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Logistical Processes Interaction Model Design in Agglomeration Development

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Abstract

Purpose of this study is to develop a logistics processes interaction model within the development of urban agglomeration, taking into account basic functional areas of logistics. Objectives of the study were to define the concept of "agglomeration logistics", to identify the main logistics processes of agglomeration, to calculate the logistics stability index (LSI) for the Almaty urban agglomeration

In this paper such research methods as text analysis, logic modeling, survey method of analysis of hierarchies were used.

The significance of the study lies in the development of a model explaining the nature of logistics processes interactions in Almaty urban agglomeration. The novelty of the research lies in adaptation and practical application of the methodology for assessing sustainability of urban agglomeration logistics and identifying most influencing factors in order to improve it.

The main results of the research are: formulating the concept of "agglomeration logistics", identifying interaction algorithms of the main agglomeration logistics processes and calculating the logistics stability index for Almaty agglomeration.

The following conclusions were made: there are problems of inefficient functioning of logistics processes within the agglomeration. Increasing number of road cargo and passengers has revealed the need to increase road transport network efficiency and carrying capacity; as a result of territorial structure, insufficient development of transport communications between the agglomerations 'districts, loads on the road transport network increased, which led to violations of fundamental logistics` rules such as "just in time", "optimal route", "high delivery speed", which increases the load on logistics processes and hinders its integration; main constraints to the sustainability of logistics in Almaty agglomeration are air pollution and poor road safety.

Keywords: urban agglomeration, logistics sustainability, logistical processes.

Introduction

Currently, the Republic of Kazakhstan has approved an interregional action plan for Almaty agglomeration in order to solve the socio-economic development problems, figure 1 (Appendix 1, Figure 1). In the current Almaty agglomeration development scheme the core is Almaty city which consists of the Esik town and 14 Enbekshikazakh rural districts, 6 Zhambyl rural districts, Otegen batyr and 8 rural countries in the Ili district, Kaskelen city and 10 Karasai rural districts, Talgar city and 10 rural districts, the Kapshagai city and 2 rural districts, administrative subordinates of the Kapshagai city and planned Gate City town. The population of the Almaty agglomeration in September 1, 2019 is 3,103. 6 thousand people, of which 1,884. 6 thousand people live in Almaty (Resolution of the government of the Republic of Kazakhstan,2020).

Formation and agglomeration development leads to the intensification of industrial, service, transport, social and cultural development ties between cities and leads to multi-component dynamic system formation of material, transport, information, and financial flows (figure 2). The model of logistics interaction processes (supply, distribution, loading, unloading and delivery) directly depends on the production process in Kazakhstan and the gross regional product (GRP). The share of GRP in Almaty agglomeration in 2019 amounted to 2. 79 trillion tenge.

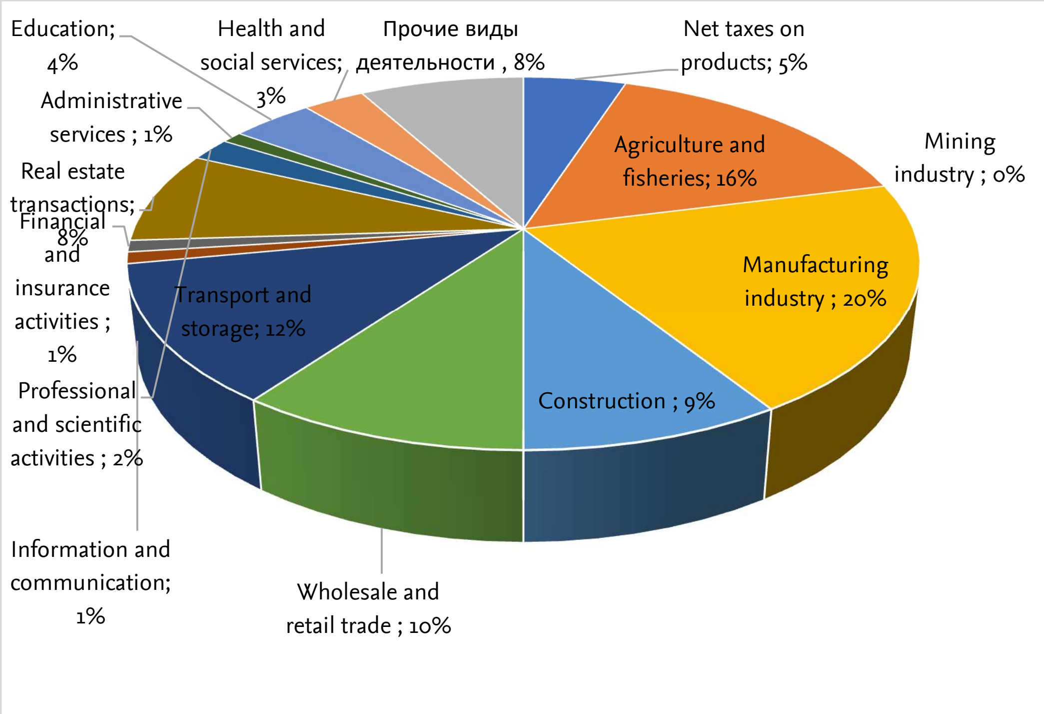

Figure 1. Average GRP share of Almaty agglomeration for 2014-2019 by economic sector. Reprinted from Statistical collection Transport, Nur-Sultan: Committee on statistics of MNE of RK, 2020

The total share of the GRP in the Almaty region was 4.52, which is the 7th place according to Figure 2.

Agriculture, forestry and fisheries well developed in the Almaty region. Almaty region ranks 5th in terms of manufacturing industry 20%, 7th place in terms of transport and storage volumes 12%, 4th place in terms of construction volume 9%. The region also shows results in the field of trade growth 45%. The main production is concentrated in the Ili, Karasai and Talgar regions.

The agglomeration formation carries a number of problems such as the lack of methodological approach to the agglomeration leads to such problems as an excessive burden on the logistics infrastructure, which negatively affects the environmental situation and economic indicators. A comparative analysis by questioning the respondents of Almaty agglomeration shows that there is a problem of inefficiency in logistics processes functioning, which leads to an increasing cost of transporting goods and passengers, an increase in losses of working time, a deterioration of environmental situation. The work forms the dependence of the GRP growth as the main indicator of the Almaty agglomeration development due to the contribution of agglomeration logistics as the basic regional economy service component.

