Occupational Labour Demand Sub-model of Latvian Labour Market Forecasting and Policy Analysis System Dynamics Model

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Abstract
This paper shows occupational labour demand sub-model of the Latvian labour market forecasting and policy analysis system dynamics model. Labour market planning is topical in any country. The novelty element of the paper relates with the practical application of the system dynamics method for the state needs in Latvia for labour market forecasting as well as with development of a one of the most powerful models of labour market forecasting in the World. In the paper structure of the model, occupational labour demand sub-model position in labour demand module of the model, as well as components of occupational labour demand sub-model and the possibilities of the model and the forecast of the most important parameters of labour market in Latvia are shown.

Keywords: system dynamics; labour demand; population; migration; employment; unemployment; working places; forecasting; education policy analyse.

Introduction

Labour market planning is topical in any country. For Latvia topicality of the problem is stressed by the new conditions: after entering the European Union (EU) Latvia faced new possibilities in international labour market. The EU member states have opened their labour markets to workers from Latvia. The largest amount of labour force moved to Ireland, Great Britain and Sweden. The migration process has a significant influence on the labour market in Latvia. These processes will also influence the future development of Latvia; therefore the research of these issues is of high importance for Latvia. It is also important internationally, because in other countries, especially in the new EU member states, the similar processes take place.

This paper shows the second part of the Latvian labour market forecasting and policy analysis system dynamics model. The first part, preconditions of development of the model, was presented in the 1st Asia-Pacific Conference of the System Dynamics Society, in Tokyo, Japan, February 22-24, 2014. In the first part of the research, the system dynamics experience in labour market forecasting and the international practice in labour market forecasting are investigated; the structure of the model and its several components (sector labour demand sub-model), as well as the possibilities of the model and the forecast of the most important parameters of labour market in Latvia are shown.

The aim of this paper is to show occupational labour demand sub-model of the Latvian labour market forecasting and policy analysis system dynamics model.

To achieve this aim, the following tasks are set:
- ✓ to show structure of the model;
- ✓ to show occupational labour demand sub-model position in labour demand module of the model;
- ✓ to show components of occupational labour demand sub-model;
- ✓ to show possibilities of the sub-model;
- ✓ to forecast the most important parameters of labour demand in Latvia.

In the paper the researched problem is related to labour market planning and forecasting model development and use.

The novelty element of the research relates with the practical application of the system dynamics method for the state needs in Latvia for labour market forecasting as well as with development of a one of the most powerful model of labour market forecasting in the World.

The object of the research is the development of occupational labour demand sub-model and the development of the labour market policy analysis system dynamics model.

The study shall use both traditional mathematical, statistical, economic and econometric analysis methods, such as time-series trends, regression method, but the principal method of the research is the system dynamics method.

The information base of the study is the unpublished information of the Central Statistical Bureau of the Republic of Latvia.

Methodological basis of the research is based on the works of the system dynamic top scientists: Forrester J., Dale Runge, Petrides L., Dangerfield B., Bo Hu, Hans-Rolf Vetter, Torres D.S., Lechon R.F., Vizayakumar K., Winch G., Skraba An., Arthur D., Moizer J., Mutuc J. and so on.

The research results have been tested and would to be implemented by the Ministry of Economics of the Republic of Latvia, as well as by other state institutions.

In preparation of this article is used technical documentation of the Latvian labour market medium and long-term forecasting and policy analysis model (published in Latvian: Latvijas darba tirgus vidēja un ilgtermiņa prognozēšanas un politikas analīzes modeļa tehniskā dokumentācija).

Research methodology

Structure of the model

To understand the meaning of occupational labour demand sub-model should be considered structure of the model. The structure of the model is shown in Fig. 1.

