Niger revision Sahel shelter kit

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Title:	Report – Niger Sahel shelter review
Date and place:	Luxembourg – 2017.09.15
Project name & code	24NE00 Review and improvement of the Sahel shelter solution
Service client	AI Croix-Rouge Luxembourg

1. Overview

The AI CRL has been working since 2013 in Diffa, Niger. In close collaboration with the Nigerian Red Cross (CRN), it carries out interventions in the area of shelter and sanitation for refugees and IDPs in the Diffa region after the crisis in Lake Chad. In this context and with the support of various funders (MAE, HCR, ECHO), the AICRL and the CRN have worked in the region of Diffa by building two types of shelters including 1,147 houses in adobe and 10,538 emergency shelters, as well as family latrines and emergency latrines.
The IFRC-SRU has been called to conduct a technical mission in Niamey (Niger) from August 20 to 27th 2017. The overall objective of IFRC-SRU's consultancy is to review and upgrade the current implemented shelter solutions in the country by showing the adequacy of the reviewed Sahel Shelter kit (BF 2017) in to a model adapted to the conditions in the Diffa region. Based on the same structural concept and regional conception, the model should address in particular the following needs:

- Improvement of durability, mobility, modularity of the current emergency Shelter Kit in Diffa
- Adjustment of the composition of the constitutive kit to propose a transitional model
- Transportability and re-usability of the kit components to complement the living spaces of the beneficiary households

2. Proposed Methodology:

The review and design methodology was organized as follows:

- Summary of the implemented shelter solutions in the country with the available data including the identification of possible developments.
- Market visit and selection of materials for the improved design
- Participatory process to adapt the reviewed Sahel Shelter kit design with the local team and workshop to build a prototype in Niamey
- Documentation and reporting at headquarters

NOTE: *In addition, the construction of a prototype in Diffa and the analysis of the adequacy of the proposed model with the needs of the beneficiaries will be done by the local team.*

CRL summary reference of the implemented projects in the country

The existing documentation on shelter projects developed in Niger by Luxembourg Red Cross (LRC) is extensive.
The following list shows the projects and emergency shelters developed and implemented in Niger by the LRC

Region	**TILABERY / TAHOUA**

Project	Internal code	Donor/partner	Date
Emergency aid for refugees in northern Mali - Emergency shelter	-	-	2013
Emergency aid for refugees from the north of Mali. Emergency shelters for the relocation of camps	-	-	2013

Region	DIFFA		
Project	**Internal code**	**Donor/partner**	**Date**
Strengthening the capacity of local communities to provide shelter for Nigerian refugees	17NE06	UNHCR	2013
Construction of shelters for refugees and returnees from Nigeria	17NE08	IOM	2013-14
Reconstruction for disaster victims	17NE09	MAE (LUX)	2014
Protection and assistance to Nigerian refugees and Nigerian nationals	17NE12	UNHCR	2014
Assistance to Nigerian and Displaced Nigerian Refugees	17NE19	MAE (LUX)	2015
Assistance to Nigerian and Displaced Nigerian Refugees	17NE21	UNHCR	2015-16
Assistance in emergency shelter and health facilities for Nigerian and Nigerian refugees	17NE20	MAE (LUX)	2015-16
Assistance in shelters and emergency latrines in response to population movements	17NE24	ECHO	2016-18
Assistance in shelters and emergency latrines in response to population movements	17NE25	MAE (LUX)	2016-17

Summary of types of emergency shelter developed by region, target population and period:

Beneficiaries	Date	Region	Quantities	Image
Malian refugees	2013	Tillabéry, Tahoua	3000	
Comments	Emergency shelter Shade net placed on the tarpaulin; Incorrect use of shade net reported (no photos available). Plastic cover not reinforced, but no comments about the durability due the Shade net effect.			

