LIFESHELTER®

Field Report

Development of Lifeshelter Community Structures (LS5 and LS6)

Conducted by Lifeshelter
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1. Introduction

Lifeshelter is providing innovative shelter solutions for displaced and temporary communities.
With the refugee and IDP situations growing education becomes increasingly important. UNHCR currently has close to 20 million refugees under their mandate, whereof 7,5 million are of school age (UNHCR 2019). The enrolment in primary school is 63% while the enrolment is only 24% in secondary school. Though exact numbers are less accessible, the issue among IDP seems to be as disturbing (UNICEF 2019). Sustainable Development Goal number 4 aims to "*Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all"* (SDG, 2015).

The innovative, durable and well tested design of Lifeshelter's housing solution (LS4) has the potential to be scaled in size providing structures big enough to be used for e.g. classrooms. Lifeshelter has made the LS5 and LS6 community structures to provide affordable quality shelter, also when bigger rooms are needed. When costume fitted for the specific need and context, the LS5 and LS6 can be used for community centres, secure space for women groups, dormitories, CFS or classrooms helping to meet the immense educational gab among Refugees and IDP.

2. The First Pilot Projects

Based on the catenary curve that guides the shape of Lifeshelters, the 5-meter version has been made. The standard version of the LS5 offers a floorspace of 41m^2. As with the LS4 the panels are made from ROCKWOOL Stone Wool panels, plastered with cement and painted with weather guard paint. To increase the airflow through the room while creating a confined and private space the end walls in the LS5 are made from bamboo poles. As for the LS4, the LS5 comes in a stronger and airier "*plus*" version, which is also more permanent. The LS5+ sits on a concrete slap and the curved panels are raised from the ground on a 50-centimetre plinth wall.

Image 1 – Lifeshelter LS5+ at Undugu Primary School in Nduta Refugee Camp

The first tests of the LS5 prototypes were carried out in Denmark at Roskilde Music Festival in July 2017 and during UNLEASH in Aarhus in August 2017. Based on the findings from these two events, a list of iterations was made on the design. The first tests of the LS5+ prototypes in a refugee context began in March 2018. These are being carried out in Nduta Refugee Camp in the Kibondo District, North-western Tanzania, where two classrooms were erected at Undugu Primary School in collaboration with Danish Refugee Council (DRC).

Undugu Primary School is run by Caritas and has around 3500 students and 60 teachers. There is a total of 20 classrooms at the school; 9 permanent classrooms constructed by the Tanzanian Ministry of Education (TME), 9 Semi-permanent classrooms constructed by UNICEF and the two Lifeshelters. The TME Permanent and the UNICEF Semi-Permanent classrooms resembles the local standard for learning environment and will be used as comparison for the LS5+. Both classrooms have a floorspace of 68m^2 and comes in blocks of three classrooms. The TME permanent classroom has a cement floor, walls of burned bricks and a roofing structure made from timber and corrugated iron sheets. The UNICEF semi-permanent classroom has a floor of sundried mudbricks, walls of bamboo mats, posts of eucalyptus poles, and a roofing structure made from timber and corrugated iron sheets.

Image 2 – UNICEF Semi-permanent classrooms.

Image 3 – TME Permanent Classrooms.

3. Preliminary Evaluation

In March 2019 Lifeshelter, in collaboration with SC Denmark and the Technical University of Denmark (DTU), carried out a preliminary evaluation of the classrooms in Nduta Refugee Camp. The evaluation was based on focus group interviews with students, teachers and the school's Parent Teachers Association (PTA). Interviews with the headteacher of the school, with education officers from SC and Caritas and with DRC and UNICEF construction engineers were carried out. The interviews were supplemented by in depth observations of the learning situations and inspections on the structural qualities and deterioration of the LS5.

The classrooms proved to be structurally sound while providing a fair learning environment. As it would be expected from any development project, the LS5+ however lacked important details on a list of parameters. As described in section *4 Redesign and Upgrades* these details were quickly rectified by Lifeshelter.

As mentioned earlier the prototypes of the LS5+ are only 41m^2 while the other classrooms at the school are 68m^2. The standard class size in Nduta was 60 students per class but due to a lack of classrooms the numbers at times went above 100 students per room. The management at Undugu Primary School did not

do anything to mitigate for the LS5's inferior size meaning that the classrooms were highly overpopulated. The highly congested classrooms resulted in a poor learning environment, bad air quality and general misuse of the room.

To fit in as many students as possible, the benches and tables were placed along the side walls of the room. On multiple occasions during the lectures it was observed how the students were painting on the walls or pealing of the paint and plaster, thereby damaging the classroom.

The TME Permanent Classrooms in the camp were decorated with illustrations and learning materials, making the room more inviting and inspiring while averting the students from damaging the walls.

