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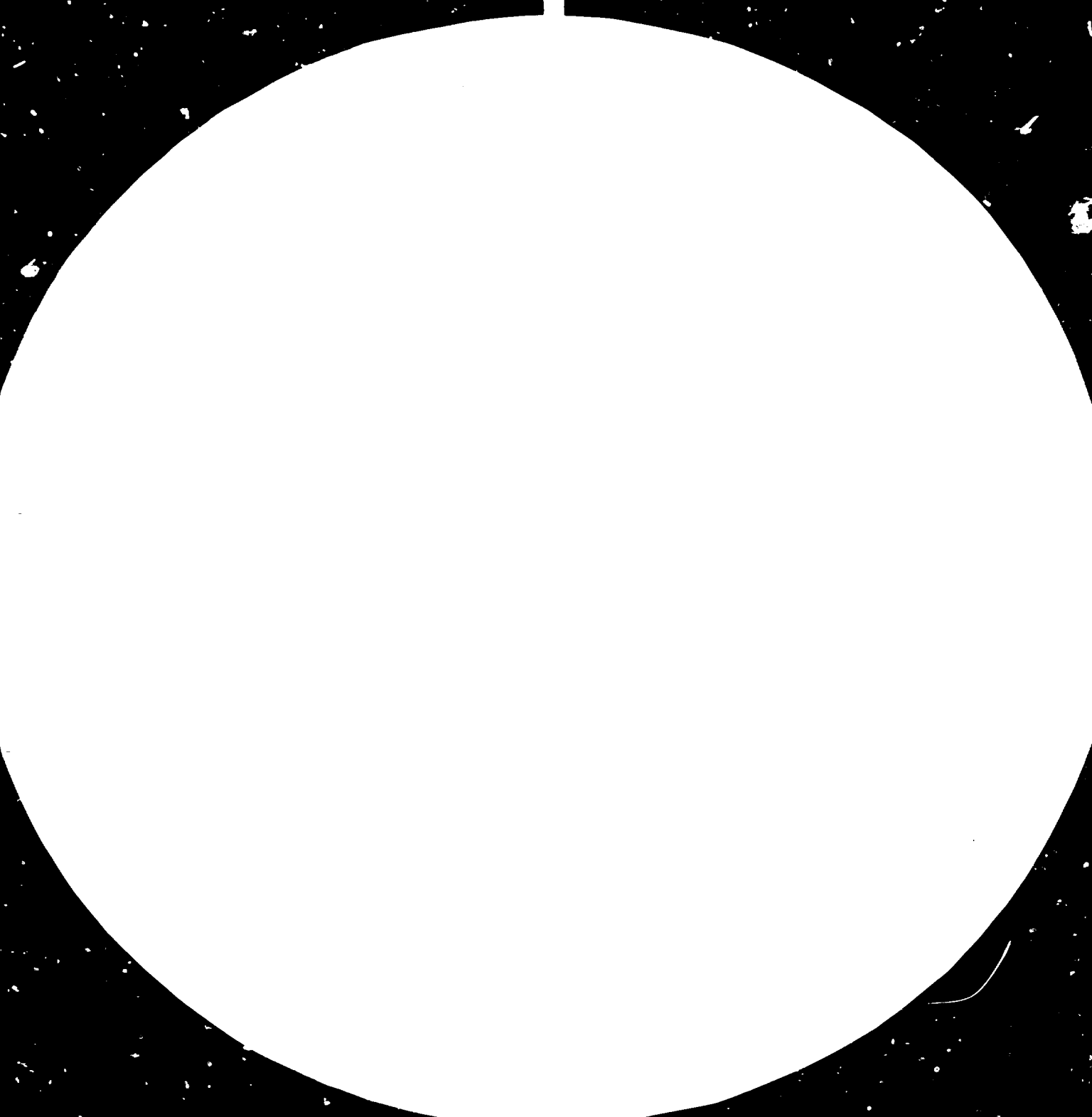
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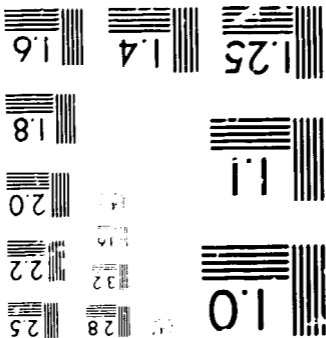
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Furniture Industries