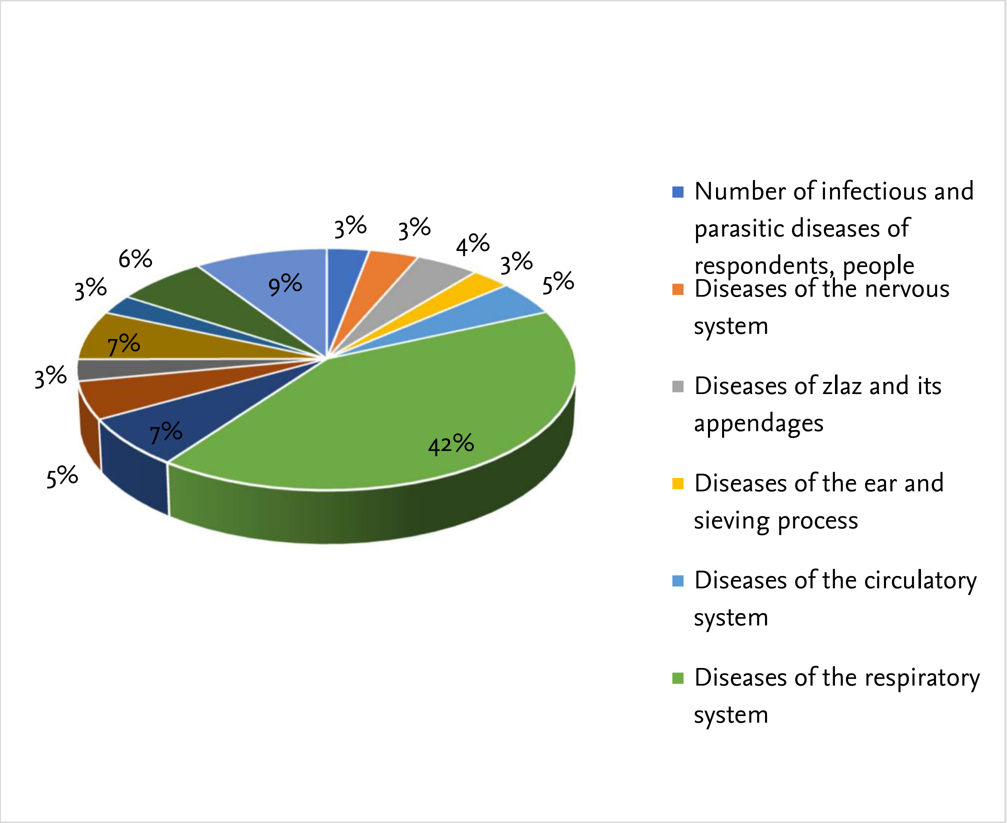

Figure 2. The structure of Almaty agglomeration population morbidity. Adapted from Health statistical collection of the Kazakhstan population and the activities of health organizations (Usser, 2019) and compiled by authors based on the source.

Literature review

According to the statistics in Figure 3, respiratory diseases of the population in Almaty agglomeration account for 41.8%, which indicates the level of air pollution and environmental problems.

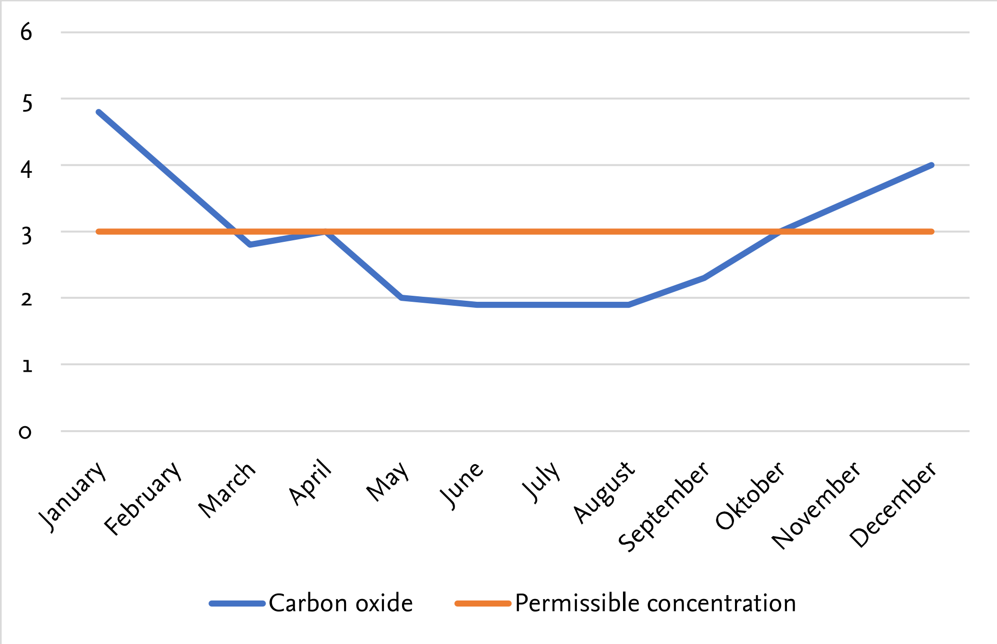

Figure 3. Average annual distribution of oxide concentration. Carbon in the Almaty agglomeration, mg / m3

Today, there are three indicators of air quality used in the Almaty agglomeration:

1) API – Total air pollution index.
2) SI – Standard index (maximum one-time impurity concentration divided by MPC).
3) NP in % (the highest frequency of exceeding the MPC) (Prokifyeva and Lopatkin, 2017).

Figure 4 shows the annual distribution of averaged carbon monoxide concentrations. The excess of MPC values occurs only during the heating season, their values reach 4,8 mg/m3 in January, 4,0 mg/m3 in December, with the maximum permissible no more than 3,0 mg/m3. The increase in concentration in winter is associated with the work of heat and utility companies, as well as a weak wind regime in winter. In the summer, more intensive mixing of air layers in the atmosphere occurs (Committee on statistics of the MNE of the Republic of Kazakhstan, 2020).

Therefore, its minimum falls on May, when the concentration reaches a level of 9 mg/m3 for 2019.