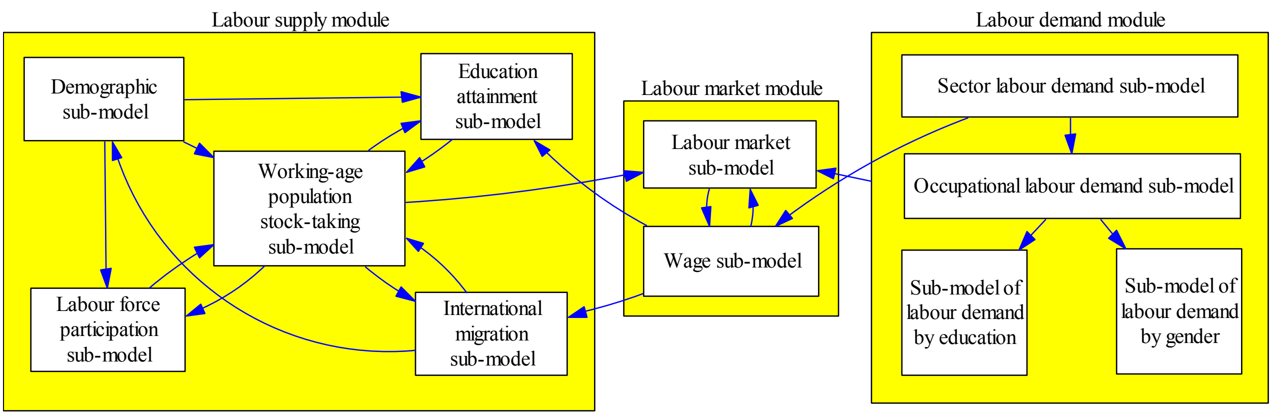

Fig. 1 **Logic structure of the model**

The Fig. 1 shows, the model involves three modules - labour supply, demand, and market modules.

Labour demand module simulates the labour productivity, labour demand by fields and levels of education, occupations and gender. Labour demand module consists of sector, occupation, education and gender labour demand sub-models.

Sector labour demand sub-model determines the labour productivity and labour demand by sectors on the basis on GDP forecasts.

The labour demand by occupations (in the sub-model of the labour occupational demand) is being calculated on the basis of the sector labour demand.

The labour occupational demand sub-model provides the calculation of the labour demand by levels and fields of education (in the sub-model of the labour education demand), as well as labour demand by gender (in the sub-model of the labour gender demand).

Labour supply module simulates the demographic processes, division of the population by age, gender, economic activity, education and occupation. Labour supply module consists of demographic, education attainment, working-age population stock-taking, labour force participation and international migration sub-models.

Demographic sub-model defines population by age groups and genders. This sub-model defines the population fertility, mortality and aging. When the population reaches the 7-year-age, the demographic sub-model defines the number of incoming in the education system population. When the population reaches the working age, demographic sub-model defines the growth of the labour force (in the working-age population stock-taking sub-model), in accordance with previous education (education attainment sub-model) and the estimated economic activity. When the population reaches the retirement age, demographic sub-model defines the decline in labour. The same happens in case of death before the retirement age.

Working-age population stock-taking sub-model represents the labour structure by 5-year age groups, genders, economic activity, education and professional occupations, that is, reflects the operating results of other sub-models.

Labour force participation sub-model defines the labour structure in the field of economic activity.

Education attainment sub-model defines not only the increase of the primary labour amount (along with demographic sub-model), but also the changes of the labour structure along with education attainment, including lifelong education system.

International migration sub-model defines the change of population and labour along with the international migration processes.

Labour market module simulates employment, unemployment, working positions, unoccupied vacancies and wages. Labour balancing module consists of two sub-models: labour market and wage sub-models.

Labour market sub-model combines supply and demand, taking into account the working positions, unoccupied vacancies, the amount of labour and wages.

Wage sub-model analyses the most important processes in the national economy (change of productivity) and labour demand and supply amounts, forming the labour salaries. Labour salaries affect both labour market balance and labour supply formation, that is, affect the choice of education and international migration.

Components of the labour demand module

Labour demand module is responsible for modelling labour productivity, labour demand by sectors, occupations, education and gender. The module consists of 4 sub-models: sector labour demand sub-model, occupational labour demand sub-model, sub-model of labour demand by education and sub-model of labour demand by gender. Module structure is presented in the Fig. 2.

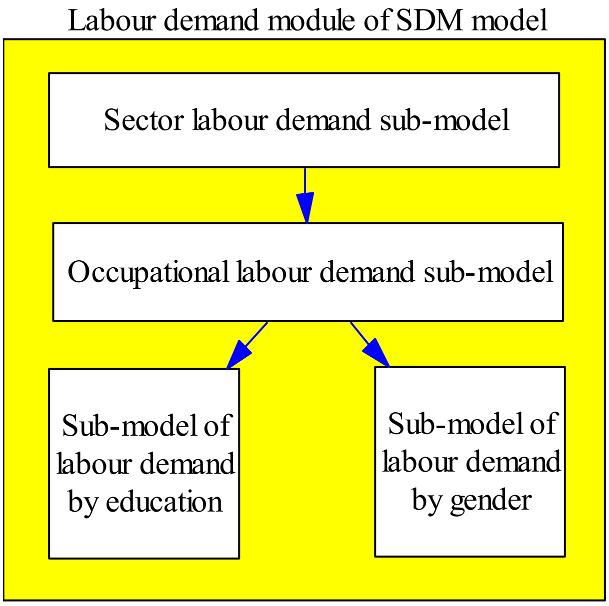

Fig. 2 **Logical structure of the labour demand module**

Fig. 2 represents that the labour demand by occupations, and further - by education and genders, have been calculated from the sector labour demand in the labour demand module. For the calculation of labour demand in the mentioned dimensions the relevant sub-models have been developed.