Beneficiaries	Date	Region	Quantities	Image
IDP Niger	2013-2017	Diffa	12227 (2016)	
Comments	Emergency shelter Sustainability expected 6 months. The population stays longer. Tarpaulin reinforced IFRC. Wood, tools, mats and ropes purchased locally. Shade net eliminated due to incorrect use by the beneficiaries. Termite attacks reported in poles.			

Obtained key indications

The shelters distributed in Niger until the end of 2016 have a structure entirely made of eucalyptus wood without protection against termites.
The shelters planned for 2017 also have the same shape and material of structure (eucalyptus). A modification to upgrade the shelter solutions avoiding termite attacks appears as the immediate need to improve the shelter response in the Diffa region. The implementation of a reviewed solution will have repercussions on budgetary, operational and administrative aspects.

Analysis of the shelter implemented in Diffa

The two weaknesses identified:

1- Reduced shelter durability due to the impact of termite attacks: damaged shelter wood
2- Pre-positioning of kits limited due to the short warehouse life expectations of the used materials

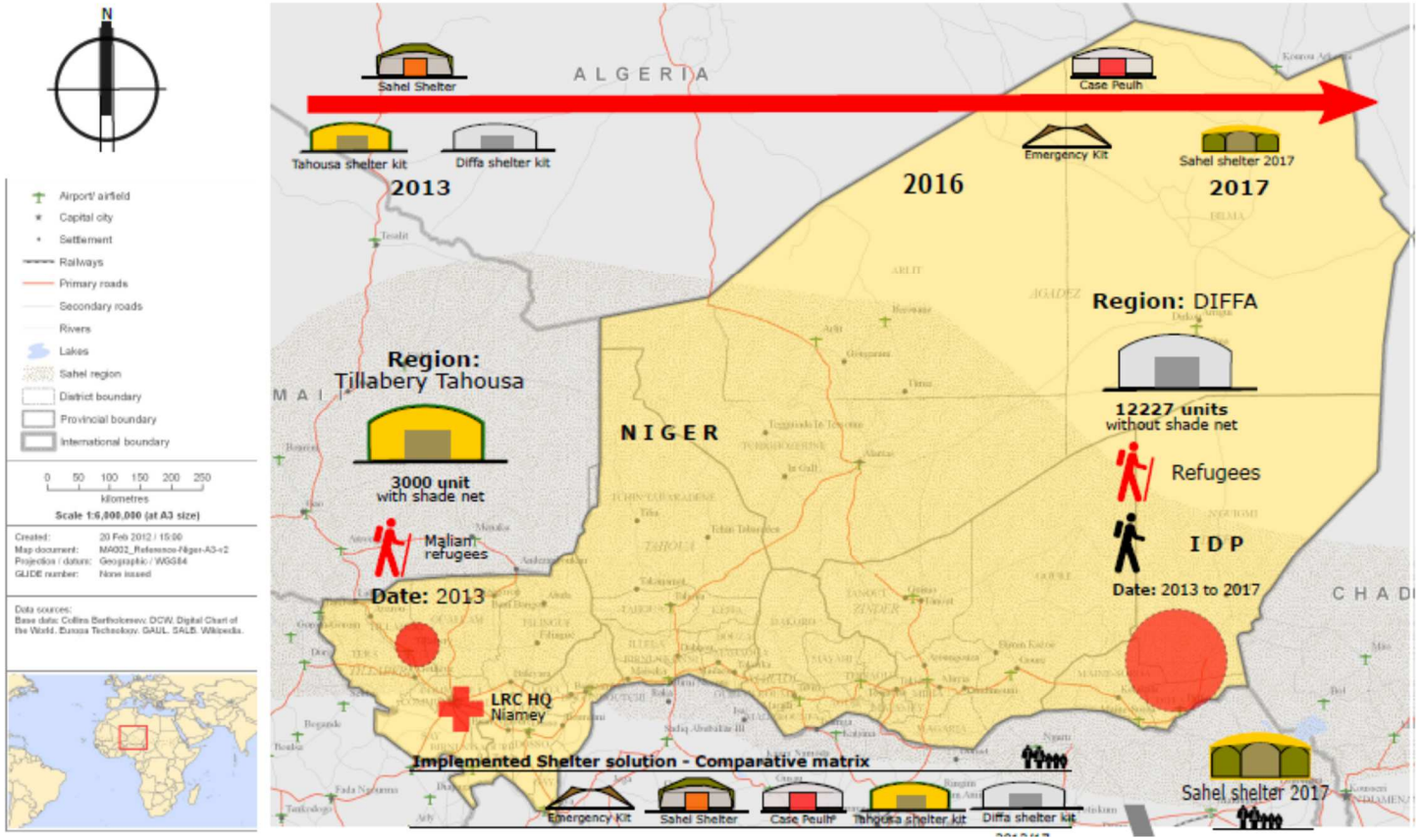
The impact of these first two constraints is important:
Termite attacks reduce the sustainability of the shelters which should have an expected life duration of 6 months for an emergency. However, a lengthier durability would be desirable because the reality of Diffa makes the beneficiaries stay longer in the shelters.
Failure to pre-position kits (materials) limits the ability to respond immediately if there is a sudden need. Furthermore, the logistic operations become complex due to the lack of long time warehousing materials.

