A Transitional Post Disaster Shelter

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ABSTRACT: The unpredictability of disasters has left Researchers and Designers developing and manufacturing a variety of modern temporary emergency shelters. These shelters, being universal in design are unquestionably unsuitable and uncomfortable for the diverse climates, and furthermore fall short of satisfying basic needs. The meagre attempts made at design to overcome this situation, concludes with haphazard development of the camp city depending heavily on the host cities and organisational bodies. The result is undeniably a temporary but seemingly permanent camp with unhygienic and unbearable comfort conditions, inadequate solutions and disappointed refugees.
The aim is to focus on an approach to provide a sustainable and transitional society in the aftermath of a disaster, through an indicator system. The strategy is to prioritise and categorise all the data chiefly influencing the post settlement, assess them in a generic order in consideration with the social, cultural and post disaster planning standards; and then specify these issues for a particular case which would give advantageously dissimilar outcomes allowing the variations of the climate and society. In conjunction with this assessment, a shelter design for the climate of Iran is put forward to demonstrate the practicality of this technique. The design experiments with a cyclic process which would enable insight into conservation, accessibility and provision of energy and materials, to attain a self sufficient society.

Conference Topic: 01 Low Energy Architecture
Keywords: post disaster shelter, transitional, self sufficient, indicator system, breakdown chart

1. INTRODUCTION

The challenge to formulate the theory of an indicator design scheme commenced by an evaluation of different emergency shelters, by architects Shigeru Ban, Nader Khallili, Jans and Gelalcic which personify the methodology of achieving a sustainable prototype for a particular environment, and existing camp cities in Gaza and Lukole, Tanzania. The criteria for selection of shelters was the use of Ban's Paper Log House in three diverse climates of Japan, India and Turkey with adequate modifications; Khallili's Super-Adobe dome houses utilised exclusively for one climate; Jan and Gelacic's three type of shelters with different building materials for a planned camp city in Kosovo. While the camp in Kosovo is designed and would mature into foundations for the future city, the ones in Tanzania and Gaza are sporadic and have been inhabited for years in spite of being stated as temporary cities. These case studies are assessed and compared under different conditions like the location of the disaster hit area - longitude and latitude, weather profile of the place, stipulated disaster planning standards for the region, cultural and social background, individual design strategies for a shelter - functional and climatic, available local materials for reuse, repairs and recycle, possibilities of disposal and/or further growth of the society.

The indicators are constructed on the basis of the results of the assessments by validating or nullifying the available data. The indicators are prioritised according to most dominant factors, damaging or otherwise, to provide with guidelines for the groundwork of the camp and shelter. The prioritisation initiates the indicators to determine a design strategy for any potential disaster striking area. The preset information avoids the time delays after disasters in planning for habituating the refugees to a new location.

2. THE BREAKDOWN CHART

The philosophy of dissection of assessment criteria led to the conception of the 'breakdown chart' for the case studies, which is divided into physical and environmental attributes, further divided into an individual shelter and camp style.

2.1 Physical Attributes

The physical factors describe the statistical data on the refugee status and the transitional building development stage of the shelter and camp, which is measured by the set UN standards indicative of universal issues.

Data is organised as per displaced population, number of refugees, social and cultural backgrounds, occupation data per shelter, fair distribution of the urban space per individual, occupants minimal needs vs. luxuries, immediate and urgent needs vs. developments in the camp area (e.g. provision of toilets, hospitals, roads as against schools, recreation, educational units etc), life cycle of the shelter to define its temporary shelf life, use and availability of materials for construction and development and daily sustenance of life, quality of the structure and space provided, ability and adequacy of the shelter to protect the occupant.

Table I exemplifies a part of the assessment sheet showing attributes for individual shelter sectioned general and building materials.