Beijing, China, 23 March to 7 April 1981

GUIDELINES FOR THE SELECTION OF OPTIONS IN ESTABLISHING  
WOOD BASED PANEL INDUSTRIES IN DEVELOPING COUNTRIES \*

by

A panel of Chinese and UNIDO-appointed Consultants\*\*

802105

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PREFACE

UNIDO and the Government of the People's Republic of China convened a two week Seminar on Wood-based Panels and Furniture Industries in Beijing from 20 March to 4 April 1981. One week each was devoted to the two major fields (wood based panels, and furniture). The summing up of the first week was through a three-hour panel discussion grouping four Chinese consultants<sup>1/</sup>, five consultants appointed by UNIDO<sup>2/</sup> and the UNIDO staff member<sup>3/</sup> conducting the panel discussions.

The general theme of this particular discussion was "Guide-lines for the Selection of Options in Establishing Wood-based Panel Industries in Developing Countries". It was a natural summing-up to lectures on the various wood-based panels: plywood<sup>4/</sup>, particle boards (including cement bonded board and oriented strand board and waferboard)<sup>5/</sup>, fibreboard (including medium density fibreboard)<sup>6/</sup>, the surface finishing of wood-based panels<sup>7/</sup>, and low cost automation in the wood-based panels industries<sup>8/</sup>. This summing-up

- 
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  - 3/ A.V.Bassili, Senior Industrial Development Officer, Division of Industrial Operations.
  - 4/ "The process of plywood manufacture" by Mr. Wang Feng Shang (ID/WG. 335/7 Rev.1) and "Recent Developments in Plywood Production" by Mr. Gotthard P. Heilborn (ID/WG.355/9)
  - 5/ "The Manufacture of Flat-pressed Particle Board in the Beijing Woodworking Plant" by Mr. Ba Ru-You (ID/WG.335/5) and "Recent Developments in Particle Board Production" by Mr. J.L.Carré (ID/WG.335/15)
  - 6/ "Technology and Equipment of a Small-scale Wet-process Hard Fibreboard (Hardboard) Plant" by Mr. Chian Ying-lin (ID/WG/335/3 Rev.1) and "Production of Medium-density Fibreboard" by Mr. P. H. Wiecek (ID/WG.335/14)
  - 7/ "Surface Treatment of Wood-based Panels" by Mr. R.Vansteenkiste (ID/WG.335/10 Rev.1) and "Decorative Laminates" by Mr. Xia Zhi-Yuan (ID/WG.335/6)
  - 8/ "Mechanization and Automation Possibilities in the Wood-based Panel Industry" by Mr. H. P. Brion (ID/WG.335/4)

session for which no document was originally prepared - enabled the participants to assess better the relative merits of the products, their limitations and the problems to be overcome in establishing each of these industries in developing countries. The participants requested the secretariat of UNIDO to publish this material for distribution to them and to other interested parties after the seminar. The text is based on notes taken during the panel discussion, and each chapter reproduces the comparative table filled out during the discussion with the approval of the members of the panel and the participants of the seminar. Non-compressed fibreboard ("softboard") was not considered in this comparative study because of its limited potential in developing countries.

#### INTRODUCTION

Many developing countries which have not yet established wood-based panels industries in spite of the fact that the main raw materials (wood or other ligno-cellulosic material) are available.

Wood-based panels (plywood, particle board and fibreboard and their more specialized sub-types) are to a large extent interchangeable for many potential end-uses. Most of them also utilize raw material which could also be used to produce any other type of wood based panel.

Government licencing authorities, planners, industrialists and investors in developing countries that have not yet established wood-based panel industries will, it is hoped, find this comparative study useful.