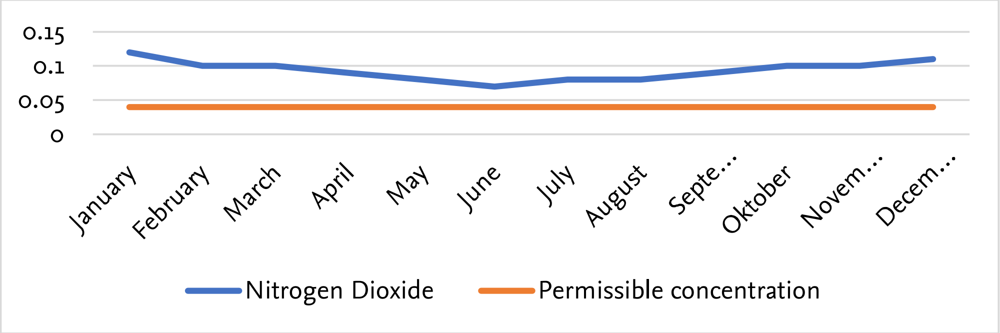

Figure 4. Average annual distribution of dioxide concentration nitrogen, mg/m3

Nitrogen oxides (NO_2) formed during combustion at high temperatures by oxidizing part of the nitrogen in the atmosphere. Nitrogen dioxide is the main source of tropospheric ozone and nitrate aerosols, which make up a significant part of the atmospheric air mass, Figure 5.

The main sources of NO_2 emissions are: internal combustion engines, industrial boilers, furnaces. Even at low concentrations nitrogen dioxide, breathing disorder, cough observed.

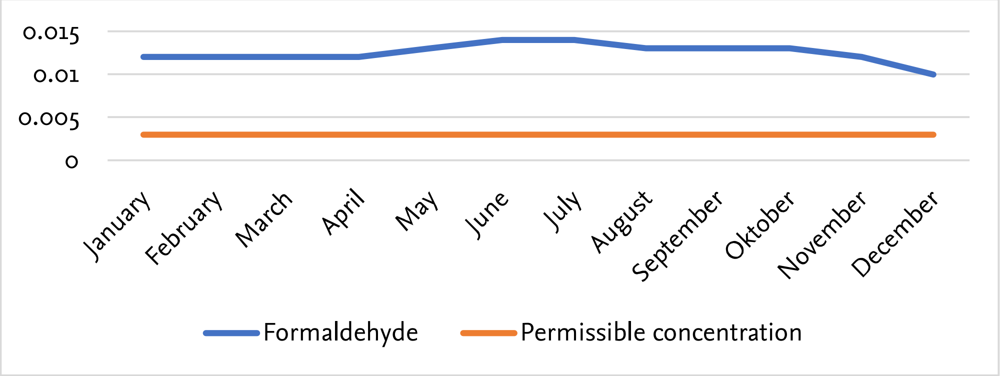

Figure 5. Average annual distribution of formaldehyde concentration, mg/m3

The formaldehyde distribution, as shown in Figure 6, is quite different from the above pollutants' distribution.

The excess of the MPC is visible throughout the year, reaching its maximum values in summer, where the values reach 4.7 MPC, for example, in June, July up to 0.014 mg / m^3. The minimum values fall on December, where the value is less and is 0.011 mg / m^3.

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In general, in Almaty agglomeration, the average annual concentration of nitrogen dioxide was 2.1 MPC, and formaldehyde - 1.3 MPC. Content of suspended solids - 1.2 MPC, sulfur dioxide - 1.12 MPC, the content of other pollutants did not exceed the maximum permissible concentrations. The maximum individual concentration of nitrogen dioxide was 5.0 MPC, suspended particles PM-2.5-3.9 MPC, suspended particles PM-10 - 3.2 MPC, carbon monoxide - 3.1 MPC, nitric oxide - 2.5. MPC, sulfur dioxide - 2.3 MPC, suspended solids - 1.8 MPC. MPC for phenols and formaldehyde not exceeded, the data indicate the deterioration of the environmental situation in the Almaty agglomeration

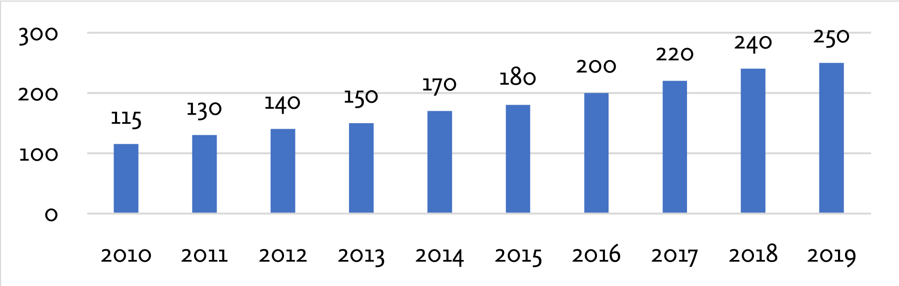

Figure 6. Transported cargo and luggage, cargo luggage by road in. Almaty agglomeration, million tons. Statistical collection transport (2020).

According to Figure 7, it is necessary to note an increase of transportation of cargo and cargo luggage volume in Almaty agglomeration. If in 2010 traffic volume amounted to 120 million tons, then in 2019 it was 250 million tons, there was a 2-fold increase + 130 million tons in 10 years, which indicates the development of road transport in Almaty agglomeration.

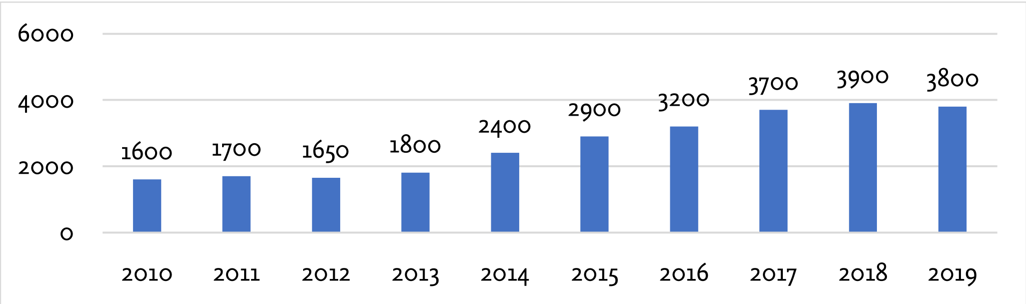

Figure 7. Passengers transported by road in the Almaty agglomeration, thousand people. Compiled by authors based on the Department of Statistics in Almaty city statistical collection, Almaty 2014-2019 (Statistical collection Transport, 2020)

According to Figure 8, it is necessary to note an increase in the number of passengers in Almaty agglomeration. If in 2010 the number of passengers was 1,500 thousand people, then in 2019 there were 3,700 thousand people, there was an increase of 2.5 times + 1,800 thousand people in 10 years, which indicates the development passenger traffic in Almaty agglomeration

Number of cargo transportation and passengers growth by Almaty agglomeration road transport reveals the need to increase the throughput and carrying road transport network capacity

It can be concluded, that consequence of the territorial structure, insufficient development of transport communications between the Almaty agglomeration regions, increased loads on the road transport network have become, which leads to logistics rules violation "just in the lines", "optimal route", "high delivery speed". This factor increases the burden on logistics processes and prevents its integration (Anikina, 2020).

