Productivity improvement in informal furniture manufacturing- A case of PAK-GERMAN WOOD WORKING CENTRE, PESHAWAR, KPK

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In the name of Allah, the most

Beneficent and the most Merciful

Declaration

It is hereby declared that this research study has been done for partial fulfillment of requirements for the degree of Master of Science in Biomedical Engineering. This work has not been taken from any publication. I hereby also declared that no portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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Dean / Principle

Dedicated ….

*All mighty " **ALLAH** "*

*To a Person who is "**The Rehmat**" for all the universe,*

And

To my Parents, , my brother Sibghat ullah , my wife, my best buddy Shehryar Afridi and my teachers Dr Khalid akhtar , Dr liaqat Ali and Dr Shahid ikram ullah. Without there guidance, technical support,and there feed backs my thesis will not be able to complete

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SAIF ULLAH

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CHAPTER 1

FURNITURE MANUFACTURING INTRODUTION:

Wood furniture global market is rapidly growing in last few years. The technologies like knock-down are developing to help assembly design and also to keep customer needs in mind. Development and product designing knowledge is shared between members of designing team during each stage of development. Integration in part design is helpful in manufacturing process design phase. (C. northing 2010). The furniture production process should be sequential and controlled. First the big particle panels have to be reduced to acquired size. This process is very difficult to manage because of the structural data of the process.

After the process of cutting, pieces are made to finished parts. The workstation consist different machines, each one perform some operation. The number of different parts with large volume are produced which are processed simultaneously which leads to complex control flow.

Now when parts for the specific model are ready, the parts are assembled at packaging line.

1- WOODEN FURNITURE MANUFACTURING IN PAKISTAN:

The wooden furniture demand is enhancing in the domestic market as well as in international market because of tr4aditional usage and durability. Skilled labor force and the wooden seasoning centre are available. All the equipments needed in manufacturing of furniture are available in market at low cost.

2- OPPORTUNITY IN MARKETS:

Wooden furniture contributes great amount in Pakistan's sales. With the sudden increase in new housing schemes, the increase in the demand of furniture product is noticed.

National housing policy 2001 states that the yearly demand is approximately 570,000 house units whereas the yearly production is calculated approximately 300,000 house units resulting the deficiency of 270,000 house units yearly. Now the different bank has introduced different kind of schemes for housing whi8ch has increase the purchasing power of the people. Due to new and oblique designs and style there is 4% increase annually in the demand in Pakistan **(statistical division of Pakistan**).

FOR FURNITURE PRODUCTION

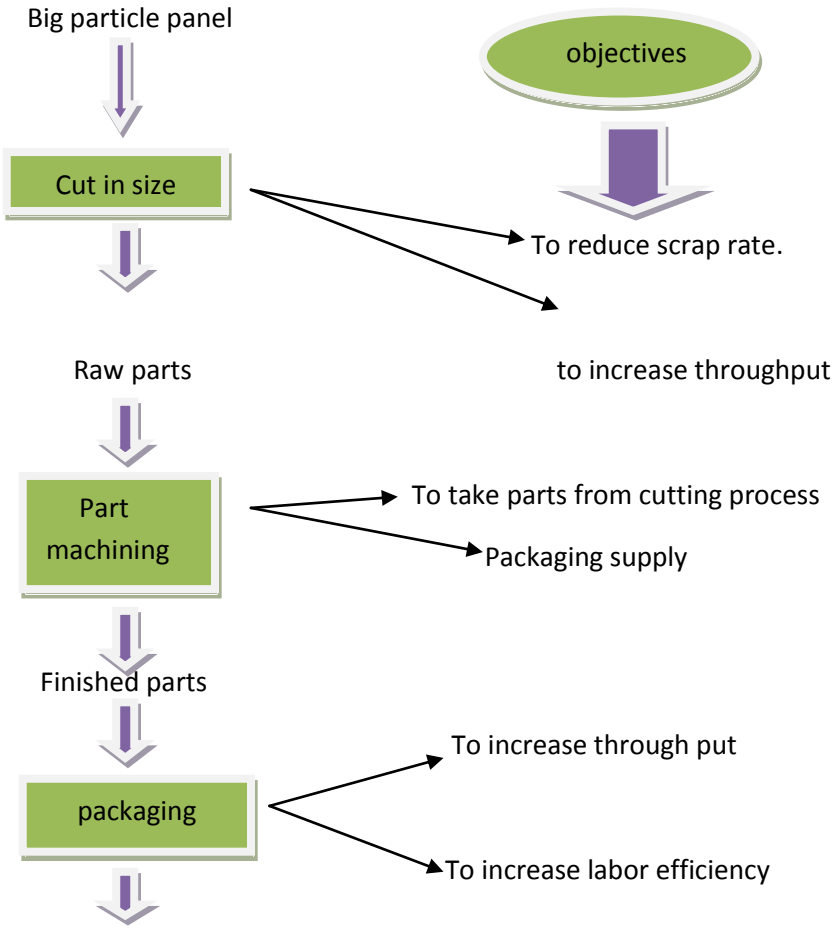

Fig 1.1: Full Process from Raw to Delivery

1- PAKISTAN FURNITURE EXPORT (in USD);

Year	2003	2004	2005
World	**9.318%**	**9.616%**	**11.818%**
Growth		**3.22%**	**22.85%**

Table 1.1: Pakistan Furniture Export

2- THE TARGETED MARKET (in Pakistan) INCLUDES THE FOLLOWING;

- New built housing units.
- Offices (private and public sector).
- Renovation.
- Dowry.
- Departmental and institutional buyer.

3- RAW MATERIAL

Wood is the basic raw material for the furniture manufacturing. Primary quality wood is obtained from the forest. Mainly 42% of the area of forest reserve comprises of raw material wood. Nails, screws, glue solution, spirit, lacquer, sealer and hardener etc are the other raw material use in manufacturing process of the furniture. Mainly for the quality and standard wooden furniture, dry wood is recommended. She sham wood is the basic furniture manufacturing unit in Pakistan. Other manufacturing units of the wood are;

- **Teak wood**
- **Walnut wood**
- **Keekar wood**

This manufacturing unit of woods is classified in wood workstation as;

1- **Solid wood**

2- Semi-finished wood: laminated particle ,plywood , melamine or fiber board among the other solid wood

1- SOLID WOOD

This manufacturing unit of wood is classified depending on the criteria they are use in different ways.

The basic criteria are hardness and the property of texture.

- **SOFT WOOD**: black poplar, chestnut, birch etc.
- **EXOTIC WOODS**: rosewood,ebony,mahogany,teak etc
- **HARD WOOD**: beech, oak, Holm oak etc
- **FINE WOOD**: cherry, walnut etc

Fig 1.2: Solid wood

2- SEMI-FINISHED WOOD:

1- LAMINATED WOOD:

Diverse length, low thickness sheet, joined together by means of countable joints and stuck together through adhesive. The fibers are in same direction because to obtain stiff elements in shape of rectangular shape.

Fig 1.3: Laminated Wood

The lamination regarding the board's surface is the main drawback of natural wood, limited log diameter. For this problem artificial boards or prefabricated boards are produced, mainly of nice quality and economical, manufactured from low quality woods or wood wastes.

2- PARTICLE BOARD:

These are wood particles glued with each other (glue / particles of 1:9). Thai gives us many advantages

- They are cheap
- Not damaged by insects or disease wood. They are design in large sizes. Their entire is usable. They are easy to work on and have medium density and stiffness.

3- PLYWOOD BOARDS:

Made of thin wood plates bind with each other with glue (used resin or phenol or thermo-setting resin can be used) . The final thickness needed which gives us the knowledge how many plates should be bonded but number of plates should be odd (3 to 19).

4- MELAMINE BOARDS:

Directly polarized particle boards covered with melamine cover, which give more resistance to external agents and also gives impermeable surface.

5- FIBRE BOARDS:

Made up of pressed fiber wood, which is taken out from wood particle gridding, resulting in threads of small woods . Fibers are bind with each other with binding resins or glues. This result in uniform material and gives same strength as solid wood (milling and carving etc). This finish edges and surfaces are perfect. High weight is only drawback.

Fig 1.4: Fiber board

4 FINE BEHAVIOR:

Wood not easily burn as it is made of combustible material. It need temperature above 400 degree Celsius or higher for ignition which needs temperature up to 250 degree in the presence of fire for ignition. The firing property of the wood depends on the wood thickness, sixe and volume and also depends on the combustible or flammable material such as varnished, polymers or glued.

5 CHEMICAL PRODUCTS:

- Dyes, paints, glues, lacquers and other finishing products.
- Leather, fibers, organic foams (e.g. poly-urethane), fabric, when upholstering operation is taken place.

6- METAL ELEMENTS: (iron-work) such as lock, rivets, hinges and screws.

7- PACKAGING MATERIAL:

Card board or plastic corner units, plastic for shrink wrapping and card board boxes.

CHAPTER 2

Literature Review

The first and foremost concern for improving the efficiency of production being carried out is to establish a proper manufacturing line. There are several approaches for this

1- **Singular production**
2- **Batch production**
3- **Continuous production**

The most valuable option in current scenario is batch production approach in which group technology is the most perfect for implementation.

Single person mind can manipulate very limited data at a time, computer and other hand process more data than human brain. Even computers has limits in manipulating data , for this reason a method is derived where all process data is retrieved and analyze at the same time

As large industries make thousands of different parts and it becomes more complex to manipulate data if the parts are small and complex.

In group technologies, data with similar reading are manufactured at first. similar reading mean that if parts has similar geometry , function or manufacturing process are group in order to get the upper level of integration among the function and design. Group technology really help large industries in manufacturing process lead time and cost reduction and make ease to operator and designer to manipulate and analyze data.

S. Kumar and P. Kumar [1] studied cycle time reduction of a truck body assembly in an automotive industry by lean principle. Group manufacturing process tools are lined and balanced in order to reduce the time cycle in an automobile assembly workshop.

Many time and cost consuming activities, by lining and balancing improvement, the delay in workstation can be reduced. They studied the lean manufacturing process for the continuous elimination of all waste in production process, will increase the flow cash and operating project of the industry also by the decreasing the time waiting and grouping the product of similar families under the same production line.

Based on the work done, the operation and strategy of the organization and take time for the production line are calculated by comparing the cycle time and efficiency of the organization before and after the line balancing

O.A Malinda, K. Mpofu and A.P.I popoola [2] studied review of the status of reconfigurable manufacturing system (RMS) application in South Africa mining machinery industry. In various industries and companies, reconfigurable manufacturing system (RMS) is used for flexible, stable, modulated and customized products in order to reconfigure in the less time and decreased cost of production.

South African mining department shifted expertise and needed intelligent coal mining technologies from china. They redesign those according to RMS which help them to eliminate the process of underground lifts, loaders and dummy trucks, while directly decrease the production cost and increase the industry profit.

High demand of the world leads to the great future of the mining industry. Reconfigured manufacturing system (RMS) is used to develop load haul dumps (LHD) multiple bits of drilling. The main deficiency is skilled man power and institutes.

Daniela gracanin, brut bushmaster and began lilac [3] studied "using cost-time profile for value stream optimization. They present the value stream optimized framework by uniting cost-time profile and value stream costing. This represent very useful tool for activity visualization of production flow in order to keep watch and eliminate non value added functions. Value stream mapping (VSM) also keep watch of cost reduction possibilities which is very important factor in the work station.