## I. RAW MATERIAL CONSIDERATIONS

### A. Availability of Raw Materials

#### 1. Form of the ligno-cellulosic material:

Plywood: Its production calls for the availability of ligno-cellulosic material in the form of good quality logs. Though their diameter can vary considerably, tropical countries may peel logs of very large diameter, while in Scandinavia, diameters of less than 20 cm are needed. (The equipment of course is similar but quite specialised).

Fibreboard (hardboard), Medium Density Fibreboard (MDF), and Particle Board (both those using synthetic adhesives and mineral binders) all accept raw material in any form (logs, offcuts or chips of wood or agricultural residues). If only chips are used their size and other characteristics (bark) may affect the properties of the end-products.

#### 2. Range of species that may be used:

Plywood: Most timber species may be used, the requirements are that they can be peeled (or sliced). In many cases the peeling characteristics can be improved through steaming or other heat treatment: Only wood can be used.

Fibreboard (hardboard): requires a raw material base, which, although it could comprise a mixture of species, these should have a limited density range. Wood and/or ligno-cellulosic material from agricultural residues can be used.

Medium density fibreboard (MDF): The situation is similar to that of fibreboard, except that the limitations to the range of density are stricter. So far MDF has only been produced from wood, but it could well be produced from certain agricultural residues.

Particle Board: All wood species are acceptable for use in conjunction with synthetic adhesives. A wide range of agricultural residues have also been found suitable, after testing, for this use.

Ligno-cellulosic material used in conjunction with cement should have low tannin and sugar contents.

3. Chemicals required:

Plywood uses either urea formaldehyde (UF) for interior types of plywood or phenol formaldehyde (PF) for exterior types. In both cases the requirements are roughly 4 percent by weight of the weight of the timber.

Fibreboard (hardboard) does not require any chemical additive if produced by the wet process, and approximately 3 percent of phenol formaldehyde (by weight) if produced using the dry process.

Medium density fibreboard (MDF) calls for the addition of about 9 percent (by weight) of urea formaldehyde.

Particle boards: Those using the synthetic resins require between 8 and 10 percent (by weight) of urea formaldehyde. (Phenol formaldehyde is sometimes used, but it is far less common.)

Those using cement as binding agent are of two types: low density boards (of the wood-wool or wood-chip type) require about 50 percent (by weight) of cement, while the high density (smooth surface) boards require about 300 percent (by weight) of cement.

B. Cost of Raw Materials

1. Cost at source:

Plywood: The cost of the veneer logs at the source is always very high when compared to the requirements for other wood based panels.

Fibreboard (hardboard), medium density fibreboard (MDF) and particle board: The cost of the wood raw material is always low. (If agricultural residues are used, their cost varies and should be determined in each particular case.)

2. Transport and handling costs

Plywood: The transport and handling costs for veneer logs are always high when compared to those of the raw materials used for the other wood based panels.

Fibreboard (hardboard), medium density fibreboard (MDF) and particle board: The transport and handling costs are low in all cases where wood is used. If the raw material is an agricultural residue, its cost varies and should be determined in each particular case.

Transport and handling costs of timber used for low density cement bonded particle board (wood-wool or wood chip boards) are rated "medium".

3. Cost of Chemicals

The unit costs of the synthetic adhesives (urea formaldehyde or phenol formaldehyde) are equal, irrespective of the type of wood based panel for which they are used. By and large, they are considered to be high in all developing countries. (They often have to be imported.)

On the other hand, the cost of the cement required for producing cement bonded particle boards is "low".

C. Need for Research and Development Work

Plywood: It is considered that no further research and development work is needed before introducing this industry in developing countries, other than developing equipment to peel logs of smaller

diameter, or down to a smaller core.

Fibreboard (hardboard) and medium density fibreboard (MDF):  
If the raw material is wood, then no further research and development is needed. If, on the other hand, it is an agricultural residue, then some research and development work will most probably be needed.

Particle board: When using wood and synthetic resin no further research and development work is needed. The tannin and sugar content of the wood raw material might have to be tested before using it for cement bonded particle boards.