Table 1. Analysis of the population mobility types and their Almaty agglomeration share

Cycle structure	Sequence of movement targets in closed loops	The specific weight of cycles, %	The specific weight of movements, %
linear	Home ↔ Work	36,6	33
	Home ↔ Cultural and household facilities	31,1	28
	Home ↔ Study	17,6	16,2
Triangular	Home ↔ Study ↔ Cultural and household facilities	6,4	8,6
	Home ↔ Cultural and household facilities ↔	2,6	3,8
	Home ↔ Study ↔ Cultural and household facilities	1,6	2,3

Quadrangular	Home ↔ Work ↔ Cultural and household facilities ↔ Home	2,6	4,8
Others		1,3	3,3

Note. Compiled by the authors based on their research.

The analysis of the population mobility types and their Almaty agglomeration share according to the data in Table 1 indicates the linear movement of 33% of the population "Home ↔Work", 28% "Home ↔ Cultural and household facilities" and 16.2% "Home ↔ Study" (Appendix 1 Figure 2).

The analysis of the total mobility distribution by purpose of travel in the Almaty agglomeration and the numerical values of Figure 9 indicate that 75% are citywide travel, and 65% are travel from home.

Table 2. Analysis of the main mobility travel purposes per inhabitant of Almaty agglomeration per day.

Purpose of travel	Mobility per inhabitant per day	Transport utilization rate
Labor	1,06	0,76
Educational	0,28	0,50
Household	0,83	0,48
Cultural	0,21	0,52
To resting places	0,45	0,53
Total for all goals	2,83	0,60

Note. Compiled by the authors based on their research.

Analysis of the main travel purposes and mobility per inhabitant of the Almaty agglomeration per day in Table 2 show the labor travel purposes with a transport utilization rate of 0.76.

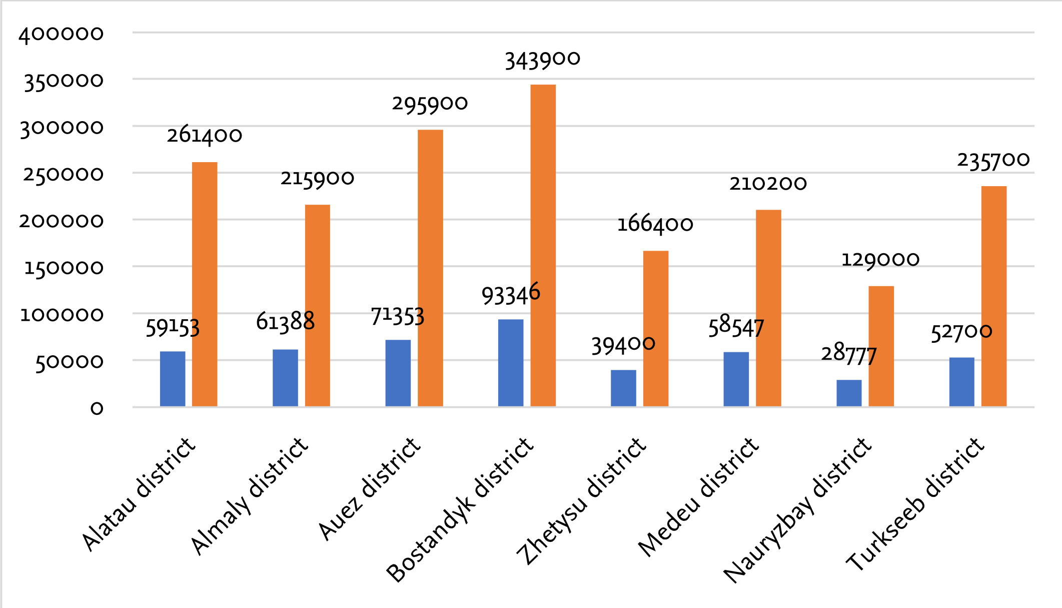

Figure 8. Number of jobs and population in Almaty for 2019.

Note. Compiled by the authors based on Statistical collection Transport (2020).

According to Figure 9, the total number of employees in Almaty was 464,664 people. This number of residents move in the direction of "Home-Work".

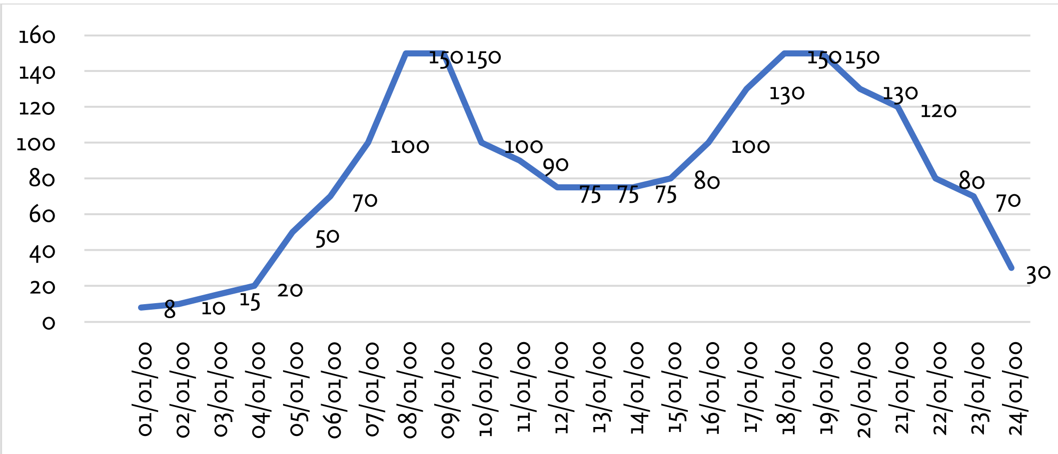

Figure 9. Change in traffic intensity during the day in the Almaty agglomeration

Note. Compiled by the authors based on Statistical collection Transport (2020).