The value stream mapping is the presentation of all valuable and non valuable activities that bring customer's product from raw material

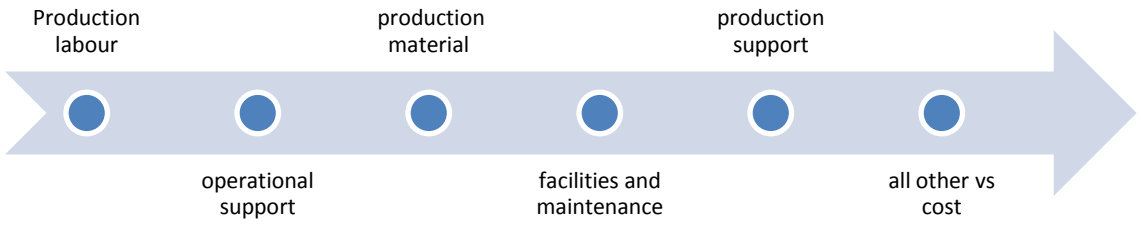

Fig 2.1: Value Stream Mapping

The target of their paper was to show the importance of the time and money relationship and to emphasize the value of value / stream optimization framework. The framework they suggested was not totally operational due to the factor of different strategies approaches. The great challenge to adopt this framework is the difference in cost / time flow profile. More research is needed to fully operational the framework for modern companies.

Ramamurthy C, Dr. V. Selladurai and Dr. Rajesh ranganethan [4] studied experimental cost reduction in pump manufacturing industries through software based mechatronics system. They studied that by because of increase in customer demand of pattern changing. In this scenario the pressure of increasing the price and of reducing the internal cost of the industry . As not possible to increase the product sell price . The only way for surviving in field is by decreasing the selling price and to upgrade the performance of the product of the organization. They suggested Mechatronics based software approach, which give us digital vision running

machine instead of physical which give them virtual, experimental cost, lead time reduction, data reliability, for data accuracy improving. The proposed of their methodology reduces the lead time approximately to 59%, the improvement from 2 to 4 digits was registered in data accuracy and the data reliability was increased to 90%.

Ely divan and v. Srinavasan [5] studied the impact of nit cost reduction on gross profit: increasing or decreasing return. They suggested that decreasing cost of new products will generate high returns. They studied the view of 111 managers and employees of few international firms. They added benefit like when unit cost reduces, the sales demand increases which alternately increase the net profit. Secondly in some researchers view cost reduction increases defects but there view is cost reduction means the design more efficient , less number of defects in part and also less assembly.

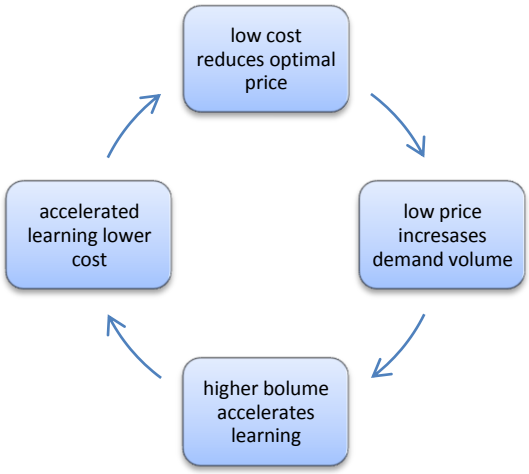

Fig 2.2: design for manufacturing and assembly (DFMA)

This all is done through design for manufacturing and assembly (DFMA). There research shows that DFMA reduces the factor as;

1- **Assembly time = 64%**
2- **Assembly operation = 55%**
3- **Separate fasteners = 69%**
4- **Assembly defects = 68%**
5- **Service cells= 59%**
6- **Time to market = 50%**

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K.kanketraman, b. Vijay remnant, v. Muthu kumara and c. elanchezhia [6] studied Application of value stream mapping for the reduction of cycle time in a machining process. They observed that from last few years manufacturing industries are focusing on efficiency improvement and removing and decreasing wastes. They focus in the installation of lean manufacturing techniques in crank shaft production industry in south India. Multi-purpose decision making frame work is produced in order to help the manufacturing industry to make decisions. This lean manufacturing system (LMS) help them in quality , delivery targets and costs their research decreases 40% of lead time , manufactured products defects were reduced, capability of processing was increased . Crank shaft manufacturing industry involves 13 different operations for the production of product. Their case study successfully explain the installation of LMS tools and it techniques for development

Jiao Malta and Pedro F. Cunha [7] studied a new approach for cost modeling and performance evaluation within operation planning. They studied for the continuous competition I the market the impressive planning evaluation and control is important. They propose a new framework for the improvement of the system. They suggested that for the continuous improvement in performance the evaluation is needed at regular interval for this the regular observation and sequence of steps are required with certain suggested methods and analysis will be done to give new and improved operational framework. Traditional models of framework do not give such information where organization can analyze and gets the improved feedback for the operation. There suggested approach helps the organization in improving the performance, cost reduction, lead time deduction and helps in executing the plans in better way. A lot to be done more in order to give continuous improved feedback and performance evaluation. Also in promoting network, value streaming cost, continuous improvement is needed.

Schonemann m, thiede.s and Herrmann's [8] studied "integrated product characteristics into extended value stream modeling" they studied that the product features like material usage, part quality have large effect on process time as well as production cost. As in modern era , the manufacturing companies face a lot of challenges to stay in market like costumer ease used product design , low cost , more advance , but to meet there requirement the time and cost pressure increases . Design error costs up to 70% of the total production that why designing the product is considered an important stage. In many industries the information needed fir phase development stage and the product manufacturing process are incomplete. In this scenario the difficulties for the developer increases. Expert knowledge about the developing product increase the product quality and well as shorten the lead time and manufacturing cost. Software tool manufacturing results in the reduction of lead time and manufacturing cost. Over engineered and un-required parts manufacturing are easily neglected because pre-designed model of the product especially for the high volume product. More research is needed in designing and to provide more information to the designer about manufacturing and life cycle phase of the product which will help in improvement of cycle time of the product.

Maurizio D. Deuces M, Flagon K, Ethicon K and Matzorou V studied [9] knowledge-based estimation of manufacturing lead time for complex engineering –to-order products. They observe that the complexity of the product drives the manufacturers to be unpredictable in estimating the precise performance of manufacturing product. Problems arise during the initial stages. They developed the method in a software tool to give the customer the graphical view

which helps them to submit orders. The data can be saved and reused to the lead time estimation. This process gives significant reduction in lead time improving the time consumption of industry as compared to the traditional approach. In modern manufacturing, the data of the previous manufacturing process are reused, which improves the performance, design operational stages and planning. In engineered-to-order type of manufacturing industry relies great deal on operator but the reuse of the data of previous manufactured product really helps the operator during performing operations. There study really tackled the problem of slow and inaccurate manufacturing lean time but a lot to be developed in order for quantities improvement.

John Milton burg and David purling [10] worked on managing and reducing total cycle time: Model and analysis. In this they studied that TQM and JIT is the basic of the time line management and its reduction. TCM is the term used for the management of the time required in the manufacturing process of certain product. They suggested three different models for the time management. These are stochastic model, where the data is limited, queuing model when the data is quite impressive, and the moderate approach Markova model is the average data. These approaches are quite helpful when used according the conditions of manufacturing like make to stock, assemble to order or make to order.

There studied is further encouraged when previous few years different approaches of different manufacturing industries are taken under observation. These industries has taken TQM and JIT to the further level to make the theory CTM (cycle time management) productive. CTM includes all the activities from order from customer to the shipment to the customer. They suggested that manufacturing cycle can be divided in to five independent sub cycles.

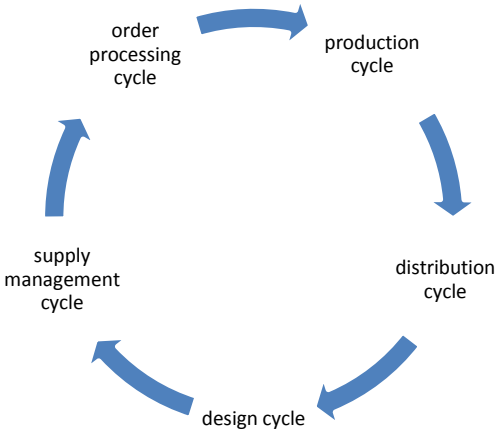

Fig 2.3: CTM (cycle time management)

They observed the few manufacturing industries that are implementing CTM has shown remarkable improvement in their development

		Development time	
Company	Product	Before	After
Honda	Automobiles	5 years	3 years
AT & T	Telephones	2 years	1 years
Navistar	Trucks	5 years	2.5 years
Hewlett Packard	Printers	4.5	1.8

Table 2.1: Industries Improvement after Implementing CTM

Maria cardio, marguerite per and Andréa sansei [11] studied linking product modularity and innovativeness to supply chain management in the Italian furniture industry. There researched in the companies with modular production process , the under observed different firm which has different lead of manufacturing process produces and compared them in under to design the suitable supply chain model.

The basically investigate that how supply chain model design in inter-linked with the innovation of product and its modularity and how the effective supply chain model can be designed by the help of data that includes innovativeness and modularity of the latest product of the firm, the ongoing up gradation in supply chain and the last these effect in the process performance.

They concluded that the main factor in making supply chain model of the firm is

1- **Multi-level communication degree**
2- **Integration (vertically)**
3- **Network concentrator**
4- **Supplier quantity**
5- **Firm acquaintance**
6- **Consumption variation**

In order to enhance the research on how to upgrade and improve the supply chain model . More firms should be taken under observation to collect more statistical analysis. Christian amender, Diego kabana, ornate Bernard [12] studied lead time considerations for the multi-level capacitated lot-sizing problem. They observed that for the correct and precise prediction of the requirement, the classical multi-level lot sizing formulation is not suitable the prediction made by classical formulation gives us either plan with costly, useful parts or they synchronized the two aspects batch and also the scheduling the model prepared by synthesizing the two aspects is than compared with traditional model, the comparison of traditional with the new approach shows 30-40 % cost saving and feasible plan. There research indicates that the traditional plan increase 15-60% the overall cost. They established the mechanism where both lot-streaming and batching are used. Further work is needed to prepare more efficient models for the leas time reduction in multi-level processes.

Farad A. Abdul male and jay ant raj opal [13] studied analyzing the benefit of lean manufacturing and value stream mapping via simulation. They observed that lean approach is more productive in discrete manufacturing as compared to the continuous process production firms. They studied the lean manufacturing process for the large scale steel mill. They studied the lean manufacturing process for the large scale steel mill. They used the value stream mapping technique and developed the before and after detail through simulation in order to see the lead time and work in process reduction percentage.

Lean manufacturing technique are less used in the small firms because of the thinking that it is not that much effective and also less documentation available. They suggested that lean manufacturing technique is quite productive in the firms where continuous and discrete manufacturing process both is used like in the steel mills. Their research helps to demonstrate the basic performance data which facilitates the manager to take decision effectively and accordingly.

Armani A.R and Muhammad al-aura [14] studied production flow analysis through value stream mapping: A lean manufacturing process case study. They work on the flow of production with researched on value stream mapping on the automotive industry. They tool small sequential steps to upgrade the manufacturing process. Analysis on the state of before and after implementing lean production before value stream mapping. VSM is the usual tool that gives us the whole analysis of value added and non-value added which facilitate the firm to design lean process flow to remove the wastes. They concluded from their research that VSM upgrade the lean production approach in industrial process by removing the waiting time and other non-value added. The result they acquired also shows the same impact regarding to the reduction of waiting time. Value stream mapping also shows quite notable difference between the real and standardized work which help the manager and engineer to thoroughly observe the defects in workshop and machines.

