts, time use research is meaningful as it provides detailed information about: individuals' behavior at the national and international levels; work-life balance; the influence of time allocation on employed inhabitants' work and personal life; the influence of time allocation on person's health; the influence of time allocation on wages; the influence on time differences between genders; and other valuable information. Therefore, the research analysis of time allocation research is extensive, and scientists can provide useful information for the employed population by developing and further discussing the distribution of time for work and personal life.

In summary, it is possible to claim that the main theoretical aspects of time division between work and personal life are revealed by analyzing labor-leisure (personal life) modeling, its formation assumptions, budget, time, and environmental constraints.

This article follows the notion that the model of labor-leisure (personal life) describes the behavior of a rational subject when time is allocated to work and leisure (for personal life). Differences in time distribution between the employed population may result in personal preference. Individuals who give priority to private life and those who give priority to work (workaholics) are named as extremes. It is considered that one of the most acceptable options in the context of time distribution is individuals who seek to balance work and private life.

Although research on time distribution is relevant and useful, the lack of the theoretical and empirical analysis of time distribution has been identified. This situation encourages further analysis of time allocation, providing new practical insights and recommendations for the employed in the context of time allocation.

### **Presentation of the optimal time allocation for work and personal life model and the methodology of empirical research carried out**

*The purpose of the empirical study* is to review time distribution of the employed population in Lithuania in 2017, determining the optimal distribution of time for work and personal life among employed Lithuanians.

The logic of the research is based on R. Kumar (2011), an eight-step model. **The questionnaires and time diary method** (the questionnaire and the time diary were compiled on the basis of Eurostat (2009) methodological recommendations for the implementation of the HETUS survey) were used for collecting the primary data:

1) *the purpose for using an individual questionnaire* – is to find out the respondent's type, the main needs, the current and desired wages, general information about the respondent;

2) *the purpose of using time diary* – is to find out how long the respondent (employed person) devotes to eight time allocation areas. The time diary was being completed for two days: during one work day and one free from work day. The diary of time has been structured so that respondents should indicate the time allocated to eight time distribution areas: sleep; other physiological needs; work; study; house work and childcare; leisure time (in the narrow sense); travel; and other activities. This time distribution model has been selected based on the public data available from the HETUS (2007) database on the original time allocation areas, and based on M. Hirshkowitz et al. (2015) the importance of sleep time in a person's life.

*Research population* – employed Lithuanian persons. The concept of an employed person in this study is based on the definition of the Department of Statistics of the Republic of Lithuania (2016a): persons aged 15 and over who work and receive an appropriate wage or profit share.

*The research sample* – is 406 respondents, with a sample error of 4.9 percent. The research sample was conducted according to the following four criteria: gender, age, type of person, place of residence. The distribution of respondents by personal type is related to the size of the salary, and this is related to the employee's productivity. In order to objectively determine this distribution, based on the data of the Statistics Lithuania (2016b) of the Republic of Lithuania (more recent statistical data were not available at the time of the survey), three adjusted salary intervals were established. These wage ranges are based on the following assumptions: (1) individuals who give priority to their personal lives receive relatively low incomes (Cuff, 2000); (2) persons seeking to balance work and private life, earn an average wage; (3) those who give priority to work receive the highest wages (Hammermesh, Slemrod, 2005).

The distribution of the survey sample in relation to gender, age and place of residence (county) was established taking into account the data of the Department of Statistics of the Republic of Lithuania (2016b; more recent statistical data were not available at the time of the study). Criterion, quota, random, "snowball" sampling methods were used for respondents in the primary data collection process.

It is assumed that the population of the employed population is fully described by the three types of employed population (the ranking of individual types is presented at random):

The first type – individuals who prioritize personal life. These individuals are defined as employed people who relatively more time per day spend on seven activities that are not related to work: sleep, other physiological needs, house work and childcare, leisure activities (in the narrow sense), study, travel, or other activities.