According to the data of the motor transport movement time study, it is necessary to conclude that the main flow is concentrated from 6 am to 10 am, which indicates the movement of the population in the direction of "Home - Work" and "Home - Study" in relation to schoolchildren and students.

The next peak occurs in the time frame from 5 pm to 9 pm, which indicates the direction "Work - home", "Study - home"

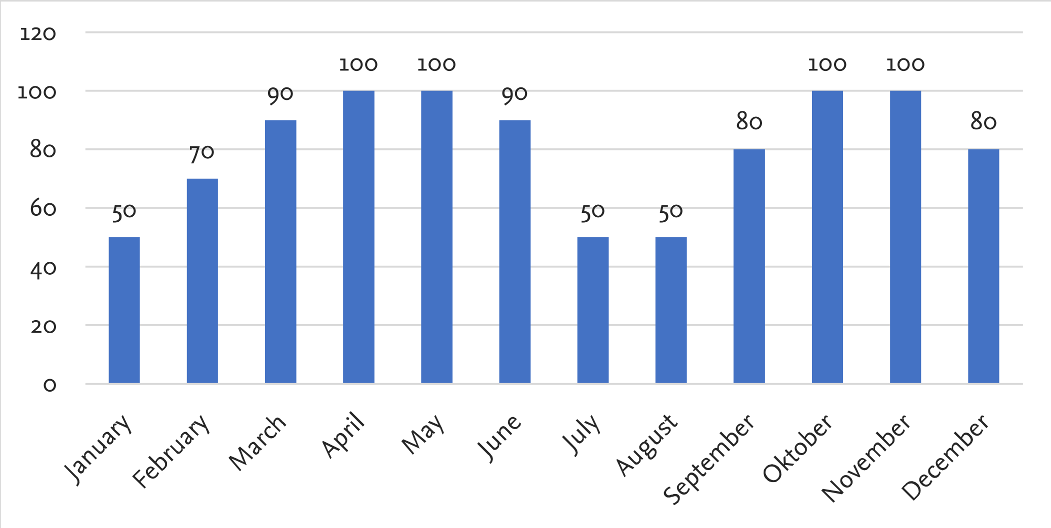

Figure 10. Change in traffic intensity throughout the year in the Almaty agglomeration

Note. Compiled by the authors based on Statistical collection Transport (2020).

According to the data of the road transport movement chronometric study in Figure 11 during the year, it is necessary to conclude that the main flow is concentrated in the months of March, April, May, June, September, October, November, December. The decline in traffic intensity in January, July, August testifies to the vacation period of the working population and the vacation period for students.

Based on the above data, a "Model of the logistics processes interaction in the agglomeration development " was compiled (Appendix 2, Figures 1,2,3) considering the types of logistics development, such as production, warehouse, information, environmental, lean, customs according to the domestic regional product development in Almaty agglomeration. Highlighted logistics processes such as transportation, storage, information services, customer service, production organization, customs clearance. The main goals of the logistics agglomeration are determined. When investigating the issue, the authors have developed a new definition as "logistics of agglomeration" - a complex of logistics solutions, actions, processes aimed at optimizing organizational solutions for the vehicles and material flow movement within the agglomeration subsystems (Burakov, 2009).

The authors have developed a "Model for making a decision on the logistics development in a specific agglomeration" based on the Almaty agglomeration development analysis (Appendix 2, Figures 1, 2, 3). To make a decision on the logistics services and processes quality, characterizing parameters in the Almaty agglomeration conditions, taking into account the road transport development intensity and the increase in the roads throughput and the transport infrastructure inconsistency, are criteria as "the right place", "the right time" and "emission reduction". This indicates the deterioration of the ecological situation in Almaty agglomeration. In conditions of the maximum intensity of automobile and urban transport movement organization, it is difficult to withstand the conditions for making the decision "the right place", "the right time" and "emission reduction". In this regard, the main evaluation criteria are set to parameters such as "speed of traffic", "quality of services in transport", "digitalization", "quality of roads", "delivery time", "optimal price of the service", "level of pollution", " traffic safety " (Burakov, 2008; Gadzhinsky, 1999).

The implementation of the tasks proposed in the framework of the Model for deciding on the logistics development in a particular agglomeration (Appendix 2, Figures 1, 2, 3) will allow to form an integrated agglomeration logistics, creating a basis for the further Almaty agglomeration development.

Methodology

Sustainable development in modern realities is one of the most urgent problems from natural and applied Sciences to fundamental ones. In logistics, there are several approaches to determining sustainability of logistics system, supply chain, company and its business processes that considered in the territorial aspect.

The method of indicative assessment of logistics sustainability LSI, developed in the framework of the SULPiTER project, involves a comparative assessment of criteria affecting logistics' integrated development in the study area. The calculation steps are shown in the figure 11 below (Dzhunusova and Zhameshova, 2019).

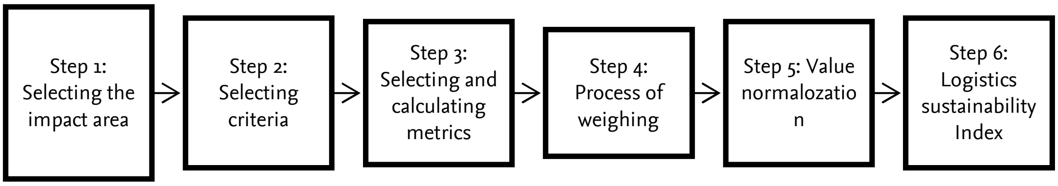

Figure 11. Stages of LSI calculation (D.T.1.2.1 SULPITER Software Tool Development For Understanding Fright Behaviors and Impacts in FUAS, 2018).

Step 1. The choice of the impact area. The first stage is the selection of the impact zone. There are seven areas of impact, and the user chooses for which the assessment will be performed. According to the LSI calculation method, the main areas affecting the sustainability of logistics development in a certain territory are: economy and energy; environment; transport; mobility and society; policy maturity; social recognition; user perception (Dzhunusova and Zhameshova, 2019).

The focus area for this study is the city of Almaty as the largest economic activity center in the Republic of Kazakhstan. The Almaty agglomeration, along with the agglomerations of Nur-Sultan and Shymkent, has a key strategic role in the formation of the Kazakh economy on the so-called hub principle according to a number of strategic program documents, such as the "national plan - 100 concrete steps to implement five institutional reforms" and The state program "Kazakhstan 2050".

Step 2. Criteria selection. The indicators are selected taking into account the areas of impact, from the point of view of stakeholders – business, the population and the state.