4. Redesign and Upgrades

By highlighting the above issues, the preliminary evaluation served as important feedback to Lifeshelter. Most of the problems discovered through the research proved to be simple to solve from a technical perspective but plays a crucial role for how the classrooms are experienced. Already in June 2019 a team of Lifeshelter workers upgraded the prototypes at Undugu to fit the newest iteration of the LS5+. The floors are screed with cement and the curb at the door is removed making it easy to clean the classroom and increasing the accessibility for disabled users. A wall to wall blackboard specially fitted to the curved walls is now standard in the LS5. To improve the durability of the classroom the walls have been reinforced on both inside and outside and a guideline for community involving school decoration is being developed. At the same time, it has been highlighted how clear guidelines for handover and maintenance are key to get the most out of the structures.

Image 4 – The refurbished LS5+ at Undugu Primary School

In early 2019 one of the LS5+ was erected working as a conference room at JKT Suma in Dar Es Salaam, Tanzania. To accommodate for the more exclusive use glass windows and doors was used for the structure and electricity was installed.

During June and July 2019, 10 of the new iteration of the LS5+ were constructed in Baidoa, Somalia for Save the Children (SC). Due to security issues in the region it was not possible for the Lifeshelter staff to be at the construction site of the school. During a period of 12 days a Lifeshelter technical specialist trained a team of local construction workers by erecting one LS5+ inside SC's guarded compound in Baidoa. Subsequently the local team of 9 people erected the last 9 classrooms for the school in less than 2 months. The project thereby proved the simplicity and availability of the Lifeshelter concept and demonstrated how the principles can be quickly adopted by local labour. Ownership was created among the local team and the rest of the construction process was supervised by Lifeshelter from afar. The quick training of local staff and remote management of the projects allows for a rapid scale up of the Lifeshelter production.

Image 5 – Ongoing construction of 9 Lifeshelter LS5+ at a Save the Children School in Baidoa, Somalia.

The small but highly important iterations on the LS5+ described above do not solve the need for a bigger room. A need which was discovered during the Preliminary Evaluation. The evaluation showed how the management at Undugu Primary School had a hard time mitigating for the different sizes of the classrooms resulting in over congested classes. This highlights how the solutions need to be context specific to avoid unforeseen misuse of the products. To accommodate for the insufficient size of the LS5, Lifeshelter has developed the LS6 and LS6+. Building on the same principles as the LS4 and LS5, the LS6 is 6 meters wide and has a floorspace of up to 70m^2.

5. Evaluating the Upgrades

In October 2019, User Experience Manager at Lifeshelter (MSc. Design and Innovation Engineer, Kristian Lund), visited Nduta refugee camp to inspect the upgrades of the classrooms at Undugu. Throughout observations on the structural quality, the upgrades and the wear and tear on the LS5+ were carried out

with the DRC Shelter and Infrastructure Officer. These were supplemented with semi-structured interviews with the Head Teacher, the Head Teacher Assistant, the Inspector and a 4th grade teacher doing daily teaching in the Lifeshelter classroom.

The response and the experienced quality of the classrooms were significantly different from before the upgrades.

The floor was clean, and the rooms were generally tidy, while some benches and tables had been removed, thereby making the room airier. The screed concrete floor was highlighted as an advantage in both the Permanent and Lifeshelter classrooms by the respondents. At the same time all highlighted how the big blackboards made the classrooms much better, there were now space for teaching and the students furthest away could see what was written on the board.

In one of the classrooms, there were a few small damages in the plaster and rendering (diameter of 2-5 cm). It was proposed by the respondents that decorating the wall could help prevent the kids from pealing the plaster. Also establishing a plant bed along the outside wall could prevent the kids from damaging the walls.

When it is raining the teaching stops because of the noise in both the TME Permanent and in the UNICEF Semi-Permanent classrooms – the students cannot hear what the teachers are saying. All respondents however explained how the noise was not an issue in the LS5 and the teaching could continue even during heavy rains. At the same time the Lifeshelter was experienced to be less cold than the other classrooms during the rainy season. "*The Lifeshelter keeps a more stable temperature – it is cooler when it is warm and warmer when it is cold.*" (Ntakirutimana John, grade 4 teacher in LS5+). Especially in the Semi-Permanent classroom spray from the rain was described as an issue, at times forcing all the students to the one side of the classroom. In the two other classrooms minor spray was experienced on the seats closest to the openings – the back row in the Lifeshelter and the window seats in the Permanent classroom.

When comparing the Lifeshelter classrooms to the other classrooms at the school, all respondents explained that they would choose the Lifeshelter classroom before the two others. Price, construction time, absence of noise during rain and indoor climate was given as arguments. If price and construction time was not taken into consideration the permanent classroom was however preferred, but this was due to its bigger size.

6. Environmental impact

From the LS4 it has been proved how the Lifeshelter construction concept provides durable and long-lasting shelter solutions. The long lifetime ensures a minimal environmental impact due to the low use of resources and little maintenance needed.

