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Prospective Clustering Models of Small-Town Systems into Small Agglomerations

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Abstract. In the context of self-isolation and restrictions of vehicles' mobility, a widespread trend on economic digitalization primarily manifested itself in a transition to remote working and learning regimes. Crisis conditions cause a threat to the development of agglomerations of small towns, which appeared thanks to the diurnal commuting migration of the workforce to the economic centers of such agglomerations. In this respect, the article provides an overview of systemic factors of inclusion of small towns' human resources aimed at mitigating the risk of a mass exodus of young people from such towns and their consequential depopulation in countries and regions subject to this risk. Taking into account a ubiquitous increase in the level of computer literacy among young people, it is feasible to actively develop online learning in many demanded professions and include them in production processes in a remote regime. To do this, production processes should be organized on the principle of technology clusters distributed in small agglomerations of towns tied to a large production center while commuting migration of workforce should be replaced with freight services provided to the local branches of a large production enterprise. This approach is supposed to develop a new type of agglomerations where people can live and work in the same small towns while the interconnection between these towns is carried out through the migration of goods tied to one basic enterprise in the middle of such an agglomeration. The size of such an agglomeration can exceed the former types of urban entities because freight vehicles are not as limited by strict time frameworks as workforce transportation to the workplaces.

Keywords: Agglomeration of small towns, diurnal commuting migration, remote working regime, depopulation threat.

1 Introduction

Contemporary problems of small Russian monotowns that lost their town-forming function require comprehensive and prompt decisions. Many of these monotowns are characterized by a difficult socio-economic situation. There are numerous studies on managing the diversification of monotowns' economy, establishing the cooperation between the government and private

sector, and organizing the retraining of the unemployed of working age. At the end of 2019, the study by Makagonov et al. [4] showed the opportunities for improving the situation with the help of self-organization of monotowns' population in the Sverdlovsk and Chelyabinsk regions. This self-organization constitutes diurnal labor migration to large and/or more economically stable cities.

Self-organization of the population is mainly manifested in the form of diurnal labor migration to cities with more job opportunities. In the majority of cases, these are the nearest larger cities with more preferable economic conditions. This is the initial reason for agglomeration processes in regions with a large number of small monotowns. Self-organization is sometimes manifested in initiatives to establish small and micro-businesses that are not related to the town-forming enterprise that has lost its significance. In Russia, however, such initiatives are generally underpinned by federal or regional support programs. In case these programs are overdue, a major impact is exerted by negative factors that hinder the development of businesses in small towns.

The first factor is a lack of traditions in the organization of small business in monotowns, which were based on public employment. For example, Dmitrieva [6] considers the insufficient entrepreneurial activity of the population to be the most important factor that hinders the development of small businesses in monotowns. This inactivity is underpinned by the influence of generations associating themselves with employment in a town-forming enterprise. Another important factor that is characteristic of monotowns' population is a lack of resources to undertake new industrial activities.

The 2020 pandemic limited the opportunities for migration processes. The example of Russia demonstrated the vulnerability of diurnal migration to large industrial centers as a crisis response. Under these circumstances, the opportunities for the monotowns' population to use self-organization for commuting migration are restricted. Taking into account the fact that migrants from small towns normally fill vacancies requiring secondary professional education, job opportunities for remote workplaces are significantly limited.

Opportunities for certain self-organization and initiative in small towns can appear thanks to the Internet. It is known that in small towns the Internet is primarily used for communicating: the percentage of social media users grows in proportion to a decrease in the city size. The number of social contacts increases without reference to geography and is primarily associated with areas of interest.

An increase in the online activity of the population of small towns and monotowns in Russia can be used for the self-organization of community at the level of local Internet forums, the development of crowdsourcing, and the establishment of cooperation with the local administration at the level of creating local e-government aimed at formulating a strategy for resolving the monotown's crisis.

To implement the aforementioned options, it is necessary to develop a set of ideas that is based on the existing Russian and international experience. The Russian experience is mainly associated with small monotowns with a stable socio-economic situation. Guseva and Amelkina (2016) [7] claim that "innovative development is possible for cities having a network of research institutes, laboratories, higher education institutes, and modern production, that is, for towns with a relatively high innovative potential. This potential allows them to create innovative clusters of fundamentally new high-tech industries.