Step 3. Selection and calculation of indicators. Within the criteria given above, the following indicators were selected to assess the sustainability of logistics in Almaty:

Economy: the level of development of industrial production (in terms of production volume), the level of development of the small and medium – sized business - since these two sectors are the main consumers of transport and logistics services.

Environment: emissions volume of solid pollutants into the air, since this indicator is the main influencing factor of transport and logistics activities on the environment. In Kazakhstan, emissions of pollutants are recorded from stationary sources, i.e. from enterprises, while separate statistics on the impact of transport on the environment are not kept.

Transport. This group of criteria is reflected in two main indicators – transport productivity (cargo turnover) and road safety (number of road accidents per year).

The maturity of the policy. This criterion is cut off in the indicator "investment in fixed assets" (direct investment).

Step 4. Weighing prosses. Weighting, according to the LSI calculation method, is the process of comparing two or more elements according to the preferences of the decision maker. There are several weighing methods, but they all follow the same standard principle: the higher the weight, the more important the corresponding element (D.T.1.2.1 SULPITER Software Tool Development For Understanding Fright Behaviors and Impacts in FUAS, 2018). In the framework of the SULPiTER project, Analytical Hierarchy Process (AHP) method of for criteria evaluation is used to calculate the logistics sustainability index.

AHP is considered the most widely used multi-criteria analysis method in the field of transport and urban logistics. The main strengths of the AHP method are: it can be used in a very wide range of applications; it is easy to understand; flexibility and ease of use; the interdependence of various criteria; it can be used for both monetary and non-monetary scales (D.T.1.2.1 SULPITER Software Tool Development For Understanding Fright Behaviors and Impacts in FUAS, 2018).

According to this method by Saati (2016), a subjective comparative assessment of the priority of the criteria for sustainable logistics development relative to each other is made, followed by measuring the specific impact weight on the final index of each of the criteria.

The process of determining the specific weight of each criterion for calculating the final rating is carried out by collecting public (expert) opinions of respondents from various groups: legal entities engaged in logistics activities in the study area – representatives of the logistics business; public administration entities in this territory; the population of the study area.

The focus group consisted of 224 respondents from the category of logistics business sector and local population of Almaty. The age structure of respondents is shown in the graph below (Figure 12).

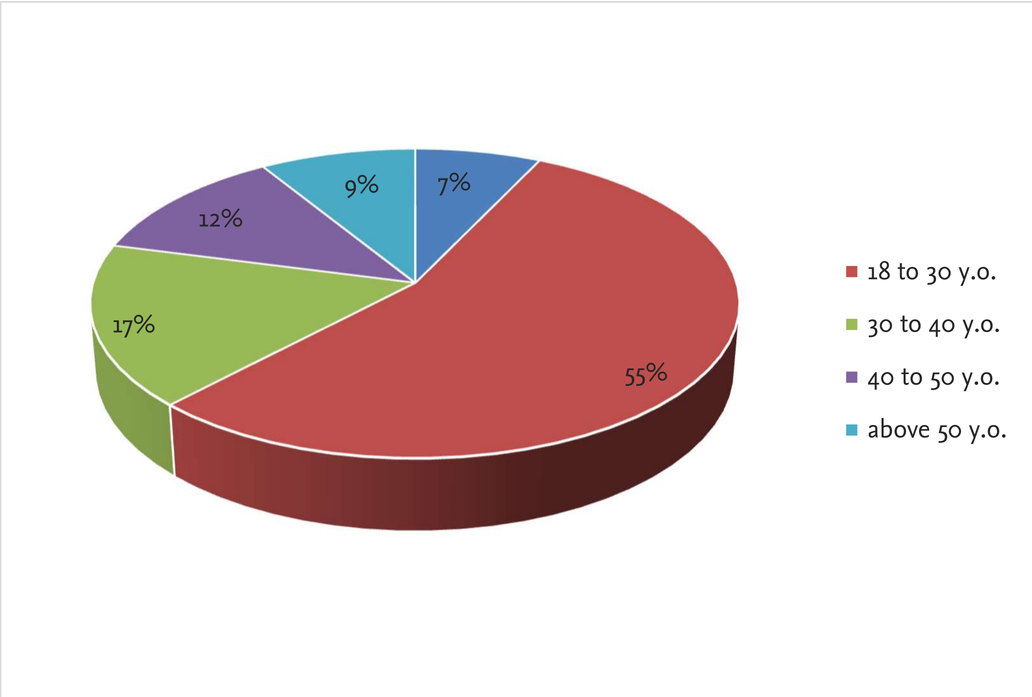

Figure 12. Focus group structure (224 responses).

The survey was conducted online. It is noteworthy that more than half of the respondents are between 18 and 30 years old. The smallest number of respondents is people over 50 years of age. This is probably due to the high economic and social activity of people aged 18-30: employment, ability to use electronic and technical resources, which contributed to the success of the survey online. And, on the contrary, significantly lower economic, social and informational involvement of the category of people over 50 years of age. The contingent of respondents was 54% of the respondents from the number of middle and senior managers of companies engaged in logistics activities on the territory of Almaty and 46% of the city's population who are not employed in the field of transport and logistics (Figure 13).

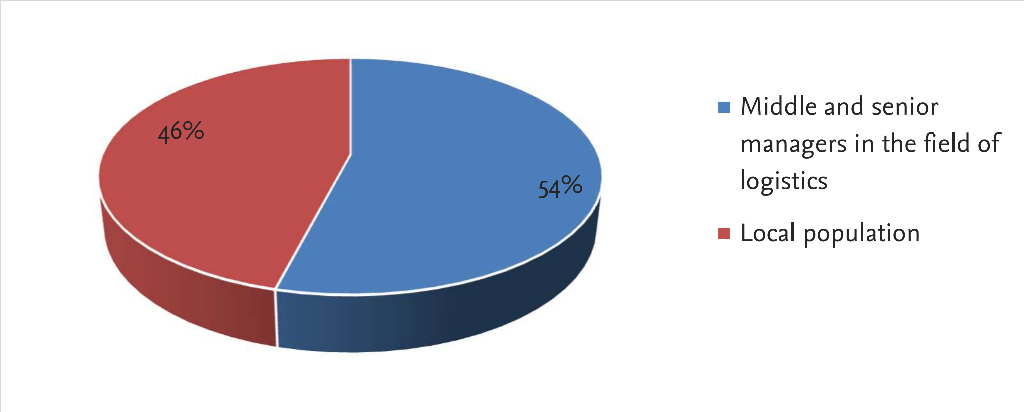

Figure 13. Structure of respondents.

