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TIMBER FRAME BUILDINGS FOR EMERGENCY SHELTER

TF/CRO/93/D10

CROATIA

Technical report: Prospect for commercial production of kit form buildings*

Prepared for the Government of Croatia by the
United Nations Industrial Development Organization

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* This document has not been edited.

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1. EXECUTIVE SUMMARY

Title of the project:

Timber Frame Buildings for Emergency Shelter

(Prefabricated timber framed wall elements and trussed rafters)

Target group:

Refugees and displaced people in Croatia

Location:

Croatia (Virovitica and Sisak districts)

Beneficiaries:

Refugees and displaced people from Croatia and Bosnia

Estimated number of beneficiaries:

Directly - more than 360

Indirectly - more than 12,000 people

Objectives of the project:

1. To provide community buildings in war destroyed areas of Croatia.
2. To transfer the technology of light timber framing.

Budget of the project for all buildings and services:

US$ 700,000.00 (including UNIDO overheads of 13%)

Project scheduled to begin:

October 1994

Project scheduled to end:

December 1995

2. INTRODUCTION

The General Assembly of the United Nations adopted Item #144 'International Cooperation and Assistance to Alleviate the Consequences of the War in Croatia and to Facilitate its Recovery' at its forty-seventh regular session, GA resolution #47/165.

The wood processing industry in Croatia is very developed and has a long-term tradition, especially in the field of primary and secondary wood processing. This sector provides the much needed building materials for reconstruction as well as building carpentry, thus providing employment in different areas in addition to rebuilding what has been damaged by the war.

The wood processing firm *Dren* received technical assistance as stipulated in the agreement between UNIDO and the Republic of Croatia under this project. Based on that agreement, UNIDO signed another agreement with *Dren*, according to which *Dren* was to provide workshop facitities for the production of the prefabricated wood elements for the timber framed buildings as planned by the project.

The project aims at providing six or more basic community buildings of about 300 m^2 as emergency shelter/community buildings by introducing prefabrication of timber framed wall elements, trussed rafters and other materials in 'kit form' as an appropriate building technology.

3. PROJECT BACKGROUND AND HISTORY

The idea of the project is to help Croatia in two ways: to produce basic shelter or community buildings from wood prefabricated elements as emergency buildings, and to introduce the system of producing prefabricated timber framed wall elements and trussed rafters as an appropriate building technology. The aim is to help the Croatian government in its efforts in organizing the return of the people to their damaged towns and villages and the resumption of the normal economic and social life.

The agreement between UNIDO and the Croatian government included the establishment of a prefabrication workshop for the production of timber buildings of the emergency shelter project. The agreement covered areas such as use of space, i.e. the workshop, secure storage materials, staffing arrangements regarding the training of the personnel in prefab procedures, understanding concerning the supply of dried softwood as the raw material used for building components, option for the delivery of prefabrication wall and roof elements, and hand-over procedures regarding workshop equipment and excess material.

Preparatory work was to be the task of the Croatian government and the Municipalities concerned. The latter were to be responsible for the work on the building sites, such as doing the foundation and providing utilities and construction labor.

The development of the project began in July 1992 when first contacts between UNIDO and the Croatian government were made. Subsequently, for the first time, two prefabricated wood buildings were built in Vinkovci (one of 600 m^2 and a "mini-farm" building of 50 m^2). A 320 m^2 school building in Slavonski Brod followed.

4. PROJECT OBJECTIVES

The objectives of this project are divided into short-term objectives and long-term objectives.

a) Short-term objectives:
   1. Return of the refugees and displaced persons to their homes and farms.
   2. Rebuilding of households.
   3. Rebuilding of agricultural farms.

b) Long-term objectives:
   1. Introduction of the light timber framing building method
   2. Revival of the economy generally and of the wood processing industry in particular.

The housing sector in Croatia is characterized by traditional masonry and block building technology. It was estimated in 1994 that more than 300,000 housing units and many other buildings were damaged or destroyed by the war. Many towns and villages were affected in some way and the number of refugees and displaced persons reaches hundreds of thousands.

Based on recent surveys and estimates of the damage, it is estimated that the number of families that could safely return to their towns and villages ranges from 30,000 to 50,000, particularly after the recent military operations were undertaken.

5. PROJECT DESCRIPTION

The project is intended and designed to satisfy the need of the refugees and displaced people in Croatia for buildings for various purposes. Since housing in Croatia is characterized by traditional masonry and block building this type of prefabricated housing offers great advantages. Namely, it can provide finished prefabricated wood houses in a relatively short time as well as provide shelters and other buildings for public use.