The second type – individuals who seek to balance work and private life. These employed people coordinate time devoted to eight areas of time allocation to avoid work-life conflict.

*The third type – individuals who prioritize work (workaholics).* These individuals are understood as employed people who relatively allocate the most of the time to work, compared with other areas of life.

The primary data collection process was carried out in Lithuania from January 3 to March 5 in 2017. 10 counties of Lithuania, 15 cities, and 5 villages participated in this research.

### Mathematical model

A mathematical model is developed to determine time distribution optimization of employed population in Lithuania based on the data collected by individuals seeking to balance work and private life. Persons who give priority to their personal lives and those who give priority to work (workaholics) are defined as exceptions in the research population.

The mathematical model consists of *eight variables* indicating how the time is allocated to the appropriate time distribution domain (per day, in minutes):  $x_1$  – is the time for sleep;  $x_2$  – is time for other physiological needs;  $x_3$  – is time for work;  $x_4$  – is time for study;  $x_5$  – is time for house work and childcare;  $x_6$  – is time for leisure (in the narrow sense);  $x_7$  – is time for travel;  $x_8$  – is time for other activities.

The used model is realized in two cases depending on the person's current / desired monthly net wage. In this research presented in the paper, the *current net monthly wage* is understood as the net monthly wage earned at that moment. *The desired net monthly wage* is defined as the net monthly wage, which would fully satisfy the basic needs of the individual in relation to the primary eight time allocation areas. Primary statistics were obtained from a survey questionnaire.

*Eight goals and limitations* are formulated based on the analysis of scientific literature, economics, mathematical logic, and social experience. In the multicriterion optimization task, individuals who seek to balance work and private life have the following goals: to maximize sleep, work, house work and childcare, and leisure time (in the narrow sense), and to minimize time allocated for other physiological needs, study, travel, and other activities. Restrictions on all time allocation areas, except time spent on work, are associated with the minimum and maximum time allocation, data derived from time diaries. Work target limitation is defined as the minimum / maximum value (in euros) of the current / desired monthly net wage for the most commonly chosen range. The limitation of the work target is expressed mathematically in such a way that the inequalities are aligned with the logical, economic, and mathematical meanings.

In the mathematical model, the *target weights* are determined according to the order of satisfaction indicated by respondents of the person's type concerned (indicated in the questionnaire survey). Also, based on mathematical logic and social experience, it is assumed that each of the above priorities is twice as important as before.

The order of *priority* satisfaction in the mathematical model is determined on the basis of the questionnaire results. In all cases, it is assumed that the target related to time devoted to other activities is the lowest priority. Only if the target(s) of the above priority has been implemented can the following objective(s) be realized.

*A mathematical model to determine time allocation optimization, in order to balance the time spent on work and private life, and taking into account the current / desired net monthly earnings of the employed person* (see formula 1, the restrictions are given in formulas 2–10):

$$\min Z = \sum_{j=1}^n s_j d_j^+ + s_j d_j^-, \quad (1)$$

when

$$x_j + d_j^- - d_j^+ = a_j, \quad (2)$$

$$x_1 \geq 420, \quad (3)$$

$$x_1 \leq 540, \quad (4)$$

$$x_3 \leq 720, \quad (5)$$

$$x_2 + x_4 + x_5 + x_6 + x_7 + x_8 = 480, \quad (6)$$

$$x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 = 1440, \quad (7)$$

$$x_j \geq 0, \quad j = \overline{1,8}, \quad (8)$$

$$d_j^+ \leq (b_j - a_j), \quad j = \overline{1,8}, \quad (9)$$

$$d_j^- \geq 0, \quad j = \overline{1,8}. \quad (10)$$

Here:

$Z$  – function of minimization of deviations from the corresponding targets;

$s_j$  – target weights when  $j = \overline{1,n}$ ;

$d_j^-$  – a deviation that measures how much is missing towards the goal,  $d_j^- \geq 0$ ;

$d_j^+$  – deviation, which measures how far the target is exceeding,  $d_j^+ \geq 0$ ;

$j$  – time allocation area (action) when  $j = \overline{1,8}$ ;

$n$  – sample;

$a_j, b_j$  – the appropriate time distribution domain ( $j = \overline{1,8}$ ) minimum ( $a$ ), maximum ( $b$ ) value.