R.sundai, A.N balladic and R.M scathes Kumar [15] studied a review on lean manufacturing implementation techniques. They all approve the idea of increasing the utilization of recourses through minimizing the waste. They suggested that with the continuous development in the techniques and process, the strategies of the lean manufacturing plans also get enhanced and productive.

They worked on different aspects such as

1. **value stream mapping (VSM)**
2. **inventory control**
3. **u- line system**
4. **single lean route map**
5. **cellular manufacturing (C M)**
6. **line balancing**
7. **single minute exchange of dies (SMED)**

By analyzing all these aspects they tried to develop the synthetic developed and upgraded plan for lean manufacturing. Their survey successfully revealed that for the productive and effective lean manufacturing system, the proper integration along with proper sequence is needed. There proper road map remarkably reduces the

manufacturing time of the product and also reduces the time wasting process. Further studies is required due to rapidly and continuous fluctuating business competiveness environment.G. , M. Shippers and M salmon [16] studied cutting manufacturing failure costs in the tool and die industry by implementing a knowledge transfer system to avoid and correct mistakes more effective. They work in the reduction of tool making process mistakes and reduce cutting cost. There work comprises of three steps for handling mistakes. (1) collection of information which they did it by capturing image , data collection , describing of mistakes and actions (2) knowledge creation was suggested through data sheet, measure development and graphic preparation and (3) knowledge management through proper knowledge distribution.

Although the introduction of effective KTS (knowledge transfer system) is remarkable but there are still possibilities to make improvements. These improvements can be further enhanced in wide range. The lot of work is also needed to educate the work so that the design data can be embedded in the software data base. Mohammad A.sharah, S. El-kiln and E. El-spayed [17] studied value stream mapping simulator using extends. They suggest that as value stream mapping is the simple paper/pen tool for designing the status of the operations, the simulation software can early facilitate the work modeling. This software's divides the work manufacturing process to the smaller group where it becomes easy for the firm to understand the process, pickups the wastes and to take effective and productive decisions. They introduce value stream mapping with the help of extends through which they design the impressive and effective model. Mapping with the help of extends is more productive and effective as compared to traditional paper/pen mapping because it give clear view of the process plan which can be manipulated, edited where require and reusable. They studied the implementation of extends value stream modeling. There work presented the union of simulation with the value stream which shows the in-process state of the production and manufacturing process at any time. Simulated value stream mapping make easy to make decision because it give the firms the flexibility to make experiment and modify as the scenario required. Extends value stream mapping help allot in reducing cost of production process by removing the wastes and also decrease cycle time which erase the waiting time.

CHAPTER 3

Furniture manufacturing process

The wood furniture design;
There are two main phases of furniture product design which are

1- **Conceptual , detail design**
2- **General product design**

Conceptual detail design defines the product function to meet the requirements of user, while the detail design is product in 2 or 3d design model. In addition, comfortable, delivery, ease to use, strength, functional, safety and easy to maintained are the key points in product design process.

In manufacturing process dimension and tolerance are considered for each component of product, material selection is important, and also accessories and fitting of each component are considered in design phase.

1- Feature and parametric design for product (furniture)

A feature is design which give information about the product, which help manufacturing and designing. Design parameters (tools like cutting, machines, fixtures, volume of production and conditions of cutting), cost, limitation of design are the information in manufacturing features.

The main components of furniture are accessories, fitting and structural parts. Triangular, circular and rectangular are the main principle geometry. Feature base library are established for those features and also reuse and remodel dimensions for manufacturing new parts. In order to decrease the lead design time, parametric and design f feature based is used in furniture designing.

In standard feature library, features are defined, so can be use to design new furniture product. Accessories and fitting are used to fasten the furniture product different component in assembly module. CAD software is made to support detail design of furniture.

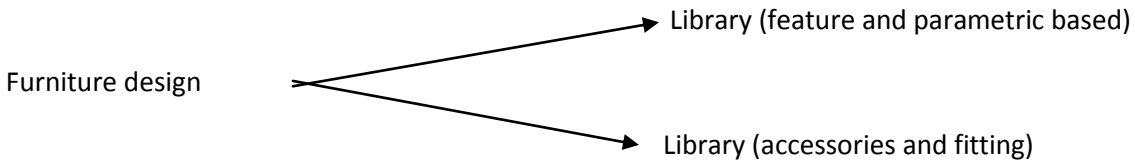

Fig 3.1: Furniture Design

FULL VIEW (FROM PRODUCTION TO DELIVERY) OF THE PRODUCT:

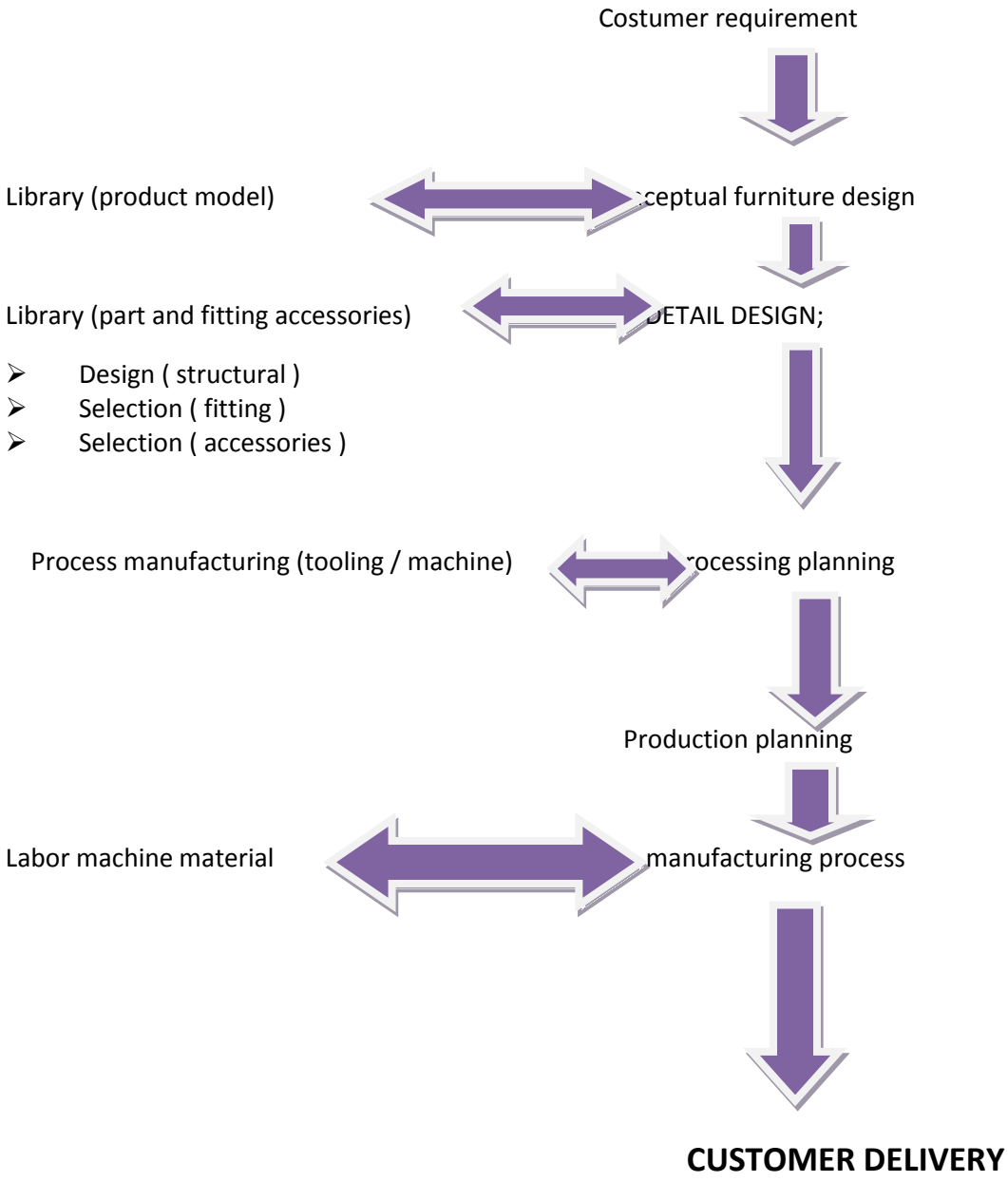

Fig 3.2: From Raw material to Delivery – full process

2- MANUFACTURING PROCESS:

The manufacturing process of furniture enterprises of

1- **Drying (seasoning)**
2- **Machining**
3- **Cutting**
4- **Edging process**
5- **Coating / laminating**
6- **Assembling of furniture**
7- **Finishing**

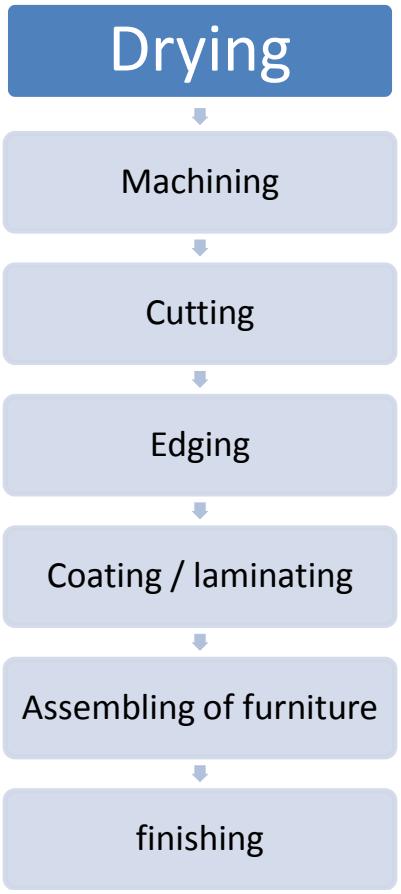

Fig 3.3: Manufacturing Process

1- DRYING:

Drying is done by dried timber, and also by drying on-site fired by a boiler oven or drying kiln. Wood wastes are used in boiler for the emission air from timber drying. The removal of the moisture or water saps contents is called drying or seasoning of wood. The main theme of the seasoning is to remove the unwanted saps contents from the timber.

Defects like warping as well as shaking is caused by drying / seasoning that's why green wood or unseasoned timber are not used in manufacturing. Timber can be twisted, shirked or swelled after they are once dried.

The main reason of seasoning of wood before use is

- **To get needed moisture contents**
- **To decrease the chances of fungi decay.**
- **To reduce the attacks of insects.**
- **To strengthen the wood.**
- **To reduce the war page of wood.**

1- CLASSIFICATION OF DRYING / SEASONING;

Generally seasoning / drying are categorized into two parts

- Natural seasoning
- Artificial seasoning

1- NATURAL SEASONING:

Natural seasoning is done by air, water or by smoke.

1- AIR SEASONING:

The oldest of them is air seasoning of timber wood which depends in the free flow of air across the timber to evaporate the water saps and moisture

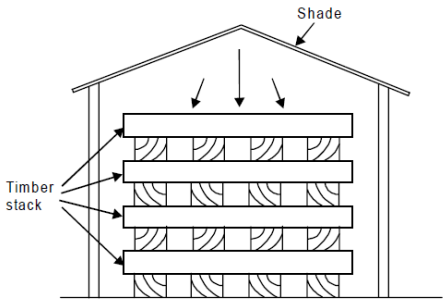

Fig 3.4: Air seasoning

2- *WATER SEASONING:*

In water seasoning, the timber wood is dipped in water for 15 to 20 days. During this time, saps from wood are removed by flowing water. Water seasoning takes less time in drying than air seasoning but the strength is reduced. The cracking problem is overcome in water seasoning. This drying method is suitable for the green wood, full of sap.