Sector labour demand sub-model from the GDP forecasts determines labour productivity and labour demand by sectors.

Calculation of the labour demand by occupations is based on sector labour demand (in the occupational labour demand sub-model).

On the basis of the occupational labour demand sub-model, the labour demand by levels and fields of education has been calculated (in the sub-model of labour demand by education), as well as labour demand by gender (in the sub-model of labour demand by gender).

Previously, in the 1st Asia-Pacific Conference of the System Dynamics Society, sector labour demand sub-model, as well as it components were shown. The further sub-section describe occupational labour demand sub-model.

Occupational labour demand sub-model

The sub-model is based on sub-model of labour demand by sectors, as well as on occupations - sectorial statistical data, the ratio of occupations by sectors, and determines the changes of labour demand by occupations - sectors, taking into account the changes of labour demand in the sectors (in relation to changes of GDP in the sector), and structural changes of the occupations on the basis of the target structure.

In order to ensure the operation of sub-model in the forecasting time the functional labour demand sub-model of the sector (with all the incoming indexes and data) should be available, as well as statistical data on occupations - the number of the employed persons in the base period and the target structure of the labour demand by occupations - sectors in the end of the forecasting period.

The sub-model logic of the labour demand by occupations is presented in the Fig. 3.

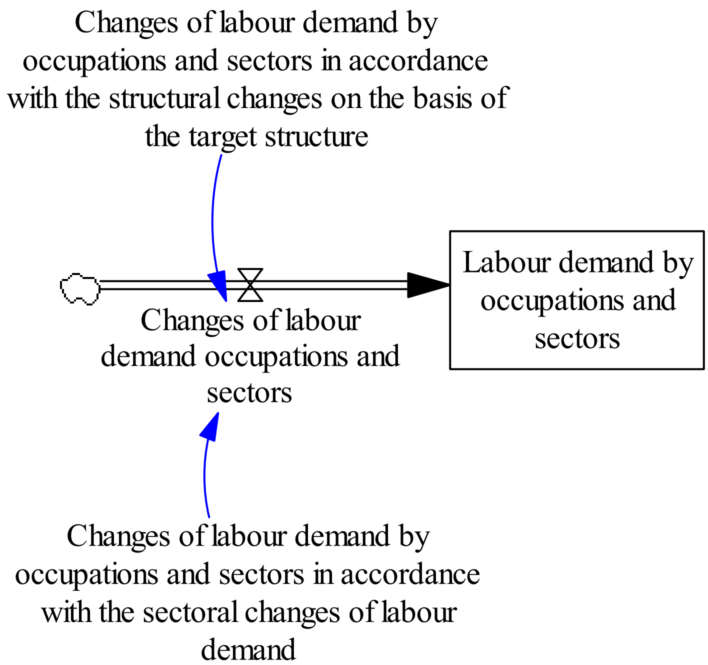

Fig. 3 **Sub-model logics of labour demand by occupations**

As shown in Fig. 3, the changes of labour demand by occupations and sectors are made of two algorithms: on the basis of the target structure of the changes and on the basis of the demand. The constituent algorithms of the changes are viewed below.

Sub-model has only one stock - "labour demand by occupations and sectors". Stock initial level is determined from statistical data. Stock changes are determined by the flow of "changes of labour by occupations and sectors" which have been developed by summing the changes associated with structural changes on the basis of the target structure and changes associated with changes in volume of labour demand.

Calculation scheme of the changes of labour demand by sectors, in accordance with the target structural changes are presented in the Fig. 4.