As in the case of fibreboards, if agricultural residues are used then some research and development work will most probably be needed.

Table I below gives a synthesis of the above considerations.

TABLE I  
SYNOPSIS OF RAW MATERIALS CONSIDERATIONS

ASPECT	PLYWOOD	FIBREBOARD (HARDBOARD)	MEDIUM DENSITY FIBREBOARD	PARTICLE BOARD
<b>A. AVAILABILITY</b>				
1. Form of ligno-cellulosic material	Only logs	logs, offcuts and chips	logs, offcuts and chips	logs, offcuts and chips
2. Range of species	most species	only a limited density range can be used	the density range is even more limited than for fibreboard	all are acceptable
3. Chemicals needed	UF or PF + 4 Z	Wet process: nil Dry process: 3% PF	UF: + 9%	UF: 8-10% Cement: 50% for low density 300% for high density board
<b>B. COST</b>				
1. Cost at source: - wood - agricultural residue	very high n.a.	low depends on local conditions	low depends on local conditions	low depends on local conditions
2. Transport and handling: - wood - agricultural residue	high n.a.	low depends on local conditions	low depends on local conditions	low depends on local conditions
3. Chemicals: - UF and PF - cement	n.a. high	(in most developing countries) n.a.	n.a.	panel made low
<b>C. Need for R+D:</b>				
- wood - agricultural residue	none n.a.	none most need further R+D	none most need further R+D	none for UF bonded boards (?) for cement bonded boards most need further R+D

## II. MARKET CONSIDERATIONS

### A. Size of the Market

#### 1. The present and potential markets:

Plywood: Local markets for plywood are generally good in countries with abundant raw material (wood) at early stages of panel industry development although potential must be considered less good due to eventual encroachment by other wood based panels when plants to produce them will be established.

Fibreboard (hardboard): Both the present and potential local markets are considered to be "good".

Medium density fibreboard: Although the present local market is but limited, the potential local market for this product is considered to be very good.

Particle board: The present local market is considered to be "good", while the potential of the local market is rated very good.

#### 2. The present and potential export market:

Plywood: The present export market for plywood is considered to be very good. It is believed that the potential export market for this product is even better (rated very good to excellent).

Fibreboard (hardboard): The present export market is limited, and the potential export markets for fibreboard are rated very low.

Medium density fibreboard: This is a relatively "new" product, and at present production facilities are still small. The present export market is rated low and it is estimated that export potentials are limited.

Particle board: It is estimated that both the present and potential export markets for all types of particle boards are very low.

#### B. Promotion Requirements

Plywood and fibreboard (hardboard): It is considered that no promotion is required to develop local or export markets for these products.

Medium density fibreboard: Since this is a relatively new product, serious promotion campaigns must be planned and carried out to develop both the local and export markets.

Particle board: Both synthetic adhesive - and cement-bonded particle board need promotion on the local market. It is deemed that synthetic adhesive bonded particle board needs no promotion on export markets.

#### C. Range of Applications

##### 1. Markets for the panel as produced:

Plywood: The range of applications for plywood is very large.

Fibreboard (hardboard): The range for this type of panel is limited, due to the panel's properties and characteristics.

Medium density fibreboard: The range of applications for MDF is special and is considered to be broader than both hardboard and particle board.

Particle board: The range of applications is considered to be large.

2. Markets for the panel in vertically integrated plants:

Plywood: The range of applications is even larger than if raw sheets are marketed.

Fibreboard (hardboard): Although the range is enlarged through integration, it is still limited.

Medium density fibreboard: The range of applications is improving and could be rated "very good".

Particle board: Here again, vertical integration improves the range of applications and these are more than for MDF, warranting a rating of "very good".

3. Versatility:

Plywood: It is the most versatile wood based panel, since it can be used both for interior and exterior applications.

Fibreboard (Hardboard): This is the least versatile wood based panel: it can only be used for interior applications.

Medium density fibreboard: Although MDF can also only be used for interior applications, it is more versatile than hardboard, as good as particle board.