3- *SMOKE SEASONING:*

In smoke seasoning, timber is dried up using smoke of useless timber and other water burring leaves. Wood used in boats is seasoned by smoke.

4- *ARTIFICIAL SEASNING:*

Artificial seasoning is define as the drying / seasoning which is controlled by both heat and humidity which quickly and accurately reduce the saps contents / moistures from the wood .artificial seasoning makes the wood hard as compared to natural seasoning which makes it soften.

5- *KILN SEASONING:*

Kiln seasoning is one of the important types of artificial drying in which draught of hot air by force is used for the reduction of air sap/moisture from time.

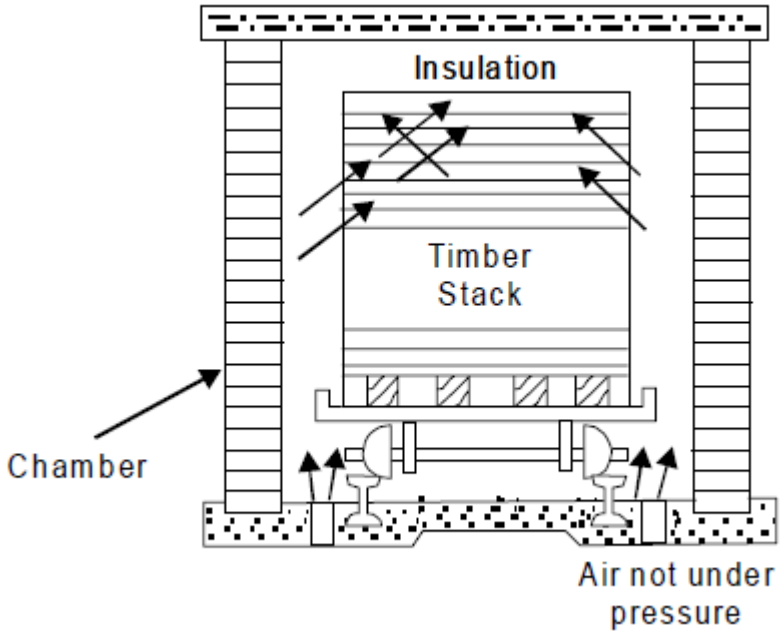

Fig 3.5: Kiln Seasoning

2- MACHINING:

Once the timber is seasoned, timber is machined to the shape of required. Circular saw, band saws, scroll saws, radial saws and portable hand saws are the type of power saws used in manufacturing of wood products.

After sawing, the wood is shaped, surface is flattened, planned by the help of wide wedged lade or by using blades called planer, joint planer, which has blades used for the manufacturing process is the important type of power planer. The result is normally wood chips.

The requirement of some product is the wooden part to be bent. This also requires planning process, some softening agents and high atmospheric pressure. After bending, drying is same as drying raw wood by using drying Kilns which use boilers to produce heat.

3- COATING:

Coating applications are very vast in manufacturing industry of wood furniture. The methods of coating are:

1. **Flat –line finishing**
2. **Spray application**

1- Flat-line finishing:

This method of coating is used only in flat parts of furniture and cannot be used for pre-assembled parts or curved pieces.

The principle way of flat-line finishing is two;

1- Roll coating
2- Curtain coating

1- ROLL COATING;

The process contains coating material by series of rollers.

2- CURTAIN COATING;

This method of flat-line finishing involves rolling the parts of furniture through curtain or cascades of coating material.

2- Spray Coating:

The spray coating technique comprises of different methods.

1- AIR SPRAY COATING:

The technique of air spray is conventional which requires compressed air for spraying him coating material through the small nozzle at high pressure.

2- HVLP (HIGH VOLUME LOW PRESSURE):

In this process the pattern of low speed particles are sprayed at high volume and low pressure to atomize the material to be coated.

3- ELECTRO-STATIC SPRAYING:

This kid of spraying is used for metal working and industries like motor vehicles to cover the metal products

4- THE UNICARB PROCESS:

This is new process, uses union carbide for coating material. This kind of process uses both fast evaporating (diluents) and slow evaporating (watering). This UNICARB process is now replaced by fast evaporating (diluents) solvent with liquid carbon dioxide. With the help of air less spray gun, the wood is coating through by carbon dioxide solvent coating mixture.

4- ASSEMBLY:

In wood industry, final product is made by coating, than assembled or by assembled and then coated depending on the type and design of furniture. Product that is curved, irregular shape are assembled and then coated / finished. This kind o furniture product is made for institutions, residential and office. While others which have regular shape are assembled than coated and finished.

In assembly process, when wood is ready for processing, the assembling is done by adhesive (product/synthetic or natural) and by other nailing. Polyvinyl acetate or hot melts and other adhesive formulation containing solvent are used in assembly of manufacturing furniture industry. Amount of adhesive used depend on the type of assembly.

1- VENEER APPLICATON:

The veneer application is the next step of production process. Veneer is thin wood piece with uniform thickness. Veneer is not usually used in all wood/ furniture application. Timber and wood product manufacturing EET manual is used for veneer production. The product that requires heat, high pressure or some kind of adhesive uses veneer applications.

For the finishing stage, the product/furniture part is sanded in order to smoothing the surface, after the application of veneer and furniture assembly. Closed –coated sandpaper or open are used in roller sanding machine, belt and disk for sanding. 50% to 70% of surface is coated by open-coated sandpaper. While close-coated sandpaper coats complete surface.

5- FINISHING:

The wood furniture production finishing process is divided into two different processes

1- **interior finishing (indoor usage furniture)**
2- **exterior finishing (outdoor usage furniture)**

The process of finishing is same in both; the differentiation comes in coating material used.
Sanding furniture, drying and coating are the applied in series until the desired final product in not accomplished. Small setup uses manual mediators to move the furniture parts b/w the setup, while large mechanical belts, conveyor are used to move the part between the furniture manufacturing facilities. In some industries overhead chain conveyors are used in some facilities.
High concentration VOC, s is applied which are volatile during the finishing is done. In ink, finishes paints and also in stain, solvents of VOC, s are used, cleanup operation of over-sprayed particles are done through it.

CHAPTER 4

SMALL INDUSTRIES DEVELOPMENT BOARD; PAK-GERMAN WOOD WORKING CENTRE, PESHAWAR FRAMEWORK

1- INTRODUCTION;

Pak-German wood working centre, Peshawar was established in 1972-73 under the technical assistance agreement between government of Pakistan and federal republic of Germany at the total cost of 2.604 millions including F.E.C of Rs 1.823 million is for the promotion and development of wood working industry o most modern lines, with the following aims and objectives.

1- **Training services**
2- **Advisory/consultancy services/sub contracting.**
3- **Common facilities services**
4- **Extension services**
5- **Production unit**

1- TRADING SERVICES.

The centre is arrange for the short terms as well as long term courses for the development of modern wood technology to cover the demand of skilled workers and machine operators in the private sectors. Two year certificates and 3 ½ year diploma courses are during the initial stage of the centre.

2- ADVISORY / SERVICES / SUB: CONTRACTING:

Layout plans and flow charts for wood working units inside and outside the estates are produced. Modern working is introduced. Advice is given how to work with modern material. Design of modern furniture, doors and windows are produced as request, along with detail drawing. Organizational set for different enterprises are worked out.

3- COMMON FACILITIES.

The centre will be equipped to provide the following services to the private enterprises at cost (Rs 181 lac).

a- **Wood seasoning facilities.**
b- **Tool sharpening facilities.**
c- **Production facilities offered through expensive machinery which a small sized concern cannot afford to install in its factory.**

4- EXTENSION SERVICES

- Intensive training of counterparts.
- Extension and updating of survey on wood working sector in NWFP.
- Assessment of need of industries
- Selection of promotion-worthy units
- Assistance in purchasing locally manufactured machines and tools and provision of investment capital loans to private wood working units to purchase local manufactured equipments
- Administration and disbursement of extension services revolving loan funds (funds established in 1971 K.P.K government contribution Rs 750,000/- FRG through GTS D.M 200,000).
- Supervision of installation and utilization of machines / tools.
- Intensive co-operation with local machines /tools manufacturers in order to develop appropriate, functional equipment with emphasis on upgrading and inspiring units within K.P.K.
- Planning, drawing –up and implementation of wood working industries both in the public and private sector.
-

5- PRODUCTION / UNIT:

Intensive training of counter parts , operation of pak-german wood working centre on a profit oriented , appropriated technology using production centre of standardized furniture , introduction of raw material and auxiliary material i.e. chipboards , veneer , synthetic glues , nitro cellulose lacquers different type of hardware , fixture for furniture ,introduction f modern manufacturing equipment and manufacturing techniques quality oriented timber resources surveying furniture manufacturing. Application of modern planning production sheering and progress control methods.

Application of coating methods according to modern business administration standard cost factor revision

-

2- ACHIEVEMENTS

1- TECHNICAL PROGRAMS:

Technical training programmed have substantially controlled towards contributed towards the transfer of modern wood working technology to the private sector (educated youth matriculates) in large number (135), certificate holders (77). Diploma holders' producible technicians and great helped in the private units and public sector organization in K.P.K/ even other provinces. They are serving their industry well in Peshawar, charsadda, mardan, haripur, abbot bad, dera Ismail khan, karak, Gujarat (Punjab) and Quetta, Baluchistan.

2- ADVOSORY SERVICES/SUB CONTRACTING:

The project has extended managerial help to various private sectors
(mention a few . wood co. Mardan , karigar furniture , Pak Danish Peshawar in work preparation , designing and costing etc which have greatly assisted in establishing these famous units. It is worth mentioning that the project reports had visited each and every machinery manufacturer in Pakistan particularly, Gujranwala, Sialkot, and Lahore improved their work men ship and technology to modern techniques in the machinery and after strenuous efforts the project experts were in a position to select the best manufacturers.

The small wood working unit had no organized marketing facilities, the project realizing the necessity of the private units introduced the facility of sub-contracting and this is the first of its kind in the province. In the beginning it was in shape of components of different items, while on the receipt of bulk orders from education department, some of non standard like desks/benches. Teacher table, office chairs stools, tablet chairs etc, were given to genuine sub-contractors for manufacturing.

Some of the wood working units (sub-contractors) assisted by the pak-german wood working centre Peshawar have appreciated the facilities provided by the project while the other such units established at small industry estate Peshawar have demanded certain additional facilities some of those areas under;

1- **Limiting of maximum amount of security deposit**
2- **Procedure of furniture inspection on site.**
3- **Increasing of profit margin to the sub-contractor.**
4- **Distribution of placing of order on sub-contracting.**
5- **Providing of assistance of sick wood working units.**

3- COMMON FACILITY:

Its common facility services have provided adequate care to private sector units. pak-german wood working centre as a whole remains open to private enterprises in order to inquire and get informed about all facts of the operation common facility service is also provided to the private sector .if they are interested in getting common facility service from pak-german wood working centre Peshawar just have to contact concerned department , that includes;

- **Seasoning**
- **Sharpening**
- **Pressing**
- **Dowel making**
- **Sanding facilities**

Till up to now hundreds of unit has get facilities from Pak-gem and wood working centre Peshawar.

4- EXTENSION SERVICES:

The project extension services programmed introduced for the first time like Japan, Germany, the most important factor, is unique in the province which has been greatly appreciated for and wide. It was even

By other province wood working centre Gujarat (Punjab). Under its standardized program various items of furniture of international standard are being manufactured by the centre,

Its multiple effect has been quite phenomenal and visible that beside 320 small wood working units in private sector through extension service training n machines was being given to private units closed machine were put into operation, sketches / drawing were prepared and given to them, system for oiling, greasing etc of the machinery were introduced to this safety guides and measure were made known to them. All these technical measures were very essential for maintenance of the machinery and equipment due to which smoothness and flow of the work had resulted in their operation.

