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Supply logistics and social security in aging societies: a literature review and conceptual model proposal

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Abstract. The aging of societies represents one of the most significant challenges of the 21st century, generating a need to adapt to social, healthcare, and logistical infrastructure. Previous analyses of issues related to the social security of older adults have primarily focused on systemic aspects, marginalizing the role of supply logistics as a crucial link in social infrastructure. The research niche of this article is the analysis of the impact of supply logistics on the social security of older adults and the assessment of the potential for integrating logistics with the concept of universal urban planning. The aim of the study was to determine the importance of supplying logistics for the quality of life of seniors and to analyze the effectiveness of new logistics technologies in the context of a progressively aging population. The article presents the following hypotheses: (H1) Supply logistics positively affects the quality of life of seniors by improving access to basic services; (H2) The integration of logistics with smart city structures reduces the risk of social exclusion among older adults; (H3) The ghettoization of senior services negatively affects the availability of social and healthcare resources; (H4) The phenomenon of double aging increases the demand for specialized logistics services; (H5) The application of two-tier logistics infrastructure is an effective way to address the challenges arising from demographic changes. The study employed theoretical methods, including a review of the relevant literature, international reports, and legal documents. The analysis was conducted from an interdisciplinary perspective, combining the theory of social security with logistics, the sociology of aging, and social policy. The findings confirm that well-organized supply logistics significantly

improve the quality of life for older adults, particularly in terms of access to healthcare and social services. The integration of logistics with smart city technologies, despite certain digital barriers, positively influences the reduction of social exclusion among seniors. The negative impact of the ghettoization of senior services on their accessibility was also confirmed. The conclusions indicate the necessity of developing integrated logistics models that consider both physical and digital infrastructure, which will enable more effective responses to the needs of aging societies and prevent the marginalization of older adults.
Keywords: social logistics, aging society, social security, logistics innovations, social exclusion

Introduction

The aging of societies is one of the most significant demographic challenges of the 21st century. This phenomenon requires countries to adapt various sectors of the economy and infrastructure, including supply logistics, which plays a key role in ensuring social security. Such an approach is also consistent with the concept of universal design, which serves as a tool for implementing the principle of equality, full participation in social life, and access to the public sphere as well as all goods and services for all individuals, regardless of their degree of ability, age, or other conditions. It applies to all areas of life—from the physical environment (e.g., buildings, parks), products, transportation, technologies, and information and communication systems (e.g., websites) to other objects (e.g., ATMs) and services (e.g., postal or tourism services) (Sydor et all, 2023).

Activities in the economic sphere, including supply logistics, are a response to demographic changes that have become a key societal concern for many countries. Supply logistics encompasses processes related to the transport, storage, and distribution of goods, including essential items such as food, medicines, and medical equipment, which are particularly crucial for older adults who are less mobile or dependent. In an aging society, there is a growing demand to adapt logistics services to the specific needs of this group, such as access to healthcare, medication delivery, and the development of remote services. Under these circumstances, supply logistics becomes part of critical infrastructure, supporting countries' ability to respond to emergencies such as natural disasters or pandemics, which particularly affect the most demographically vulnerable groups (Cipora, Mielnik, 2021). Effective supply logistics thus become a foundation of social security, contributing to an improved quality of life for seniors, reducing social inequalities, and enhancing societies' capacity for long-term and sustainable development (Jarzebski, M.P., Elmqvist, T., Gasparatos, A. et al., 2021).

The aim of this article is to analyze the role of supply logistics in ensuring social security and in the context of universal planning within an aging society. To this end, the article will present the main challenges, technological innovations, and examples of activities undertaken at national and international levels that can serve as models for developing effective logistics infrastructure in aging societies.

The key research questions that the article seeks to address are:

- How does supply logistics affect the quality of life of older adults in the context of their access to essential goods and services?
- What is the relationship between supply logistics and social security in the context of demographic changes?
- What technologies and logistics innovations are the most effective in delivering services to an aging society?

The following research hypotheses were also formulated and subsequently verified during the conducted research:

H1: *Supply logistics has a significant positive impact on the quality of life of older adults by improving their access to essential goods and services.*

H2: *The integration of supply logistics with smart city infrastructure reduces the risk of social exclusion among older adults*.

H3: *The ghettoization of services for older adults negatively affects their access to social and healthcare resources*.

H4: *Demographic changes, particularly the phenomenon of double aging, lead to increased demand for specialized logistics services in healthcare and social assistance.*

H5: *Societies that adopt a dual-level logistics framework (physical and communicational) are more effective in addressing the challenges posed by an aging population.*

The research is based on theoretical analysis, including a review of subject literature, international reports, and legal documents, employing an interdisciplinary approach that combines social security theory with logistics in the context of social policy.

Methodology

This article is based on a qualitative, theoretical analysis of academic literature as well as strategic and legal documents. A **conceptual research approach** was adopted, which—unlike empirical studies—does not involve collecting original data, but rather interpreting and synthesizing existing sources of knowledge.