Small innovative companies play a key role in the development and approbation of innovative technologies, the creation of new products, and the organization of import-substituting production. Their development is largely informed by business incubators, industrial parks, reengineering centers, and other infrastructural objects of public support which should be established in a monotown."

It is known that urban agglomerations and innovative clusters primarily appear based on cities the economic activities of which create a common manufacturing chain.

However, from the technical perspective, this chain can be based on the freight traffic between cities forming a spatial cluster in which manufacturers use raw materials or semi-finished products coming from the neighboring cities.

In the frame of such clusters, it is possible to produce the final product (e.g., high value-added metallurgical products).

The article by Makagonov et al. (2016) [3] discusses the opportunity for realizing the scientific potential of monotowns, the specialization of which stems from the location of knowledge-based enterprises as well as the organization of such monotowns. The question of resolving the crises of monotowns remains open. This refers to monotowns with a difficult socio-economic situation as well as monotowns having risks of deterioration of the socio-economic situation. Let us, therefore, address the experience in solving the problems of poverty, unemployment, and migration in regions with crisis-stricken small towns.

2 Some of the Existing Approaches to the Solution of Problems of Poverty, Unemployment, and Population Migration

It is important to get acquainted with the existing approaches to the solution of problems of poverty, unemployment, and population migration. A situation similar to that described above took place in the 1990s in southern Mexico in the state of Oaxaca. A low level of education of the local population accompanied by unemployment caused mass emigration. For example, more than 440 thousand people moved from the region of Mixteca (the northwestern part of Oaxaca) to the USA while the total population size of the region amounted to approximately 550 thousand people.

In their research, Makagonov et al. [3] emphasized the consequences of the implementation of the federal program of organization of a system of public universities (SUNEO) in small towns in the Mexican state of Oaxaca (Vazquez [1, 2]). This state was characterized by insufficient industrial development rates, a low literacy level of small towns' population, and high protest activity. It was a little lower than in the neighboring state of Chiapas gripped by guerilla movement and numerous nonviolent political acts with the use of new media technologies.

Out of 16 public universities opened during 30 years of program operation, the majority of universities were found in small towns with a population size of fewer than 50 thousand people. Some of these universities were opened within the last 5-10 years and the development achievements of towns underpinned by the newly opened universities only start to emerge. Several SUNEO university towns are located on the Pacific coast while some of their campuses are situated in industrialized towns.

This is why the development achievements triggered by the establishment of universities should be distinguished from the overall development progress. For that reason, we consider only two towns where the consequences of the establishment of public universities can be examined directly without taking into account the impact of other regional factors. These are the town of Huajuapan de León with Technological University of Mixteca (UTN) established in 1990 and the town of Miahuatlán with University of the South Sierra (UNSIS) established in 2000.

The main indicator of development achievements in a small town in the state of Oaxaca is population dynamics because the majority of small towns lose a large part of their population because of migration to the USA and large Mexican cities including three cities in Oaxaca: Oaxaca City, the capital of the state, Tuxtepec, a center of sugar and paper production, and Salina Cruz, a seaport. The table below shows the data on population dynamics in university towns. The table includes data on the first two towns where SUNEO universities were opened and the third town, which is selected for the analysis.

Three major Oaxaca cities have large industrial parks. However, the authors of the research are aware of the fact that the industrial park in the town of Huajuapan de León (with Technological University of Mixteca) was opened in 2006. It is called KadaSoftware[1]. While the population size in the majority of small towns in Oaxaca remains stable during the last 30 years, the size of the population in the towns mentioned in the table

[1] http://kadasoftware.com/

Town and university name	University foundation year	Population size by year					
		1990	1995	2000	2005	2010	2015
Huajuapan de León, UTM	1990	39488	47827	53219	5 808	69839	77547
Puerto Ángel, UNMAR	1991	25701	30911	36982	38798	43860	47476
Miahuatlán de Porfirio Díaz, UNSIS	2000	27448	28918	32555	32185	41387	42312

increased 1.96, 1.85, and 1.54 times respectively. In the latter case, the university was opened 10 years later, so the population growth turned out to be a little bit weaker.