3- FINANCIAL POSITION:

To clear the financial position of the cater, the following comparative statement Fr the last 5 year with ratio analysis are enclosed

1- **Balance sheet**
2- **Profit and loss account.**
3- **Sources and uses of fund**
4- **Sources and disposal of value added.**
5- **Ratio analyses.**

4.1 Detail Of Work Done For Sub-Contractors

Year	No. Of sub-contractor	Work ordered	Work done
2008-09	77	33	19
2009-10	85	42	23
2010-11	85	43	21
2011-12	49	14	9
2012=13	35	15	8
2013-14	22	7	3

Table 4.1: Detail Of Work Done For Sub-Contractors

4.2 Common Facility Service

Year	Sawing/dowel making	Seasoning	Pressing	Shaping	Total
2013-14	474	5133	53,669	4996	64,254
2012-13	4992	6708	62,641	14,090	88.026
2011-12	2643	9150	3620	12.117	27,530
2010-11	9360	-	1938	9,170	20,469
2009-10	1958	938	8425	16.033	27,368
2008-09	946	3971	-	10,334	13,257
2007-08	126	5304	-	2236	7775
2006-07	67	3216	4581	9467	17712
2005-06	64	5149	11.515	25,105	46,496

Table 4.2: Common Facility Service

4.3 Schedule Of Sales

YEAR	GOVT,DEPTT	PRIVATE	TOTAL
2013-14	88	13	101
2012-13	94	18	112
2011-12	56	2	58
2010-11	47	1	28
2009-10	38	3	41

Table 4.3: Schedule of Sales

4.4 Furniture Supplied

YEAR	SUB:CONTRACTER	GOVT,DEPTT	PRIVATE ORGANIZATION	TOTAL
2013-14	42	45	13	100
2012-13	52	42	18	112
2011-12	21	34	2	57
2010-11	18	29	1	48
2009-10	10	27	3	40

Table 4.4: Furniture Supplied

4.5 Schedule of Production

YEAR	SUB-CONTRACTING	PAK-GERMAN CENTRE PRODUCTION	STANDARD PRODUCTION	TOTAL
2013-14	29	40	13	82
2012-13	43	41	11	95
2011-12	13	23	8	44
2010-11	7	28	14	49
2009-10	4	19	14	37

Table 4.5: Schedule of Production

4.6 No. Of Employs

YEAR	NUMBER OF EMPLOYESS
2014	218
2013	290
2012	216
2011	207
2010	178

Table 4.6: No. Of Employs

CHAPTER 5

PAK-GERMAN WOOD WORKING INDUSTRY PRODUCTION MACHINES AND LAYOUT PROBLEM FORMULATION AND ANALYSIS:

Pak-german wood working industry is an important branch of our furniture sector and is established in 1972-3. Their products are chair, table, computer table,

Dice and other furniture products in order given by Government and private sector . In this chapter, all the manufacturing process from the drying of the timber to the surface finishing and assembly will be discussed briefly.

The production process of the furniture manufacturing in categorized in following groups:

1- **Inventory**
2- **Drying (seasoning)**
3- **Machining (drilling / milling)**
4- **Assembly of furniture**

1- Inventory (raw material);

The most difficult part of wood manufacturing is the proper management of inventory. From storage of limber to the finished product, a lot of time wastage and wood wastage is noticed. A proper chain mechanism is needed for the continuous supply of wood.
Negative impact like raw material, over stocked is noticed.
As the raw material is the first form of the product, which is of different forms like chips, composites and lumbers.

Weather is also main factor. It is noticed that excess amount of storage decreases the profit of industry. Mainly the **work in process** (WIP) is used to overcome the deficiency shows in scheduling and planning.
Work in process (WIP) can leads to overhead costs, labor charges and a lot of damaging of raw wood in accommodation area.

Fig 5.1: Log Area

SUGGESTIONS:

To overcome their loses **Make to stock** (MTS) strategy is applied. Make to stock determines how much stock should be produced.
For MTS strategy the high accuracy for demand forecast is needed. For these demands forecast, the managing staff should be well aware of the industry demands and production capabilities. In accurate demand forecasts can leads to losses in production cost and also damages due to overhead stock in inventory
Other alternative strategies are made to order (MTO) and assemble to order (ATO). The main target of "make to stock "is to give highest production of demand in time with least amount of raw material (inventory) in the log area.

2- SEASONING:

For the wood to be used in industry, first of all it is properly dried to remove all the moisture from the wood. Wood has the ability to absorb or desorbs moisture up to its in equilibrium with its surrounding. This equilibrium can damage the wood if I is acquired rapidly , so the seasoning machine are used in order to slowly dry the woods need for the furniture manufacturing process.

In Pak-german wood working industry, the seasoning plant temperature is gradually increased from 15 degree Celsius to 70 degree under the period of 3 weeks. The slow increasing in temperature is done in order to overcome the cracking problem. The fan continuously takes out the evaporated moisture of the wood from the seasoning plant. daily for 5 to 6 minutes, dampers are opened in order to exhaust the moisture.8 to 10 hours waiting time is needed as direct impact of heated wood with the surrounding damage/crack the seasoned / dried wood.

Fig 5.2: SEASONING machine

SUGGESTION;

When the moisture is approx 12-15% remained, the seasoning machine can be stopped while the exhaust fans for removing the moisture are continued. After 2 $_{l/2\ weeks}$ continuous heat up the wood. The inner high temperature of wood can evaporate the remaining moisture. This will save a lot of money and energy of the industry.

3- MACHINING:

After seasoning is done the main portion is of furniture manufacturing comes, that is cutting/ machining. PAK-GERMAN wood working centre 8 different machines for cutting, edging according to the given customer order, there machines are;

1- **Band saw machine**
2- **Pendulum saw machine**
3- **Multiple width cutting machine**
4- **Cutter machine**
5- **Thickness adjustment machine**
6- **Jointer machine**
7- **Molder machine**
8- **Veneer cutting machine**
9- **Fix sander**
10- **Edge sander**
11- **Joint making machine**
12- **Surface sander**
13- **Double fix**
14- **Molder (intake)**

1- BAND SAW MACHINE:

Band saw machine is the cutting machine design to make the desired dimension pieces that are usable by the upcoming cutting machine for the production of the product. The band saw machine is much more economical and feasible than hand saw machine which can produce accurate rectangular, squared shape pieces of wood.

The main part of band saw is the blades. The blades are made of alloy steel. They are flexible as the body of the blade is annealed and teeth are made harden.

The important aspect of the blades is pitch. The pitch is teeth per inch (Tip). The term pitch with 14 means 14 teeth per inch.

FIG 5.3: BAND SAW MACHINE

TIME REDUCTION AND COST REDUCTION SUGGESTION IN BAND SAW MACHINE:

1- For the proper operation of the band saw machine, the blades selections according to the material, the thickness of the material to be operated and the sawing operation are taken under observation.
2- The blade pitch selection is also very important, the thicker the wood, the more high pitch blade should be used. The recommended rule is that at least 3 blade at any time during the sawing operation must be in contact with the operated wood.
3- The widest blade should be used during the straight sawing with proper pitch. As narrow blades can be broken during operation of hard wood is therefore the wider blades can be used.

The radius of the blades is accordingly to the below table:

Radius to be cut (in inches)	Width of band saw blade to use (in inches)
2 ½ to larger	½
1 7/16 to 2 7/16	3/8
1 to 1 3/8	5/16
5/8 to 15/16	¼
5/16 to 9/16	3/16
1/8 to ¼	1/8

Table 5.1: The radius of the blades

4- Blade wear: blades can damage due to prolonged usage during operation. High speed sawing damages the blade in great deal also is light than blades that are used on hard wood, this produces, the abnormal wear in the wood produced piece.

5- There are several ways to know the blades tearing, where you have to replace the blades

a- When the blades cut slowly or when the wood is entered into by hands

b- If the teeth of blades are bright on the edges, it also shows the dullness.

c- When the blades during cutting flows to the left or right or changes the path of cutting is the sign of blade changing.

d- Stop the machine and remove the blades and feel the sharpness, if the edge sharpness is not felt than replace the blades.

Time cycle reduction suggestion in band saw feeds:

Feeding is the pressure used by the material being cut to be the band saw blade feeding can be done by either hand or machine.

As PAK-GERMAN wood industry is using machine.

Total process time	Blade wearing / damaging	Time consumed in replacing	Total time consumed in process due to replacing/day	Cost of blade / meter	Cost of 10 meter blade	Total cost of blade used / day
8 hours = 480 mints	2 blade/ 3 days = 0.67 blade / day	30 mints	30*0.67 = 20 mints /day	1500/ m	1500*10 = 15000 rest	0.67*15000 = 10050 rest

Table 5.2: Band Saw Old Machine, Time & Cost

BY PROPER SELECTION OF BLADE, PROPER TPI :

Total process time	Blade wearing / damaging	Time consumed in replacing	Total time consumed in process due to replacing/day	Cost of blade / meter	Cost of 10 meter blade	Total cost of blade used / day
8 hours = 480 mints	1 blade / 3 days = 0.334 / day	30 mints	30*0.334 =10.02 mints/day	Rs 1500/ m	1500*10 = Rs 15000	15000*0.334 = Rs 5010

Table 5.3: Band saw new Machine, Time & Cost

PERCENTAGE IMPROVEMENT IN COST & TIME:

MACHINE (BAND SAW)	COST / DAY	TIME / DAY	%TIME IMPROVEMENT	%COST IMPROVEMENT
WITH PROPER REPLACEMENT	Rs 10050	20 mint	= (20 – 10.02)/ 20 = 9.98 / 20 = 0.499 = 49.9 %	= (10050 – 5010) / 10050 = 5040 / 10050 = 0.501 = 50.1 %
WITH PROPER REPLACEMENT	Rs 5010	10.02 mint		

Table 5.4: **PERCENTAGE IMPROVEMENT IN COST & TIME**

- **% COST IMPROVEMENT = 49.9**
- **% TIME IMPROVEMENT = 50.1**

4- PENDULUM SAW MACHINE:

In large shop, pendulum sawing machine is used. They are used because of their ability to cut accurately in angle and in straight line cutting.

These saw machines are power operated and can cut different variety of thickness which makes it first priority.

The powerful motor gives the advantage to pendulum saw but the thickness of the material can also be the main factor regarding the pendulum saw performance. This is the only

. Another limitation of pendulum saw is its immovable nature unlike small radial arm saw and compound miter saws, they are stationery and “in shop” unit.

Fig 5.4: PENDULUM SAW MACHINE

SUGGESTION:

The saw blade holder of the pendulum saw is fixed with one kind of saw used. There is a lot of different variety of holder available for different pendulum saws. This can help pendulum saw machine to work with more versatile range.

MACHINE (pendulum saw machine)	Thickness	Length	Width	Time consumed	% improvement
With rigid blade	1.475-1.550 m	10 m	2 m	20 sec	= (20 – 13) / 20
With flexible blade	1.475-1.550 m	10 m	2 m	13 sec	= 7 / 20 = 0.35 = 35 %

Table 5.5: Pendulum Saw Machine Time Improvement

5- MULTIPLE WIDTHS CUTTING MACHINE:

With the continuous demand of the furniture, it is necessary to have continuous flow of cut furniture in usable form.