The article presents and discusses five hypotheses:

(H1) Supply logistics positively influences the quality of life of older adults by improving access to basic services;

(H2) Integrating logistics with smart city structures reduces the risk of social exclusion among older people;

(H3) The ghettoization of senior services negatively affects access to social and healthcare resources;

(H4) The phenomenon of double population aging increases the demand for specialized logistics services;

(H5) The implementation of a two-tier logistics infrastructure constitutes an effective response to the challenges posed by demographic change.

The aim of this research was not to empirically verify these hypotheses using quantitative or qualitative methods, but to **develop a theoretical framework** for better understanding the complex relationship between supply logistics and social security infrastructure in the context of aging population.

The analytical approach was **interdisciplinary**, integrating perspectives from the sociology of aging, social logistics, social policy theory, and smart city research. The primary sources included peer-reviewed academic literature in both Polish and English, reports from international organizations (e.g., Eurostat, WHO, ILO), and selected policy and legal documents (e.g., *Poland's National Development Concept 2050*, *EU guidelines on deinstitutionalization*).

The source corpus was **purposefully selected** based on relevance and recency, focusing on publications from the past 10–15 years that explore the links between demographic processes and social service infrastructure. Classic concepts were also incorporated, such as the **dual model of infrastructure** (physical and communicative), **service ghettoization**, and **splintering urbanism**. Conceptual frameworks from digital sociology and infrastructure studies, such as **Actor-Network Theory (ANT)**, were also applied.

The analysis proceeded in three stages:

- Identifying key challenges and knowledge gaps at the intersection of demography, social policy, and logistics;
- Synthesizing fragmented data and theoretical perspectives into a coherent interpretive model;
- Conceptualizing two support models for senior-oriented logistics, derived from the processed literature.

This method allowed for an in-depth exploration of the topic and the formulation of **conceptual and policy-relevant recommendations**. It should be emphasized that the proposed models are theoretical and have not yet been empirically validated—their practical applicability requires further **quantitative or qualitative field research**. Thus, the article serves a **heuristic function** and may provide a foundation for designing case studies, fieldwork, or comparative analyses.

The choice of a theoretical approach also stems from the **limited availability of comprehensive empirical studies** on social logistics in the context of aging societies. This gap alone justifies the need for deeper conceptual reflection aimed at identifying directions for further research and public policy action.

Results

The aging population is a complex demographic phenomenon that has become increasingly significant, especially in developed countries. Its causes include medical

advancements, improved quality of life, and low birth rates. According to Statistics Poland (GUS), the number of older adults in Poland will rise until 2060, with those aged 60+ increasing from 10 to 14 million and those over 80 doubling to 4 million (GUS, 2023a; GUS, 2023b).

GUS outlines three demographic scenarios—low, medium, and high—based on fertility, mortality, and migration. The most realistic, the medium scenario, projects a population decline from 37.7 million in 2023 to 33 million by 2060 (GUS, 2023a, pp. 30–32). These forecasts are vital for public policy planning, particularly in gerontological social work and preventing the marginalization of older adults. Demographic shifts will require new support strategies, especially in rural areas, where aging may be more pronounced (GUS, 2023b).

The increase in the number of older adults, particularly those over the age of 80, is one of the most dynamic aspects of population aging. According to estimates, by 2050, the number of individuals in this age group may exceed 3.5 million. This phenomenon, known as "double aging," poses numerous challenges for care and social support systems. It is particularly important to adapt infrastructure and services to meet the needs of older adults while ensuring their active participation in social life. Eurostat data from 2023 indicates that population aging in Europe affects various aspects: the increase in the number of older adults, changes in demographic structure, and disparities between EU countries.

While increased life expectancy is a positive outcome of societal progress, it also brings significant challenges. The key issue remains ensuring that individuals maintain good health and functional fitness for as long as possible. The concept of "compression of morbidity" aims to limit the duration of chronic diseases and disabilities to the final years of life. Conversely, the phenomenon of "expansion of morbidity" describes a situation where increased life expectancy is accompanied by prolonged periods of disability and chronic illness (Fries, 1980; Olshansky et al., 1991). These issues are crucial for planning care services and ensuring the efficiency of healthcare systems. According to Eurostat, in 2022, individuals aged 80+ constituted 27.1 million (6.1% of the EU population), projected to rise to 64 million (15.3%) by 2100 (Eurostat, 2023a). This shift increases economic burdens and highlights structural aging. The working-age population (15–64 years) is expected to decline, raising the old-age dependency ratio from 33% in 2022 to nearly 60% by 2100 (Eurostat, 2023b). In 2022, the EU population was 15.0% under 15, 63.9% working-age, and 21.1% aged 65+ (Eurostat, 2024), confirming ongoing societal aging. In 2022, EU member states showed significant differences in age structures. The highest percentages of young people were in Ireland (19.7%), Sweden (17.6%), and France (17.5%), while the lowest were in Italy (12.7%), Portugal (12.8%), and Malta (13.4%). The highest proportions of seniors (65+) were in Italy (23.8%), Portugal (23.7%), and Finland (23.1%), with the lowest in Luxembourg (14.8%) and

Ireland (15.0%) (Eurostat, 2024). Demographic changes will require investments in social care and new aging support strategies. In Poland, the population is projected to shrink to 29.5 million by 2100, with more older adults (Eurostat, 2023b). By 2080, seniors (65+) may comprise nearly 30% of Europe's population, with those 80+ reaching 12.3% (Eurostat, 2023c).