Particle board: Urea formaldehyde bonded particle board can only be used for internal applications. These nevertheless are quite varied.

The applications for cement bonded particle board are more limited; although it is an "exterior" type of board, it can only be used for construction.

D. Price Range

Plywood: This is the most expensive type of wood based panel.



Fibreboard (hardboard): In timber surplus countries, hardboard is the second lowest wood based panel pricewise, after low density cement-bonded boards.

In timber deficient countries where no cement bonded boards are usually produced, hardboard, although selling at higher prices, is still the lowest priced wood based panel.

Medium density fibreboard: In timber surplus countries MDF is the second most expensive wood based panel (after plywood); while in timber deficient countries - where no plywood is produced, it would be the most expensive type of wood based panel.

Particle board: In countries having a surplus of timber, synthetic resin bonded particle board would be priced between hardboard and MDF. If the country is a timber deficient country, the position remains unchanged - only prices would be higher.

Low density cement bonded particle board is the lowest priced wood based panel. On the other hand, the price of high density cement bonded particle board is higher than that of UF bonded board - of the same order of magnitude as MDF.

Table II below gives a synthesis of the above considerations.

TABLE II

SYNOPSIS OF MARKET CONSIDERATIONS

ASPECT	PLYWOOD	FIBREBOARD (HARDBOARD)	MEDIUM DENSITY FIBREBOARD	PARTICLE BOARD
<b>A. Size of market:</b>				
1. Local market: - present - potential	very good good	good good	limited very good	good very good
2. Export market: - present - potential	very good very good/ excellent	limited very low	low (?) limited	very low very low
<b>B. Promotion Requirements:</b>				
- local market	none needed	none needed	needs serious promotion	needs serious promotion (for all types of panels)
- export market	none needed	none needed	needs serious promotion	none needed
<b>C. Range of application:</b>				
1. Panels "as produced"	very good	limited	medium	good
2. Improved panels	even better than C1	better than C1, but still limited	good	very good
3. Versatility	Most versatile type of panel (interior and exterior use)	least versatile (only interior use)	better than fibreboard, but not as versatile as particle board (interior use only)	UF bonded board: varied applications (only interior use). Cement bonded board: Only construction (interior + exterior use)
<b>D. Price range <sup>1/</sup></b>				
- timber surplus countries	5 <sub>2</sub>	2	4 0	UF bonded boards: 3 Cement bonded boards: low density: 1 high density: 4
- Timber deficient countries	n.s. <sup>2/</sup>	3	5	UF bonded boards: 4 Cement bonded boards: n.s. <sup>2/</sup>

<sup>1/</sup> Rated from 1 (lowest) to 5 (highest)

<sup>2/</sup> Unlikely to be produced locally.

### III. TECHNOLOGICAL CONSIDERATIONS

(from the point of view of developing countries)

#### A. Wood Raw Material Yield <sup>1/</sup>

Plywood: This has the lowest yield among the various wood based panels - of the order of 40 to 50 per cent. Furthermore the raw material used is most expensive.

Fibreboard (hardboard): The yield is relatively good, of the order of 75 percent.

Medium density fibreboard: The yield is very good; of the order of 90 percent.

Particle board: The yield for synthetic adhesive bonded particle board and high density cement bonded particle board could also attain 90 percent. For low density cement bonded particle board it varies considerably - depending on the type of raw material used. It could be as low as 50 percent for some types of wastes.

#### B. Technological Level

##### 1. Suitability for developing countries:

Plywood: The technology of producing plywood is simple. It is the most suitable one for developing countries.

Fibreboard (hardboard): Two technological processes exist: the wet and the dry process. There exist two manufacturing systems for the wet process: the batch (or Deckle box) system, a simple process suited to all developing countries; and the continuous (conventional process) which might be considered too advanced

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<sup>1/</sup> It is impossible to give yields for non-wood raw materials (agricultural residues) as these would vary considerably from material to material.

for countries at an early stage of development. The dry process is more sophisticated and recommendable only to the more advanced developing countries.