In multiple widths cutting machines the piece of board / wood are cut longitudinal as well as cross wise.

FIG 5.5: MULTIPLE WIDTHS CUTTING MACHINE

SUGGESTION:

In pak-german wood working industry. The multiple width cutting machines has fixed blades positions with constant speed motors for the flow:

WOOD PIECE WIDTH:

Thickness	Length	Constant speed	Time consumed
75mm	1550mm	60 rpm	10 sec

Table 5.6: Wood piece old cutting time

If its blades and converted from fixed to flexible and change motor speed. Multiple widths cutting machine can be used in production different varieties of width board pieces as required .The points that can reduce the lead time.

With multiple rip saws, it is convenient for the firm to cut it accordingly with the flexible saw:

Thickness	Length	Speed	Time consumed
75 mm	1550 mm	85 rpm	7 sec

Table 5.7: **With multiple rip saws, wood piece new cutting time**

TIME IMPROVED:

- **10 – 7/10 = 3/10 = 30 % improved**

6- CUTTER MACHINE:

Wood cutter is the machine used in wood industry. The machine is vertically fixed to the table. The speed of the blade is approximately 3,000 to 10,000 rpm. Its work is same as router table with the only difference is wood cutter is a machine stationery fixed and is designed to cut down large pieces in accordingly dimensions.

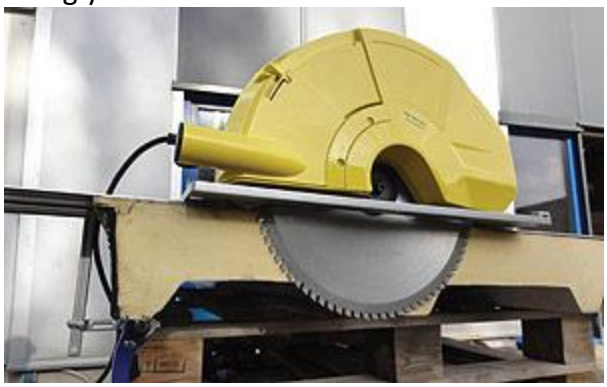

Fig 5.6: Cutter Machine

Wood cutter came with 2 designs

1- The spindle is fixed on the side of the table which cuts the work piece across the sides.

2- The spindle is fixed at the bottom, which is used to cut the bottom portion of the work piece.

The sharper/ spindles are connected to the power motors through the shaft which came in different ranges from ¾" to 1 ¼" and 30 mm length.

SUGGESTIONS:

Power feeders/ conveyor belts across the table can make the process fast.

WOOD CUTTER MACHINE WITHOUT POWER FEED

MACHINE	SPINDLE (rpm)	TIME TO CUT
WOOD CUTTER	4500 rpm	10 sec

Table 5.8: WOOD CUTTER MACHINE WITHOUT POWER FEED

WOOD CUTTER MACHINE WITH POWER FEED

MACHINE	SPINDLE (rpm)	TIME TO CUT
WOOD CUTTER	4500 rpm	6 sec

Table 5.9: WOOD CUTTER MACHINE WITH POWER FEED

- **Time saved = (10 sec – 6 sec) / 10 sec = 40%**

7- THICKNESS ADJUSTMENT MACHINE:

Thickness machine is used for planning the timber/wood to uniform thickness. During cutting, first thing to adjust the depth of the cutter, according to the design needed. After adjusting the timber is feed in it and required thickness is retrieved from outside of the machine thickness planar is power fed and their power fed area is guarded to prevent from danger to operator.

Fig 5.7: THICKNESS ADJUSTMENT MACHINE

SUGGESTION:

The thickness machine used is very old versioned. The thickness machine used is capable of cutting ten pieces at the time and will take only 20 sec but due to conveyor belts fault only one piece at the time is used which take 20 sec instead of 10 pieces can be operated at that time if proper conveyer belt is used.
The power roller with anti-kick can be placed in front of feed roller which will convoy the timber through the thickness machine with constant speed and straight path.

The statics are:

Machine	Belt version	No. of pieces operated at a time	Time required for operating 10 pieces	% improvement
Thickness machine	Old	1	5 sec	
	New	1	1sec	

Table 5.10: Thickness adjustment machine

8- JOINTER:

Jointer is the machine used for side surfacing and edge to edge cutting. It consists of two tables in the row with the cutter between them. The electric motor is fed in the cutter. These tables are called " in feed" as timber/wood enters through it and the second table is called " out feed" as work piece is required shape is fed out through that table the cutter heads axis of rotation I perpendicular to the direction of feed while is parallel to surface of table. The direction of cutting of the knives is opposite to the feed.
Jointers came in 2 models one with 4-6 inches (100-150 mm) width of cut, while other with 8-16 inches (200-400 mm)

FIG 5.8: JOINTER

SUGGESTION FOR IMPROVING THE JOINTER MACHINE FUNCTION:

The common problem is the jointer machine is the even thickness of the timber. The conventional way of the even thickness cutting is adjusting indeed and out feed table as acquired thickness. This takes a lot of time. The thickness planar is used on the in feed side of the machine which make easier for the operator to cutter according to required thickness. By the help of thickness planar twist cutting can also be done. If 20 mm twist cutting is need, with the help of thickness planar, 10 mm of one side and than 10 mm from other end can easily be done.

9- VENEER CUTTING MACHINE:

Veneer is called for the wood pieces cutter in slices. In veneer cutting machine the rotator knives are used for cutting the log as required angle. In this machine the knife is installed at the centre. In this machine during the process the work piece is mounted in with the mark on the path to be cutter. The performance of the veneer machine depends on the thickness of the work piece and the speed is varied accordingly. The cutting angle usually not exceeds 27 degree.

FIG 5.9: VENEER CUTTING MACHINE

SUGGESTION:

To improve the surface of the work piece, the holder is used which gives straight path to the log to be cut in straight or angle.
In pak-german wood working industry, the constant speed machine is used by replacing it with the variable speed machine can improve the working performance in great range. The main reason is because of thickness and it is important to vary speed with the thickness.

Time consumed by constant speed veneer machine:

Machine	Thickness of work piece	Length of the work piece	Constant speed of the machine	Time consumed
Veneer cutting machine	10 mm	10 m	3 m/sec	15 sec

Table 5.11: Time consumed by constant speed veneer machine

Time consumed by variable speed veneer machine:

Machine	Thickness of work piece	Length of the work piece	Constant speed of the machine	Time consumed
Veneer cutting machine	10 mm	10 m	6 m/sec	7.5

Table 5.12: Time consumed by variable speed veneer machine

- **Time improved = (15-7.5) sec/ 15 sec = 0.5 = 50 %**

10- MOULDER MACHINE:

The molder machine is used to give the wood work piece the shape as required with the help of profiled cutter. This profiled cutter is fed into the power motor of the machine. Wood molder can also call planar.

Fig 5.10: MOULDER MACHINE

The size of the planar blade varies according to the power of motor as well as the spindle diameter. They generally came in 2, 3 and 5 horse power.

SUGGESTION:

The version of molder used in the pak-german wood working industry is older. In new version the splinter rotates both directions which are necessary for some work piece wood. The time wastage came in that point when full reverse
the motor is required instead of the inverting the rotation of the motor whole working piece is rubbed back to front direction.

The statistical improvement in replacing version:

MACHINE	WORK PIECE LENGTH	TIME CONSUMED BY OLD MACHINE	TIME CONSUMED BY NEW MACHINE	% IMPROVEMENT
MOULDER MACHINE	5 m	25 sec	16 sec	(25-16)/25=0.36 =36%

Table 5.13: **The statistical improvement in** MOULDER MACHINE

11- MOULDER (INTAKE):

Intake molder is the molder machine with the round motor with a mounted sand paper. This kind of molder is used to smoothening the curves or regalities in the product work piece.

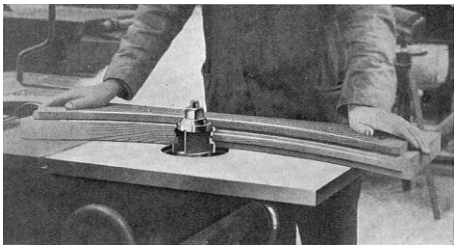

FIG 5.11.1: MOULDER

SUGGESTION:

By passing wood through planar at a slight angle helps to eliminate chatter from the rages. If constant speed motors are replaced with the variable speed motors, the process time will improve.

FIG: 5.11.2: Intake Molder

-Machine (molder intake)	Curve length	No. of samples	Time consumed on average
Constant speed	17”	10	4 mints
Variable speed	17”	10	3 mints and 15 sec

Table 5.14: Machine (Molder Intake) Time Improvement

- **Improved time = (4 – 3.25) mints / 4 mints = 0.75 / 4 = 0.1875 = 18.75 %**

1- FIX SANDER:

The fix sander consists of motor on which the close loop on sand paper is mounted. Fix sander is used for planning the surface of the wood work piece.

Fig 5.12: Fix Sander

SUGGESTION:

In pak-german wood working industry , the issue was of the humidity blockage, in case of sanding process dry wood piece are easily process while humid wood take a time in smoothing in sanding process.

The observed and suggested statistics are:

Wood	Nature	Length	Width	Pieces/hours
Fix sander	Dry	1.5 ft	10 "	30 pieces/ hour
Fix sander	Humid/wet	1.5 ft	10"	15 pieces/hour

Table 5.15: The observed and suggested statistics (time)

2- EDGE SANDER:

Edge sander is the smaller than fix sander which is used to planning / smoothing the edges of the surfaces of work piece. In edge sander the sand paper is mounted over the roller which is connected to the motor through the shaft.

FIG 5.13: Edge Sander

SUGGESTION:

Constant speed, quality of the sand paper is necessary for the edge sanding process.

3- JOINT MAKING MACHINE FOR ASSEMBLY:

This machine is used to make dowels (joints) for the assembly of the wooden pieces. Dowels are round, cylindrical small size pieces of wood.

FIG 5.14: Joint Making Machine

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--SUGGESTION:

In pak-german wood industry the dowel making machine used to make ½ ft joint in 5-6 sec as there is no pushing roller pair as the end of the machine. By installing it the output dowel will out the help of extra worker pushing it out.

-

Machine	Time consumed without roller	Time consumed with roller	% improvement
Dowel maker	5 sec	3 sec	(5-3) sec / 5 sec = 0.4 = 40%

Table 5.16: Dowel maker

4- -SURFACE SANDER:-

Surface sander is larger of all the sander machines. It consists of two portions. Lower fixed portion on which the wood piece is placed while the upper portion is flexible which consists of large size sand paper.

Fig 5.15: Surface Sander

SUGGESTION:

Sand paper used can smooth from 150-200 pieces from one sand paper. In pak-german wood working industry manual surface sander is used. If we use hydraulic motor presser than it will automatically reduced.

Machine	Dimension of piece	Time	% improvement
Surface sander without hydraulic presser	8*4 ft	6 min	(6-4) sec/ 6 sec = 0.33 = 33 %
Surface sander with hydraulic presser	8*4 ft	4 mint	

Table 5.17: Surface Sander Improvement Table

5- DOUBLE FIX:

Double fix is the boring machine used to make hole which the different parts to assemble with the help make ½ ft depth in 5-6 sec/ depth.

Fig 5.16: Double Fix

SUGGESTION:

The used machine is single line machine make a single bore at a time if it is replaced with multi line machine,

The output will be:

Machine (double fix)	No. of drills	Time consumed
Single line	5	25 sec
Multi line	5	5 sec

Table 5.18: Improvement in Double Fix

- **Time improved = (25-5) sec/ 25sec =20/25 = 0.8 = 80%**

4 ASSEMBLY:

1- VENEER PRESSING MACHINE:

Veneer pressing machine is the heat utilizing machine which uses clamps for the pressing / attachment of the side wood strips on the work piece.