### **Explanations of the general constraints of the compiled mathematical model.**

*Restricted time to sleep* – according to medical recommendations (Hirshkowitz et al. 2015), 18-64 year old people are recommended to sleep for at least 420 minutes and not more than 540 minutes a day (see formulas 3–4).

*Restricted time to work* – according to the Labor Code of the Republic of Lithuania (TAR, No. 64-2569; see formula 5) one cannot work more than 720 minutes per day.

*Restricted time to personal life (except for sleep)* – according to A. B. Bakker et al. (2013) 480 minutes should be allocated for personal life (excluding sleep) in a traditional work-rest cycle (see formula 6).

*Twenty four hours time constraints* – the total time of all allocation areas in a day can not exceed 1440 minutes per twenty four hours (see formula 7). Also, the time spent per day must be non-negative for the appropriate time allocation (see formula 8).

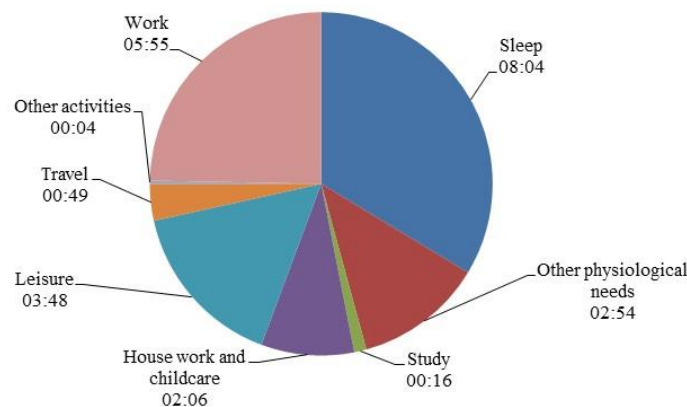
*Deviations* – a deviation measuring how much a target is exceeded must not be greater than the difference between the maximum and the minimum value for the time domain in question (see formula 9). The deviation measuring how much is missing to the target must be non-negative (see formula 10).

Thus, in this article, based on the eight goals set forth, a time-optimization model is presented estimating the current / desired monthly net wage. This model is suitable for individuals who seek to balance work and private life.

### Summary of the empirical study results of optimal time allocation for work and personal life

In this part of the article, the results of general distribution of work time and personal life of employed Lithuanians are presented first. It is followed by an overview of the distribution of the current and desired wages of employed Lithuanians among different types of persons. Finally, a mathematical model is implemented and the optimal time allocation between work and personal life among employed Lithuanians is identified, taking into account the size of the current / desired salary. Based on the results of the research, recommendations are made for the employed Lithuanians seeking to balance work and private life.

**Actual data on the time distribution of employed population.** Reviewing time allocation data of the employed Lithuanians in 2017, it was found that on average 75.3 percent of employed persons spend time on private life, and 24.7 percent of time to work (see Figure 1).



**Figure 1.** Distribution of working time and personal life of the employed population in Lithuania (according to the data of the empirical research time diaries)

Note: leisure is analyzed here in the narrow sense. The time is given in minutes, so there may be 00:01 hour error.

In the area of personal life employed people, relatively the most time spend on sleep (08:04 hrs.), leisure time (in the narrow sense, 3:48 hrs.) and other physiological needs (e.g., eating, personal hygiene, etc., 02:54 hrs.; see Figure 1). The least amount of time in a day is allocated to other activities (00:04 hrs.) and travel (to work, home, etc., at 00:49 hrs.).