Medium density fibreboard: This is a relatively new process. It would only be suitable for the more advanced developing countries.

Particle board: The flat pressed, synthetic bonded and cement bonded processes (for high density boards) are suitable for almost all developing countries. (The extruded particle board process has been superseded. It is used only for very specific applications: in construction of partitions.)

On the other hand, the process for producing low density cement bonded boards is very simple and suited for all developing countries.

## 2. Maintainability of the equipment:

Plywood: The equipment is simple and easy to maintain.

Fibreboard (hardboard): The equipment used in the wet process is relatively unsophisticated. Its maintainability in developing countries would be rated "medium". That used in the dry process is more sophisticated, and hence difficult to maintain in most developing countries.

Medium density fibreboard: Like in the case of the dry process fibreboard, the process is sophisticated and the equipment difficult to maintain in most developing countries.

Particle board: The equipment used to produce low density cement bonded particle board is very simple, and hence easy to maintain in all developing countries.

On the other hand, that used to produce synthetic resin bonded particle board and high density cement bonded particle board is relatively sophisticated, and its maintainability should

be rated "medium".

3. Industrial infrastructure required:

Plywood: Only a simple industrial infrastructure available in almost all developing countries is needed.

Fibreboard (hardboard) and medium density fibreboard: A "medium" level of industrial infrastructure is needed for these two types of wood based panels.

Particle board: The production of flat pressed boards, synthetic bonded or high density cement bonded, calls for a medium level of industrial infrastructure.

On the other hand, the production of low density cement bonded boards calls for only minimal industrial infrastructure.

4. Research and development needed:

Plywood: The production of plywood in developing countries calls for limited R+D work. The production of the other wood based panels (Fibreboard - hardboard, medium density fibreboard and particle boards - both synthetic resin bonded or cement bonded) call for "medium" amount of R+D work if the raw material to be used is wood, and a "high" level of R+D if it is an agricultural residue (depending on the type of residue to be used).

5. Operation of the Process:

Plywood: It is possible to produce plywood on a one shift basis.

Fibreboard (hardboard): One shift operation is possible only if the wet discontinuous (Deckle box) process is used. The other processes (conventional and dry) call for continuous operation of the plant.

Medium density fibreboard: Production calls for continuous operation of the line.

Particle board: The production of low density cement bonded particle board is the only type of particle board that can easily be produced on a shift basis.

The production of synthetic resin bonded and high density cement bonded particle board on a one shift basis, although feasible, is technically difficult and should be avoided if at all possible.

### C. Minimum Economic Capacity

Plywood: Like for all other wood based panels, two levels of minimum economic capacities exist: one is for a plant to cater only for the local market, and enjoying a certain amount of protection, and the other for a plant that would be competitive on world markets. The first is of the order of 7.000 m<sup>3</sup> of finished product per year, while the size of the second (producing from tropical hardwood logs) is of the order of 42.000 m<sup>3</sup> of plywood.

Fibreboard (hardboard): The corresponding figures are 15 to 20 tons per day and 75 tons per day respectively.

Medium density fibreboard: The corresponding figures are 50 to 75 tons per day and 150 tons per day respectively.

Particle board: The figures for low density cement bonded particle board are very low (1000 to 2000 m<sup>3</sup> per annum). Exports of this product are unlikely.

The corresponding figures for the other types of particle board (synthetic resin bonded boards and high density cement bonded boards) are 20 to 30 m<sup>3</sup> per day for plants catering only for the local market and approximately 150 m<sup>3</sup> (approximately 200 tons for cement bonded board) per day for plants that will export.

#### D. Energy Requirements

##### 1. Electric power requirements:

Plywood: The power requirements to produce plywood are low.

Fibreboard (hardboard): the power requirements are high (i.e. more than for particle board, but less than MDF).

Medium density fibreboard: The power requirements are the highest among the wood based panels, but not considerably more than for hardboard.

Particle board: The power requirements can be rated as "medium", i.e. less than fibreboard but more than plywood, for all types of particle boards except low density cement bonded board. The power requirements for that type of panel are very low (less than plywood).

