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Research paper

Container settlements for internally displaced people in Ukraine built in 2015 and 2022 – architectural characteristics

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Abstract: Container settlements (CS) have been widely used as emergency and temporary dwellings in Europe due to the advantages of rapid deployment, cost-efficiency and relatively good living standards. Nevertheless, many authors emphasize the risks of disturbing the spatial order and stigmatization of residents that can lead to deepening the feeling of unrooting and generate substantial social problems. The purpose of the article is to demonstrate the main architectural characteristics of CS built in Ukraine to address internal migration caused by war. Multiple comparative case study includes 18 settlements built for internally displaced persons (IDPs) in three distinctive phases. The research focuses on the features critical to human comfort and life quality: settlement size, program, building typology, spatial arrangement, circulation, unit layout, degree of privacy. Results show that developments from 2015 and 2022 have similarities including basic program, size of dwelling units and density, but there are important differences related to the time allocated to designing and construction as well as expected period of operation. Basic recommendations for improving existing and planned developments are increasing the privacy by creating collective-private space outside and inside, developing a rich program, use existing greenery and new landscaping, providing good transit to the urban centres, using all-year weatherproof typologies and technical solutions suitable for long-term use. This fact must be considered in the process of designing new CS for IDPs and refugees, that are being planned and constructed in Ukraine and Europe.

Keywords: internally displaced people, container settlement, emergency shelter, temporary homes, refugee camps

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1. Introduction

Massive migration was one of the consequences of the military conflict in Ukraine that started in 2014 and intensified in 2022. According to the International Organization for Migration, as of August 23, 2022, there were 7.1 million internally displaced persons (IDPs) that moved to relatively peaceful western regions of the country [1, 2]. All of them needed to be placed in new accommodation, at least for the time of the war.

One of the ways of addressing the problem of accommodation for refugees and IDPs is deployable settlements built of containers, which are the focus of this study. Our paper defines "container" as a portable, stackable structure made of steel and prefabricated in volumetric elements suited for standardized container transport and rapid construction. It is to be used as a stand-alone building or in clusters. This definition excludes shipping containers and other container-like structures not complying with the container frame ISO standards.

This paper aims at diagnosing the architectural characteristics of IDPs container settlements (CS) built in Ukraine between 2015 and 2022. Based on the comparative analysis of 18 settlements we determined urban patterns, architectural design solutions, and positive and negative design aspects and residents' opinions on the quality of life. These findings may be useful to develop recommendations for improving existing and future CS.

2. State of knowledge on non-permanent container housing

The housing reconstruction process ranges from immediate short-term action to the provision of new or renovated homes [3–5]. Quarantelli divided the process into four stages that can involve both building new structures and upgrading the existing ones: emergency shelters, temporary shelters, temporary housing, and permanent housing [5, 6]. Emergency shelters are organized immediately – a few hours to a few days after the crisis – usually without any prior preparation [6]. This stage may include arranging reception centers in public facilities as well as relocating to friends, relatives or neighbors [7, 8]. Temporary shelters are used for days or weeks after the disaster [3, 5]. They can be rapid deployment structures like tents or mobile buildings as well as hotels and resorts etc. [3, 6, 8]. The next stage, temporary housing, planned for six months up to three years, has relatively higher quality allowing for daily routines and activities [8]. It can be provided as prefabricated or mobile houses, self-built homes but also as rented ordinary apartments [8]. Permanent housing can be used for an unlimited period. It includes rebuilding or renovating old homes or new development [7]. This stage completes the process of housing recovery [6].

According to existing studies [9, 10] housing for migrants should address five basic needs: environmental protection, comfort, dignity, health, safety and be flexible enough to accommodate the complex demographic and social structure of refugee families.

Prefabricated container units are affordable and quick and easy to assemble and dismantle and relatively comfortable [7, 10]. Therefore, they are suitable for all stages of a post-disaster housing recovery. For different situations, types of settlements and locations CS can be effective to a different degree [11].

For a better understanding of the Ukrainian context, new CS built for IDPs in Ukraine could be referenced to housing raised during the European refugee crisis in 2015–2016. Despite many differences, solutions implemented at that time in the northern part of Europe are relevant examples due to similar weather conditions, available technology and built environment. The cases from Germany (to where almost half of 2.45 million refugees came in 2015–2016 [12]), especially the ones in the relatively small Land of Berlin which received about 70,000 refugees [13], deserve special attention. Initially, the refugees were accommodated in hastily prepared sites, such as airport halls, sports halls, and schools. Afterwards, temporary container houses dubbed Tempohomes were built. Each quadruple unit included a separate entrance, two 13-sqm-large double rooms, a shared bathroom and a kitchenette [10]. Tempohomes had single- and triple-story variants and additional community zones (e.g., recreation, homework, laundry or classroom). They have operated longer than expected pending the construction of new apartment blocks for more than 3 years [10].

Despite these efforts, dwellings in containers, however temporarily necessary, are not well assessed by their inhabitants. In Berlin the place identification and "bottom-up" transformations were suggested by [14]. Improvements that include decoration and rearranging of the settlements may be undertaken by the residents themselves. A critical analysis [15] presents urban layouts of container estates in Berlin as a potential starting point for creating a set of good practices. Co-designing the sites with their users would present more adequate and dignified projects.

According to the state-of-the-art, CS have been widely used in Europe due to the advantages of rapid deployment and relatively good living standards. Nevertheless, many authors emphasize the risk of negative spatial and aesthetical effects induced by building CS on an ad hoc basis and extending the exploitation beyond the technical life of the structures [14, 15]. In our view these threats – the lack of spatial order and low potential for place-making – combined with insufficient long-term living conditions can lead to deepening the feeling of unrooting and generate substantial social problems.

3. Methods and sources

This paper covers multiple comparative case studies of architectural characteristics of the CS built in Ukraine in 2015 and 2022.

We aimed at examining the largest possible number of CS. Due to the inaccessibility of some of them in the conditions of ongoing war and due to the dynamic process of raising new CS during the research phase, we had to limit the study to locations that were either possible to visit in 2022 or to cases with available archival data. In total, 18 CS were analyzed in urban and architectural scale (Fig. 1).