The wood prefabricated housing is based on well-established timber framing building methods. Without prefabrication it is on-site building, also called 'stick building.' This building technique offers a practical way of producing houses quickly under emergency conditions but relies on experienced tradesmen. This project used an intermediate system which combined speed of prefabrication and on-site construction and the use of local material and human resources, to suit building practices in the country.

This system lends itself well to the production of community-type buildings intended to provide shelter to people in or adjacent to their villages. It can also be applied to the construction of kindergartens, primary schools, medical clinics, and small single family houses.

In addition to prefabricated houses, the project also intended to introduce the production of prefabricated roof trusses.

The first basic unit of this program used a 320 m^2 primary school building, designed by architects in Slavonski Brod as a model community building.

The implementation of project objectives was planned as follows:

1) Produce wall panels and trussed rafters in a local workshop equipped with basic wood processing industry machines;
2) Transport components and other building materials to building sites;
3) Erect frames and trussed rafters;
4) Fix walling and roofing materials, including gutters, drain pipes and similar;
5) Build in doors and windows;
6) Install services and utilities;
7) Train carpenters and builders on site including fixing the interior wall lining (gypsum board).

The implementation of the project began after the signing of the agreement between UNIDO, Ministry of Economy and *Drvn* (the wood processing workshop) to establish the unit for the production of basic wood elements. UNIDO staff and *Drvn* personnel were

in charge of the organization of the workshop. UNIDO provided pneumatic nailers, a compressor unit, and other necessary basic equipment and tools for work with light wood elements.

The workshop was equipped with a special large working table suitable for the preparation and fixing of the wood elements in frames and trussed rafters.

The organization of the production of basic wood elements began with the order of sawn-wood from the sawmills. In the workshop the wood was processed into the defined elements as specified by UNIDO documentation as follows:

a)

Walls:	Other wood elements:
- Top plate	- Lintel jacks
- Bottom plate	- Lintel studs
- Studs	- Packers
- Nogs	- Doors jacks
- Sill window	- Door lintels
- Sill jack	

b) Trussed rafter (type A, B, C, D, E, F, G, J, K, L) and gable end (modified queen post)

c) Different wood elements for finishing

The elements were prepared and assembled according to precise dimensions by a group of four workers. The elements were assembled and fixed by pneumatic nailers into trussed rafters and walls according to the basic layout of the building.

The finished trussed rafters and the walls were then transported to the location where the reinforced concrete foundation and floor had been prepared. The transportation was performed by a truck and trailer 15 m long.

The production, assembly, transportation and the work on the building site was organized as follows:

1) One month for the production of the wood elements with four workers in the workshop;

2) Four weeks for the assembly of the wood elements with four workers in the workshop;

3) Two days for the transportation with loading and unloading of the produced walls and trussed rafters with four workers;

Erecting the building on the building site took fourteen weeks with four workers.

6.0. COSTING SYSTEM FOR THE PRODUCTION OF PREFABRICATED ELEMENTS AND OTHER COMPONENTS REQUIRED FOR THE COMPLETION OF THE BUILDING SHELL READY FOR INTERIOR FINISHING

The purpose of the costing system as well as cost analysis is to define the real cost of production and installation of such wood prefabricated house (320 m^2 based on the Slavonski Brod documentation). We collected the data on the cost of each phase of work.

The production phase was started by purchasing softwood (fir/juniper) of second and third class with humidity of about 20%. The wood was delivered in boards to the workshops where it was sawn by hand and circular standard saw machines in the required dimension and into the final shape. Approximate utilization amounted to about 90% while waste ranged from 8-10%.

The basic calculation of the first phase is based on the following elements:

1) Cost of input wood;
2) Cost of production: - production overhead
   - cost of labor.

Table No. 1.