Preliminary base of work and complementary information

- *Termite shelter attack*: We can consider the possibility of a fast reaction in modifying shelters planned for 2017 that are not yet purchased and replace the wooden posts + drain oil (highly ecological impact involved in this operation) for metal tube posts as proposed in the general Sahel shelter model implemented by LRC.
- *Warehouse and prepositioning:* We would define two possible complementary options: create a 100% storable shelter kit.
  - The currently implemented shelter solution designed by the SRU in Burkina Faso appears as the track to follow focussing on the Sahel context and shelter operations of LRC. With alternative materials to wood and vegetal mats, the proposed shelter responds 100%/ entirely to the warehousing requirement.
  - Define logistical strategies to complete a partially storable kit in sufficient time with local perishable materials. Examples: store a limited amount of the complete kit to meet the immediate needs of the contingency plans, while the local procurement process is in place / create framework agreements with suppliers to ensure immediate delivery.
- *Warehouse and logistics:* Currently the wood comes directly from the plantations to Diffa, transported by suppliers. The quality control on site is becoming complex due to the short time and dynamics of the operation. Furthermore, the effort of the charge / discharge makes the process complex and completely depending on the supplier's capacity. The CRN proposes to use the three existing warehouses in the regions (Marad, Tahoua and Zinder). The operational relevance of these pre-position points should be assessed together with the concept of using metallic poles and other alternative materials for the shelter structure.
- *Shelter model:* To ensure a uniform shelter model, the Red Cross volunteers assist the most vulnerable people in the shelter construction. This action is complemented with volunteers trainings and monitoring during the construction process. However, the rest of the beneficiaries do not have this assistance and they built the shelters according to his individual knowledge, capacities and cultural approach. The result is that the variety of

the implemented shelter is diverse and rich in forms, surface and other particularities showing the flexibility and good acceptance of the current shelter kit approach. In order to ensure minimum safety in the built shelter and construction techniques it could be recommended to include a series of “soft activities” to complement the operational aspects. It can be interesting to consider workshops, example shelters, gender sensitizations, awareness brochures, among others.

Graphic summary of findings and base of design



3. Proposed design for T-Sahel shelter (*Niger variation*)

Overview

2017 Niger revision of the Sahel shelter solution

In the context of a regional approach, we have proposed a basic design for a common emergency shelter solution in the West Sahel region. The shelter solution was developed in Burkina Faso with the support of the LRC. With the current design variation in Niger, we aim to show that the strategy of a common concept with a stable structure, specific shape and materials can be easily adapted to the particular variations of the Western Sahel context with the same good performance.