Table I: Physical Attributes – Individual Shelter: General and Building Materials

	Paper Log House			Super Adobe	Jans and Gelacic	Lukole Camp	Camp
	Japan	Turkey	India	Iran	Kosovo	Tanzania	Gaza
Intended Type of Shelter	Temporary	Temporary	Temporary	Permanent	Immediate	Temporary	Temporary
Occupancy Level	3-4	5-6	4-6	4-6	3-4	5-7	4-6
Walls	Paper Tubes	Paper Tubes	Paper Tubes	Sand Bags, Barbed Wire, Mud	Bamboo Or Ceramic or Cardboard, Scaffolding, Steel	Wooden Sticks, Plastic, Woven Palm, Banana Leaves	Mud-Brick, Brick, Concrete
Roof	PVC	PVC, Fibreglass	Bamboo, Cane mat, Plastic	Sand Bags, Barbed Wire, Mud	Bamboo Or Ceramic or Cardboard, Scaffolding, Steel	Wooden Sticks, Plastic	Concrete, Brick

2.2 Environmental Attributes

The environmental attributes illustrate information based on climate classification and detailed weather data of the area.

Table II: Environmental Attributes – Camp: General and Climate, Individual Shelter: Structure and Post Disaster Strategy

		Paper Log House			Super Adobe	Jans and Gelacic	Lukole Camp	Camp
		Japan	Turkey	India	Iran	Kosovo	Tanzania	Gaza
Latitude		34.4	41	23.1	30	42.39	-4.5298	31.1998
Longitude		135.1	28.6	69.5	48.43	21.09	29.3798	34.4002
Temperature Average		14.3	14.3	27	25.3	10.3	23.6	20.4
RH Average		74	76	58	42	70	72	65
Precipitation Average		112	55.16	25.25	19.16	45	77.3	14.75
Daylight Factor (Adequate Daylight)		High	High	High	Low	Medium	Low	High
Ventilation rate (Adequate Ventilation)		High	High	High	Medium	High	Low	High
Water Permeability Risk		High	High	High	Low	High	High	Medium
Condensation Risk		NA	NA	NA	NA	NA	NA	NA
Heat Gain		Insulation	Insulation	Cross Ventilation	Thermal Mass	NA	No additional protection provided	Concrete structure
Heat Loss								
Floor	Coupled	-	-	Yes	Yes	-	Yes	Yes
	Stilts	Yes	Yes	-	-	Yes	-	-
Super structure	Separate/ Integrated	Integrated	Integrated	Integrated	Integrated	Separate	Separate	Integrated
	Insulation	No	Yes	No	Yes	No	No	No
Door and Window	Single/ Double	Single	Single	Single	Single	Single	Single	Single
	Insulation	No	Yes	No	No	No	No	No
Fabric	Single/ Double	Double	Double	Double	Thick	Single	Double	Single
	Air Permeable	Medium	Medium	Medium	None	None	None	None
	Cavity	Yes	No	Yes	No	No	No	No
Transportability (%)		90%	90%	90%	60%	90%	75%	25%
Demolition (%)	Recycle	60%	60%	55%	10%	50%	10%	10%
	Reuse	30%	30%	15%	75%	35%	35%	15%
	Reduce	10%	10%	30%	15%	15%	55%	75%

The camp and shelter layout strategies are established as per climatic conditions, proximity and availability of natural resources, occupancy levels in individual shelters, performance of the shelter, category of construction materials (e.g. dependency on foreign/local bodies, and labour skills), architectural approaches used for the shelter design, utilisation of water, energy, sanitation on site, application of solar passive design or vernacular strategies, post disaster scenario, use of vegetation and effects on surrounding ecosystems.

Table II explains some general categories for a camp such as location (latitude and longitude) and annual climatic conditions; several of the environmental factors for shelter listed here are the adaptive-ness of the structure looked at as individual elements in relation to the climate (e.g. walls, roof, floor, openings etc) and post disaster scenario (transportability of the whole structure, demolition strategies etc) after its shelf life.

3. THE INDICATOR DIAGRAM

The breakdown chart leads to the structure of ten generalised indicators for evaluation; to determine the adequacy and proficiency of the system – the camp and the shelter.

These indicators are scaled on a platform of 1 -10; 10 signifies that the system is self sufficient in the particular criterion and does not depend largely on external facilities for its provision and maintenance. In contrary, 1 notes that the system is mainly relying on foreign and host organisations for its development.