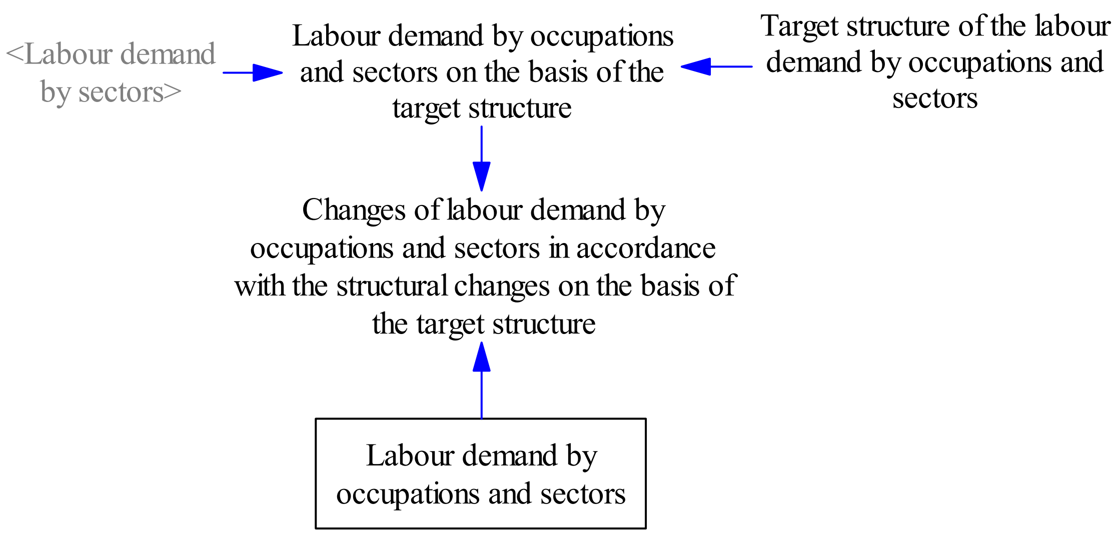

Fig 4. **Calculation of the changes of occupational labour demand by sectors in accordance with the desired structural changes**

The first index, affecting the sectorial - occupational separation, is the "changes of labour demand by occupations and sectors in accordance with structural changes on the basis of the target structure". Its calculation algorithm is following: "labour demand by occupations and sectors on the basis of the target structure" is being calculated from the target structure of labour demand by occupations and sectors and labour demand by sectors (from the sub-model of sectorial labour demand), further, comparing the target and actual labour demand in occupation by sectors, and taking into account the time provided for changes, the changes of labour demand in occupation by sectors are being calculated, taking into account the structural changes on the basis of the target structure.

The calculations involve the time elements. They help to split the time difference between the actual and target labour demand in the occupation. The target labour demand in the occupation by sectors shows a target level; its difference from the actual labour demand in the occupation, and the sector indicates, which should be the structure changes throughout the forecasting period. By separating the target changes throughout the whole forecasting period by forecasting period (which is calculated as forecasting last year minus forecasting current year), the required changes by occupations are being calculated within a year. Inclusion of time elements creates the dynamic changes. If there were no other factors affecting the structure, developed algorithm would ensure gradual, smooth transition from actual condition to the target level. If the system involves other factors, the rate of structural changes will be changed.

The other index affecting sectors-occupations distribution is "change of labour demand by occupations and sectors in accordance with sectorial changes of labour demand". This calculation is related to the uneven response to the sectorial changes of labour demand.

In one of the first works on system dynamics "Urban Dynamics", which for the moment has become a classic in this field, Jay Forrester in 1969 developed a separation of labour for workers, specialists and managers. With the development of the economy, the changes of labour demand in each of these groups are different. In the sub-model Forrester principles are taken into account by developing the separation of labour from the three groups to the division of occupations in accordance with Occupational classification of the Republic of Latvia (3-digit level of the occupation code).

One of the modern management concepts considers the organizations as a hierarchical structure, which higher-level elements are based on lower-level elements. This approach may be also transmitted to the labour market, separating by basic occupations (which attract the largest labour amount), specialised occupations (which are ensured by the work performance conditions for workers with basic occupations), management occupations, etc. in the specialty distribution market. The most common hierarchical systems are presented in the form of a pyramid, which is shown in the Fig. 5.