As previously agreed, the solutions should match the following requirements:

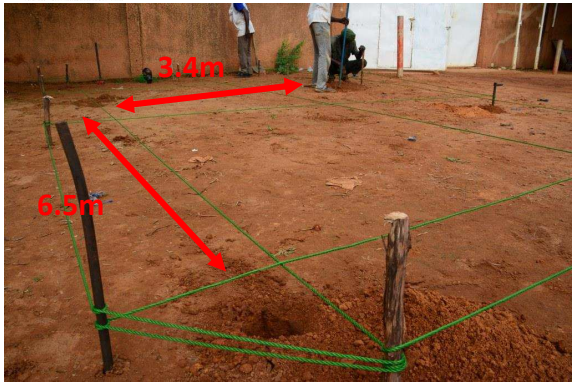
Requirement	Value
Shelter covered surface	Min 20m^2
Target price per unit in the local market	200Euros*
Construction time	1 to 3 days
Target durability of the shelter in predefined conditions	12 months
Warehousing materials	At least 75% of the items
Target warehouse time	3 years

Note:* Price for the needed materials in the field (not included local transport/construction fees and/or others)

In addition, due to the operational conditions in the field, we worked on two prototypes with the same structure and shape design but with different cladding materials in order to respond to specific demands.
The Cladding materials of the first shelter were selected in the local market focussing on the warehouse time and availability. Notice that we define the minimum of the warehouse conditions as a dry and covered space.
For the second shelter, the focus was on the immediate response and we used the same materials that are currently used in the operations (Diffa region).
With these two prototypes, we show the flexibility of the proposed regional solution: it can be deployed fast as a prepositioned shelter and it can also be used as a shelter solution for a mid to long-term operation with local materials that cannot be prepositioned for a long time.

Shelter design

7.1	Structure kit
Foundation Plan and Stakeout The proposed dimension for the Shelter is 6,50m x 3,40m with a total surface area of 22.10m^2 covered surface (Sphere Standard 3,5m^2 per persons). The rationalisation and standardisation of the dimensions of the shelter also facilitates the stakeout process. It is recommended to use of basic methods “3,4,5” or metallic bevel would facilitate the process and ensure the quality of the construction. A reduced number of pillars consequently also means a reduced number of excavations. Furthermore, with the measures undertaken to stabilise the structure and make it more self-supporting, the depth of the new excavation will be in function of the soil context with minimum 25 cm deep (max. 40cm) for each pillar. Additional measures can be necessary to ensure the structural stability depending on the soil type and shelter exposition to the wind pressure.	



Stakeout prototype

Alignment of pillars

Poles (walls)

The poles in metal tubes were used instead of wooden poles with a section of 30 x 30mm or Ø=40mm; e>1,5mm.
The main ideas behind using metal poles are to: improve the structural resistance, increase durability; long warehousing life and (based on the experience) avoid the possibility of termite infestation.

The height of the central pillars is set to 2,20m (2,50m in total), the height of the corner pillars is 1m (1,30m total) and the height of the perimeter pillars is up to 1,80m (2,10m in total). The head of the pole finishes in a U-shape piece that will receive the dome structure. At the foot of the pole, a “ring piece” will allow the introduction of and additional bar to create a T-shape increasing the resistance of the shelter in sandy grounds.

None of these structural modifications affects the shape of the actual shelter solutions and the general proportions of the original model remain similar. However, the new dimensions allow for standardisation and simplification of the construction process through reduction of materials for structure. In addition, the roof will have a double surface shape that will considerably increase the overall resistance of the shelter. Finally, the interior space is higher than the older shelters which is widely appreciated by beneficiaries.