The overall performance of a project is judged by the linear graphical mapping of these indicators; the more the high rise composition, the more the system tries to be self sufficient, sustainable society; whereas a flat plain signifies an overloaded city.

3.1 Climate Classification

This first indicator determines the region where the disaster has struck has moderate or harsh climatic conditions to adapt to in terms of biological, physical and psychological changes in an individual.

The scaling is based on the human thermal responses to Standard Effective Temperature (SET) (after Markus and Morris) corresponding to the Köppen system of climate classification (after Wladimir Köppen) to create a climate indicator.

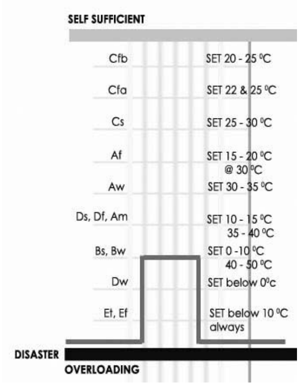
Figure I shows the case for Iran, which falls in the dry arid region, a true desert climate (Köppen Type Bw). An individual with clothing of 0.6 clo in air movement at 0.2 m/s and activity level of 1 met would be distinctly very hot or very cold at SET of +40^{0}C or below 0^{0}C respectively, interpreting limited tolerance to the climate conditions which could lead to failure of free skin resulting in death if the body temperatures drop or rise around the narrow margin of 37^{0}C.

3.2 Climate Data

The indicator is set up according to the available annual average diffuse solar radiation, wind speed and precipitation in the region. The outcome is that one should be able to comprehend the passive design strategies that could be applied through these potential resources.

The indicator takes into consideration the diffuse radiation which would be more consistent to estimate the possibility of solar harvesting. The wind and precipitation scales could be divided into ten steps for the speed up to 5 m/s and rainfall above 400 mm.

Figure II for Iran shows high values of solar radiation and wind speeds render it possible to harvest efficiently solar and wind energy throughout the year. Possibility of wind turbines and PV cells for water heating, electricity are extremely profitable and sustainable though cost producing at the preliminary stages. Rainfall being minimal; water is very precious and requires efficient storage for correct use.



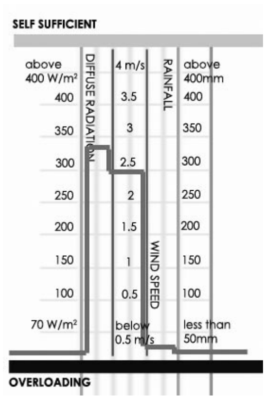
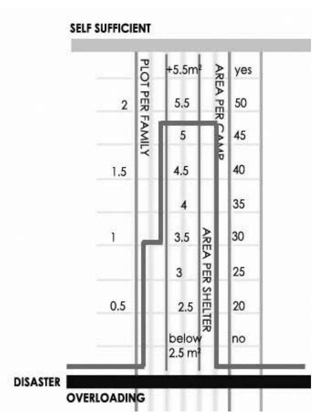


Figure I: Climate classification Indicator, Iran
Figure II: Climate Data Indicator, Iran

3.3 Plot Rationing

The indicator is a simple method of values against the UN standards of plot rationing per family according to the average family size of the place, area per person per shelter as per climate and area per occupant in the camp; it intends to stipulate that fair and adequate distribution of land space to each refugee if at all the camp is extended beyond its temporary shelf life. This section could also have additional category of daily rations on food, clothes, water per person.

Figure III, intended for an average Iranian family size of 6 persons, has individual space allotment per shelter higher than the stated $3.5m^2$ for the reason that winter months make people stay inside. Area per camp would depend on the refugee status and camp space availability which can be predicted only during the disaster period.