Another significant issue associated with population aging is the increasing ghettoization of services dedicated to seniors. The ghettoization of services for older adults, in the context of civil supply logistics, refers to the restriction of service availability and diversity tailored to seniors' needs, resulting in their marginalization within logistics systems. In many regions, there is a noticeable trend of concentrating on senior services in specific locations, such as nursing homes or specialized housing estates, which can lead to social isolation and hinder access to a broader range of civil services. Additionally, supply logistics, particularly in the areas of food, medicine, and daily necessities delivery, often fail to address the specific needs of older adults, such as limited mobility, the requirement for direct deliveries, or specialized health-related needs. The lack of integration of these services with mainstream systems exacerbates the sense of exclusion and complicates the efficient distribution of resources. The challenge lies in developing integrated logistics models that are both cost-effective and inclusive, minimizing the risk of ghettoizing this social group (Andresen, Runge, 2002; Alley, Liebig, Pynoos, Banerjee, Choi, 2007).

At the European level, guidelines for transitioning from institutional care to community-based care emphasize the need to provide services tailored to older adults' individual needs to counteract their segregation and marginalization (Fundusze Europejskie, 2012). In Poland, the "National Development Concept 2050" identifies preventing the social exclusion of older adults through infrastructure and service development as a priority (Ministerstwo Funduszy i Polityki Regionalnej, 2022). Furthermore, research indicates that the concentration of individuals with similar social status in specific areas can lead to ghettoization and reduced social interaction, which negatively impacts social integration (European Commission, 2011, pp. 34–40). Therefore, it is essential to develop integrated logistics systems and public services that consider older adults' specific needs to counteract their marginalization and ensure their full access to social resources.

In contemporary digital societies, the orchestration of delivery logistics targeted at elderly populations presents a complex socio-technical challenge that intersects with multiple theoretical frameworks in digital sociology (Lupton, 2015; Marres, 2017). This analysis examines the dual-faceted nature of delivery systems through both materialist and communicative theoretical lenses, while considering the broader implications for smart city integration and social inclusion, as conceptualized in recent digital urbanism studies (Kitchin, Dodge, 2011; Shaw, Graham, 2017).

The fundamental architecture of elderly-oriented delivery systems necessitates addressing two primary domains of logistical implementation. First, the delivery

logistics of goods represents a critical infrastructure component that transcends mere distribution, encompassing broader social implications for health maintenance, community integration, and quality of life among elderly populations (van Deursen, Helsper, 2015). This dimension requires careful consideration of accessibility patterns, mobility constraints, and the social determinants that influence distribution networks, as outlined in Greenfield's (2013) critique of smart city infrastructures. Second, the delivery logistics of services emerge as an equally crucial element, particularly in the context of financial and social security systems that underpin elderly welfare (Czaja, Lee, 2006).

The conceptualization of a dual-level infrastructure - physical and communicative - provides a theoretical framework for understanding the socio-technical assemblages that enable effective delivery systems, building on Actor-Network Theory approaches (Latour, 2005; Law, Hassard, 1999). This binary approach, while simplified, offers valuable insights into the complex interplay between material and informational flows in contemporary urban environments.

The physical infrastructure component manifests as a material network of distribution channels, embodying what Castells (2010) termed the "space of flows." This infrastructure operates through a hierarchical organization of transportation systems, each serving distinct yet interconnected social functions. At the macro level, we observe the integration of large-scale transportation networks - railways, highways, and intercity systems - which function as the primary arteries of goods movement (Stasiak-Cieślak and Grabarek, 2023). These systems represent what Graham and Marvin (2001) described as "splintering urbanism," where infrastructure networks simultaneously connect and divide urban populations.

The communicative infrastructure represents a parallel yet equally vital dimension of the delivery system, managing information flows and system coordination through digital networks (Plantin et al., 2018). This infrastructure operates according to two fundamental principles: distribution efficiency and universal accessibility. The emphasis on mobile telephony as a primary communication channel reflects both practical considerations and social realities, as documented in studies of elderly technology adoption (Peek et al., 2016).

The theoretical framework for smart city integration provides a compelling context for understanding how these delivery systems can evolve within digitally enabled urban environments (Kitchin, 2014; Leszczynski, 2016). Smart city infrastructure represents what Kitchin and Dodge (2011) term "code/space," where digital and physical infrastructures become inextricably intertwined. The integration of elderly-oriented delivery systems within smart city frameworks necessitates careful consideration of existing infrastructure networks, including transportation systems and wireless communication networks (Buffel et al., 2012).

Discussion

The process of population aging within the EU is closely linked to social security, which refers to the state's ability to ensure social order and provide care for citizens in difficult life situations. Social security, according to the International Labour Organization (ILO, 2016), encompasses the protection of individuals and households by ensuring access to healthcare and income stability, particularly in the context of old age, illness, disability, or job loss. The fundamental components of social security are institutions that guarantee safety and the legal system, both of which become crucial when addressing social risks such as old age, illness, disability, or poverty (Soler, Adamczyk, 2023).