Fig 5.17: Veneer Pressing Machine

SUGGESTION:

- As in pak-german wood industry the clamp used are having pressure up to 300 lbs. if it is replaced with " basses edge clamps " with the pressure 500 lbs ,

The pressing time is reduced.

Machine	Length of the piece	Time consumed	Improvement
With 300 lbs clamp	10 m	30 mints	(30 – 23) mint/ 30 mints
With 500 lbs clamp	10 m	23 mints	=7/23 =0.304 = 30.4 %

Table 5.19: The Pressing Time Is Reduced

-
- big problem was that they use heat supplier with constant speed up to 50 degree Celsius temperature. In cold weather it takes up to 2 hours initially to reach that 50 degree Celsius temperature... if the temperature regulator is use, the heat supplied to the clamps will be regulated according to the surrounding temperature, maximum limit is 70 degree Celsius temperature in veneer pressing machine, above which it will damage the sheet.

Machine	Length of the piece	Time consumed	Improvement %
With 50 degree	10 m	30 mint	= (30 – 20) / 30
With 70 degree	10 m	20 mint	= 10 / 30 = 0.33 = 33 %

Table 5.20: Drying Time Reduction in Veneer Pressing

2- SEWING MACHINE:

Sewing machine in industry is used for combining the sheets used over the wooden work piece.

Fig 5.18: Sewing Machine

3- ASSEMBLY (small scale):

Small scale chair and table are assembled in this area.

4- ASSEMBLY (large scale):

In this part of industry, the large scale products are produced.

SUGGESTION:

Here one assembly at the time is done which require 2.5 hours for each assembly due to glue drying. If 5 batches at the time are done than glue drying time will be common and more products can be assembled at that time.

Process	No. of parts	Dry time	Total time consumed	Per piece time	Improvement %
Alone dried	1	2.5 hrs	2.5 hrs	2.5/ piece	= (2.5 – 1.4) / 2.5
Batch dried	5	2.5 hrs	7 hrs	1.4/ piece	= 1.1 / 2.5 = 0.44 = 44%

Table 5.21: Assembly Processing Time Reduction

5- GLUE STIFFER:

Glue stiffer are used when the different parts of the products are combined together.

FIG 5.19: Glue Stiffer

SUGGESTION:

Normally at the room temperature it takes 1.2 hours for the part joints to dry up, if the proper humid environment is given to it, it will improve the drying time.

Process	Normal temp	Humid temp	Improved %
Glue process	1.2 hours	40 mints	80 – 40 / 80 = 40 / 80 = 0.5 = 50 %

Table 5.22: Drying Time Improvement in Glue Stiffer

6- COMPUTER TABLE AND OTHER COMPLEX PART ASSEMBLY LOG:

In this portion computer and other complex part are assembled.

SUGGESTION:

Here 7-8 pieces of the product are assembled in one shift of 8 hours. If 2 shifts are used with one extra labor mean on the place of 2, 3 are used.

7- GLUE MACHINE:

Glue machine is used to give color to the chip board which is than attached to the wood work piece. The color is mixed with glue. Glue helps the color in attaching the chips.

FIG 5.20: Glue Machine

SUGGESTION:

The problem comes in the drying of the glue. It takes 20-25 mints. If the dryer is used, it will reduce the time from 25 to 15 mints.

- **Time improved** = **25 – 15 / 25**
  = 10 / 25
  = 0.4
  = 40 %

8- HYDRAULIC PRESSING MACHINE:

Hydraulic pressing machine is the machine which presses the sheet from the glue machine with the wood working piece. It used the shelves which are connected to the power supply which make it heated. This shelve is pressed by the force of 1500- 2000 lbs for 30 mints. This attaches the sheet of the board.

SUGGESTION:

3 shelves are used in hydraulic pressing machine, if the shelves are increased, the time will improve.

FIG 5.21: Hydraulic Pressing Machine

Machine	Time	No. of pieces got ready	To get 15 pieces Total-time consumed	Improvement %
With 3 shelves HPM	30 mints	3	150	=150-90 / 150
With 5 shelves HPM	30 mints	5	90	= 60 / 150 = 0.4 = 40 %

Table 5.23: Hydraulic Pressing Machine Improvement Table

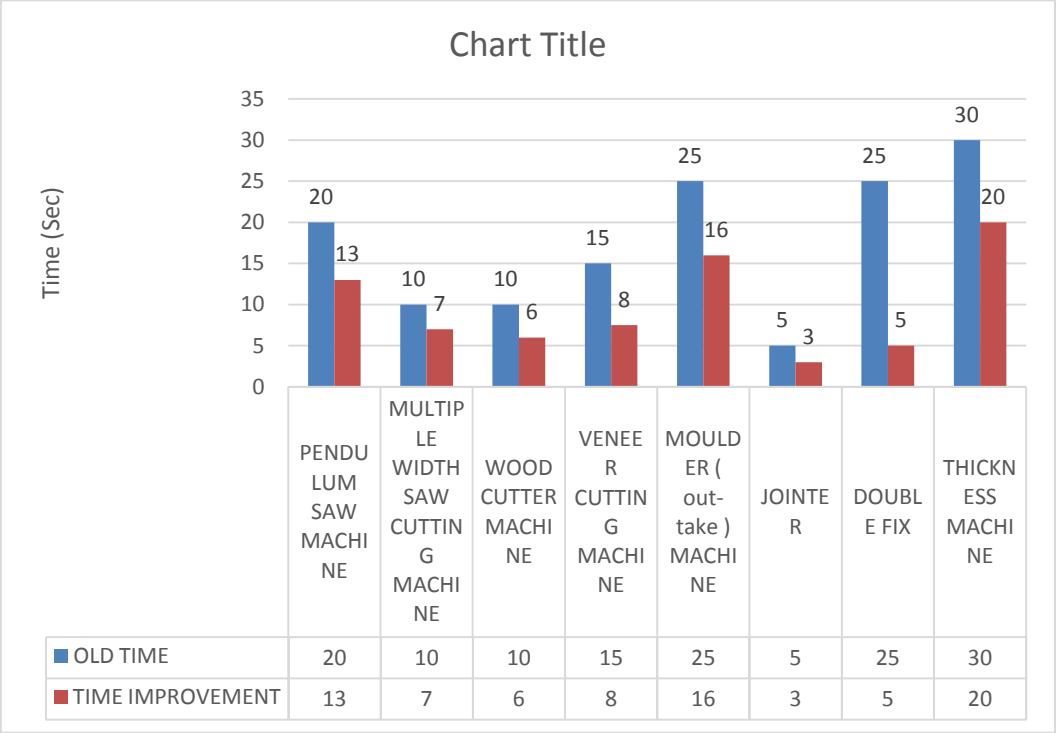
CHAPTER 6

RESULTS & CONCLUTIONS AND VERIFICATIONS:

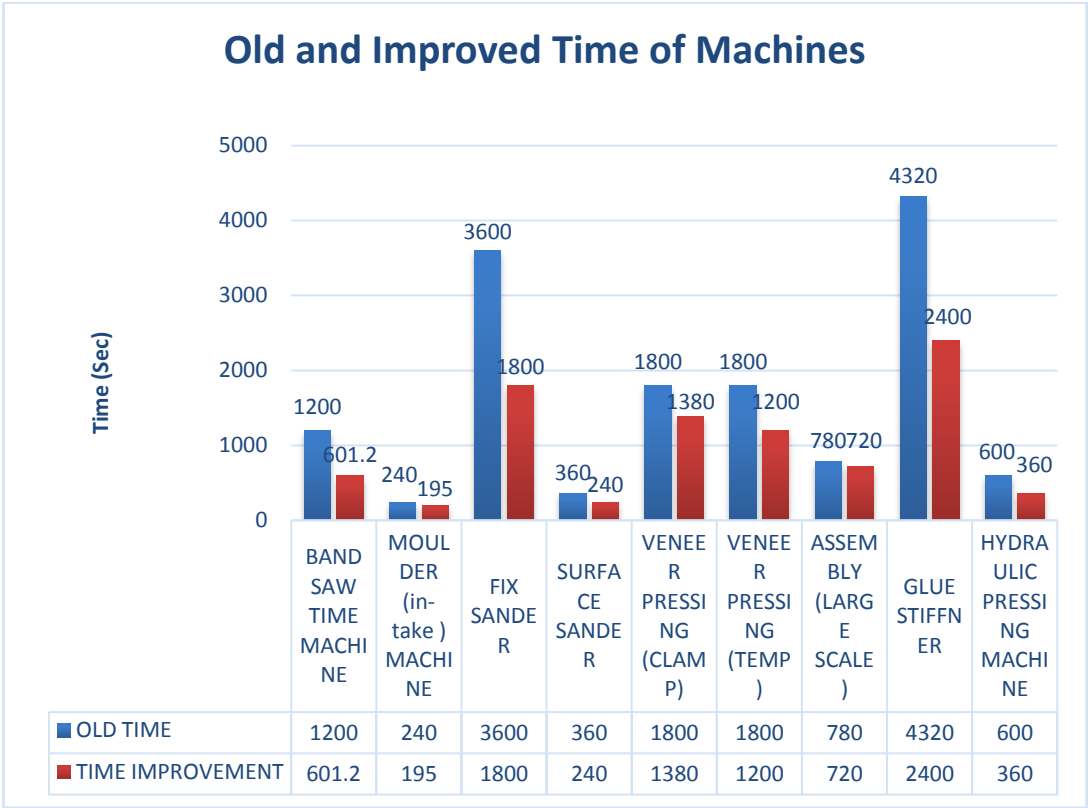
1- Machine Old And Improved Timings After Suggestions:

MACHINE NAME	OLD TIME	TIME IMPROVEMENT AFTER SUGGESTED ACTION
BAND SAW TIME MACHINE	= 20 minutes = 1200 seconds	= 10.02 mints = 601.2 seconds
PENDULUM SAW MACHINE	= 20 seconds	= 13 seconds
MULTIPLE WIDTH SAW CUTTING MACHINE	= 10 seconds	= 7 seconds
WOOD CUTTER MACHINE	= 10 seconds	= 6 seconds
THICKNESS MACHINE	= 30 seconds	= 20 seconds
VENEER CUTTING MACHINE	= 15 seconds	= 7.5 seconds
MOULDER (out-take) MACHINE	= 25 seconds	= 16 seconds
MOULDER (in-take) MACHINE	= 240 seconds	= 195 seconds
FIX SANDER	= 3600	= 1800 seconds
JOINTER	= 5 seconds	= 3 seconds
SURFACE SANDER	=360 seconds	= 240 seconds
DOUBLE FIX	=25 seconds	= 5 seconds
VENEER PRESSING (CLAMP)	= 1800 seconds	= 1380 seconds
MACHINE (TEMP)	= 1800 seconds	= 1200 seconds
ASSEMBLY (LARGE SCALE)	= 780 seconds	= 720 seconds
GLUE STIFFNER	= 1.2 hours = 4320 seconds	= 40 minutes = 2400 seconds
GLUE MACHINE	= 1.5 minute	= 1.5 minutes
HYDRAULIC PRESSING MACHINE	=10 minutes = 600 seconds	= 8 minutes = 360 seconds
TOTAL TIME	= 4.11 hours	= 3.07 hours