Large scale displacement is well known to accelerate already ongoing depletion of natural resources in host areas (Maystadt et. Al. 2019). The environmental degradation implies, among others, rapid deforestation due to land clearance for farming and an extensive need of wood for construction and cooking. As an example, the forest cover in Uganda has decreased from 23,8% of the total landmass in 1990 to 10,4% in 2015 (IndexMundi, 2019). Burned bricks are one of the major construction materials used in East African countries and forms the basis of the standard permanent schools. With an excessive waste of energy most of these bricks are burned with firewood by artisans and small- and medium-scale manufacturers (Hashemi

& Cruickshank 2015). When burning bricks in traditional kilns approximately 3 cubic meters or what is equal to 1 ton of wood is needed for burning 1000 bricks (240x115x73mm) (Beamish & Donovan 1988). For a block of three 68 m^2 TME permanent classrooms a total of 11.000 (280x150x100mm) bricks are needed. The volume of these bricks is around the double of those described by Beamish & Donovan, 6 cubic meters of firewood therefore goes on 1000 bricks. In other words, 68 cubic meters of firewood is needed to burn the bricks for one block of TME permanent classrooms. Much of the wood for brick burning often comes from natural forests, where the pace of woodcutting largely surpasses the afforestation efforts (Aswile 2012). To increase the durability of the shelters and to avoid deforestation in areas of mass influx there are used no wood in the Lifeshelters. The bamboo used in the gables of the LS5 and LS6 are chosen because of its low environmental impact and are sourced from local sustainable farms.

As part of the extensive research project; *Healthy Housing for the Displaced* (HHFTD) researchers at Bath University have made a carbon emission calculator for housing shelters. When comparing the LS4 to the 81 other shelter solutions in the HHFTD database, Lifeshelter proves to be one of the far most climate friendly emergency and transitional shelters (HHFTD, 2019). HHFTD uses the functional unit; *kilos of emitted CO^2 equivalent per square meter per year*. The LS5 and LS6 is essentially just scaled up versions of the LS4 and these structures can thereby be assumed to be as well performing – the environmental impact per square meter is minimal for the Lifeshelters.

If the need is no longer where the structures are, the Lifeshelters can be cut apart and erected at a new and relevant location. The process is simple and fast, and it can thereby be secured that no structures are left unused. The materials alone can however also be reused to energy upgrade new or existing buildings. The ROCKWOOL panels can easily be straightened out and used as façade, floor or roofing insulation. ROCKWOOL panels are also widely used for acoustic dampening and the panels can thereby be used to upgrade the acoustic properties of other more permanent buildings, e.g. classrooms.

7. Cost efficiency

The price of the LS5 is $3400 while the price for the LS6 is $5000, making them highly cost effective compared to other semi-permanent structures. At the same time the durability and easy maintenance of the Lifeshelter plays central role not only for the user satisfaction and environmental impact but also for the cost efficiency of the structures. Compared to permanent structures the cost per square meter for the LS5 and LS6 is around the half. At the same time the construction time is significantly lower – one LS5 can be erected in less than two weeks.

Living up to the Grand Bargains commitment to localization (IASC, 2016), all materials for the Lifeshelter apart from the ROCKWOOL panels are sourced locally. All production, assembly and construction of the shelters are done within proximity of the shelter's final destination with the use of local labor, taught through the Lifeshelter training module. The projects thereby contribute both to the local economy and to capacity building in the communities.

Through interviews and dialogues with country directors, education coordinators and field officers from SC, IRC, NRC, DRC, Caritas, DFID, and UNHCR it is confirmed that LS5 and LS6 has the potential to fill out a gab of affordable quality community structures providing e.g. quality learning environments for emergencies. The LS5 and LS6 falls into a category of semi-permanent structures that are more durable than the current solutions while being much cheaper and faster to set up than the permanent burned brick structures.

8. Conclusion

The needs, the standards and the expectations to semi-permanent structures are different from place to place so in order to provide quality structures to emergency situations the solutions need to be context specific. The Lifeshelter community structures can therefore be provided in two different widths and in whatever length that is needed. At the same time the *plus* version of the shelters allows for higher durability and more airspace if this is needed.

Based on the experiences from the LS4 and the field tests in Nduta the Lifeshelter LS5 is ready as a commercial product. Building on Lifeshelters user centred and explorative approach the products are continuously going through iterations enhancing the details in the attempt to make the best possible shelter. Whereas the LS4 has been tested throughout a 5 years period the LS5 has only been tested for 1,5 years. projects with LS5 Lifeshelter is therefore highly attentive to the performance of the product and follows its use, durability and need for maintenance closely.

The Lifeshelter innovative construction concept combined with the Lifeshelter training module has proved to allow for rapid scalability. Training of trainers can happen within less than two weeks allowing for fast construction of many structures at multiple locations at the same time.

From the field tests it is clear that the LS5 and LS6 has the potential to fill in the gab of affordable semi-permanent structures of high quality. The Lifeshelters are cheaper and must faster to erect than the permanent classrooms while providing a much better room than other semi-permanent structures.

Figure 1 – Lifeshelter LS5 Community structure at JKT Suma in Dar Es Salaam, Tanzania. The community Structures can be fitted for whatever purpose a shelter is needed for.

9. References

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