The multiple case study employed several various qualitative and quantitative research methods depending on the year of construction [16]. For all settlements we did archival research covering online news articles, video reports and social media content as well as construction drawings. We aimed at collecting the site plans and floor plans for all CS. These drawings were a primary source for the analysis of the architectural form, site development and the use of space. We also collected key information on the time of opening and planned period

Fig. 1. CS for IDPs in Ukraine: ▲ – built in 2015, included in the study; ● – built in 2022, included in the study; ■ – built in 2022, not included in the study

of operation of the CS. In addition, we used available reports and surveys of the settlements from 2015. For developments from 2022, located in Central and West Ukraine, we conducted field visits, during which unstructured interviews with random occupants and unstructured naturalistic few-hours-long observations of the site were made.

Buildings were classified as one of 4 types: 1) single – detached stand-alone unit used for living, sleeping, sanitation, eating, and cooking; 2) quadruple – a building made of several containers containing four independent dwellings with separate entrances; 3) row – a building made of individual container units with dedicated external entrances set in a line; 4) multiunit block – a building made of three rows of containers, where internal rows is circulation area and the external rows serves for habitation and other functions.

Spatial arrangement of the site was assigned according to the main theme of the spatial composition: 1) street grid; 2) courtyard; 3) irregular.

The diagrams of each settlement were made, indicating the private – individual habitable space (for families or a limited number of unrelated IDPs, usually up to 4 persons), semicollective – shared indoor space, not entirely open to all IDPs of the settlement (children playrooms, corridors, shared sanitation, etc.) and collective – indoor spaces (laundries, administrations, canteen etc.) shared by all IDPs of the settlement, use of space [17].

The result is a comparative case study built upon multiple sources of evidence focused on the architectural features critical to human comfort and life quality [10, 18].

4. Case study

Settlements analyzed were built in two major steps: 2015 and 2022 (Fig. 1). Closer studies showed time-dependent differences between early and late 2022. Therefore, 3 phases were distinguished and further described as 3 distinctive cases.

4.1. Case 1 – Developments in 2015

In 2014, the development of plans IDPs housing with a total budget of around 25 million euros was jointly engaged by German Agency for International Cooperation (GIZ), the Red Cross of Ukraine, regional administrations and local governments [11].

In Dnipro, alternative locations were considered, including two areas situated in proximity to the city center [19]. However, as in other cities, a site located on the outskirts of the city was chosen. The distance between the settlements and the centres in Kamianske, Dnipro, Kharkiv, and Zaporizhzhia is approximately 8.5 to 12.5 km. Nevertheless, there is also an example of a settlement established on the site of the former Myrivske settlement, located 25 km from Kryvyi Rih, which has resulted in difficulties with accessibility [20]. In contrast, in Pavlohrad and Nikopol the center is approximately 7.5 and 5 km away.

The settlements are conveniently located within walking distance to schools, with the exception of Nikopol where the school is situated approximately 2 km away. However, the situation with kindergartens is less satisfactory. The Kamianske settlement has a kindergarten located within a radius of approximately 360 m, while the ones in Nikopol and Kharkiv are about 500 m away. In the other settlements, a longer distance must be covered to reach the kindergarten.

The plots vary in size, ranging from 0.72 to 1.99 ha. Consequently, each settlement has the capacity to house between 424 and 640 individuals (Table 1).

The plots in the settlements are usually rectangular and arranged in a grid pattern, often with a central plaza (Fig. 2). Each settlement has a similar program, including units for living, cooking, eating, laundry and sanitation. The distance between container buildings ranges from 6 to 28 m. In five of the settlements two service buildings (administration, laundry) are centrally located, with Kharkiv having three and Kryvyi Rih having one. Each service building is typically adjacent to a playground. The landscaping usually includes playgrounds, recreational areas, parking and garbage disposal containers.

At the time of their opening, the temporary living areas lacked green spaces, which contributed to overheating. But over time, the greening of the settlements increased. Initially, all settlements were covered either with gravel or with crushed stone, which was later replaced by cobblestone walkways featuring benches and tables [19]. Each settlement provides amenities such as asphalt-surfaced parking, dumpsters, and a playground. In Kamianske small playgrounds with sandboxes are located near the buildings' entrances and are covered with handmade awnings during the summer. The settlements in Nikopol, Kharkiv and Kamianske are fully enclosed by a metal fence to provide a sense of security by restricting access to outsiders and preventing unauthorized parking.

During operation new functions were sometimes added, for instance one in Dnipro was enlarged by a container for sewing and repairing clothes, where residents work [21].

In 2015, two types of residential buildings were used for CS: multiunit block and quadruple buildings. The multiunit blocks provided a minimum level of privacy, as each dwelling unit was accessible through a shared corridor that acted as a buffer zone. Privacy in quadruple buildings was limited, as there was no vestibule to protect the first bedroom from collective space.

A total of 67 quadruple buildings (Fig. 3b), 20 to 27 container buildings (Fig. 3a), and 4 to 28 container buildings were assembled in 2015. The buildings consist of either 27 or 28

Table 1. General characteristics and quantitative indicators of the CS in 2015

	Kharkiv	**Pavlohrad**	**Zaporizhzhia**	**Kryvyj Rih**	**Nikopol**	**Dnipro**	**Kamianske**
Opening date	22/01/2015	13/02/2015	16/02/2015	20/02/2015	04/03/2015	13/03/2015	15/04/2015
Area [ha]	1.07	1.0	1.12	1.99	0.8	0.72	0.8
Beds	488	640	544	424	456	456	480
Area per 1 unit [m^2]	54.0	40.0	52.3	119.9	45.5	40.7	41.9
Beds per 1 cu	2.46	2.56	2.54	2.55	2.59	2.57	2.51
Building typology	3MB+ 10Q	4MB+ 13Q	4MB+ 10Q	3MB + 8Q	3MB + 9Q	3MB + 9Q	4MB + 8Q
Room units [cu]	42	56	56	42	42	42	56
Bathroom [cu]	15	20	20	15	15	15	20
Corridor [cu]	18	24	20	15	15	15	20
Kitchen [cu]	3	4	4	3	3	3	4
Canteen [cu]	3	4	4	3	3	3	4
Other [cu]	17	12	10	8	8	9	9
Quadruple* [cu]	100	130	100	80	90	90	78
TOTAL [cu]	**198**	**250**	**214**	**166**	**176**	**177**	**191**