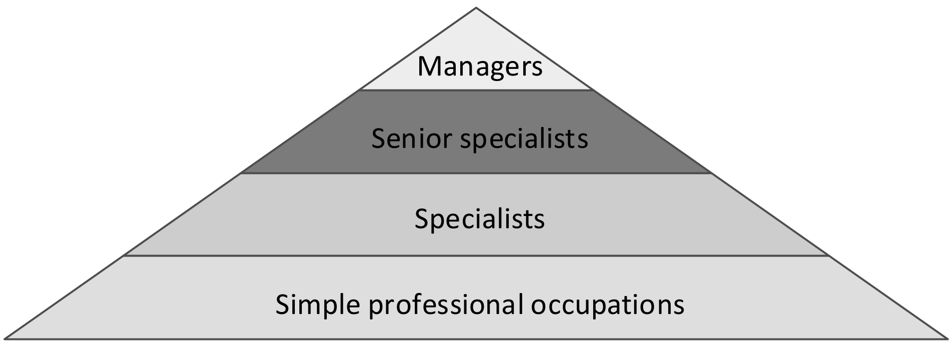

Fig. 5 **The sample of hierarchical system in the labour market**

Fig. 5 represents the hierarchical sample of the traditional sector, which is based on the elementary occupations, then the specialists, senior specialists and managers are coming. Some sectors do not correspond to this sample, for example, the general staff in education or medicine are specialists or senior specialists, but their work conditions may be ensured by the staff from simple occupational groups. In the improved sub-model on the basis of the statistical data the establishment of the hierarchy of occupations is being proposed, determining the basic occupations that are most commonly found in a particular sector, but the higher level occupations are relatively rare in the analysed sector.

The development of hierarchy of occupations by the staffing is associated with a different response to the growth of the sector and growth of staff demand. The higher the occupation in the hierarchical pyramid is, the smaller are the changes of its representatives (employees), by changing the staff in the sector. And vice versa, the major changes in the sector staff are ensured by occupations, which are most prevailing in the sector and form the basis for a hierarchical pyramid. The increase of the number of employees in the hierarchy is schematically reflected in the Fig. 6, using one sector as the example - fishing sector (B) in accordance with the NACE classification.

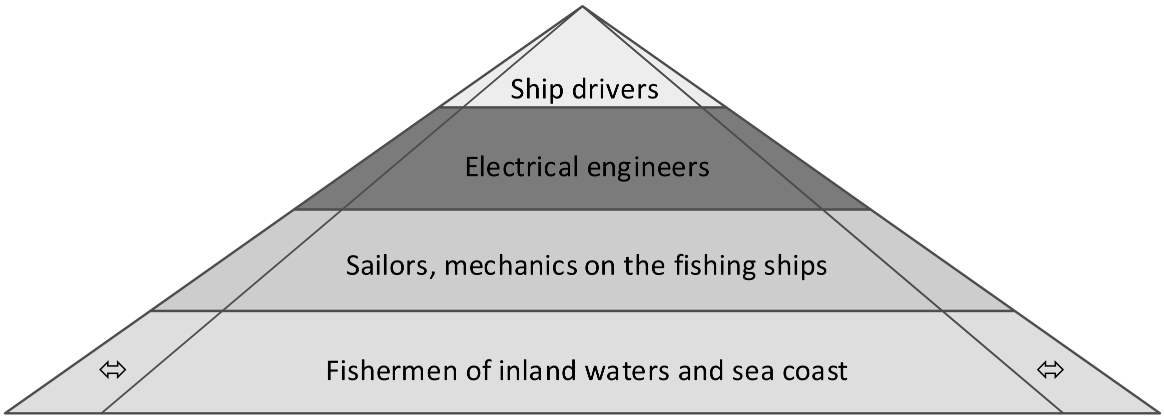

Fig. 6 **Sample of the increase of the number of the sector hierarchy employees for the fishing sector**

Fig. 6 shows by the example of the fishing sector that the growth of the number of the employees is mainly ensured by increase of the lowest level of the hierarchy number of employees.

Management practices shows that not always the growth of the lower level of hierarchy occupations causes an increase in higher groups. Management theory explains that with the means of the administration scale. Every manager has his certain optimal number of subordinate employees and boundaries. With the change in the number of subordinate employees within the optimal boundaries, the number of the managers does not increase. When the number of subordinate employees is beyond the optimal boundaries, the number of managers changes as well. This management concept is also appropriate for labour market in order to forecast occupations. Application of the given concept for forecasting of the occupations in the labour market will ensure dynamism of occupational structure in the sectors.

The development of the changes of occupational labour demand by sectors, taking into account the changes of the sectorial labour demand, is presented in the Fig. 7.