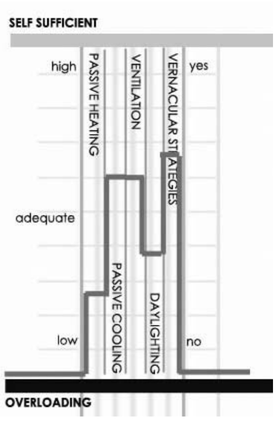


Figure III: Plot Rationing Indicator, Iran
Figure IV: Passive Design Strategies Indicator, Iran

3.4 Passive Design Strategies

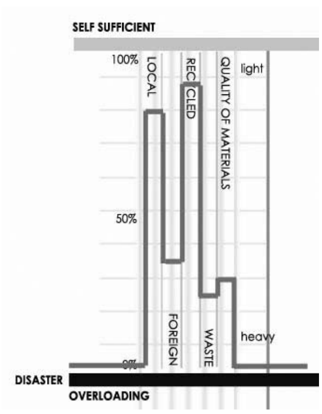
The indicator is used to calculate the potentiality of passive design strategies based on climate data indicator. It describes if passive heating, cooling, natural ventilation techniques and daylighting integrated with the design is low, adequate or high and if the vernacular architectural features and cultural styles of the region are incorporated in the design. While the former takes the camp towards a sustainable design, the later tries and gives the temporary housing system a much more familiar and acceptable aura.

Figure IV for Iran shows the probable passive design strategies and the potentiality of using them. Considering that an emergency shelter may not be able to suffice as an airtight mass, passive heating cannot be adequately employed as passive cooling. Ventilation and daylighting could be applied generously as well as vernacular strategies of minimising heat gain and loss, courtyard layout, heavy thermal mass etc.

3.5 Materials

The indicator quantifies in percentages the building construction materials as local, foreign, recycled or waste and also states if the materials are heavy or light weight. This indicator has a direct influence on the post disaster indicator as it quantifies the proportion of the shelter that could be stored, destroyed or transported and reused for some different purpose. The heavy/light quality of the structure indicates if the shelter has high/low thermal mass.

Figure V shows diagram relating to the proposed materials for the design in Iran. Barrels, sand, fabric are the chief components for the proposed shelter. Most are available locally; barrels if not locally produced are widely available and recyclable. Polyethylene is easily available though not recyclable. The materials being mostly heavy thermal mass cannot be easily transported but are natural and hence simple to dispose of.



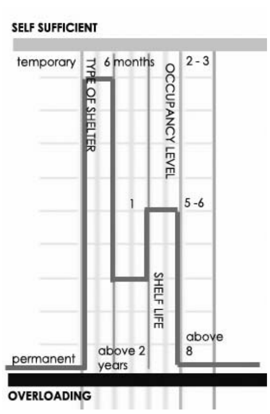


Figure V: Materials Indicator, Iran
Figure VI: Shelter - Structure Indicator, Iran

3.6 Shelter – Structure

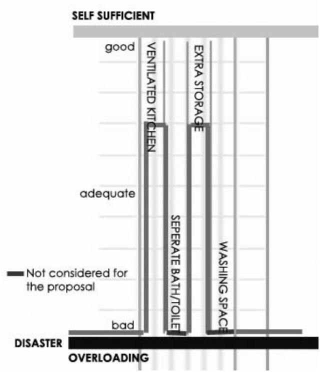
The indicator defines the type of shelter – temporary or permanent, intended shelf life of the shelter and the occupancy level in each shelter. The purpose for this indicator is that it could be stipulated if the design for the shelter needs to be much more stable and permanent if the intended shelf life is longer than standard temporary period of 1 – 2 years. Additional input to this category could be a check for vector risks and design strategies to prevent those risks.

Figure VI demonstrates that the proposed shelter is designed to be a temporary edifice but due to its quality of continuing as permanent, the shelf life could go beyond one and half years or more. The occupancy level is for six people of a standard Iranian family. However this number can be easily increased if the family size is large by using two connected shelters as a family unit.

3.7 Shelter – Facilities and Quality

The indicator describes if an adequate ventilated kitchen has been provided, separate bath/toilet facilities for the shelter, extra storage and washing space. It insists on the quality of life provided for a family with minimal needs in these temporary conditions. This indicator could be further detailed out for provisions of blankets, sleeping gear, daily consumed toiletries and kitchen equipment, etc.