COST PER UNIT

No	MATERIAL OR ELEMENT	QUANTITY	PRICE PER UNIT	TOTAL COST US$
1	2	3	4	5
6.1.1.	INPUT WOOD FOR 220m2 WALLS	15 m3	580 DM/m2 414,3 US$/m2	6.214,30
6.1.2.	WALLS PRODUCTION OVERHEADS	105 hr	1,5 DM/hr. 1,07 US/hr.	112,50
	COST OF LABOR FOR THE WALLS PRODUCTION (4 LABORERS)	(105 HR) 105x4=420 hr	5,7 DM/hr 4,07 US$/hr.	1.709,40
6.2.1.	ROOF PRODUCTION COST OF INPUT OF WOOD	9,5 M3	580 DM/m3 414,30 US$/m3	3.935,85
6.2.2.	ROOF PRODUCTION OVERHEADS	105 hr.	1,5 DM/hr. 1,07 US$/hr.	112,50
	ROOF PRODUCTION LABOR COST	105 HR. (4 laborers)	5,7 DM/HR. 4,07 US$/HR.	1.710,00
6.3.1.	EXTRA SAWNWOOD FOR JOINING TRUSSED RAFTERS ETC. MATERIAL	8,5 m3	580 DM/m3 414,30 US$/m3r.	3.521, 55
6.3.2.	PRODUCTION OVERHEADS	50 hr.	1,5 DM/hr. 1,07 US$/hr.	53,50
	LABOR COST	50 hr. (4 Laborers)	5,7 DM/hr. 4,07 US$/hr.	814,00
6.4.	PLYWOOD (Roofing)	594 sheets	8,25US$/sheet	4.900,50
6.5.	GYPSUM BOARDS	284 sheets	12,5 US$/sheet	3.550,00
6.6.	MELAMINE-FACED PLYWOOD (Walls)	150 sheets 445,5m2	6,60 US$/m2	2.940,30
6.7.	MINERAL WOOL	255 bales (100x55x9 cm)	17,86 US$/bale	4.554,30

1	2	3	4	5
6.8.	GUTTERS, DRAIN PIPES FLASHING PROTECTION	-	-	2.777,14
6.9.1.	NAILS	7.500 nails	13,51 US$ 1000	101,33
6.9.2.	DAMP PROOF COURSE (DPC)	466 m (100 mm width)	0,744 DM/m2 0,53 US$/m3	247,64
6.9.3.	HILTI NAILS FOR NAIL GUN	188 nails	0,8 DM/piece 0.57 US$/piece	107,43
6.9.4.	PVC FOIL	2.066 m2	0,64 US$/m2	1.322,24
6.9.5.	SILICON	50 tubes	5,36 US$/tube	268,00
6.9.6.	PVC JOINTS (between plywood wall sheets)	376 m	0,54 US$/m	203,04
6.9.7.	STAIN (OIL FOR PROTECTION)	100 liters	6,32 US$/liter	632,00
6.9.8.	LAMINATED BEAMS AS LIFTERS OVER DOORS	12 m'	24,29 US$/m'	291,48
6.10.1.	WINDOWS	8 windows (600x600) 13 windows (900x900) 30 windows (1.800x1.000)	138,57 US$/wind. 190,00 US$/wind. 300,71 US$/wnd.	1.108,56 2.470,00 9.021,30
6.10.2.	FAN LIGHT OVER DOORS	5 piece (2.100x460) 7 piece (510x464)	253,57 US$/piece 82,14 US$/piece	1.267,86 575,00
6.10.3.	OUTSIDE DOORS	6 doors (2.160x2.100)	561,43 US$/piece	3.368,57
6.10.4.	INTERNAL DOORS	13 doors (2.050x900)	242,14 US$/piece	3.147,86
6.10.5.	INTERNAL DOORS	8 doors (2.050x700)	217,14 US$/piece	1.737,14

1	2	3	4	5
6.10.6.	INTERNAL SWINGING DOORS	2 doors (2.166x2.100)	1.071,43 US$ piece	2.142,86
6.11.	EXTERNAL FINISHING WOOD ELEMENTS	2,2 m3	1.321,43 US$ m3	2.907,14
6.12.1.	POST PRODUCTION COST FACTORY ASSEMBLY	122 hr.	4,05 US$ hr.	3.110,40
6.12.2.	ROOF COVERAGE WITH SHINGLES	550 m2	-	3.259,00
	LAYING OF SHINGLES	40 hr. (4 laborers)	5,71 US$ hr.	914,28
6.12.3.	TRANSPORTATION (LABOR)	12 hr. (4 laborers)	4,05 US$ hr.	194,10
	TRUCK COST	2 trucks (160 Km)		2.785,71
			TOTAL	78.089,08 US$
6.13	REINFORCED CONCRETE FOUNDATION AND FLOOR	320m2		17.760,00
6.14.	PLUMBING (LABOR&MATERIALS)			15.444,00
6.15.	ELECTRICAL INSTALLATION (LABOR&MATERIALS)			13.899,60

THE TOTAL COST OF STRUCTURAL SHELL OF 320 m2 IS **US$ 78,089**
SO THE COST PER SQUARE METER = 78,089 / 320 = **US$ 244,03/m2**