The central pillars are higher to increase the inner space

Metallic piece on the pillar foot – improving resistance in soft soil

Dome Structure

The design includes the dome concept for the roof shape. The geometry of the dome was created through arches attached in a rectangular perimeter over the poles heads. With this layout, using diagonals and triangulations, the resistance of the entire system is improved and the rationalisation of used material represents another substantial improvement. The chosen material is PVC (d=32mm) commonly used in the region for black water conduction. With the inclusion of this material the warehousing time will increase up to 3 years, the risk of termite attack will disappear and the expected durability of the shelter structure will be more than 12 months. Furthermore, the experience in Burkina Faso shows that the beneficiaries appreciate the material and the shelter remains stable and with no changes for the last two months.

Triangulation of the bars to ensure load transmission

Double curved surface increases resistance in all directions

Bracing

The reduction of different structural elements required additional measures to ensure stability of the structure. In order to ensure the required rigidity an arch system was introduced in the perimeter as a complement of the dome structure. The used material is the same PVC (d=32mm) fixed with metal wire on the pillars and perimeter arches.

Arches to improve the structural resistance between pillars

Bracing placed with a U shape in the short direction of the shelter

Structural Joints

The proposed structural joints facilitate the implementation of the shelter solution without decreasing the structural resistance. A simple attachment using metal wire for the connections provide a strong joint system and is a well-known material by the volunteers.
Note: This fixing system with secure and stable knots could need preparation and monitoring of staff and beneficiaries.

Metallic wire for the unions attached with a clipper

U-piece on the head of the pillars to ensure the union with the arch

7.2	Cladding System kit

Vertical Cladding

For the first shelter *(warehouse version):*

For the walls, we tested a combination of two materials: poly-cotton and jute fabrics. However, for the final warehouse version we will use a Poly-Cotton fabric for the walls. Please notice that is not recommended to use a pure white colour for cultural reasons, clear colours are recommended but not the pure white.

On the walls, the fabrics are attached directly to the “lintel-beam” with a continuous sewing line and sewn vertically to the metal poles. On the longer side, the fixation of the fabric can be improved by adding a horizontal bar attached on the bottom part of the wall.

For the second prototype *(immediate response):*

The walls made with 12 vegetable mats of 120 x 220cm directly stitched on the shelter structure. The mat stitched directly over the lintel-beams, bracing arches and metallic poles. Please notice that the stitch can be done with metallic wire and/or 1mm rope.

“Warehouse” version with Poly-cotton fabrics in the walls

“Immediate response” version with vegetable mats

Dome Cladding - Inner Layer

For the first shelter *(warehouse version):*

The inner layer that covers the dome structure (PVC) is made of jute fabric from recycled bags. This layer is pre-confectioned before setup. The jute bags are opened and stitched together to a full cover of the dome. This cladding element is prepared with 18 pieces of 120 x140 cm from the open sacs. Finally, the cover is fixed over the dome as one piece, serving to protect the second layer - the plastic sheet - from the wooden structure and/or metallic wire joints, while at the same time providing insulation and a comfortable interior ambience.

For the second prototype *(immediate response):*

The inner layer that covers the dome structure (wood or PVC) is made of vegetable mats. The mats stitched together to a full cover of the dome with 14 units of 120 x 220cm. Finally, the cover is fixed over the dome as one piece.

Jute bags stitched over the dome structure

Vegetal mats as a first layer of the dome

Dome Cladding - Outer Layer

This layer is reduced to one 4m x 10m tarpaulin from a roll, or 2 (4 x6m) standard tarp. The tarpaulin is fixed with a 4mm nylon rope. The tarpaulin sides are stitched to the lintel beam with a 1mm nylon rope. This rope is used to pull down and tension the plastic layer and fix it directly to the shelter structure at the 4 corners. Furthermore, the plastic sheet is pulled down over the short ends and anchored to the lower part of the structure at four poles. This solution provides extra protection against lateral rains and winds during the rainy season.