Social security can be analyzed from two perspectives. The first is the macro--social perspective, which involves a systemic approach encompassing the entire society. This perspective examines institutions, social and economic policies, and societal processes that impact the security and well-being of the entire population. This includes social policies such as pension systems, healthcare services, and educational programs, along with the functioning of social institutions (governments, NGOs, international organizations). Issues such as poverty, inequality, unemployment, migration, and population aging are critical to social stability and security. The macro-social perspective also involves analyzing the labor market and its influence on citizens' sense of financial security (Scherer & Palazzo, 2011; Standing, 2011; Gough, 2003; Golinowska, 2009).

The second perspective is the micro-social analysis, which focuses on unmet individual needs. From this perspective, the inability to fulfill basic needs threatens an individual's sense of security and can lead to cumulative life difficulties for both the person and their family. This approach assumes that unmet needs may destabilize an individual's situation, becoming a source of further challenges (Gerber et al., 2016).

In aging societies, ensuring long-term social security, particularly in old age, is a key public policy priority in many European countries. This security includes not only access to essential healthcare but also income protection throughout childhood, adulthood, and retirement, providing a minimum level of social protection for all residents. Such an approach aligns with the ILO's recommendations (ILO, 2012), which emphasize that guaranteeing basic social protection is a human right and crucial in combating poverty and social exclusion.

Social security for older adults is also essential for sustainable social development. In this context, economic, social, and axiological aspects are significant, ensuring universal access to resources and services necessary for individuals to function. An interdisciplinary approach, which includes political, efficiency-based, and narrative theories, underscores the state's role in stabilizing income, reducing poverty, and providing adequate health and social services for older adults. Social security, in this context, serves as the foundation for the social integration of older

individuals, influencing their quality of life and social stability (Cox, 2020; Stopka, 2020). Furthermore, processes related to ensuring a minimum level of social security, especially in the context of an aging population, should adopt a broader social and economic perspective to maintain the long-term stability and cohesion of social security systems in response to evolving demographic needs (Szymonik, 2021).

What, then, is the relationship between delivery logistics and social security in the context of demographic changes? This relationship is closely connected to ensuring stability and access to essential services in aging societies. Demographic processes, particularly double aging, lead to increased demand for care services, healthcare, and income security, presenting delivery logistics with challenges related to the efficient provision of these services. It is essential to remember that logistics involves planning, executing, and controlling the efficient flow of goods, information, and other resources from the point of origin to the destination. It is a complex process that encompasses various aspects of supply chain management.

In aging societies, delivery logistics plays a crucial role in ensuring access to healthcare, medications, social services, and home assistance. Social security for older adults—recognized as both a human right and a fundamental aspect of social policy—requires appropriate logistical support, particularly in regions with high proportions of older adults. In this context, delivery logistics can be viewed as a tool that facilitates the efficient distribution of services and resources necessary to maintain a minimum level of social and health protection (ILO, 2012). From a macro-social perspective, logistical processes are vital in supporting social insurance, pension, and healthcare systems, which are the pillars of social security. Delivery logistics, in this sense, involves managing the flow of resources and services required for these systems to function effectively (Banabakova, 2021; Filippov, 2015).

In social insurance systems, delivery logistics ensures the efficient transfer of benefits and financial assistance to eligible individuals, such as retirees or those receiving pensions and allowances. Logistical operations include both the distribution of financial resources (e.g., bank transfers) and the development of infrastructure to access these benefits (e.g., payment centers, information systems). Efficient logistics allow beneficiaries to receive financial assistance without disruption, which is critical for their material stability and sense of social security (Iwaszkiewicz-Góralska, 2016).

In pension systems, delivery logistics supports the proper functioning of pension payments and fund management. This involves processes related to transferring funds to beneficiaries and managing data about age, health status, and employment history—information necessary for accurately calculating and disbursing pension benefits. The efficiency of these processes ensures financial stability for retirees, directly influencing their sense of security. Similarly, in healthcare systems, delivery logistics facilitates access to medical services, medications, and equipment (Gawrońska-Błaszczyk, 2016). In response to the growing number of older adults, effective

delivery logistics are essential to maintain consistent access to necessary services, such as outpatient care, rehabilitation, and medication delivery. Additionally, the logistical management of healthcare infrastructure, such as hospitals, clinics, and pharmacies, is crucial for ensuring equal access to medical care, thereby contributing to the overall level of social security (Szołtysek, 2014).

The implementation of alternative information distribution systems, such as technological kiosks in locations frequently accessed by elderly populations, represents an important adaptation of smart city concepts to address specific demographic needs (Sixsmith, Sixsmith, 2008). These physical-digital hybrid spaces serve multiple functions: they act as information access points, service delivery nodes, and social gathering spaces. This multi-functional approach aligns with what WHO (2007) and scholars have termed "age-friendly cities," where urban infrastructure is specifically designed to accommodate the needs and capabilities of older residents.