In other small towns with the largest population (with the population size from 44 to 22 thousand people), the growth indicator lies within the limits from 0.98 to 1.2.

Small towns with a population size of fewer than 10 thousand people are characterized by a population decrease.

Let us enumerate the key economic consequences of universities' presence in the aforementioned towns. Misael Ramirez Juárez [9], a bachelor at UNSIS, showed that an increase in the urban area of Miahuatlán constituted only 9.9% for the period from 1990 to 2000. However, for the period from 2000 to 2005 when the town became a part of the SUNEO system, an increase in the urban area of Miahuatlán almost tripled in comparison to the previous decade. It remained stably high during the next seven years from 2005 to 2012 (plus 70 ha or 17.6%).

This increase in the urban area is underpinned by the arrival of students, teachers, and managers as well as their families. This resulted in a significant increase in demand for rental housing, revitalization of the local cultural life, an increase in service needs including financial operations, Internet service, and other consequences. Such stores as, for example, Bodega Aurrera, Elektra, and Coppel were opened in the town during that period and their appearance generated new job opportunities. University departments associated with medicine, social studies, and management training contributed to the appearance of the Federal Center for Social Reintegration in 2012 - 2017.

The municipal administration experienced difficulties with an increased amount of solid waste in landfills, increased demand for drinking water, and changes in land use because a significant part of agricultural land turned into residential areas.

However, municipal administration training at UNSIS helps to overcome the aforementioned difficulties in the university town. Zepeda García [8] provided an overview of the article about public universities in several Brazilian towns written by Hoff et al. [10]. Overall, apart from their primary town-forming mission of "education," universities contribute to the development of university towns in several ways:

1. Job generation and rental of premises;
2. Changes in the local infrastructure;
3. Changes in the total demand;
4. Revitalization and enrichment of the cultural environment;
5. Empowerment of the business environment;
6. Stimulation of both local and regional economy.

It is also fair to mention the international division of labor (transportation of semi-final products to countries with cheap labor force) and the post-war experience of the Japanese industrial sector with the diurnal delivery of semi-final products to villages for manual processing or assembling and the return of finished products to towns with the same low-tonnage cargo vehicles. One should not think that this model could be applied only to attract low-skilled labor force to the local production workshops or manufacturing sites.

Apart from participating in the production cycle of a principal enterprise through the division of labor, it is also possible to launch the production of small-batch goods that do not fit large-scale manufacturers (e.g., goods for left-handers the

output and priority of which are too low for large producers). It is also necessary to bear in mind the experience of generating computerized workplaces with an opportunity to work in distributed network production.

Finally, permanent facilities and pre-retirement staff of scientific divisions, as well as research and development units, can be converted into industrial parks (with the financial and technical assistance on the part of government bodies of the middle management level). These parks would take into account the grade of qualification of the local population including the part of the economically active population that has already begun working in their native small town in the frame of a principal enterprise located in the neighboring large city. Even if the proposed measures seem to have only a short-term positive impact, their effectiveness is supported by the fact that they set up a tangible (perceived) tendency to create small urban agglomerations.

3 The Relevance of the Problem in Russia and Mexico

Some elements of the aforementioned strategy can be applied to solving the problem of survival of small and medium-sized monofunctional towns in Russia. In the majority of cases, the main option for economic diversification in monotowns is support and development programs aimed at local small and medium-sized businesses. The overwhelming number of these programs is short-term while industrial parks and clusters can continuously support the initial efforts of entrepreneurs.

In the context of forced restrictions of people's mobility within a specific region during the pandemic or other crisis periods, it is feasible to consider opportunities for the transition from spontaneous migration to controlled localization of small monotowns' population in small industrial parks. This transition will allow replacing diurnal labor commuting migration flows with low-tonnage freight traffic carrying semi-final and finished products after their processing in workshops located in small towns.

These workshops and storage premises can be deployed based on abandoned permanent industrial facilities with a minimal renovation. An outline of a roadmap to overcome the crisis of monotowns with a difficult socio-economic situation can be made based on the foregoing discussion.