Figure VII indicates the proposed shelter is provided with an adequately ventilated kitchen. The louvers are opened whenever needed if cooking is in progress in the shelter. Bathroom/toilet and washing areas are not considered in the design proposal; however these can be provided as extensions against the face of the wall. Extra storage is made out of the hollow circular walls at the junctions.



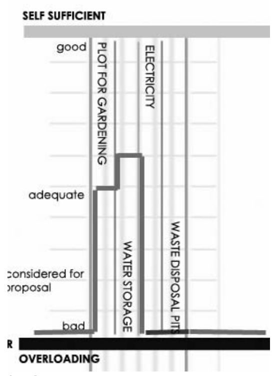


Figure VII: Shelter – Facility & Quality Indicator, Iran
Figure VIII: Resources Indicator, Iran

3.8 Resources

The indicator describes if the plot is assigned a garden or agricultural space, if it is provided with adequate storage of water in individual shelter, if the camp has an electrical system and waste disposal techniques (refusal pits). The indicator chiefly influences the layout of the camp and the services provided. Further additions to this indicator would include provision of public sections for ablution/toilet, storage and treatment of water on urban scale, provision of electricity (grid, turbines, PV etc) to the camp and shelter or use of other fuels for the same, use of cooking fuels, adequacy of waste disposal system per refugee camp size, disposal of household refuse and excreta etc.

Though not openly stated in the proposal, Figure VIII, a small gardening plot can be provided for the individual shelter. This helps in cooling by creating a suction effect due to the vegetation. The problem of individual water storage for a shelter is overtaken by providing at least one circular corner wall with a barrel to be filled with water. This efficiently is allotted on the north or east corner where the extension for the ablutions can be provided. Electricity and waste disposal systems have not been included in the design proposal.

3.9 Infrastructure

The indicator provides data on the accessibility to the camp site, road network in and to the camp and other facilities (e.g. educational, recreational, medical etc). It reflects on the development of the camp on an extended and sometimes undefined time scale and also the ease of provision of essentials other than the daily fundamental needs. Further input to the road network would be provision of public transports to and fro a nearby host city.

The indicator for infrastructure has not been added in this study as it is based on the statistics of the refugees and on urban development.

3.10 Post Disaster Scenario

The indicator gives percentages of post disaster use of the shelter and camp - demolition, recycle, and reuse, transportation and repairs. It is influenced, more or less by all the former indicators and provides an insight into effective disposal of the temporary city which otherwise ends up as a discarded uninhabited recluse occupying valuable land and resources. Another contribution to this scale would be the use of materials if reused or recycled and the ways of changing the temporary shelter, if desired, into a permanent abode.

Post disaster situation of the proposed shelter, figure IX concludes that the shelter can be completely demolished. Most of the soil is recycled, and/or reused; the barrels and polyethylene will have no use. The shelter cannot be transported but the barrels could be used for the same design in a similar climatic region if required. As the principle being that the design has to be intrinsic to the region, the shelter need not be transported to a new location unless it has the same characteristics.

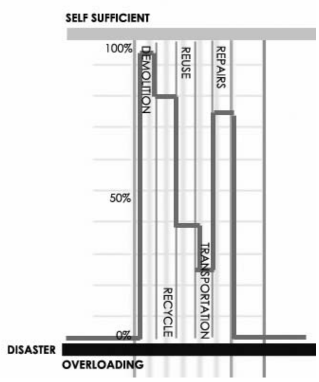


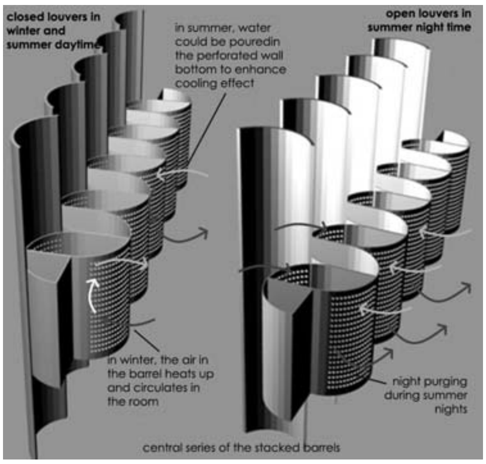
Figure IX: Shelter – Facility & Quality Indicator, Iran