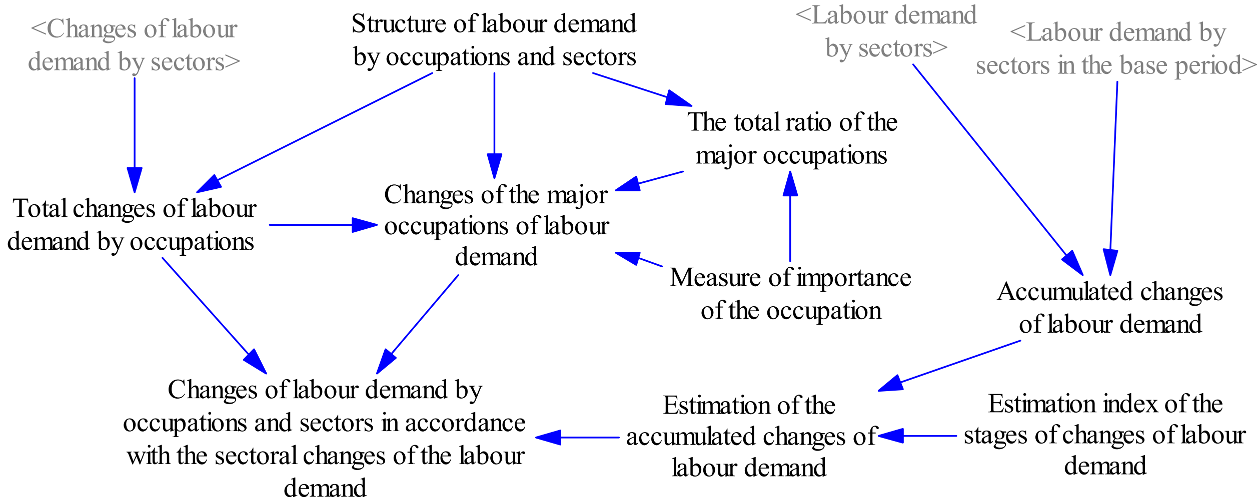

Fig. 7 **Formation of changes of occupational labour demand by sectors in accordance with the development of the sectors**

Fig. 7 shows that the starting point of the sub-model is the change of labour demand and the structure of occupation in the sector. Changes of labour demand in the sectors are divided according to the structure of the occupation, by using two algorithms, which are titled as "total changes of labour demand by occupations" and "changes of the major occupations". Changes of occupational labour demand are using one or another algorithm, taking into account the rate of growth of the labour demand.

According to the theoretical assumptions, depending on the sectorial growth of the labour demand growth, the changes of occupational labour demand by sectors, taking into account the changes of the sectorial labour demand, are composed of two affecting indexes: "the total changes of labour demand by occupations" (under conditions of the accelerated growth (boom) of the sectorial labour demand) and "changes of the major occupational labour demand" (under conditions of moderate growth).

The main point is how the algorithms of occupational labour demand and structural changes modify due to the growth of labour demand. The index "estimation of the accumulated changes of labour demand" divides the changes of the labour demand in the stages: "paired" and "unpaired". The determination of the stage nature is associated with the belonging of the half of the index "estimation of the accumulated changes of labour demand" to the group of integers. If the index divided by two is an integer, the stage is paired, and vice versa - if the index divided by two is not an integer, the stage is unpaired. The first unpaired stage starts from zero.

The economic and system dynamical essence of this mathematical equation is the following. When the growth level is close to zero the sector extension (growth of labour demand) is associated with the increase in primary occupations: the number of vendors is growing in trade, the number of workers - in the sector, the number of different categories of staff (cleaners, drivers) is not growing, but the existing reserves are being used instead. In the sub-model explanation this stage is denoted as "unpaired". In the further development the reserves disappear. At the stage when the system has no reserves, there is total growth of occupational demand. In the sub-model explanation this stage is denoted as "paired". Then the reserves are created at the paired stage, leading to the end of the paired stage and the start of the unpaired stage. This algorithm can be continued indefinitely, it is possible to be applied both for the labour growth and decreases. Schematically, the development of this process is presented in Fig. 8.

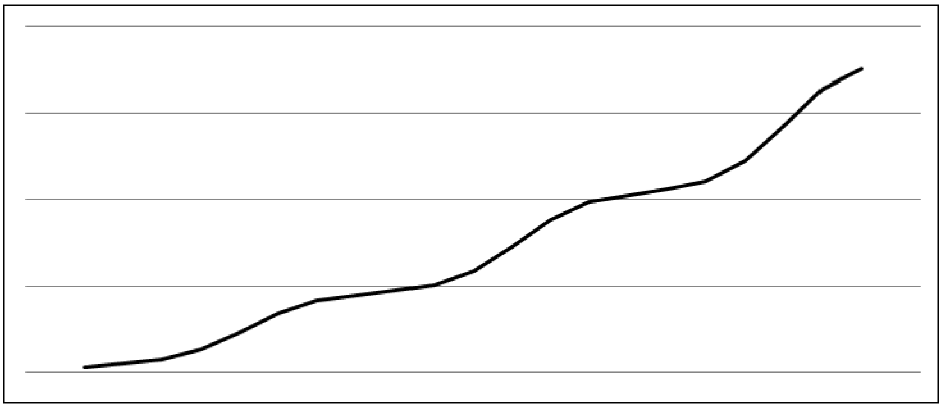

Fig. 8 **Example of gradual development**

System dynamic emphasizes the developmental character of the non-linear processes and points out that one of the alternatives and the most probable tendencies is a gradual development.