Quality plastic sheeting fixed to the bottom part of the metallic poles

Avoiding holes in the plastic sheeting to ensure water proofing

7.3	Additional kits that could be used in this shelter

Flood Protection

The proposed solution is a barrier with sand bags positioned around the perimeter of the shelter. The bags are made from 90kg (50 x 90cm) plastic sacks available in the local market. They are cut in half and sewn by hand to form tubes of 25cm x 90cm and finally filled with sand (or available soil) from the site. The plastic bags have to be placed inside the shelter to protect the plastic from the UV radiation and hold down the shade net walls. A very simple and cost effective solution that works well.

Plastic bags cut in half and stitched

Physic barrier to avoid water from the ground inside the shelter

Doors

The design of the shelter includes two doors placed on the long side of the shelter and situated opposite each other. With this disposition of the main doors we will facilitate the cross ventilation. Furthermore, the doors can be opened fully by rolling up or partially to create a space protected from the direct sun exposition; a passive architectural solution to easily increase the comfort inside the shelter. At the bottom part of each door a wooden piece is stitched in order to facilitate the closing system by attaching the door to the metallic poles.

The open door configurations

Door view from inside closed and attached to the poles.

Inner partition

Based on the feedback of the beneficiaries from BF and the particular requirements of the Niger context (polygamous society), the shelter solution should allow the beneficiaries to make one or more interior partitions. The distribution of the inner space in the shelter can easily provide the opportunity to divide the shelter in 1, 2 or 3 interior spaces. Proposed solution for this interior partition: using a fabric attached to the structure to divide the interior space.

Interior partition open

Proposed interior partition closed

7.4	Logistics and Economics

The proposed shelter design provides longer life span, better stability, comfort inside the shelters and a full storable kit. The structural concept and materials have proved good results in terms of resistance, acceptance and market availability. The different variations for the cladding solution verified the adaptability of the proposed solution.

It is pertinent to flag that the use of new storable items (e.g. plastic tubes) that are not well known by beneficiaries who are more familiarized with a seminomadic life and ephemera architecture, can negatively affect the acceptance and change the cultural approach of the shelter kit. The conception of the improved shelter solution includes the flexibility in terms of selected materials. The tubes for the dome structure can easily be changed with eucalyptus wood d=30mm+; and the shade net on the walls can be changed for vegetable carpets.

Proposed variation with dome in eucalyptus wood

Shelters with the same structure concept but alternative cladding materials

The concept of the proposed reviewed Sahel kit offers the possibility to distribute a combination of complete solutions that can be complemented by additional kits according to the specific needs and situations. In addition, the total weight of one shelter kit is 75kg and can be distributed in two packages for easy transportation.

The full kit organized in 2 hand carried packages

Transport of the package

The proposed solution provides the flexibility to adapt the composition of each kit separately to the locally available materials and operational requirements. Furthermore, this kit conception facilitates distribution in logical phases of the building process and seasonal requirements (rain proofing, flood-protection, shading).

7.5 Detailed BoQ of the two shelter prototypes

The following tables presents the cost of the separate kits and the complete shelter in the two versions (warehouse and immediate response), using the best value for money prices for 1 prototype and from local suppliers in Niamey, Niger (as of 2017.08).

Niger revision Sahel Shelter (immediate response)					
Material	**Dimension**	**U/shelter**	**Unit price (CFA)**	**CFA**	
Post with (30x30mm L>1,30m)	unit	4	1800	7200	
Post with (30x30mm L>2,10m)	unit	6	2267	13600	
Post with (30x30mm L>2,50m)	unit	2	2500	5000	
PVC tube 32mm	unit	22	2000	44000	
Wire metallic roll (min 3kg)	unit	2	3000	6000	
Subtotal Structure					75800
Vegetable mat (1.2x2.2)**	unit	26	1000	26000	
Tarpaulin (4x6m)	unit	2	9000	18000	
Nylon Rope (Ø4.0mm)	roll	1	3500	3500	
Plastic mat- doors (1.2x2.2)	m2	4	2000	8000	
Thread & sewing needle	kit*	1	1200	1200	
Subtotal Cladding + Roofing					56700
Plastic sacks (30x40x90cm)	unit	16	350	5600	
Flood kit					5600
Grand total CFA					138100
Grand total Euro					**210,84 €**