Table 1 continued on the next page

Table 1 continued from the previous page

	Kharkiv	**Pavlohrad**	**Zaporizhzhia**	**Kryvyj Rih**	**Nikopol**	**Dnipro**	**Kamianske**
Program**	A, L, K, C, 2 PG, P	A, L, K, C, PG, P	A, L, K, C, SG, PG, P	A, L, K, C, PG	A, L, K, C, M, PG, P	A, L, K, C, PG, P	A, L, K, C, PG, P
Spatial arrangement	courtyard	grid	grid	grid	irregular	grid	grid
Relation to city space	gated	gated	open	open	open	semi open	gated
Transition from collective to private	buffer zone (corridor)	direct collective /private interference, buffer zone (corridor)	direct collective /private interference, buffer zone (corridor)	direct collective/ private interference, buffer zone (corridor)	direct collective /private interference, buffer zone (corridor, courtyard)	direct collective /private interference, buffer zone (corridor)	direct collective /private interference, buffer zone (corridor)

cu – container unit; MB – multiunit block; Q – quadruple; * – inc. integrated bathrooms and kitchenet, ** – according to analysis key at the Fig. 2.

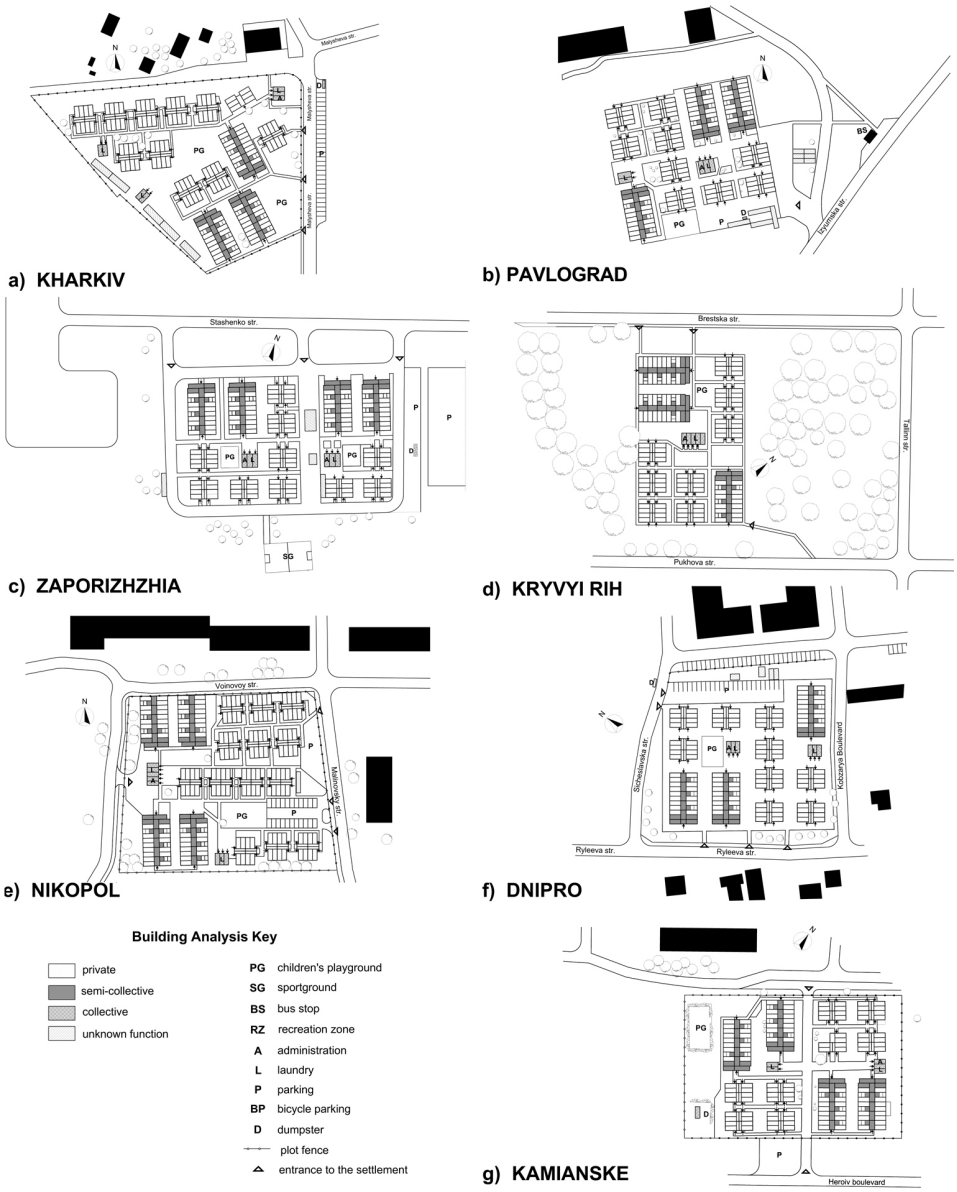

Fig. 2. CS built in 2015 – case1

containers and are designed to accommodate 14 dwelling units, accessible from a common corridor. Eight of these units possess an individual bathroom while the remaining six do not. The buildings also contain a kitchen, a dining room, and a utility room (Fig. 2a). Quadruple buildings function as independent households, with the only shared amenity being the laundry

facilities. The administration container is always positioned adjacent to the laundry containers and arranged in a row of 3 to 5 units with a yard entrance to each room (Fig. 3c). An additional laundry unit is constructed with 2–3 containers blocked in a row (Fig. 3d).