Comparing time distribution of employed Lithuanians in 2017 with the time distribution data in 2003 (employed people database is used – UNECE, 2017) several changes can be noted. In 2003, employed people in Lithuania spent 17:54 hours a day on personal life, and 06:06 hours for work. It can be assumed that the employed population in Lithuania seeks to balance the time spent on work and private life, since the time allocated for personal life increased by 00:10 hours in 2017 compared to 2003, and the time spent on work fell by 00:10 hours. In this case, based on A. F. Alesina et al. (2006) and 2017 time allocation data, it can be stated that in 2017 in Lithuania, European culture begins to dominate in terms of time allocation, with a relatively higher focus on leisure time. Thus, the employed population in Lithuania allocates approximately one fourth of the time to work, and begins to devote more attention and time to personal life (in comparison with 2003).



**Distribution of the current and desired wages of the employed population.** In 2017, employed people in total (29.6 percent) and by gender (30.2 percent for men, 29.0 percent for women), had *the current net monthly wage* fall usually in the range of [419; 519] euros (see Table 1).

Employed persons Interval of wage	The current net monthly wage						The desired net monthly wage					
	Total	Men	Women	1st type	2nd type	3rd type	Total	Men	Women	1st type	2nd type	3rd type
≤ €317	8.1%	6.5%	9.7%	15.6%	6.5%	2.6%	0.2%	0.5%	0.0%	0.0%	0.4%	0.0%
€[318; 418]	14.3%	15.6%	13.0%	26.7%	11.2%	7.9%	0.2%	0.5%	0.0%	1.1%	0.0%	0.0%
€[419; 519]	<b>29.6%</b>	<b>30.2%</b>	<b>29.0%</b>	<b>30.0%</b>	<b>29.9%</b>	26.3%	3.2%	3.0%	3.4%	7.8%	2.2%	0.0%
€[520; 616]	24.9%	23.6%	26.1%	16.7%	<b>28.8%</b>	15.8%	7.1%	5.0%	9.2%	7.8%	7.6%	2.6%
€[617; 874]	17.7%	17.6%	17.9%	7.8%	18.7%	<b>34.2%</b>	21.4%	20.1%	22.7%	23.3%	19.8%	28.9%
€[875; 2090]	4.4%	5.0%	3.9%	3.3%	3.6%	13.2%	<b>61.1%</b>	<b>63.3%</b>	<b>58.9%</b>	<b>48.9%</b>	<b>65.1%</b>	<b>60.5%</b>
≥ €2091	1.0%	1.5%	0.5%	0.0%	1.4%	0.0%	6.7%	7.5%	5.8%	11.1%	5.0%	7.9%
Sum	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

**Table 1.** Distribution of the current and desired net wages of the employed population in Lithuania in 2017 (according to the data of the empirical survey questionnaire)

Note: the first type persons – individuals who prioritize personal life; the second type persons – individuals who seek to balance work and private life; the third type persons – individuals who give priority to work (workaholics). There may be minimum error in column sum due to action of rounding.

The difference between men and women in the most commonly received monthly net wage is relatively small, i.e., 0.8 percentage points (see Table 1). Thus, it can be argued that there is no discrimination in this case.

Considering the distribution of the current net monthly wage, rational differences are observed. Persons who prioritize private life usually receive monthly net wages that fall into the range of [419; 519] euros (30.0 percent; see Table 1). Persons who seek to balance work and private life, usually receive a monthly net wage, which (in general) falls into the range of [419; 616] (58.7 percent). Relatively the highest net monthly wage is received by persons who give priority to work, that is monthly net wages fall into the range of [617; 874] euros (34.2 percent).

It is observed that the results of this study coincide with the results obtained by K. Cuff (2000) – individuals who prefer personal life receive lower net wages than other types of people. Similarly, the results of this study can be compared to D. S Hamermesh, J. B. Slemrod (2005) and show similar conclusions: workaholics earn relatively high (in this case, the highest) earnings. It can be assumed that the existing differences in the net wages of the current month between employed persons in Lithuania by type of person may be based on differences between the time spent on work and the productivity of work. However, in order to obtain more precise conclusions, a more detailed study should be conducted.