##### 2. Fuel (heating) requirements:

Plywood: No external fuel is needed if the plant burns its waste.

Fibreboard (hardboard): Fuel requirements are high for both the wet and the dry process, being higher for the latter than for the former.

Medium density fibreboard: Fuel requirements are also high.

Particle board: Fuel requirements are rated "medium" for synthetic adhesive bonded particle board and high density cement bonded particle board. No fuel is needed to produce low density cement bonded particle board.

##### 3. Water requirements:

Plywood: Production requires only very small quantities of water.

Fibreboard (Hardboard): The wet process calls for a very high water requirement (unless the technologically sophisticated "closed circuit" is used, when the rating would be "medium"). Water requirements for the dry process are small.

Medium density fibreboard: Water requirements for this product are also small.

Particle board: Water requirements are rated "small" for synthetic resin bonded particle board. They are rated "medium" for cement bonded particle board.

#### E. Ecological considerations

Plywood: The production of plywood causes only small ecological problems, which are easy to overcome.

Fibreboard (hardboard): The production of hardboard by the wet process poses very serious ecological problems. If the dry process is used, these problems are rated "medium".

Medium density fibreboard: Ecological problems exist in the production of MDI; however, they are considered to be only of medium severity.

Particle board: Like in the case of MDF, these problems are rated "medium" if synthetic resin bonded particle board is produced. They are rated "low" if the binding agent is cement.

Table III below gives a synopsis of the above considerations.



TABLE III

SYNOPSIS OF TECHNOLOGICAL CONSIDERATIONS (from the point of view of developing countries)

ASPECT	PLYWOOD	FIBREBOARD (HARDBOARD)	MEDIUM DENSITY FIBREBOARD	PARTICLE BOARD
A. Wood raw material yield	40-50%	75%	90%	Resin bonded and high density cement bonded: 90% Low density cement bonded: 50-70%
B. Technological level:				
1. Suitability for developing countries	simple, most suitable	wet process, batch: simple, suitable. Wet process; conventional: suitable for many countries. Dry process: suitable only for more advanced developing countries	Suitable only for more advanced developing countries	synthetic resin bonded board: and high density cement bonded board: suitable for most developing countries. Low density cement bonded boards: suitable for all countries
2. Maintainability of equipment	simple	wet process: medium dry process: sophisticated	sophisticated	synthetic resin bonded board and high density cement bonded board: medium. Low density cement board: very simple.
3. Industrial infrastructure required	simple	medium	medium	medium except for low density cement bonded board: very simple.
4. R+D needed	limited	wood raw material: medium agricultural residue: high	wood raw material: medium agricultural residue: high	Wood raw material: medium Agricultural residue: high
5. Operation of process	one shift operation possible	process must be continuous (except the Deckle bar process)	process must be continuous	synthetic resin bonded and high density cement bonded boards: one shift operation difficult; Low density cement bonded board: one shift operation easy
C. Minimum economic capacity (finished product):				
- local market	7,000 m <sup>3</sup> /year	15-20 tons/day	50-75 tons/day	synthetic bonded and high density bonded boards: - 20-30 m <sup>3</sup> /day - 150 m <sup>3</sup> /day
- export market	42,000 m <sup>3</sup> /year	75 tons/day	150 tons/day	Low density cement bonded boards: very low n.a.
D. Energy requirements:				
1. Electric power	low	high	higher	synthetic resin bonded boards + high density cement bonded boards: medium low density cement bonded boards: very low
2. Fuel (heating)	nil (if burns waste)	wet process: higher dry process: high	high	synthetic resin bonded boards + high density cement bonded boards: medium. Low density cement bonded boards: nil.
3. Water	very small	wet process: very high dry process: small	small	synthetic resin bonded boards: small. Cement bonded boards: medium.
E. Ecological considerations:	small problems	wet process: very serious problems; dry process: medium problems	medium problems	synthetic resin bonded boards: medium; cement bonded boards: low.