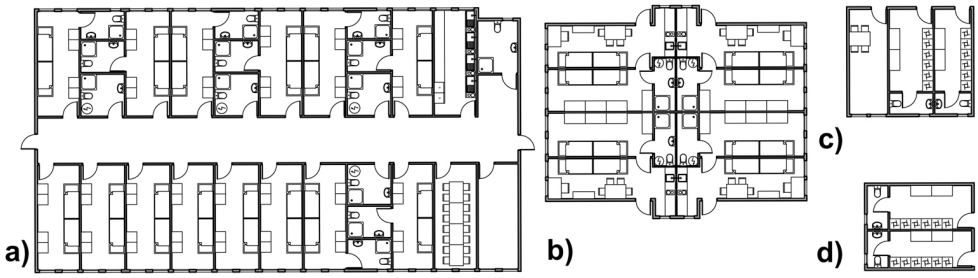

Fig. 3. Schemes of plans of container buildings in 2015: a) multiunit block; b) quadruple; c), d) service buildings

In 2015, rooms were usually occupied by 4 people. Each room is furnished with two bunk beds and four metal wardrobes (Fig. 3a). The bunk beds are constructed with a sturdy metal frame, which provides durability and anti-vandalism measures, while also maximizing the space available. Families who had the opportunity additionally equipped the apartment with their own furniture.

The quadruple residential units consist of two rooms for each family (Fig. 3b). One room contains bunk beds and metal cabinets, while the other includes two bunk beds, dining table with four chairs, a worktable with a chair, a wardrobe, and a kitchen niche equipped with a sink, an electric stove and kitchen furniture. Residents of quadruple buildings often modified their living spaces either partially or completely using furniture [22]. The bathroom contains a shower cabin, lavatory pan and a washbasin.

Settlements are equipped with water, sewage and power systems. Electric heating is provided in all buildings. Hot water is prepared in electric boilers. Containers have a warranty period of 3 years [11]. Unfortunately, some of the modules have failed even before the end of their service life due to careless use by individual residents. The electrical system of the containers caused problems in all of the settlements, considering inadequate to Ukraine weather condition design, as well as long-term operation. In 2019, the conditions in 6 settlements were acceptable [11]. In the settlement in Kryvyi Rih, the living situation was unsatisfactory, as metal corrosion, poor ventilation, leaking and mold were detected in all modules. Furthermore, the location of this settlement near to the mining and beneficiation plant had an additional, negative impact on its inhabitants [11].

In 2022, despite the exceeding the service life some people have been living in these settlements in poor technical conditions (most of them since the opening). Their residents are vulnerable segments of the population: the disabled, the elderly, large families and single mothers with children [11]. With the start of active military operations in February 2022, new families moved in. For example, the planned population of the Kamianske settlement was 480 individuals. However, on the date of July 30^{th}, 2022, only 199 occupants were present, comprising 114 initial IDPs wave and 85 who arrived subsequent to February 2022 [23].

4.2. Case 2 – Developments in early 2022

Due to the escalation of the military conflict, another CS were erected in 2022. The first phase includes locations in Lviv Oblast. Their common feature is location concentrated in and around Lviv and the short time between the war escalation on the 24^{th} of February 2022 and opening of the settlements, ranging from 54 to 110 days. Therefore, we treat these examples as another research case.

With the beginning of the war, a prompt resolution was sought to address the predicament of relocation of IDPs in Lviv, resulting in the construction of several settlements, intended to be used until September 2022. The Polish government provided furnished containers manufactured by Modular Systems company. The city government has identified three locations. The architects of the Department of Architecture and Urban Planning, a subdivision of the Lviv City Council's Department of Urban Planning, were responsible for the design. The first settlement constructed in 2022 necessitated completion within two weeks, so the decision was made to build it on asphalted sports grounds situated in Stryiskyi Park (Fig. 4a). This site was selected due to the proximity of all necessary utilities and a sport complex where IDPs resided. Additionally, this area is situated close to the city center, with well-developed transport accessibility and infrastructure. Subsequent settlements were situated further away from the city center, but with excellent transportation access to various areas of the city and established network of diverse public institutions. The second settlement was located between three colleges (Fig. 4b), and the third one belonged to the Congregation of the Salesian Fathers of Str. John Bosco, UGCC (Fig. 4c). The quality of landscaping in these settlements exceeds that of Stryiskyi park settlement, as more time was allotted for project development and implementation. Schools and kindergartens are conveniently situated in all settlements within walking distance.

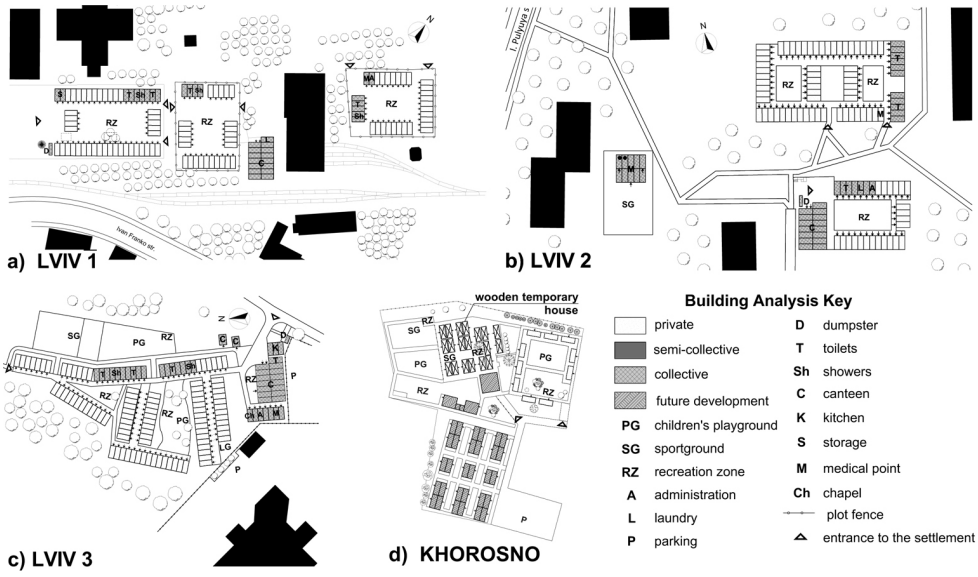

Fig. 4. CS built in the first part of 2022 – case 2

The settlement in Khorosno village was built 15 km from Lviv by Ukrainian Foundation Leo States. In this location there are primary facilities such as: primary school, retail stores, public eateries. The charity project was implemented in a phased manner, with the pace of construction being dependent on the availability of funds. Preparatory work for the construction of the settlement was carried out in March 2022. However, the first part of the settlement built of containers manufactured by a Turkish company opened on June 14, 2022 [24]. The second stage, entailing 19 wooden houses and masonry kitchen building, and the third phase with 30 modular houses and two other buildings are out of the scope of this study.