THE TOTAL COST OF COMPLETED BUILDING OF 320 m2 IS **US$ 125,192**
SO THE COST PER SQUARE METER = 125,192 / 320 = **US$ 391/m2**

7.0 SURVEY OF THE MARKET FOR THIS TYPE OF PREFABRICATED WOOD BUILDINGS

In Sept. 1993, the Croatian Government held an international conference on the subject of Rehabilitation of the Croatian Economy in Zagreb in the Hotel Intercontinental during which it offered detailed information on the situation of the refugees and displaced people. Since then their problems, needs and the situation in which they find themselves has changed.

The basic annual data from Sept. 1995, shows the following figures:

- Population is 4,779,000;
- Number of refugees amounts to 193,000 while that of displaced people reaches 180,078 for the total of 374,021 (Nov. 1995);
- War damage in Croatia is estimated at about US$ 22 billion;
- Approximately 40% of industrial capacity was destroyed during the war;
- Number of employees amounts to 1,211,000;
- GDP reached US$3670 per capita;
- Inflation in 1994 amounted to 3%.

The intention of the UNIDO project is not only to build the prefabricated units, but also to transfer this technology to the local industry and to train a working team for further eventual improvement in commercial production of such prefabricated wood buildings: community buildings, tourist accommodation and private houses.

Immediately after production began in Zagreb through partnership with *Dren*, a questionnaire was made up that included information about the project and several types of prefabricated units that were offered to the government authorities. The questionnaire was sent to several ministries engaged with the reconstruction program as well as several banks and agencies.

Unfortunately, no reply came from official institutions by the end of October. Nevertheless a survey was carried out through special personnel contacts with officials in several government institutions.

The following was received from the Ministry of Development and Reconstruction:

Table 2.

STRUCTURE OF REFUGEES AND DISPLACED PEOPLE
ACCORDING TO THEIR TEMPORARY LOCATION

STRUCTURE OF ACCOMMODATIONS	REFUGEES	DISPLACED PEOPLE	TOTAL
Private	140,481	155,695	296,176
Hotels	30,143	5,672	35,815
Organized accommodations	23,319	18,711	42,030
TOTAL	193,943	180,078	374,021

Table 3.

REFUGEES AND DISPLACED PEOPLE
ACCORDING TO REGIONAL OFFICES

REGIONAL OFFICE	REFUGEES	DISPLACED	TOTAL	
	No.	No.	No.	%
Bjelovar	1,532	5,631	7,163	1.84
Cakovac	1,017	793	1,810	0.47
Dubrovnik	5,538	3,673	9,211	2.37
Gospic	2,154	652	2,806	0.72
Karlovac	15,045	1.040	16,085	4.13
Koprivnica	1,171	1.788	2,959	0.76
Makarska	1,258	10,922	12,180	3.13
Osijek	28,335	12,203	40,538	10.42
Pula	4,723	9,997	14,720	3.78
Rijeka	7,033	11,248	18,281	4.70
Sisak	19,340	7,267	26,607	6.84
Slavonski Brod	3,192	17,353	20,545	5.28
Poz ega	7,680	6,951	14,631	3.76
Split	13,813	16,395	30,208	7.77
Sibenik	13,566	3,623	17,189	4.42
Varaz din	1,122	3,270	4,392	1.13
Vinkovci	14,863	19,031	33,894	8.71
Virovitica	1,813	4,762	6,575	1.69
Zlatar Bistrica	1,493	1,126	2,619	0.67
Zadar	22,959	1,325	24,284	6.24
Zagreb	30,583	51,722	82,305	21.16
TOTAL:	198,230	190,772	389,002	100.00

According to the information provided by the ministry, the government is focusing on the problem of renovating the destroyed houses in the regained towns and villages of Croatia. The second priority is to build in those areas public buildings such as schools, kindergartens, medical clinics, administrative offices, etc.

The regions in need of reconstruction have been classified as priorities as follows:

1. Pozesko-slavonska county (Slavonski Brod)
2. Sisacko-moslovacka county (Sisak)
3. Karlovacka county (Karlovac)
4. Licko-senjska county (Gospic)
5. Zadarsko-kninska county (Zadar)
6. Splitsko-dalmatinska county (Split)
7. Dubrova~ko-neretvanska county (Dubrovnik)

That technology demonstrated by the project is suitable for the following:

1. Roof trusses
2. Prefabricated community building's of 300-350 m2
3. Small prefabricated houses of 25-40 m2
4. Prefabricated mini-farm buildings 50-60 m2.