The index “estimation of the accumulated changes of labour demand” divides the changes of the labour demand (from the index “accumulated changes of labour demand”) into stages according to stage length (element “estimation index of the stages of the changes of the labour demand”).

The index “estimation of the accumulated changes of labour demand” represents the number of the stage of the changes. The next (current) stage begins when the accumulated increase (change) of labour demand excesses the boundaries of the given stage (boundaries are set by the element “estimation index of the stages of the changes of the labour demand”). The economic and system dynamics essence of this assumption is the following: when the system uses the labour reserve for the certain (basic) occupations, there is only one stage; further, when reserves have been used, and the labour demand is growing in all occupational groups, the next stage begins; formation of reserves causes the beginning of the next stage, etc.

Element “estimation index of the stages of the changes of the labour demand” in the model is used as the constant factor and is equal to 1. This means that the stages of the changes are related to the changes of sectorial labour in the amount of 1%. This means that by changing the sectorial labour demand by 1%, the new stage of the changes begins, where the structure change of occupations is different.

The index “accumulated changes of labour demand” is calculated from the labour demand by sectors and labour demand by sectors in the base period. Accumulated changes of labour demand reflect the changes of labour demand from the beginning of forecasting in the base period. Labour demand and labour demand in the base period are defined in the sub-model of the sectorial labour demand.

The first element affecting the changes of occupational labour demand and occupational structure, i.e., the index “total changes of labour demand by occupations” divided changes of labour demand in accordance with the existing occupational structure. This index does not provide structural changes.

Structure of labour demand by occupations in the sector is calculated as the labour demand by occupations and sectors, divided by labour demand in the sector.

The second element affecting the changes of occupational labour demand and occupational structure, i.e., the index “changes of the major occupations of the labour demand”, for the major occupational groups (for those occupational groups, which ratio in the sector is larger than defined in the element “measure of importance of the occupations”) determines from the index “total changes of labour demand by occupations” the total changes of the groups of the major occupations by sectors. At the same time, other occupational groups (which do not meet the ‘significance” criteria) will not be changed.

The economic essence of the mathematical calculation of the index “the changes of the major occupations of the labour demand” is the following: it determines the changes of the sectorial labour demand only for major occupational groups.

In the index “the total ratio of the major occupations by sectors” are summed up by sector only those occupations whose ratio exceeds the criterion of the significance of the occupational group.

The criterion of the significance of the occupational group is taken as a constant index for all sectors and equals to 3%. This means that the occupations, whose ratio is more than 3%, should be considered as important or primary occupations. The choice of the index is based on Pareto principle and is reasoned by statistical data and analysis (see the table).

The table

Compliance of the significance of occupational groups (3-character level) to the criteria 3% by sectors in 2010 in Latvia

Sectors	Number of occupational groups	Total ratio in the sector
Agriculture, hunting and forestry (A)	8	75%
Fishing (B)	6	91%
Mining and quarrying (C)	10	90%
Manufacturing (D)	7	42%
Electricity, gas and water supply (E)	7	67%
Construction (F)	12	81%
Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods (G)	8	69%
Hotels and restaurants (H)	4	81%
Transport, storage and communication (I)	8	52%
Financial intermediation (J)	10	86%
Real estate, renting and business activities (K)	10	62%
Public administration and defence, compulsory social security (L)	10	70%
Education (M)	7	69%
Health and social care (N)	8	80%
Other utility, social and personal services (O)	7	55%

Despite the low level of the boundary of significance criterion, only a small number of groups of occupations does not confirm to it. But the same occupational groups are employing the highest number of employees in the sectors, which is indicated by the total ratio of the sector (see the table).

In the sub-model the element “labour demand by occupations” has reduced number of dimensions, summing up the labour demand in the occupations by sectors.

Calculation of the labour demand by occupations in the sub-model has a technical function; this index is not being used in the sub-model, but it have significant role for labour market analysis.