The socio-technical complexity of these systems raises important questions about digital inclusion and accessibility (Robinson et al., 2015). While smart city technologies offer numerous potential benefits for elderly service delivery, they also present risks of exacerbating existing digital divides, as documented in recent studies of technological exclusion (Friemel, 2016; Quan-Haase et al., 2018).

Looking toward future developments, the integration of delivery logistics within smart city frameworks suggests several potential trajectories for research and implementation (van Dijk, 2020). These include the development of more sophisticated AI-driven delivery optimization systems, the integration of Internet of Things (IoT) devices for real-time tracking and coordination (Atzori et al., 2017), and the implementation of blockchain technologies for secure service delivery verification (Yang et al., 2019).

The development of effective delivery logistics for elderly populations requires a nuanced understanding of both technical infrastructure requirements and social dynamics, as emphasized in contemporary digital sociology literature (Rogers, 2013; Marres, 2017). The successful implementation of such systems depends on careful attention to accessibility, usability, and social inclusion, while leveraging the capabilities of emerging smart city technologies. Future research should focus on evaluating the real-world impact of these systems on elderly populations and identifying opportunities for further optimization and improvement (Neves, Vetere, 2019).

In summary, logistical processes that support social insurance, pension, and healthcare systems contribute to citizens' financial, health, and social stability, which is the foundation of social security—particularly in the context of aging societies. Ensuring an efficient delivery infrastructure, including the availability of services in rural or less-developed regions, is critical to reducing the risk of social exclusion among older adults, who may face challenges in accessing essential resources. Additionally, logistical support in distributing social assistance, such as financial

transfers, can help prevent poverty and marginalization among seniors, which is a vital aspect of ensuring their social security (Scherer & Palazzo, 2011; Gough, 2003).

Conclusions

This study confirms the validity of the research hypotheses to varying degrees. The findings support the claim that supply logistics significantly impacts the quality of life for older adults by enhancing their access to essential goods and services. The integration of logistics solutions, such as home deliveries and improved transport systems, directly contributes to seniors' well-being, particularly in healthcare, medication distribution, and social assistance. The study also shows that integrating supply logistics with smart city infrastructure reduces the risk of social exclusion among older adults, though challenges like the digital divide remain. Technologies such as digital kiosks, IoT-based monitoring, and AI-driven logistics networks improve access and optimize distribution efficiency, but their effectiveness depends on older individuals' inclusion in digital transformation efforts and the tailoring of these solutions to their needs.

The research confirms that ghettoization of services for older adults negatively impacts access to social and healthcare resources. Concentrating services in specific locations, like nursing homes or dedicated housing estates, leads to isolation, limiting access to essential services and reinforcing inequalities. This highlights the necessity of integrating logistics solutions with mainstream public services to ensure equal access.

Moreover, the study demonstrates that demographic changes, especially double aging, increase demand for specialized logistics services in healthcare and social assistance. Projections show that the population aged 80 and above will more than double in the coming decades, placing greater strain on healthcare logistics. Tailored logistics solutions, such as home healthcare deliveries and personalized service networks, are crucial in addressing the needs of an aging population. Finally, the research validates the hypothesis that societies adopting a dual-level logistics framework—combining physical and digital infrastructure—are more effective in addressing the challenges of demographic aging. Integrating both transportation systems and digital coordination enhances service efficiency and ensures the availability of essential services for older populations.

In conclusion, the study demonstrates the critical role of supply logistics in maintaining social security in aging societies. While logistics innovations and smart city integration have proven effective in improving accessibility and efficiency, challenges like digital exclusion and service ghettoization remain significant barriers. The research strongly supports the adoption of a dual-level logistics framework,

integrating physical infrastructure with digital solutions, as the most effective strategy for addressing the growing needs of an aging population.

To meet the needs of an aging population, it is essential to implement a comprehensive approach to logistics systems. These systems, which include transport, storage, and distribution of goods and services, are vital for ensuring access to healthcare, medication, and social benefits. They serve as the foundation of critical infrastructure, allowing seniors to actively participate in social life and preventing isolation (Czaja & Lee, 2006; Greenfield, 2013).

Two logistics dimensions—physical and communicational—must be addressed to cater to seniors. Physical logistics should consider the specific needs of older adults, such as mobility issues and health requirements, ensuring that transport and distribution systems are accessible and functional. Incorporating new technologies like AI, IoT, and blockchain can optimize service delivery and improve efficiency (Atzori et al., 2017; Yang et al., 2019).

Communicational logistics involves digital communication channels, such as mobile networks and information kiosks, which improve service accessibility. These technologies must be designed with seniors' needs in mind, providing simple, intuitive interfaces to facilitate their use (Peek et al., 2016). Information kiosks and mobile technologies, within smart city frameworks, can serve as platforms for everyday tasks like payments and health consultations (Sixsmith & Sixsmith, 2008). Integrating logistics within smart cities offers innovative opportunities but also presents challenges regarding digital inclusion. While AI, IoT, and blockchain can enhance senior well-being, their implementation must address the digital divide, which disproportionately affects older adults. It is vital to involve seniors in digital transformation efforts by providing adequate support and user-friendly solutions (Rogers, 2013).