The main goal here is not to struggle against unemployment because this is a short-term task but rather to restore the innovative potential of towns. To reach this goal, it is necessary to create conditions for professional retraining and advanced professional training, open advisory centers for the support of initiatives and centers for promoting vacancies in the emerging small business enterprises integrated into industrial parks and clusters as well as associations of small producers. This work should be done by a team composed of the town administration, invited representatives of enterprises located in the neighboring large and medium-sized cities with a stable socio-economic situation, and the key young activists of the local Internet forums.

What can bring positive changes is a joint discussion of opportunities associated with monotowns and their production potential with the support of regional and federal authorities. These are opportunities for using the abandoned permanent facilities, opening branches of major production enterprises located in the neighboring large cities, and developing and utilizing the human capital of monotowns on the principles of mutual acceptance and benefit as well as in the proper legal, financial, and production frameworks.

These activities should not be initiated through a unilateral decision at the administration level. If this is the case, a new agglomeration will be created by order. Consequently, this will be an agglomeration in nothing but name because in practice each town belonging to such an agglomeration lives and develops independently.

3.1 Discussion Questions at the Level of Internet Forums

At the level of self-organization of small towns' population, it is possible to create online forums, civil society websites, and e-government. It is possible to organize a discussion of problems at the level of Internet forums and e-government of a monotown or a group of neighboring monotowns including the management of the interested production enterprises located in the neighboring

large cities. Internet forums provide opportunities for:

- Defining the largest population group in a monotown, the representatives of which have jobs requiring at least a middle level of professional qualification in one of the neighboring large cities on the basis of commuting migration (either diurnal or weekly);
- Assessing an opportunity for using abandoned permanent industrial facilities in monotowns for opening new workshops with a minimal renovation to locate a cluster of small enterprises vacancies in which will be filled by the economically active population;
- Evaluating (together with the management team of the enterprise that employs the monotown's population on the basis of commuting migration) the economic feasibility of the transition of a part of work requiring a vast amount of manual labor of specialists with a middle level of qualification under the condition of small amounts of raw materials, semi-finished, and finished products that need to be transported (with a possibility to store them locally);
- Settling the issue of wages and tax liabilities of people living and working in a monotown in a proper legal framework with their tax payments being contributed to the monotown's budget.

The question of remote production workshops can be addressed in an individual manner.

3.2 Opportunities Associated with Digital Transformation

There is evidence to presume that the growing popularity of ideas about the digital transformation of education (especially taking into account the situation in spring of 2020) contributes to the transition to distance online learning that resolves the problem of permanent operation of higher education institutes in small monotowns. Due to the rapid development of online institutes and colleges with the participation of large Russian universities, people living in monotowns get access to their education programs. However, if the town-forming function of a monotown includes or has recently included a scientific component, then the use of the human capacity of highly skilled professionals can contribute to the creation of industrial parks and clusters of small enterprises which positively impact the development of small businesses in several ways:

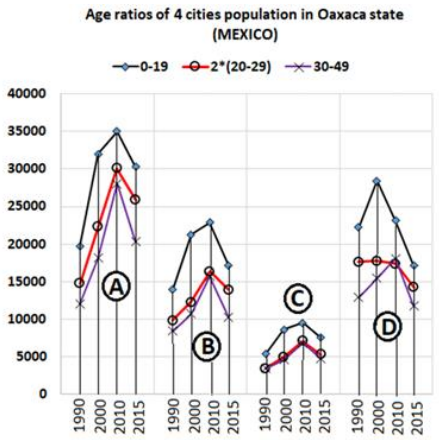

Fig. 1. Three age groups of the population living in four cities in the state of Oaxaca

- Distance learning of students in a university situated outside their hometown does not generate additional income for the town but allows students' families to save money and prevents the transfer of funds from the hometown to the places of study. In other words, many services are cheaper when students live with their families;
- Money saved by families during the entire learning period does not cause the effect of lost profit. Together with this, the involvement of the local youth in the learning process reduces the demand for jobs while the appearance of a higher education institute generates new job opportunities.