Model results

The model provides the forecasts of the following parameters:

- *labour demand* in terms of economic sectors (NACE 2), gender, skill groups (adapted according to the ISCO-08; 3-digit occupation code level; 127 occupational group units), levels (adapted according to the ISCED97; 8 units) and fields (adapted according to the ISCED97; 79 fields) of education;
- *population*, including the population long-term international migration, in terms of gender, 1-year age groups; 5-year age groups, gender, skill groups, levels and fields of education;
- *economically active population* in terms of gender, 5-year age groups, skill groups, levels and fields of education;
- *the number of employed population* in terms of 5-year age groups, skill groups, levels and fields of education and economic sectors;
- *the number of unemployed* in 5-year age groups, skills groups, levels of education and sectors of the economy;
- *the number of working places*, including free vacancies according to the requirements to gender, profession, level and field of education determined to employees.

The model evaluates the impact of the labour market policy changes on the labour market, including the changes of immigration policy, the number of study places, etc.

In the paper there are shown only significantly limited results of simulations: only common unemployed level and its changes after education and migration policy implementation, see Fig. 9. The policy implementation is based and related with occupational demand sub-model results by occupations; take into account labour supply in the state.

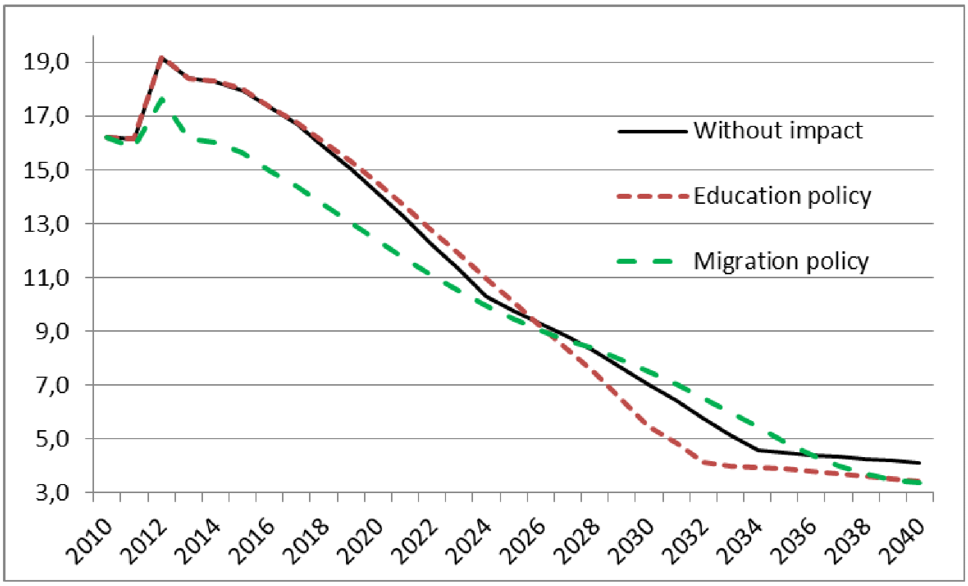

Fig. 9. **Unemployed level**

The simulations results show that the number of jobseekers and the unemployment rate are decreasing, taking into account the decline in the number of population and increase of the number of employed (due to the growth of GDP and increase of labour demand).

The results demonstrate that the education system optimization (according occupational demand) is acting over the medium term. This is related to the objective reasons: in order to prepare specialists with higher education, at least 4 years are necessary, additionally, the time is required from the formation of the shortage of occupations to the problem identification and opening of new study places, etc. Education policy allows reducing the number of employed and the unemployment rate prior to other affecting elements. However, the effectiveness of the state policy also reduces, when the unemployment rate reaches 2-3%.

In a sort run the migration policy forces a decline in the number of jobseekers. It shows that in the situation with high unemployment, labour force leaves a state, as a result unemployment decreases. The migration policy reduces the speed of decline in the number of jobseekers in a long-time run. This is related to the fact that migration increases the population. The migration policy options are also limited, when the unemployment rate is on 2-3% level.

Conclusions

This paper shows the second part of the Latvian labour market forecasting and policy analysis system dynamics model, occupational labour demand sub-model. Taking into account structure and size of the model, it is not possible to publish whole model in the conference. The author hope, that after some publication, with system dynamic society help, the research will be publish with one publication, as book or monograph. The author purpose of participation in the SD conference is to show model to the SD community and evaluate quality of the model at international scientific level. (Practically, the model is highly evaluated and will be used by government agencies in Latvia.)

The model development experience shows that with the help of the system dynamic method it is possible to develop the labour market forecasting and policy analysis model meeting the highest requirements. Taking into account the model forecasting parameters, as well as possibilities to evaluate the impact of the labour market policy, the developed model is a one of the most powerful models in the World.

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