The conducted analyses propose two models of support for seniors based on delivery logistics. The first model presents a highly simplified approach, beginning with general delivery logistics, then covering home deliveries, integration with smart cities, and digital services such as IoT and related technologies. Each stage is interconnected to clearly and structurally illustrate the flow of support.

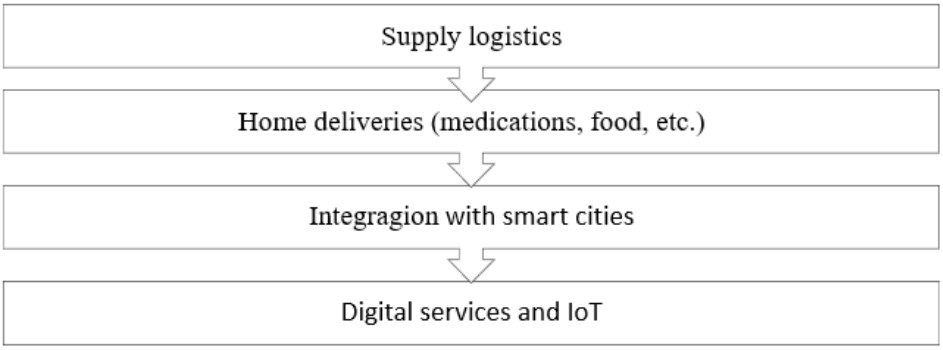

Fig. 1: The First Model of Senior Support Based on Delivery Logistics
Source: own study

The second model proposes an integrated approach to delivery logistics, considering both physical and digital infrastructure, which can effectively support seniors in their daily lives.

Senior-friendly cities must ensure access to social and healthcare services by eliminating mobility barriers and accommodating health needs. Integrated logistics models that combine physical infrastructure with digital platforms are essential to create hybrid spaces that fulfill informational, social, and care-related functions (Buffel et al., 2012; Kitchin & Dodge, 2011).

The future of delivery logistics in aging societies depends on integrating new technologies with social care and welfare systems. Building efficient systems that incorporate technological solutions will enhance seniors' quality of life and improve social security systems' efficiency, ensuring easy access to services and promoting full integration into social life (Neves & Vetere, 2019).

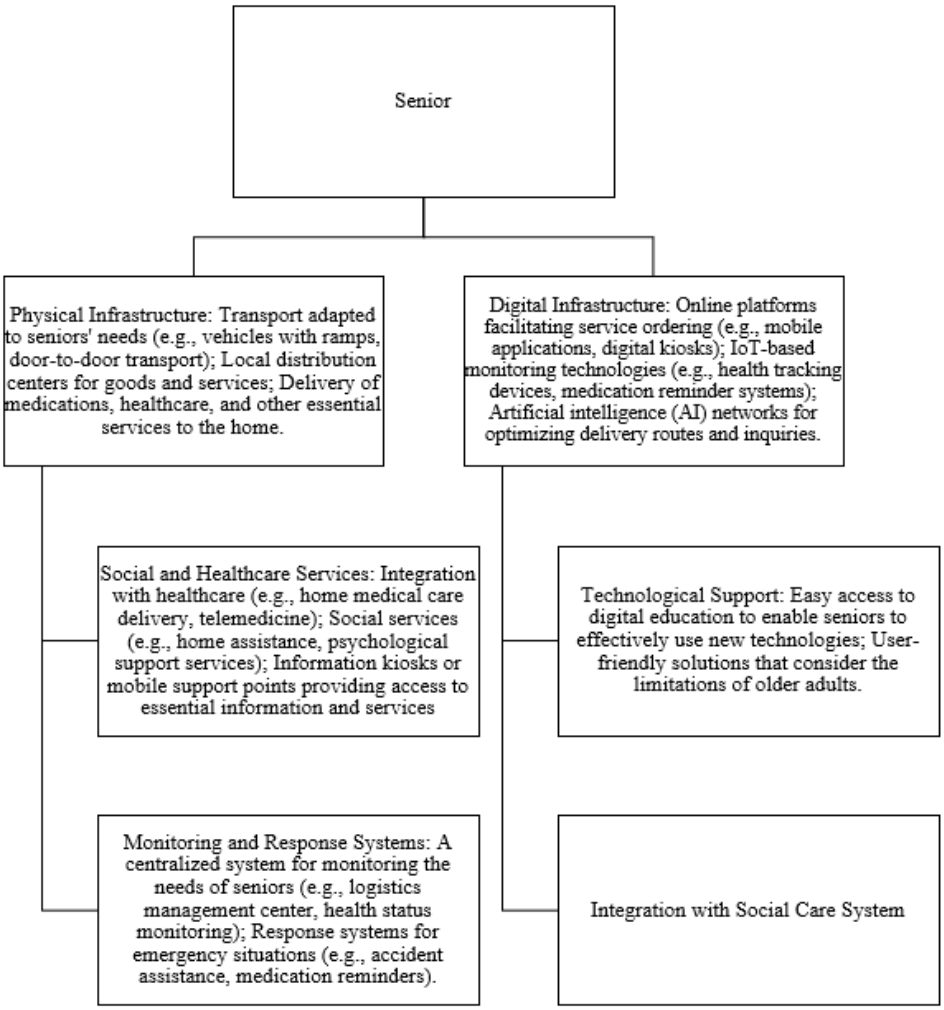

Fig. 2: Extended Model of Senior Support Based on Delivery Logistics
Source: own study

BIBLIOGRAPHY

[1] Alley, D., Liebig, P., Pynoos, J., Banerjee, T. and Choi, I.H., 2007. Creating elder-friendly communities: Preparation for an aging society. *Journal of Gerontological Social Work*, 49(1–2), 1–18.