This figure illustrates respondents` occupation structure. The territorial distribution of respondents across the city's administrative territories is shown in Figure 14.

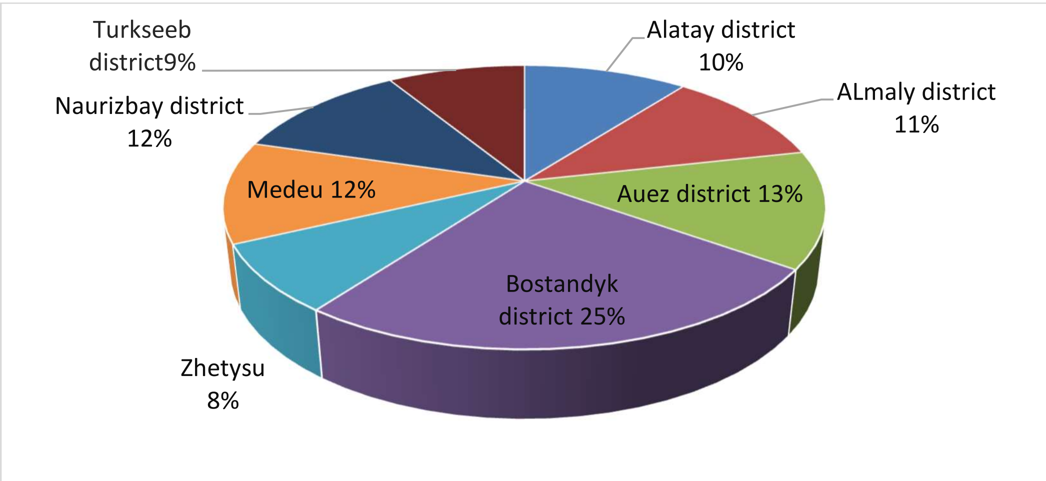

Figure 14. Respondents distribution by area of residence.

The figure illustrates respondents' structure by urban districts. The respondents were asked to subjectively determine the priority in each pair of criteria on a scale from 1 to 10, where the closer to the left or right criteria in each pair the Respondent makes a mark, the more important this criterion is for the development of the city. The average response "5" is intermediate, indicating that both criteria are equally important (Figure 14).

The questionnaire included scales for assessing the priority of the criteria "industrial production" and "air purity".

Possible scores ranged from 1 to 10. If element 1 is less important than element 2, the corresponding inverse value is assigned (for example, 1/5).

The user fills in A matrix A (n x n), called a “comparison” or “inverse matrix”, where n is the number of elements to compare. The cells below the unitary diagonal cells are filled with the input values of the user's rating, while the rest below are equal to the inverse value of the input value (Dzhunusova and Zhameshova, 2019).

An example is the following matrix A (3x3) (Formula 1).

$$A = \begin{matrix} 1 & a_{12} & a_{13} \\ a_{21} & 1 & a_{23} \\ a_{31} & a_{32} & 1 \end{matrix}$$

Figure 15. The principle of constructing the criteria evaluation matrix when calculating LSI (Dzhunusova and Zhameshova, 2019).

Findings and Discussion

A matrix of the specific weight of criteria was formed according to the respondents' assessment (Table 3). The comparison is made in pairs with determining the priority of one criterion over another. It is noteworthy that the "air pollution" criterion has a clear advantage, which reflects the respondents ' concern about the impact of the environmental situation in the city on its sustainable development, including from the point of view of logistics. Fluctuations in the priority of other criteria are not so pronounced. Most respondents gave a neutral assessment of the priority between such criteria as the development of industrial production, investment volumes, the level of SMEs development, and the frequency of road accidents when they are trampled on.

Table 3. Matrix of evaluation criteria for calculating the LSI of Almaty.

Criteria:	Development of industrial production	Direct investment	The development of SMEs	The frequency of road accidents	Air pollution
Development of industrial production	1,00	5,00	5,00	5,0	10,0
Direct investment	0,20	1,00	5,00	5,00	5,00
The development of SMEs	0,20	0,20	1,00	5,00	5,00
The frequency of road accidents	0,20	0,20	0,20	1,00	5,00
Air pollution	0,10	0,20	0,20	0,20	1,00
Sum	1,70	6,60	11,40	16,20	26,00

Step 5. Normalization of values. The use of criteria of different properties and expressed in different measurement units in the General assessment methodology requires the establishment of a comparable scale, which makes it possible to compare the criteria values. For this purpose, the so-called normalization of each criterion (and its numerical indicator) is performed. Data normalization consists of scaling data values to a single specified range, such as 0 to 1 or 0 to 100.

There are several different ways to normalize criteria value. The methodology used for calculating LSI uses normalization compared to the best alternative: all indicator values are divided by the priority of each criterion divided by the value sum of this criterion compared to the rest. (table 4).

Table 4. Criteria Value Normalization

	Development of industrial production	Direct investment	The development of SMEs	The frequency of road accidents	Air pollution
Development of industrial production	0,59	0,76	0,44	0,31	0,38
Direct investment	0,12	0,15	0,44	0,31	0,19
The development of SMEs	0,12	0,03	0,09	0,31	0,19
The frequency of road accidents	0,12	0,03	0,02	0,06	0,19
Air pollution	0,06	0,03	0,02	0,01	0,04
Sum	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**

Impacts are converted to uniform values using different methodologies depending on the specific impact. All values are then normalized, multiplied by their value weight, and the final index is estimated for each impact area, shown in tables 3 and 4.

Table 5. Normalized priority vector.

Criteria:	Normalized priority vector
Development of industrial production	0,50
Direct investment	0,24
The development of SMEs	0,15
The frequency of road accidents	0,08
Air pollution	0,03
Sum:	1,00

Table 6. Normalized priority vector results.

Criteria:	NPV	Sum	Result
Development of industrial production	0,50	1,70	0,84
Direct investment	0,24	6,60	1,60
The development of SMEs	0,15	11,40	1,68

The frequency of road accidents	0,08	16,20	1,36
Air pollution	0,03	26,00	0,82
λmax			6,30

Step 6. Sustainability index of logistics.

The criteria used to assess the sustainability of logistics in Almaty can be divided into 2 categories: indicators whose growth is a positive dynamic for sustainable development, such as development of industrial production, volume of direct investment and the development of small and medium-sized businesses; indicators whose growth has a negative value for sustainable development: the road accidents frequency per year, the level of air pollution.