Figure 1 demonstrates the yearly distribution of three age groups of the population living in four cities in the state of Oaxaca:

- A group of curves 0-19 corresponds to the number of individuals living in each city under and including the age of 19.
- A group of curves 2*(20-29) corresponds to the doubled number of individuals living in each city aged from 20 to 29 years.

– The third group of curves corresponds to another 20-year period of life of the economically active part of the population (aged from 30 through 49 years).

To make the comparison of population sizes of different age groups more convenient, the second age group (corresponding to a 10-year period, which is twice as short as two other periods) was doubled. All curves decrease in the period from 2010 to 2015. Let us emphasize the differences between them in these and other years in cities depending on the relation to the SUNEO program.

– The group of curves A corresponds to the population distribution in Heroica Ciudad de Huajuapan de León. In the frame of the federal SUNEO program, a university was opened there in 1990. In the period from 2010 to 2015, a young part of the population aged from 20 to 29 decreased not as fast as younger and older age groups.
– The group of curves B corresponds to the population distribution in Miahuatlán de Porfirio Díaz. In the frame of the federal SUNEO program, a university was opened there in 2000 but its operations gradually developed during the next 10 years. In the period from 2010 to 2015, a young part of the population aged from 20 to 29 also decreased not as fast as younger and older age groups.
– The group of curves C corresponds to the population distribution in Asunción Nochixtlán which is crossed by two highways: one intercontinental and one federal. Thanks to this favorable geographic feature, all population growth processes can be considered as stable but not resulting in rapid development.
– The group of curves D corresponds to the population distribution in Acatlán de Pérez Figueroa. It clearly demonstrates the difference in behavior patterns of the local young population to young people living in small cities with universities.

In such a manner, it can be assumed that the revealed trends will continue developing. Specifically, the concentration of young people living in towns related to the SUNEO program will keep on growing. A major obstacle to this trend is an active distribution of the coronavirus infection in Mexico that may result in a transition to remote working and learning regimes.

Based on the monitoring of visits to the portal "Culture of Mixteca"[2] [11] it can be concluded that the young part of the population is sufficiently equipped with pocketable gadgets with an Internet connection. This means that young people living in Oaxaca are, to a large extent, prepared for remote working and learning from technical and socio-psychological perspectives.

If this fact is timely understood by the state and municipal authorities as well as local private companies, it will contribute to a transition from the regime of diurnal commuting migration of the economically active population to workplaces located in economic centers to the regime of regular migration of semi-finished products that require manual processing in the regime associated with the digitalization of the manufacturing process. As a result, production enterprises located in regional centers can continue their development using the regime of return commuting migration.

However, this migration will be associated not with the workforce but with the freight traffic of resources and products from small towns to assembly and commercial centers working with finished products. To some extent, the initial steps to such self-organization were observed in regional centers in the state of Oaxaca where the municipalities of small and medium-sized towns organized permanent exhibitions of handicraft manufactured in the neighboring small towns.

Therefore, the pandemic accompanied by the digital transformation of the economy can result in the development of a new type of agglomerations where people can live and work in the same small town while the interconnection between these towns is carried out through the migration of goods tied to one basic enterprise in the middle of such an agglomeration. The size of such an agglomeration can exceed the former types of urban entities because freight vehicles are not as limited by strict time frameworks as workforce transportation to the workplaces.

[2] http://www.cumix.org.mx/sobreportal.html

4 Conclusions

In the context of a widespread trend on economic digitalization, the aforementioned systemic factors of inclusion of monotowns' human resources can be considered useful for mitigating the risk of their depopulation not only in Russia but also in other countries and regions. For instance, taking into account a ubiquitous increase in the level of computer literacy among young people, it is feasible to actively develop online learning in many demanded professions and attract highly skilled teachers to organize the learning process at the local level.

This measure will increase the attraction of small towns in the eyes of young people and involve them in production processes which are organized on the principle of technology clusters distributed in small urban agglomerations and thus replacing workforce migration with freight services provided to the local branches of a large production enterprise. This approach to the division of labor is supposed to reduce transportation costs in the family budgets of people living in small towns, contribute to the diversification of production in these towns, and increase the cultural and educational level of small towns' population.

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