[2] Andresen, M. and Runge, U., 2002. Co-housing for seniors experienced as an occupational generative environment. *Scandinavian Journal of Occupational Therapy*, 9(4), 156–166.

[3] Atzori, L., Iera, A. and Morabito, G., 2017. Understanding the Internet of Things: Definition, potentials, and societal role of a fast evolving paradigm. *Ad Hoc Networks*, 56, 122-140.

[4] Banabakova, V., 2021. The role of social logistics for the national, economic and social security. *Security Dimensions*, 39, 54-69. DOI:10.5604/01.3001.0015.6527.

[5] Buffel, T., Phillipson, C. and Scharf, T., 2012. Ageing in urban environments: Developing "age--friendly" cities. Critical Social Policy, 32(4), 597-617.

[6] Castells, M., 2010. The rise of the network society. 2nd ed. Wiley-Blackwell.

[7] Cipora, E. and Mielnik, A., 2021. Wybrane aspekty medyczne i społeczne pandemii Covid-19. Journal of Education, Health and Sport, 12, 11-20. doi:10.12775/JEHS.2022.12.01.001.

[8] Czaja, S.J., Lee, C.C., 2006. The impact of aging on access to technology. Universal Access in the Information Society, 5(4), 341-349.

[9] Eurostat, 2023a. *Demography of Europe – 2023 edition*. European Commission. doi:10.2785/798409 [online]. Available at: https://ec.europa.eu/eurostat/cache/interactive-publications/demography/2023/ [Accessed: 18 February 2025].

[10] Eurostat, 2023b. Population projections in the EU [online]. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=497115 [Accessed: 18 February 2025].

[11] Eurostat, 2023c. Population structure indicators at national level, 2023 [online]. Available at: https://ec.europa.eu/eurostat/databrowser/view/demo_pjanind__custom_9542328/default/table?lang=en [Accessed: 18 February 2025].

[12] Eurostat, 2024. *Demography of Europe – 2024 edition*. Available at: https://ec.europa.eu/eurostat/web/interactive-publications/demography-2024 [Accessed: 18 February 2025].

[13] Filippov, E., 2015. Social logistics: A tool for social problems solving. *Administration*, 3, 65-67. doi:10.12737/11512.

[14] Friemel, T.N., 2016. The digital divide has grown old: Determinants of a digital divide among seniors. *New Media & Society*, 18(2), 313-331.

[15] Fries, J.F., 1980. Aging, natural death, and the compression of morbidity. *New England Journal of Medicine*, 303(3), 130-135. doi:10.1056/NEJM198007173030304.

[16] Fundusze Europejskie, n.d. Wytyczne dotyczące przejścia od opieki instytucjonalnej do opieki świadczonej w społeczności [online]. Available at: https://www.funduszeeuropejskie.gov.pl/media/17881/12.pdf [Accessed: 15 February 2025].

[17] Gawrońska-Błaszczyk, A., 2016. Specyfika procesów logistycznych ochrony zdrowia w Polsce. Logistyka, 5, 14–15 [online]. Available at: https://www.logistyka.net.pl/bank-wiedzy/item/download/79785_a62dfcee8379bc412d9bb77348798765 [Accessed 16 February 2025].

[18] Graham, S. and Marvin, S., 2001. Splintering urbanism: Networked infrastructures, technological mobilities and the urban condition. Routledge.

[19] Greenfield, A., 2013. Against the smart city: A pamphlet. Do Projects.

[20] GUS, 2023a. Prognoza ludności na lata 2023–2060 [online]. Available at: https://demografia.stat.gov.pl/bazademografia/Prognoza_2023_2060.aspx [Accessed: 14 February 2025].

[21] GUS, 2023b. *Rocznik Demograficzny 2023*. Warszawa: Zakład Wydawnictw Statystycznych.

[22] **Iwaszkiewicz-Góralska, J., 2016.** Logistyka usług w firmach ubezpieczeniowych i jej znaczenie w kształtowaniu relacji z klientami. Ekonomika i Organizacja Logistyki, 1, 15–26. DOI: 10.22630/EIOL.2016.1.2.12.

[23] **Jarzebski, M.P., Elmqvist, T., Gasparatos, A. et al., 2021.** Ageing and population shrinking: implications for sustainability in the urban century. npj Urban Sustainability, 1(17). DOI: 10.1038/s42949-021-00023-z.

[24] **Kitchin, R., 2014.** The real-time city? Big data and smart urbanism. *GeoJournal*, 79(1), 1–14.

[25] **Kitchin, R. and Dodge, M., 2011.** Code/space: Software and everyday life. Cambridge, MA: MIT Press.