The prevailing desired net monthly wage among employed people in Lithuania is observed in all cases (in general, by gender, by type of person), which falls into the interval of [875; 2090] euros (see Table 1). It should be emphasized that in all cases (in general, by gender, by type of person) the current net monthly wage is lower than the desired net monthly wage. Relatively smallest gap between the current net monthly earnings and the desired net monthly earnings is between workaholics, and the biggest gap among the persons who prioritize personal life. It may be assumed that there should be a rational difference between the current and the desired net monthly wage, so that there is a possibility for a person to receive the corresponding desirable wage in the labor market. One of the further directions of research could be related to the identification of the rational difference between the current monthly net wage and the desirable monthly net wage.

Consequently, taking into account the existing difference between the current and the desired net monthly wages of the employed population, it became clear that the current net monthly wage does not meet the needs. It shows one of the existing problems in the Lithuanian labor market, with the possible consequences such as: increased emigration of the working-age population; involvement in the shadow market; increased social problems; dissatisfaction with political decisions, etc. Another possible further research direction could be related to the identification of needs that can not be met by employed people occupants due to the existing

difference between the current and the desired monthly net wages. Upon identification of the main unsatisfactory needs, a project / plan could be developed to enable the Government of the Republic of Lithuania to contribute to improving the satisfaction of relevant needs (e.g., subsidizing relevant areas, promoting various campaigns, etc.).

Summing up the distribution of wages of the employed population in Lithuania, one can conclude that there is a rational differentiation between types of persons. Persons who prioritize private life receive relatively the smallest net monthly salary, and those who give priority to work receive the highest net monthly earnings. Furthermore, it became clear that there is a difference between the current and the desired monthly net wages in general, by gender and by type of person. It is likely that the search to find a solution(s) to this problem, and ultimately seeking to reduce the manifestation of this problem, would contribute to the increase in the welfare of the employed population, households and the state, improving the situation in the Lithuanian labor market.

**The optimal time allocation to work and personal life by employed Lithuanians.** This part of the article presents a mathematical model based on primary data, which is realized in two cases, taking into account the current / desired net monthly wage. Later the identified optimal time allocation for work and personal life is compared to actual data, a sensitivity analysis is performed and recommendations of a corresponding nature are presented.

**1. Optimization model for time distribution for work and personal life, taking into account the person's current net monthly wage** (see formula 11, the limitations are shown in formulas 12–23):

$$\min Z = 16d_1^- + 16d_2^+ + 32d_3^- + 2d_4^+ + 32d_5^- + 8d_6^- + 4d_7^+ + d_8^+, \quad (11)$$