The Ministry of Development and Reconstruction gave priority to two types of products that were considered as needed the most:

1. Roof trusses (trussed rafters)
2. Prefabricated wood units of 300-350 m2 for various use.

Since this ministry is now in charge of the development and reconstruction of Croatia, it began planning the development for the entire country.

According to the information that was obtainable, the Ministry estimates that at least 15 to 20 buildings for public use could be used in different areas, i.e. the municipalities of Sisak, Brod, Vinkovci, Lika, Zadar and Dubrovnik.

The Ministry is also interested in buildings that could be used on agricultural farms and is considering including them in its new agricultural programs of the plans of agricultural development of Croatia (FAO Study April/1995).

Furthermore, these buildings could fit in to the concept of tourism development plans of Croatia. There is a substantial need for various types of well-designed prefabricated wood houses. Further dealings are pending the ending of the privatization process.

Generally, the attitude of Ministry officials and business people is that the cooperation and the implementation of this project should continue. They are also interested in the continuation of the transfer of technology, particularly with the private sector, in order to introduce this product and all of its varieties of production to the Croatian market.

The market for such quality product in Croatia is large, particularly since the government considers it useful for its reconstruction of the war destroyed areas as well as for the development of Croatia in general.

Another opportunity is represented by the opening of the Bosnian market, especially since the agreement between the Croatian and Bosnian governments on joint plans of reconstruction was signed.

The two producers of prefabricated wood houses in Delnice and Ogulin are in a difficult situation because of their poor financial situation as well as because of their inability to produce rationally.

The prices of their prefabricated houses are:

-- For a building of 100 m" **US$ 274.12/m"**

-- For a building of 42 m" **US$ 298.76/m"**

The prices of UNIDO prefabricated building is

For a building of 320 m" is **US$244,03/m"**

The further advantage offered by this technology is that such an intermediate degree of prefabrication permits manual handing of all components, and offers the change of the owner to use his own labor for site work. It is expected that building regulations will soon require a licensed builder to take charge of construction. That is a flexible arrangement which can be agreed upon common in the country and will speed up construction in general.

An interesting piece of information is that the Croatian government was planning to allocate about DEM. 700,000 for the renovation of the houses in 1995 and DEM. 670 million for the renovation in 1996.

The newly established Croatian Development Bank intended to fund the development and reconstruction as well as the development of private initiative, has been receiving millions of US$ for this purpose. This will help any well-organized production and prefabrication of roof trusses and houses intended for the same purpose. It is also worth mentioning that the loans by the Interamerican and Deutsche Bank that have already been agreed upon will be directed to the process of reconstruction.

8. CONCLUSION

The cooperation for establishing the prospects for commercial production of timber framed buildings in kit form as demonstrated by the UNIDO project was successful. Unfortunately, the war at the time, coupled with the economic, industry and market crises postponed the achievement of some project goals. The cooperation between UNIDO, the Ministry of Economy and *Dren* would have showed that the project could be accomplished successfully, had the crisis in *Dren* not disrupted it.

Our experience from that period showed that the purchase of inputs and other material could be organized better in the future if full cooperation with local authorities could be achieved especially now most local suppliers have been identified and are familiar with requirements.

Under the circumstances, a standard prefabricated community building was produced, transported and erected ready for interior finishing at the cost of US$ 240.03/m^2.

The market survey showed that the Ministry of Development and Reconstruction is substantially interested in these products. The figures obtained from the Ministry and from the meeting with Deputy Minister **Stjepan Sterc** showed interest in additional cooperation with UNIDO.

It was agreed that UNIDO would provide him with more information about the project and the possibility of more cooperation in the field through the Ministry of the Economy.

One of the duties was to establish a detailed costing system, which was started in *Dren* but because of the difficulties the firm has encountered could not be completed as planned.

The realistic cost of components required for the completion of the building shell ready for interior finishing has been impossible to obtain owning to the situation in Croatia. The prices of all elements are lower in the European market because the system of import duties makes them more expensive in Croatia. The eventual cost of imported materials (Plywood, gypsum board, shingles and some equipment can not now be predicted).

An attempt was made to estimate the profitability at different levels of production with the management of *Dren* but the calculations could not be finished because of the problems of the company which led to bankruptcy. Nevertheless, an estimation based on our data shows that this could be a profitable business if organized well, with more reliable local partners, possibly existing construction firms that have more experience in this field of work.