The plots allocated for the settlements vary in size from 0.5 to 0.945 ha, providing sufficient space to accommodate between 204 and 352 individuals per settlement (Table 2). Three of them (Lviv 1, Lviv 2, Khorosno) have a regular central courtyards c.a. 15,5 m by 33 m (Fig. 4a,b,d). On the contrary, in Lviv 3, row buildings form three internal courtyards of irregular shape (Fig. 4c).

Table 2. Quantitative indicators and general characteristics of the CS in the first part of 2022

	Lviv 1	**Lviv 2**	**Lviv 3**	**Khorosno**
Opening date	19/04/2022	06/05/2022	19/05/2022	14/06/2022
Area [ha]	0,5	0,55	0,945	0,7*
Beds	352	320	300	40 /204*
Area per 1 unit [m^2]	40,6	40,4	69,5	118,6*
Beds per 1 cu	2,86	2,35	2,20	4
Room units [cu]	88	82	94	10
Toilets [cu]	11	11	12	0
Showers [cu]	5	5	5	0
Canteen [cu]	14	12	14	0
Kitchen [cu]	0	3	3	0
Other [cu]	5	23	8	49*
TOTAL [cu]	**123**	**136**	**136**	**59***
Program**	A, C, L, M, S, RZ	A, L, K, C, M, RZ, PG	A, L, K, C, M, Ch, SG, PG, L, RZ	K, SG, L, PG, RZ
Building typology	row	row	row	single
Spatial arrangement	courtyard	courtyard	irregular	courtyard
Relation to city space	gated	semi open	semi open	semi open
Transition from collective to private	buffer zone (courtyard)	buffer zone (courtyard)	direct collective/private interference	buffer zone (courtyard)

cu – container unit; * – there are other non-container-units on the site;
** – according to analysis key at the Fig. 5

All settlements have similar programs containing units for living, cooking, eating, laundry and sanitation (Table 2). Additionally, in Lviv there are administrations and medical points. A two-story container medical center has been constructed adjacent to Lviv 2. The landscaping includes playgrounds, recreation areas, laundry zones, and garbage disposal facilities. Although Lviv 1 lacks a playground, one can be found in the park nearby. Lviv 3 and Khorosno have an additional sports area. The terrain is paved with various materials including asphalt, gravel, and mulch. Settlements Lviv 2 and Lviv 3, despite their seasonal purpose, had a high level of landscaping, which was possible due to the large plots. The settlements in Lviv are enclosed only where pre-existing fencing was present.

The settlements in Lviv have container rows ranging from 4 to 20 units in a line. Typically, the sanitary and hygienic containers are clustered together, either placed in a separate row or in conjunction with residential units (Fig. 5a). In the container row structure of Lviv settlements, one container is designed for administrative purposes, one for laundry facilities, and one for a medical center. Additionally, there is a one container chapel in Lviv3.

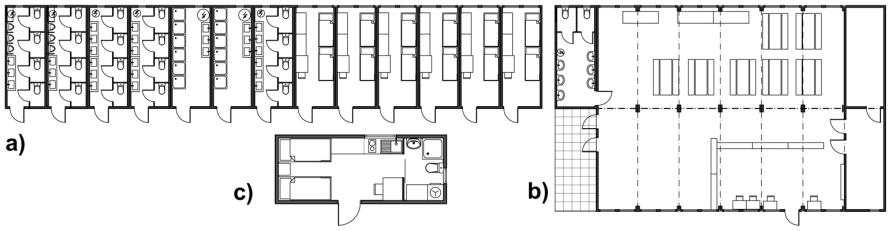

Fig. 5. Schemes of plans of container buildings in 2022: a) row; b) canteen; c) dwelling unit with sanitation and kitchenette in Khorosno

The three settlements in Lviv have canteens that serve as the largest collective spaces. In Lviv 2 and Lviv 3, the canteens were positioned at the periphery of the settlement, resulting in the farthest dwellings being up to 120 m away from the food preparation and consumption area. The canteens in Lviv consist of 14 containers, which are arranged to form a single large common space, often with a sanitary or laundry container attached; they also include play areas for children (Fig. 5b). In Lviv 3, a kitchen made up of three containers was built beside the canteen.

In Khorosno, there are 10 individual detached containers (Fig. 5c), each with an approximate area of 14.5 m^2 [24]. They are equipped with a kitchenette, a bathroom, household appliances and furniture.

All containers in Lviv are about 2.5×6 m in size (13 m^2) designed to accommodate four people. The height from floor to ceiling of the is 2.5 m., In Lviv settlements for the manufacture of bunk beds, gray chipboard sheets were used for the side parts and the lower part. While this choice could increase privacy and be suitable for strangers living together, it may not be optimal for family living, since the use of solid surfaces reduces the available space and makes the small container even more cramped.

The containers in Khorosno measure 2.6 by 6.5 m in size. The kitchen area features a sink, an electric stove, and a refrigerator. Additionally, the room is furnished with two bunk beds made of chipboard, a table with two chairs, and two wardrobes. The bathroom includes a shower with a curtain, a washbasin, a toilet, a washing machine, a bathroom cabinet, and a boiler.