when

$$x_1 + d_1^- - d_1^+ = 420, \quad (12)$$

$$x_2 + d_2^- - d_2^+ = 47, \quad (13)$$

$$x_3 + d_3^- - d_3^+ = \frac{419}{21 * 0,06}, \quad (14)$$

$$x_4 + d_4^- - d_4^+ = 0, \quad (15)$$

$$x_5 + d_5^- - d_5^+ = 8, \quad (16)$$

$$x_6 + d_6^- - d_6^+ = 51, \quad (17)$$

$$x_7 + d_7^- - d_7^+ = 7, \quad (18)$$

$$x_8 + d_8^- - d_8^+ = 0, \quad (19)$$

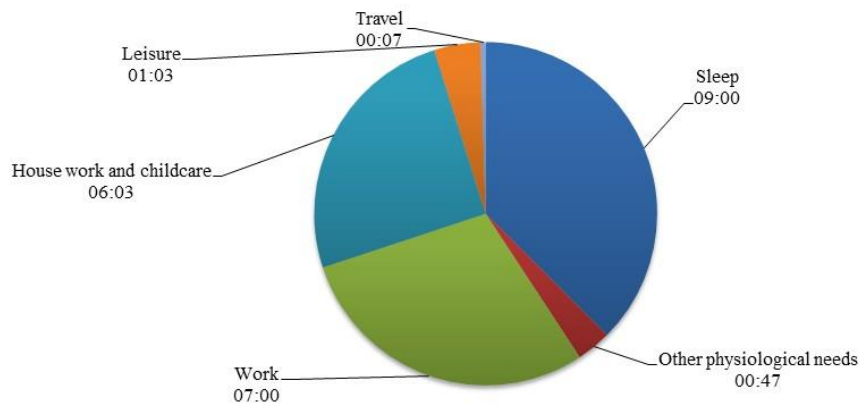
$$x_2 + x_4 + x_5 + x_6 + x_7 + x_8 = 480, \quad (20)$$

$$x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 = 1440, \quad (21)$$

$$d_1^+ \leq 120, d_2^+ \leq 278, d_3^+ \leq 156,35, d_4^+ \leq 234, d_5^+ \leq 355, d_6^+ \leq 384, d_7^+ \leq 145, d_8^+ \leq 178, \quad (22)$$

$$x_j \geq 0, d_j^+ \geq 0, d_j^- \geq 0, j = \overline{1,8}. \quad (23)$$

Using the Microsoft Excel Solver tool, a mathematical model is implemented and the optimal solution is determined = (540; 47; 420; 0; 363; 63; 7; 0). In this case, 17:00 hours a day should be devoted to personal life and 07:00 hours for work, and the person should earn € 529.20 a month (see Figure 2).



**Figure 2.** The optimal distribution of the daily time among employed people in Lithuania for work and personal life, when net monthly earnings fall into the range [419; 616] euros

Note: leisure is analyzed here in the narrow sense. The time spent on study and other activities is at 00:00 hours.

After the sensitivity analysis, variable volatility limits have been established for which the optimal solution for time allocation would be allocated: the time spent on other physiological needs can be reduced to 00:16 hours, work can be increased by 5:00 hours, study can be reduced to 00:02 hours, leisure time (in the narrow sense) – can be increased at 00:01 hours, travel – decreased at 00:04 hours. Sleep, house work and childcare, the time spent on other activities can not be changed. The total time of other physiological needs, study, leisure (in the narrow sense), travel, other activities can fluctuate in the range [468; 567.46] min.

Comparing optimal time distribution with the actual data of employed Lithuanians from 2017, it can be concluded that Lithuanians do not optimally allocate time for work and personal life (see Figures 1 and 2). Based on the realized mathematical model, it is advisable for the employed people to reduce the time allocated for other physiological needs to (02:07 hrs.), for study to (00:16 hrs.), for leisure (in the narrow sense, 02:45 hrs.), for travel (00:42 hrs.), another activities (00:04 hrs.), and increase the time spent sleeping (at 00:56 hrs.), work (01:05 hrs.), house work and childcare (03:57 hrs.). These differences may be affected by differences in hourly wage rates, non-compliance with the recommendations (or lack of information) due to the time available for sleep, the traditional work-rest cycle, etc.

**2. Optimization model for time allocation for work and personal life, taking into account the person's desired monthly net wage** (see formula 24):

$$\min Z = 16d_1^- + 16d_2^+ + 32d_3^- + 2d_4^+ + 32d_5^- + 8d_6^- + 4d_7^+ + d_8^+, \tag{24}$$