#### IV. MANPOWER AND CAPITAL REQUIREMENTS CONSIDERATIONS

##### A. Manpower Requirements

##### 1. Local availability and need for expatriates:

Plywood: Skilled personnel needed to operate a plywood plant could be trained on the job. Unskilled personnel would pose no problem. Expatriates are normally not needed.

Fibreboard (hardboard): All the skilled personnel - except for electricians and mechanics - could be trained on the job. Unskilled personnel would pose no problem. A few expatriates would be needed to operate initially a wet process plant; and a larger number would be needed to operate initially a dry process plant.

Medium density fibreboard: The situation is similar to that described for the dry process fibreboard (above).

Particle board: The situation for plants producing synthetic resin bonded boards and high density cement bonded boards is similar to that described for the wet process fibreboard (above).

For low density cement bonded boards skilled workers would be trained on the job, unskilled workers pose no problems, and no expatriates would be needed.

##### 2. Training requirements:

On the job training of skilled workers is necessary, but there is no need for any training abroad for any of the plants considered in this study.

##### B. Capital requirements for a Minimum Capacity Plant

Plywood: Capital requirements are relatively low, broken down approximately evenly between local and foreign currency.

Fibreboard (hardboard): Capital requirements are rated "medium", broken down approximately into 30 percent in local currency and 70 percent in foreign currency. This applies both to the wet and the dry processes.

Medium density fibreboard: The situation is similar to that of hardboard. Capital requirements are higher (because of the larger minimum capacity).

Particle board: Capital requirements for synthetic resin bonded board are rated "low to medium". The breakdown is approximately 30 percent in local currency and 70 percent in foreign currency.

For high density cement bonded boards, the capital requirements are rated "medium to high", the breakdown being along the same lines as for resin bonded boards.

Low density cement bonded boards require very low investments by wood based panels standards. The breakdown is approximately 20 percent in local currency and 80 percent in foreign currency.

Table IV hereunder shows a synopsis of manpower and capital requirements considerations.

TABLE IV

SYNOPSIS OF MANPOWER AND CAPITAL REQUIREMENTS CONSIDERATIONS

ASPECTS	PLYWOOD	FIBREBOARD (HARDBOARD)	MEDIUM DENSITY FIBREBOARD	PARTICLE BOARD
<p><u>A. Manpower requirements:</u></p> <p>1. Local availability</p> <ul style="list-style-type: none"> <li>- skilled workers</li> <li>- unskilled workers</li> <li>- expatriates requirements</li> </ul>	<p>could be trained on the job</p> <p>no problem</p> <p>normally not needed</p>	<p>could be trained on the job (except for electricians + mechanics)</p> <p>no problem</p> <p>wet process: few needed</p> <p>dry process; some needed</p>	<p>could be trained on the job (except for electricians and mechanics)</p> <p>no problem</p> <p>some needed</p>	<p>could be trained on the job (except for electricians and mechanics)</p> <p>no problem</p> <p>synthetic resin bonded board and high density cement bonded board: few needed.</p> <p>Low density cement bonded board: none needed</p>
<p>2. Training requirements</p> <ul style="list-style-type: none"> <li>- on the job</li> <li>- abroad</li> </ul>	<p>needed</p> <p>normally not needed</p>	<p>needed</p> <p>not needed</p>	<p>needed</p> <p>not needed</p>	<p>needed</p> <p>not needed</p>
<p><u>B. Capital requirements</u></p> <ul style="list-style-type: none"> <li>- total value</li> <li>- local currency</li> <li>- foreign currency</li> </ul>	<p>relatively low</p> <p>+ 50%</p> <p>+ 50%</p>	<p>"medium"</p> <p>+ 3 %</p> <p>+ 70%</p>	<p>"medium"</p> <p>+ 30 %</p> <p>+ 70%</p>	<p>synthetic resin bonded boards: "low to medium". High density cement bonded board: "medium to high". Low density cement bonded board: very low.</p> <p>Synthetic bonded board and high density cement bonded board: + 30% + 70%</p> <p>Low density cement bonded board + 20 % + 80 %</p>

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