All container settlements in Lviv are connected to the central city water supply and sewage network, as well as to the electricity grid. Electrical outlets and lighting devices are provided in all containers. Additionally, each residential and collective space is equipped with an electric convector to ensure proper heating. Internet connectivity has been established in all dwelling units, and the territory is well illuminated during the evening hours.

The containers in Khorosno come with a 10-year warranty [24] and are equipped with water, sewage, and electricity. The sewage tanks are located underground.

4.3. Case 3 – Developments in late 2022

After seizing military operations in Kyiv Oblast new temporary settlements were built to accommodate IDPs and locals (Fig. 6a,b,c). Additionally, at the end of 2022 there was a new large development built in Lviv (Fig. 6d) to relocate people, because older settlements were not suitable for winter.

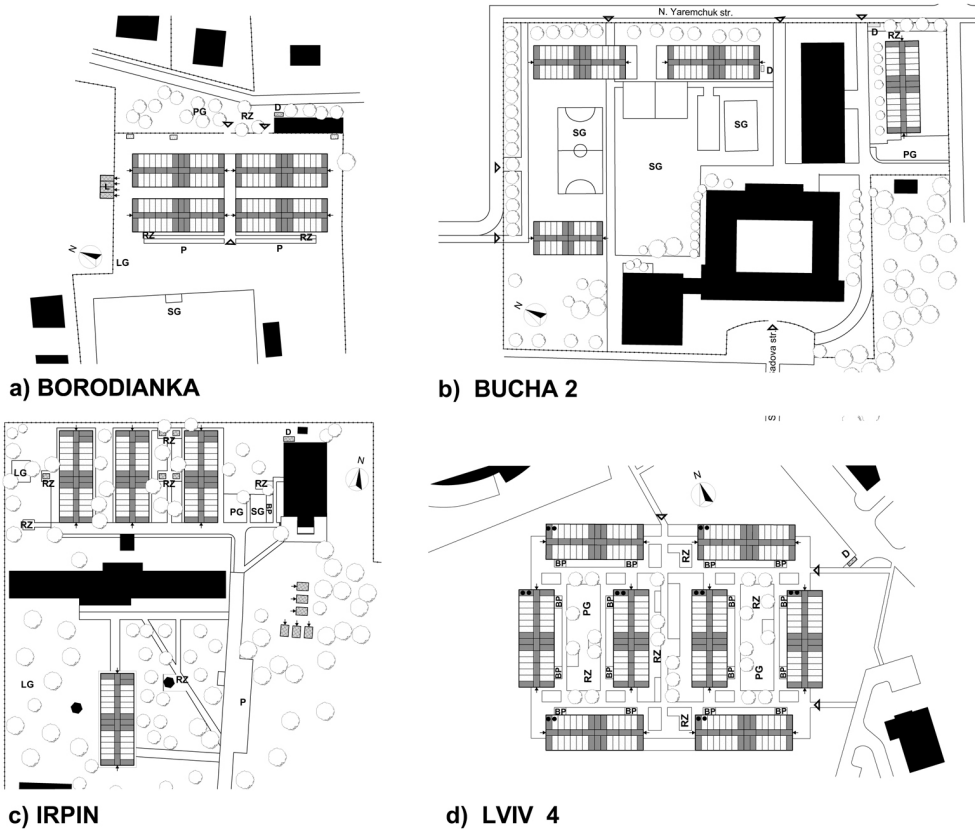

Fig. 6. CS in the second part of 2022 – case 3 (conventional designations see Fig. 4)

Settlements in the Kyiv Oblast, all raised by Zurad and Modular System companies and financed by the Government of Poland, were mostly built for local residents whose homes were damaged or destroyed. Therefore, they are located in small towns, preferably in the same neighborhood the residents had lived in before, to reduce trauma, continue social life and allow for rebuilding of homes. Due to mine risk, the local military administrations were responsible for selecting suitable locations, often on state-owned plots, previously used for other purposes: Borodianka settlement was built next to a football field (Fig. 6a), Bucha 1 and Vorzel on school premises, Bucha 2 on the parking lot (Fig. 6b), Irpin on the plot of the Dubky sanatorium (Fig. 6c) and Makariv on a rectangular, narrow plot, next to the hospital.

In Lviv the pressing need to relocate IDPs from three short term settlements to more permanent solution resulted in a new settlement, Lviv 4, build for year-round habitation. The short-term settlements Lviv 1, 2 and 3 was opened again in summer 2023 for new inhabitants. Lviv 4 was built next to the park (Fig. 6d), close to Lviv 3.

The areas of the plots range from 0.5 to 7.67 ha, but cannot be compared since the majority of them were built-up at the moment of settlement construction (Table 3). The approximate number of residents is 350, with the smallest 88 in Vorzel and the largest 1,280 in Lviv 4 [24], where two-story buildings efficiently use the1ha-large plot.

In Borodianka and Makariv a grid rectangular structure is formed by four identical buildings (Fig. 6a). Despite the same multiunit block layout, this ultra-rational scheme cannot be introduced in other settlements, due to the pre-existing site development. Lviv 4 consists of two compositions of four two-story buildings set around rectangular patios (Fig. 6d). This scheme provides good zoning between public space and semi-private courtyard but does not respect the orientation, so c.a. a quarter of all rooms will face North and not receive direct sunlight.

Various amenities have been added to the settlements, such as recreational areas, playgrounds for children, sports facilities, laundry areas, and parking. The quality of landscaping varies significantly. In Makariv, the area around the buildings is filled with gravel, with a swing located near the parking, while in Irpin the paths are paved, and gazebos and sports equipment are available. In Lviv, paver paths, benches, children's playgrounds, relax zones, and bike parking were designed [25]. The fencing of the settlements was not designed; however, buildings were often constructed on public plots that already had a fence.

All buildings in these settlements are typical and repetitive (Fig. 7) and usually comprise of 40 containers: 8 corridor, 22 residential rooms, 4 sanitary (separately for men and women), 3 kitchen/dining and 3 multi-functional units. All rooms are accessible from the common corridor with two entrances at the ends. Sanitary containers are positioned in the corners and the canteen is in the center. Three middle containers in each building have different functional purposes (In Irpin, these are library, gym and children's playrooms). Buildings in Lviv 4, each made up of 80 containers, have two stories (connected metal stairs) with similar structure to Kyiv Oblast. Furniture and sanitary equipment are similar to Case 2.