The mathematical model constraints are the same as in the first case (see formulas 12–13, 15–23), except for working time constraints. Taking into account the empirical data-based working hours fluctuation limits [694,44; 1658,73] min, it is necessary to use the maximum working time limit. Thus, the following restrictions are added to this model (see formulas 25–27):

$$x_3 + d_3^- - d_3^+ = \frac{875}{21 \cdot 0,06}, \tag{25}$$

$$d_3^+ \leq 964,29, \tag{26}$$

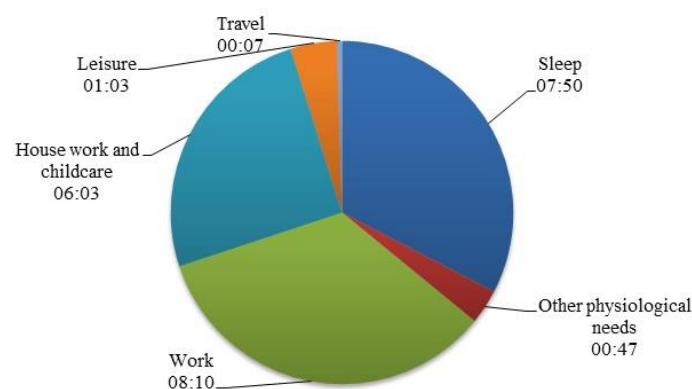
$$x_3 \leq 720. \tag{27}$$

It should be emphasized that in this case there is no optimal solution (the sleep goal is not fulfilled). This suggests that employed Lithuanians are likely to want excessive monthly net wages. In this regard, a model is implemented where the desired net monthly wage falls within the range [617; 874] euros (second option based on frequency, see Table 1). Consequently, 25–27 restrictions are abandoned and, in addition, the following working time constraints are included in the model (see formulas 28–29):

$$x_3 + d_3^- - d_3^+ = \frac{617}{21 \cdot 0,06} \quad (28)$$

$$d_3^+ \leq 203,97. \quad (29)$$

In this case, the optimal solution = (470; 47; 489,68; 0; 363; 63; 7; 0). Compared to the first case, the results of this study change the ratio of work to personal life: the work should be given at 08:10 hours, personal life – 15:50 hours, and the person should earn 617 euros per month (see Figure 3).



**Figure 3.** The optimal distribution of the time for work and personal life among employed Lithuanians, when net monthly earnings fall into the range [617; 874] euros

Note: leisure is analyzed here in the narrow sense. The time spent on study and other activities is at 00:00 hours.

Therefore, sleep should be given (daily) at 07:50 hours, for other physiological needs – at 00:47 hours, for work – at 08:10 hours, house work and childcare – 06:03 hours, for leisure time (in the narrow sense) – 01:03 hours, travel – 00:07 hours (see Figure 3). There would be no time for study and other activities.

When comparing the results of the second realized model with the first time optimization, the main difference is between work and sleep time (see Fig. 2 and Fig. 3). In other words, sleep should be given at 01:10 hours less time and this time should be given to work. Thus, when such conditions are formulated in this model, in order to obtain a higher monthly net wage, less time should be devoted to sleep and more to work. The sensitivity analysis revealed that the time spent on work could be increased by 00:32 hours, sleep time should not be changed, and the duration of other periods of physiological needs, study, leisure (in the narrow sense), travel, and other activities could fluctuate in the range [468; 530.32] min.

When comparing the optimal time allocation, when the desired net monthly wage falls within the range [617; 874] euros, based on 2017 time allocation results, it is recommended to reduce the time allocated to other physiological needs (02:07 hrs.), to study (00:16 hrs.), to leisure time (in the narrow sense, 02:45 hrs.), to travel (00:42 hrs.), to other activities (00:04 hrs.) and to sleep (00:24 hrs., see Figures 1 and 3). It is also necessary to increase the time allocated not only for house work and childcare (03:57 hrs.) but also for the time spent on work (02:15 hrs.). Thus, the employed people in Lithuania aiming to optimally allocate time between work and private life and receive the desired net monthly salary, falling into the interval of [617; 874] euros, more time is needed for work and less for sleep than within the first realized mathematical model.