4. THE DESIGN PHILOSOPHY

The apparent follow up of this indicator system led to its demonstration and substantiation through the design development of a post disaster shelter for the climatic condition of Iran. The reason for deciding on Iran was based mostly on the experimentation of a temporary shelter in one of the harshest climates. The indicator system would assess the climatic, functional, qualitative performance of the shelter in totality; while at the same time presenting a designer the independence of designing the shelter as suitable to his ideologies.

Developed on the basic design of indirect heat gain model - the Trombe wall, the system explores and exploits advantages for a temporary situation with minimal materials at disposal and within restricted time scale. At the same time it applies greenhouse and direct heat gain effects to its advantages as much as possible for winter.

The design philosophy is kept very simple by building circular sand walls in barrels, that would be able to change its surface properties from being absorbent to permeable to reflective walls depending on the need. Refer Figures X, XI, and XII which illustrate some selected images. This technique would be aided by the possibility of enhancing the performance of sand through increase in its moisture content and manipulation of the soil properties.



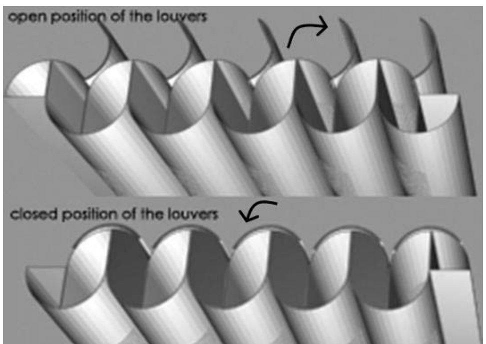


Figure X: Proposed Shelter – Day & Night Ventilation techniques through perforated cavity barrel walls
Figure XI: Proposed Shelter - Louvers for Ventilation

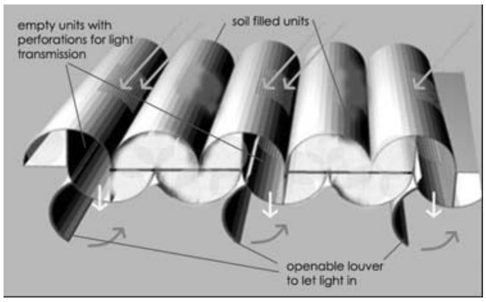


Figure XII: Proposed Shelter – Roof Design with sand Barreled roof and ventilating louvers

The efficiency of the system is tested in TAS model for individual shelter performance, EnviMet and Ecotect for the design and location study of both the shelter and the camp and adjacent units.

5. CONCLUSIONS

The entire process of arriving at the design of a transitory shelter is systemised for all climatic conditions. A similar design when arrived at through these indicators can be easily adapted for most of the comparable climates with slight variations.

Though the study tried to focus on a shelter as well as the refugee camp, it does fall short of satisfying several criteria about the urban configuration of the camp life. The reason for it being that a camp style is depended solely on the number of refugees it houses at a time and hence differs drastically from one camp to the other. The most beneficial solution to overcome this is to arrive at some general decisions for the shelter; to develop separate indicator diagrams for the camp which would list out meticulously the provisions, developments, infrastructure, sanitation, fuel availability etc for the camp. An indicator can be developed for a fixed number of inmates in the camp and modified accordingly for every camp as this number varies. In this manner then, it would be less complicated to determine the advantages and disadvantages of using energy sources such as wind turbines, PV cells, collectors etc for the whole camp; since the use of these on individual shelters may possibly be high-priced.

This study has tried to synthesize the environmental factors, architectural features and cultural and social essence of a particular location to arrive at a relatively straightforward solution for quick sheltering of the distressed refugees. The indicator system, if planned in advance for all the likely places to be struck by disasters, could make the urgent uncontrollable disaster situation much simpler to confront.

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