All dwelling units are equipped with an electric heating system. Initially some settlements in the Kyiv Oblast have problems with connecting to the water supply and sewage system, but progress has been made over time. In Bucha 2, for instance, drilling water well was required. Settlements without backup generators may experience prolonged disruptions to their water, sewage, and heating systems during power outages. In Lviv 4, these issues have been addressed as the settlement is connected to the city's water supply, sewage, and electricity networks and piping has necessary insulation.

Table 3. Quantitative indicators and general characteristics of the CS in the second part of 2022

	Borodianka	**Bucha 1**	**Bucha 2**	**Makariv**	**Irpin**	**Vorzel**	**Lviv 4**
Opening date, dd/mm/yyyy	01/06/2022	06/2022	24/06/2022	15/07/2022	13/08/2022	10/2022	Scheduled for 01/2023
Area [ha]	5.65*	0.5	3.2*	7.67*	3.31*	3.67 *	1.0
Beds	352	208	328	352	320	88	1280
Area per 1 unit [m^2]	344*	55.5	213*	479*	206*	917*	15.6
Max population density [beds/ha]	62*	416	102*	46*	96*	24*	1280
Beds per 1 cu	2.14	2.31	2.19	2.20	2.00	2.20	2.00
Building typology	4 MB	2 MB	4 MB	4 MB	4 MB	1 MB	8 2-story MB
Room units [cu]	88	52	82	88	84	22	335
Toilets [cu]	8	4	8	8	8	2	32
Showers [cu]	8	4	8	8	8	2	32
Canteen [cu]	8	4	7	12	8	***	32
Kitchen [cu]	4	2	4	12	4	***	16
Other [cu]	48	24	41	32	48	14	193
TOTAL [cu]	**164**	**90**	**150**	**160**	**160**	**40**	**640**

Table 3 continued on the next page

Table 3 continued from the previous page

	Borodianka	**Bucha 1**	**Bucha 2**	**Makariv**	**Irpin**	**Vorzel**	**Lviv 4**
Opening date, dd/mm/yyyy	01/06/2022	06/2022	24/06/2022	15/07/2022	13/08/2022	10/2022	Scheduled for 01/2023
Program	K, C, L, sport room, playroom, SG, PG, P	K, C, playroom, PG, L, P	L, K, C, playroom, SG, PG	K, C, PG, L, P	K, C, sport room, playroom, library, SG, PG, L, RZ, P	K, C, SG	A, K, C, L, 2 PG, RZ, BP
Spatial arrangement	grid	n/a**	irregular	grid	irregular	n/a*	courtyard
Relation to city space	semi open	gated	gated	semi open	gated	open	open
Transition from collective to private	buffer zone (corridor)	buffer zone (corridor)	buffer zone (corridor)	buffer zone (corridor)	buffer zone (corridor)	buffer zone (corridor)	buffer zone (corridor)

cu – container unit; MB – multiunit block; * – there are other non-container-buildings on the site;
** – spatial arrangement has not been formed; *** – Undetermined number.

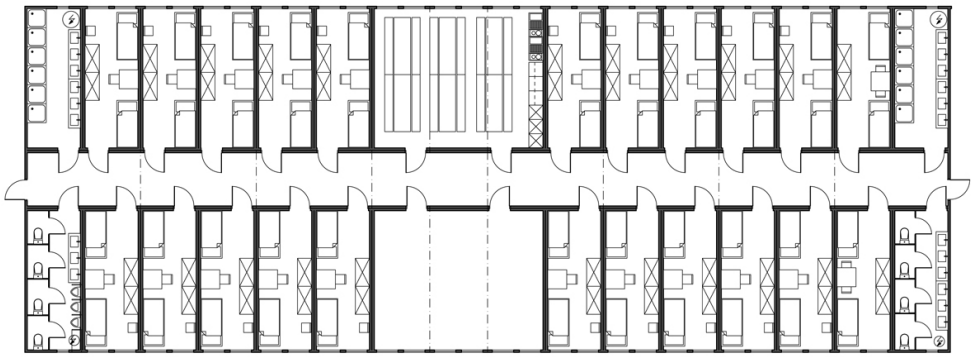

Fig. 7. Scheme of plan of multiunit block container building in 2022

5. Results

The comparative case study allows for outlining general characteristics of Ukrainian CS.

The use of containers implies typified unsophisticated architecture. The buildings share similar technical problems related to simple container technology: cooling in winter, overheating in summer and poor noise insulation.

Residential containers are about 6-meter-long and 2.5-meters-wide. In all cases the maximum planned capacity of the 12 m^2 large room was four people. Obviously, this area is not large enough for a long-term stay of more than 2 people, especially when they are not relatives. Combining two or more containers in one larger room was not found.

The only 2-story-high buildings were the medical center in Lviv 2 and 8 multiunit blocks in Lviv 4. All others are single-story, which is probably the result of the ease of construction and availability of terrain, despite the drawbacks of low density and energy efficiency.

Settlements built on separate plots in large cities have similar density (1 unit per 40–54 m^2) and programs containing units for living, cooking, eating, laundry and sanitation. Landscaping usually includes playgrounds, recreation zones, garbage disposal facilities and parking. None of the settlements had an organized care for children.

It is noticeable that the design of the CS depends on the available time prior deployment and the supplier/donor. The settlements of the Case 2 were designed and built rapidly, in the circumstances of escalating war, and were planned to be used for only half a year. In contrast, the settlements in Cases 1 and 3 were designed and built over a longer period of time with better understanding of the situation and were to be used for up to three years. These differences are visible in their architectural characteristics, like spatial arrangements and typologies. The main differences between the cases are:

Case 1: All developments are unified: plots usually have rectangular shapes; buildings are set in a grid and have a plaza in the middle. They were located on the outskirts of cities (what negatively affected the social integration and comfort of IDPs). Only quadruple and multiunit blocks were employed. The minimal level of privacy was achieved in multiunit blocks, where dwelling units are accessible by a shared corridor that works as a buffer zone. In quadruples

privacy is hampered as there is no vestibule that protects the first bedroom from collective space. In 2015 most dwellings in multiunit blocks had private bathrooms and all dwellings in quadruples had bathrooms and kitchenettes.