Summing up the optimization of time distribution of work and personal life among employed Lithuanians, it can be stated that the employed population in Lithuania does not optimally allocate time between work and personal life, when net monthly earnings fall into the interval of [419; 616] euros. In this case, it is necessary to reduce the time spent on other physiological needs, study, leisure (in the narrow sense), travel and other activities, while increasing the time spent for sleep, work, house work and childcare. Based on the formed conditions of the mathematical model, optimal time distribution does not exist when the net monthly wage of the employed Lithuanians falls within the range of [875; 2090] euros. On the other hand, having identified an optimal time distribution, when the desired net monthly wage falls within the range [616; 874] euros, it is established that the employed people in Lithuania should spend less time on sleep and more on work than in the first case, when the optimal time allocation was set, taking into account the current net monthly wage.

## **Conclusions**

1. The authors of the article analyzed the main theoretical aspects of modeling time distribution and personal life. It has been found that the working time can be divided into two main areas: work (paid work time) and personal life (free time from work, i.e., leisure in the broad sense). The functioning of these phenomena is defined in the model of labor-leisure (personal life), in which there are restrictions on budget, time, and environmental conditions. The labor-leisure (personal life) model describes the behavior of the labor supply participant, the manifestation of which is also influenced by personal preferences in the context of labor-leisure (personal life).
2. An overview of the time distribution research, it has been identified that research on this topic is important and relevant in the 21st century. On the other hand, the limitations of the theoretical and empirical nature of the analysis of time distribution is emphasized, especially in the case of Lithuania. This justifies the importance of the paper presented in the study because it provides theoretical insights and the results of the empirical study that complement the research insights and encourage further discussions in the field of time allocation.
3. The methodological part of the article presents a model for optimal time allocation for work and personal life and a research methodology. The population of the survey is employed persons in Lithuania. Primary data were collected using questionnaire and time diary techniques. The model for optimal time allocation for work and personal life has been compiled through multicriteria (targeted) optimization, using weighted coefficients and priority methods and performing sensitivity analysis.
4. The research carried out showed that the population in Lithuania in 2017 begins to devote more time to personal life compared to time allocation data in 2003. In addition, the current net monthly wages coincide in general and by gender, and usually fall into the range of [419; 519] euros. A more detailed analysis of the distribution of the net monthly wages of the employed Lithuanians, showed rational differentiation between different types of persons. Relatively the largest net monthly wage [617; 874] euros is received by people who prioritize work, while the smallest wage is received by those who prefer personal life, i.e., [419; 519] euros. It was also found that in all cases (in general, by gender and type of person), the desired net monthly wage of the employed Lithuanians coincides with the interval [875; 2090] euro. On the other hand, the gap between the current and the desired net monthly wages is identified.
5. After the implementation of a mathematical model which aimed to determine the optimal time distribution in a day, it became clear that the employed population in Lithuania is not optimally distributing the time between work and private life when receiving monthly net wages falling into the interval [419; 616] euros. For this reason, it is recommended that the employed people reduce the time spent on other physiological needs (02:07 hrs.), study (00:16 hrs.), leisure time (in the narrow sense, 02:45 hrs.), travel (00:42 hrs.), other activities (00:04 hrs.), and increase the time spent sleeping (at 00:56 hrs.), working (01:05 hrs.), for house work and childcare (03:57 hrs.). The second implementation of the mathematical model, which took into account the desired net monthly wage of the employed population, suggests that the employed people in Lithuania want a too high monthly net wage. On the other hand, it has been established that for employed persons in Lithuania seeking optimal distribution of time between work and private life and obtaining the desired net monthly salary, falling into the

interval [617; 874] euro, more time is needed for work and less for sleep than within the first realized mathematical model.

6. The study could be continued by improving or using the same research methodology at other national levels. The main aspects of research continuity could be related to the implementation of a similar study using statistics from another country. The study could also be continued on a Lithuanian scale. In this way, the most recent data of identifiable behavior of employed Lithuanians could be obtained and changes traced.

### Conflicts of Interest

The authors of the article did not have financial, professional, personal interests with other interested organizations or individuals.

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