Niger Review Sahel Shelter (warehouse version)					
Material	**Dimension**	**U/shelter**	**Unit price (CFA)**	**CFA**	
Post with (30x30mm L>1,30m)	unit	4	1800	7200	
Post with (30x30mm L>2,10m)	unit	6	2267	13600	
Post with (30x30mm L>2,50m)	unit	2	2500	5000	
PVC tube 32mm	unit	22	2000	44000	
Wire metallic roll (min 3kg)	unit	2	3000	6000	
Sub total Structure					75800
Jute (1.20x1,40)	unit	18	500	9000	
Tarpaulin (4x6m)	unit	2	9000	18000	
Nylon Rope (Ø4.0mm)	roll	1	3500	3500	
Cotton fabric (h=1.5)**	m	20	1000	20000	
Thread & sewing needle	kit*	1	500	500	
Subtotal Cladding+Roofing					51000
Plastic sacks (30x40x90cm)	unit	16	350	5600	
Flood kit					5600
Grand total CFA					132400
Grand total Euro					**203,69 €**

Note: * 2 needles + 1 roll of 1mm nylon rope
** interior partition can be add: Vegetable Mat 4 units=4000; Cotton fabric 4m=4000; other material available in the local market can be used
Tools needed: metallic bar + saw + clipper

7.6 Maintenance of the shelter

In order to achieve the expected durability a minimum maintenance is needed.
1- Tensioning the ropes that attach the tarpaulin (4mm nylon rope) is the main action of maintenance.

Action: periodic control of the ropes.

2- Sewing lines are important parts of the shelter (metallic wire or nylon rope).
Action: Periodic control of the stitches/possible replacement needed

3- Pillars transmit the load to the ground and need to be checked periodically.
Actions: compact the ground on the pillar base, control the joints on the pillar head.

4- The flood kit is a passive barrier to ensure the quality of the inner space in the shelter.
Action: protect the plastic bags from direct sun exposition with soil and other materials. Substitution of some plastic bags could be necessary.

5- Cladding provide protection to the inhabitants. Regular verification on the membranes is recommended.
Action: membrane inspection, reparation and or substitution could be necessary.

7.7 Achieved outputs

The following table shows the achieved results in comparison with the predefined values of design.

Requirement	Defined value	Result achieved	Comments
Shelter covered surface	*Min 20m²*	**22,1m²**	*Current dimensions 3.4x6.5*
Target price per unit in the local market	*200Euros**	**203 to 210 Euros**	*Local price for one unit in NE*
Construction time	*1 to 3 days*	**6h/ 5 people**	*Experience from workshops*
Target durability of the shelter in predefined conditions	*12 months*	**Expected more than 12 months**	*Theoretical durability*
Warehousing materials	*At least 75% of the items*	**100%**	*Non-organic materials used*
Target warehousing time	*3 years*	**More than 5 years**	*Dry and protected warehouse conditions*

Note:* Price for the needed materials in the field (not included local transport/construction fees and/or others)

7.8 Final comments

Lessons learned:
The proposed shelter solution uses the identified positive achievements of other emergency shelters implemented in the region. In particular, the operational durability of the shelter solution was a concern in terms of termite attack. The current solution avoids the termite attack by using metallic pillars.

Availability and warehouse:
The warehouse time was one of the main concerns for the design of this reviewed shelter solution. By avoiding the use of organic materials, we can ensure a long time of warehousing for the shelter components.

Operational flexibility:
The workshops showed that the shelter solution could be implemented with good results using different materials available in the market. This flexibility in the used materials will provide a better adaptability of the shelter and additional operational options.

Reusability: Metallic pillars as lintel beams, plastic carpets as sleeping carpets, wood or pipes with the membranes as a temporary structure.

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