Case 2: Most of the settlements are built with the single-unit or row types (from 4 to 20 units in line). In the row type, appropriate only for a short-term stay, there is no privacy provided – dwellings open to collective or semi-collective space and are detached from the distant bathrooms. Despite the rapid construction of these settlements, the architects tried to create minimal comfort by forming the spaces of the courtyards and proposing a reach development of the site. In 2022, settlements were located both on the outskirts and near the city center, but they have good transport accessibility and lay in walking distance to the main facilities.

Case 3: In the developments from the second part of 2022 the plots were more diverse in terms of area, more irregular and included existing non-container buildings. Main important difference was using only the multiunit blocks, more suitable for all-year operation in Ukraine. A dormitory-like layout is fully dependent on shared facilities. The projects of the buildings were unified, so the only possible design intervention was to place them on the site and ensure the zoning of the plot. Privacy issues for multiunit blocks are analogous to the ones from 2015. The first two-story settlement, which tries to successfully follow a regular residential typology was made in Lviv at the end of 2022.

6. Conclusions

The crisis forces the decision makers to erect container facilities for IDPs and refugees. Obviously, none of the CS was intended for long-term operation. This perspective may justify the poor living conditions. However, the evidence of settlements built in Ukraine in 2015 shows that they are being used longer than planned. This fact must be considered in the process of designing new container settlements for IDPs and refugees.

Based on the research presented and the literature discussed, a list of recommendations for shaping the space of CS was formulated:

1. The main problem is the limited space per inhabitant. Since an increase of individual space is very difficult to implement, it is necessary to look for ways of humanizing settlements in urban planning solutions and ways of developing collective and semi-collective outdoor and indoor spaces in squares, footpaths, halls and corridors. The preferable standard for a family is separate living units accompanied by a bathroom and a kitchenette. At the same time, large communal kitchens should be provided.
2. The small size of housing units should be accompanied by a high standard of indoor air quality, thermal and acoustic comfort.
3. CS are mainly located on the outskirts of urban centers. This practice seems inappropriate as it excludes the residents from the city life, negatively affects integration into the local community, and release the public pressure on decision-makers to solve the long-term problem in a systemic and targeted way.

4. Green infrastructure solutions should be used to increase comfort with buffer zones, traffic separation and shadow. Estates should be located adjacent to or preferably directly among trees, that increases the aesthetics and the psychological comfort of the users. Urban farming would benefit to social integration as well as food production.
5. The age-diverse users of settlements need spaces for social integration and activity places to create a substitute for normal functioning for all age groups.

After a short period of operation as an emergency or temporary shelter, all CS end up in one of two ways: they are being dismantled and conserved for another crisis or transformed into homes. Either way, improving their living conditions and aesthetics are the key factors for successful help to the victims and the post-crisis recovery of the area.

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Osiedla kontenerowe dla osób wewnętrznie przesiedlonych na Ukrainie wybudowane w latach 2015 i 2022 – charakterystyka architektoniczna

Słowa kluczowe: osoby wewnętrznie przesiedlone, osada kontenerowa, schronienie ratunkowe, domy tymczasowe, obozy dla uchodźców

Streszczenie:

Osiedla kontenerowe były szeroko stosowane jako schronienie ratunkowe i tymczasowe mieszkania w Europie ze względu na zalety szybkiego rozmieszczenia, opłacalności i stosunkowo dobrego standardu życia. Mimo to wielu autorów podkreśla zagrożenia związane z naruszeniem ładu przestrzennego i stygmatyzacją mieszkańców, co może prowadzić do pogłębienia poczucia wykorzenienia i generowania istotnych problemów społecznych. Celem artykułu jest pokazanie głównych cech architektonicznych osiedli kontenerowych budowanych na Ukrainie w celu przeciwdziałania migracji wewnętrznej spowodowanej wojną. Wielokrotne porównawcze studium przypadku obejmuje 18 osiedli zbudowanych dla osób wewnętrznie przesiedlonych w trzech fazach: siedem osad w 2015 r. w obwodach dnieprowskim, charkowskim i zaporoskim, cztery osady w pierwszej połowie 2022 r. w obwodzie lwowskim i siedem w drugiej połowie 2022 r. w obwodzie kijowskim i lwowskim. Badania skupiają się na cechach decydujących o komforcie i jakości życia: wielkości osiedla, programie, typologii zabudowy, układzie przestrzennym, komunikacji, układzie jednostek, stopniu prywatności. Wyniki pokazują, że przypadki z lat 2015 i

2022 wykazują podobieństwa w zakresie podstawowego programu, wielkości jednostek mieszkalnych i intensywności, ale różnią się czasem przeznaczonym na projektowanie i budowę oraz przewidywanym okresem eksploatacji i typologią. We wszystkich przypadkach mieszkańcy woleli pojedyncze jednostki prywatne niż większe budynki o wspólnym programie. Podstawowe zalecenia dotyczące istniejących i planowanych zespołów to zwiększenie prywatności poprzez tworzenie przestrzeni kolektywno-prywatnej na zewnątrz i wewnątrz, opracowanie bogatego programu, wykorzystanie istniejącej zieleni i nowej małej architektury, zapewnienie dobrego dojazdu do ośrodków miejskich, stosowanie typów zabudowy odpornych na warunki atmosferyczne i technicznych rozwiązań odpowiednich do długotrwałego użytkowania. Ważnym wnioskiem jest to, że mieszkania w kontenerach są użytkowane dłużej niż planowano. Fakt ten musi być brany pod uwagę w procesie projektowania nowych osiedli kontenerowych dla przesiedleńców i uchodźców, które są planowane i budowane na Ukrainie i w Europie.

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