[26] **Komisja Europejska, 2011.** Miasta przyszłości. Brussels: European Commission. ISBN 978-92-79-23157-5 [online]. Available at: https://ec.europa.eu/regional_policy/sources/studies/citiesoftomorrow/citiesoftomorrow_final_pl.pdf [Accessed 18 February 2025], DOI: 10.2776/53888.

[27] **Latour, B., 2005.** Reassembling the social: An introduction to actor-network-theory. Oxford: Oxford University Press.

[28] **Law, J. and Hassard, J., 1999.** Actor network theory and after. Oxford: Blackwell Publishers.

[29] **Leszczynski, A., 2016.** Speculative futures: Cities, data, and governance beyond smart urbanism. Environment and Planning A: Economy and Space, 48(9),1691–1708.

[30] **Lupton, D., 2015.** Digital sociology. London: Routledge.

[31] **Marres, N., 2017.** Digital sociology: The reinvention of social research. Cambridge: Polity Press.

[32] **Ministerstwo Funduszy i Polityki Regionalnej, n.d.** Koncepcja Rozwoju Kraju 2050 [online]. Available at: https://www.gov.pl/attachment/7f7388ea-9a67-4199-84d2-4b05454cfb21 [Accessed: 2 January 2025].

[33] **Neves, B.B. and Vetere, F. eds., 2019.** Ageing and digital technology: Designing and evaluating emerging technologies for older adults. Cham: Springer.

[34] **Olshansky, S.J., Rudberg, M.A., Carnes, B.A., Cassel, C.K. and Brody, J.A., 1991.** Trading off longer life for worsening health: The expansion of morbidity hypothesis. Journal of Aging and Health, 3(2), pp.194–216. https://doi.org/10.1177/089826439100300205.

[35] **Peek, S.T., Wouters, E.J., van Hoof, J., Luijkx, K.G., Boeije, H.R. and Vrijhoef, H.J., 2016.** Factors influencing acceptance of technology for aging in place: A systematic review. International Journal of Medical Informatics, 88, 235-248.

[36] **Plantin, J.C., Lagoze, C., Edwards, P.N. and Sandvig, C., 2018.** Infrastructure studies meet platform studies in the age of Google and Facebook. New Media & Society, 20(1), 293-310.

[37] **Quan-Haase, A., Williams, C., Kicevski, M., Elueze, I. and Wellman, B., 2018.** Dividing the grey divide: Deconstructing myths about older adults' online activities, skills, and attitudes. American Behavioral Scientist, 62(9), 1207-1228.

[38] **Robinson, L., Cotten, S.R., Ono, H., Quan-Haase, A., Mesch, G., Chen, W., Schulz, J., Hale, T.M. and Stern, M.J., 2015.** Digital inequalities and why they matter. Information, Communication & Society, 18(5), 569-582.

[39] **Rogers, R., 2013.** Digital methods. Cambridge, MA: MIT Press.

[40] **Shaw, J. and Graham, M., 2017.** Our digital rights to the city. Meatspace Press.

[41] **Sixsmith, A. and Sixsmith, J., 2008.** Ageing in place in the United Kingdom. Ageing International, 32(3), 219-235.

[42] **Soler, U. and Adamczyk, M., 2023.** The COVID-19 Pandemic and Elderly People's Rights to Social Security and Health Protection. Studia Iuridica Lublinensia, 32(3), 185-199. https://doi.org/10.17951/sil.2023.32.3.185-199.

[43] **Stasiak-Cieślak, B. and Grabarek, I., 2023.** Universal design in transport. Military Logistics Systems, 59(2), 247-262. https://doi.org/10.37055/slw/186377.

[44] **Sydor, M., Wieczorek, M., Hitka, M. and Gejdoš, M., 2023.** Experimental Study of Persons with Disability, Wheelchairs, and Car Interaction. Military Logistics Systems, 59(2), 263-286. https://doi.org/10.37055/slw/186378.

[45] **Szymonik, A., 2021.** Health security management. Military Logistics Systems, 55(2), 159-172. https://doi.org/10.37055/slw/145858.

[46] **Szołtysek, J., 2014.** Miejsce i użyteczność logistyki w zarządzaniu szpitalami. Logistyka, 5, 2114–2118 [online]. Available at: https://www.logistyka.net.pl/bank-wiedzy/item/download/79453_60b2d5dc04acc0f70ee1fb708e02df9a [Accessed: 19 February 2025].

[47] **van Deursen, A. J. and Helsper, E. J., 2015.** A nuanced understanding of Internet use and non-use among the elderly. European Journal of Communication, 30(2), 171-187.

[48] **van Dijk, J. A. G. M., 2020.** The digital divide. Polity Press.

[49] **World Health Organization, 2007.** Global age-friendly cities: A guide. WHO Press [online]. Available at: https://iris.who.int/handle/10665/43755 [Accessed: 20 February 2025].

[50] **Yang, R., Yu, F. R., Si, P., Yang, Z. and Zhang, Y., 2019.** Integrated blockchain and edge computing systems: A survey, some research issues and challenges. IEEE Communications Surveys & Tutorials, 21(2), 1508-1532.