Table 7 shows the values of these indicators in 2015 and 2019 and their impact on the final logistics sustainability index.

Table 7. The quantitative values of evaluation criteria LSI.

	Measure unit	2015	2019	Signification (+/-)
Industrial production development	millions of tenge	662 981	957 131	+
Direct investment	millions of tenge	533 370	820 449	+
SMEs development	tens of millions of tenge	366 587	833 373	+
Road accidents frequency	number	5552	4489	-
Air pollution	thousand tons	5900	7900	-

To assess the dynamics of LSI changes, the criteria were evaluated for 2015 and 2019 shown in tables 7 and 8

Table 8. Calculation of the LSI of Almaty in 2015.

	2015			
Criterion	Criterion Value	Specific weight	Significati on (+/-)	In the LSI structure
Industrial production development	1,00	0,50	+	0,495532981
Direct investment	0,80	0,24	+	0,194481828
SMEs development	0,55	0,15	+	0,081460914
Road accidents frequency	0,01	0,08	-	-0,000702654
Air pollution	0,01	0,03	-	-0,000280285
LSI				77%

Table 9. Calculating LSI of Almaty by indicators of 2019.

	2019			
Criterion	Criterion Value	Specific weight	Significati on (+/-)	LSI
Industrial production development	1,00	0,50	+	0,495532981
Direct investment	0,86	0,24	+	0,20722003
SMEs development	0,87	0,15	+	0,12827474
Road accidents frequency	0,00	0,08	-	-0,000393524
Air pollution	0,01	0,03	-	-0,000259959
LSI:				83%

As can be seen from tables 5 and 6, the LSI indicator in 2015 is 77, in 2019 this index is 83. Therefore, the logistics sustainability index in Almaty has a positive trend with an increase of 6%.

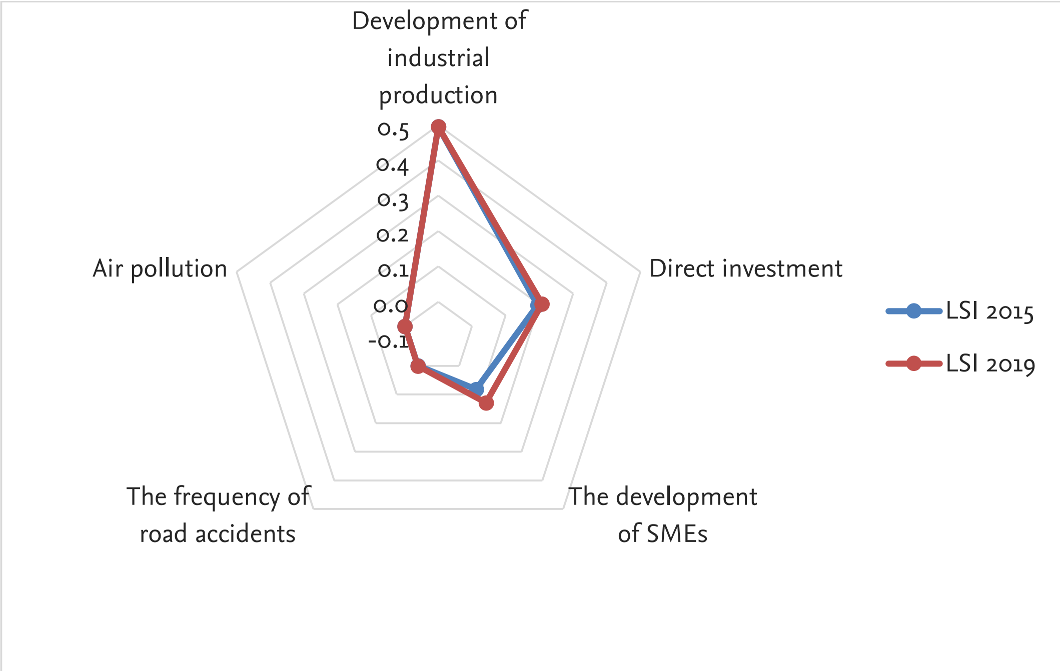

Figure 16. Comparison of Almaty LSI indices for 2015 and 2019.

The figure illustrates LSI development between years 2015 and 2019. As can be seen from figure 17, the increase is due to positive dynamics of changes in the criteria for direct investment and SMEs` development. According to The statistics Committee of the Republic of Kazakhstan, direct investment growth rate for the period from 2015 to 2019 was 53.82%; The growth rate of SMB output from 2015 to 2019 was 127.33%.

According to the graph, the areas to be further developed urban logistics sustainability indicator integrated development in Almaty are improving the environmental situation, in particular, air quality and improving road safety.

The main purpose of applying the Sulpiter concept is to create an information product aimed at providing support management decision making when choosing a transportation option for a certain territory (D.T.1.2.1 SULPITER Software Tool Development For Understanding Fright Behaviors and Impacts in FUAS, 2018). Therefore, it is a decision support tool that can be used to assess impact of a particular decision (project) on the city's` sustainable development. If the forecast results of management decision making show an increase of logistics sustainability index, the project should be adopted; if this index decreases according to the project's forecast, the project negatively affects the territory`s sustainable development and is subject to rejection.

Conclusion

Designing an integrated model of logistics processes integration in scope of urban agglomeration logistics systems is a source of increasing urban agglomeration logistics sustainability and efficiency.

The interaction of logistics processes, such as delivery, distribution, loading, unloading and delivery to consumers, in urban agglomeration is directly dependent on the development of production.

Sustainable development in modern realities is one of the most urgent problems of a number of branches of scientific knowledge: from natural and applied Sciences to fundamental ones. In logistics, there are several approaches to determining sustainability. The most common approaches are to determine the sustainability of logistics in terms of the logistics system, supply chain, company and its business processes. In this paper, the sustainability of logistics is considered in the territorial aspect.

Development of urban agglomeration and main socio-economic processes in it is linked with development of such areas as production, business, transport and transport infrastructure, investment, and road safety. These factors have different effects on the sustainability of agglomeration logistics. Based on the results of applying the LSI calculation method, it was determined that the factors of increasing logistics stability for Almaty agglomeration are increasing volumes of direct investment and the development of SMEs. Air quality and the frequency of road accidents are limiting factors.

Further research based on the results obtained can be aimed at improving the stability of agglomeration logistics by influencing negative factors. Also, this technique can be applied to other agglomerations to assess their logistics sustainability, taking into account specific factors.

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