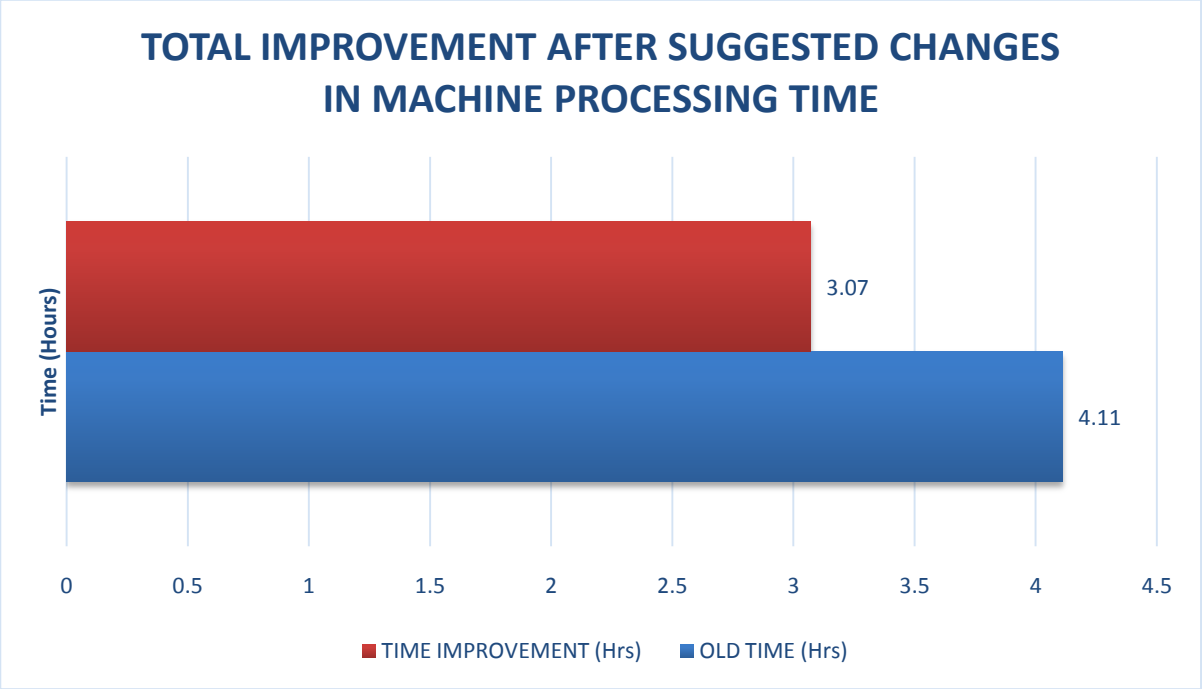
Table 6.1: Machine Old and Improved Timings after Suggestions



Graph 6.1: Machine Old and Improved Timings after Suggestions-1



Graph 6.2: Machine Old and Improved Timings after Suggestions-2



Graph 6.3 Total Time Improvement in Machine Processing Time

TOTAL IMPROVEMENT AFTER SUGGESTED CHANGES IN TIME OF PAK-GERMAN WOOD WORKING INDUSTRY MACHINES

= (**4.11 – 3.07) / 3.07 (in hours)**

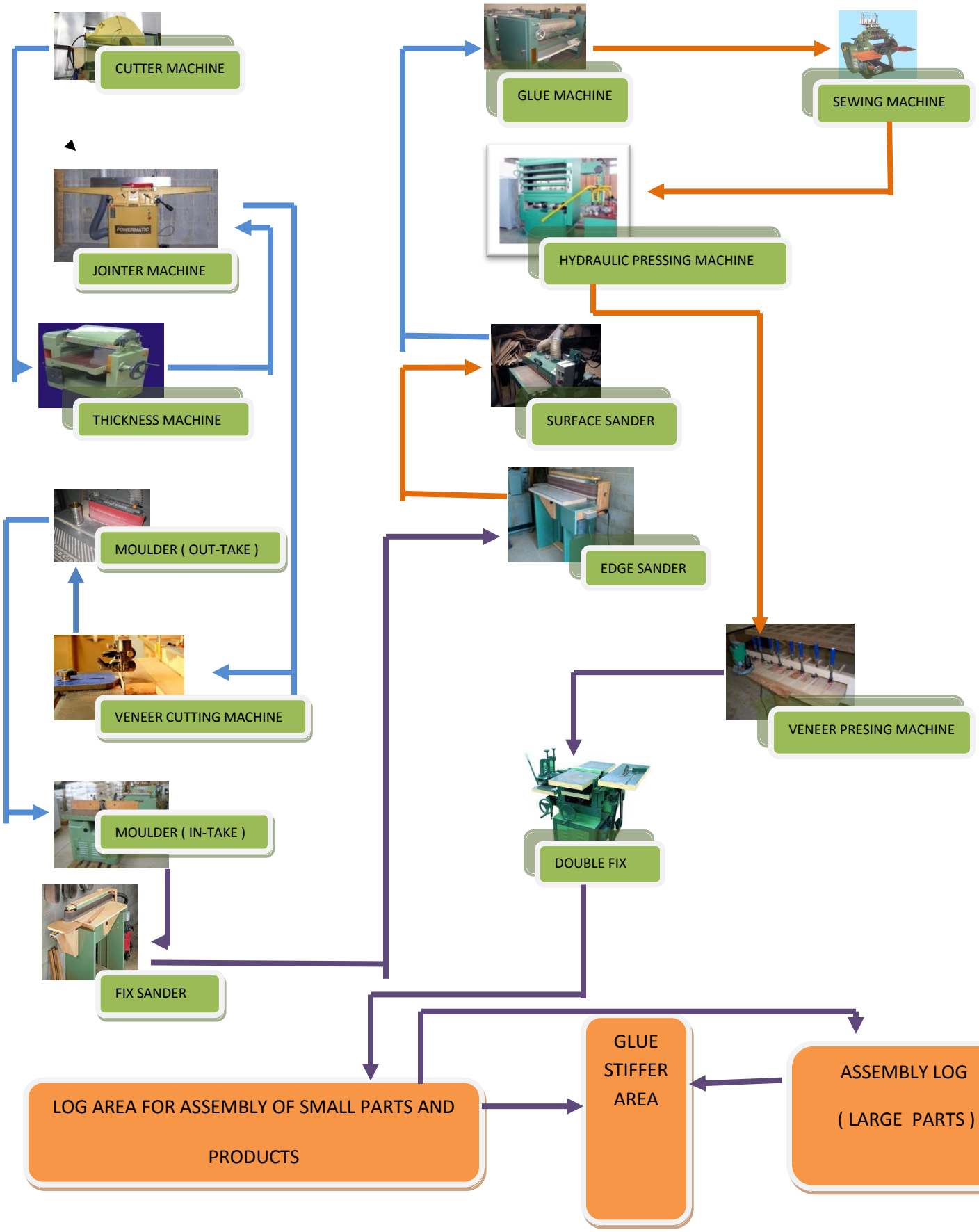
= 1.04 / 3.07

= 0.338 %

= 33.8 %

2- OLD LAYOUT

Fig 6.1: Old Layout



1- PROCESSING TIME FOR TRANSPOTATION IN OLD LAYOUT

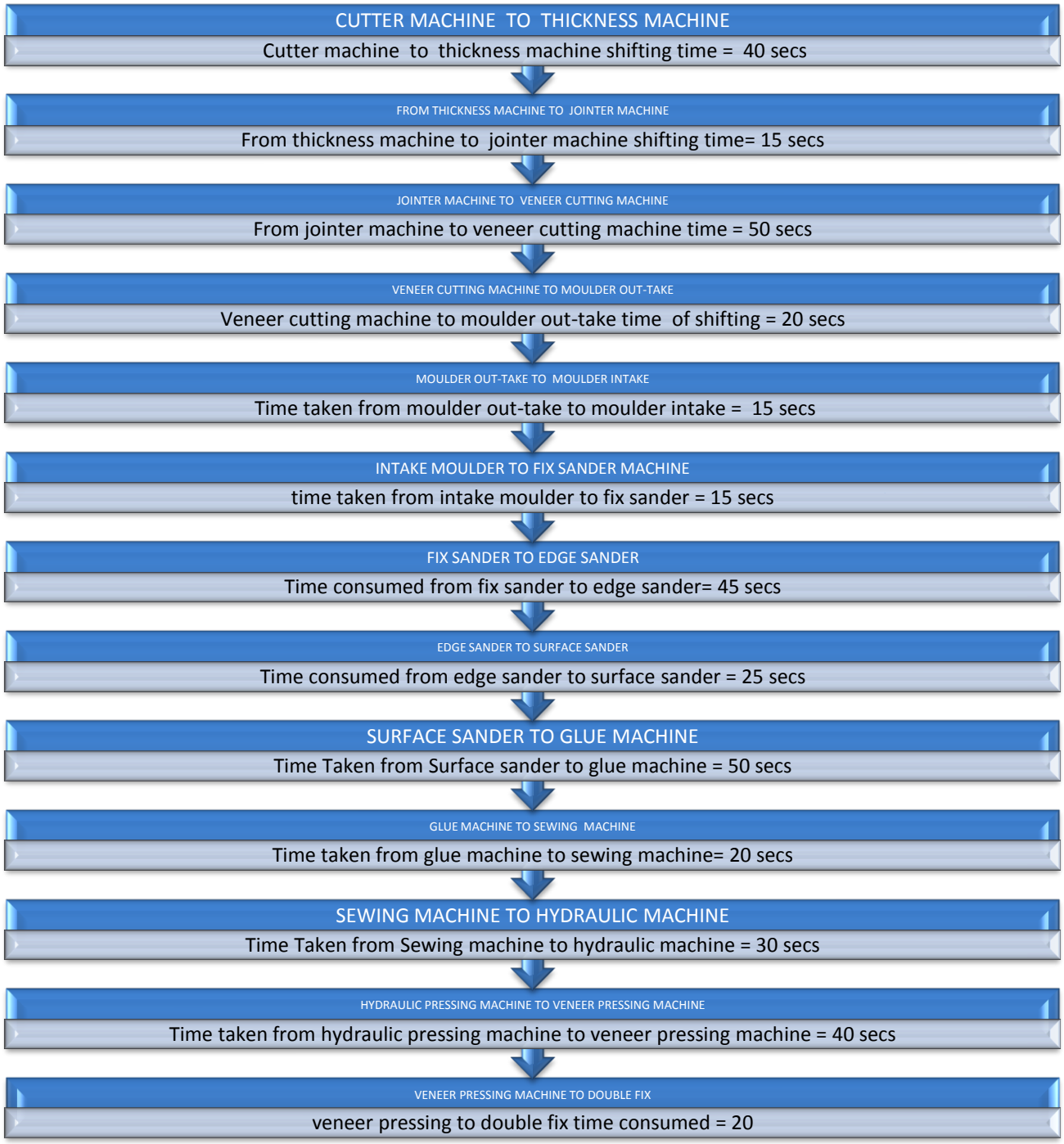


Fig 6.2: Processing Time for Transportation in Old Layout

TOTAL TIME CONSUMED IN OLD LAYOUT OF PAK-GERMAN WOOD WORKING INDUSTRY
• Cutter machine to thickness machine total time = 40 secs • From thickness machine to jointer machine total time = 15 secs • Jointer machine to veneer cutting machine total time = 50 secs • Veneer cutting machine to moulder out-take total time = 20 secs • Moulder out-take to moulder intake total time = 15 secs • Intake moulder to fix sander machine total time = 15 secs • Fix sander to edge sander = 45 secs • Edge sander to surface sander = 25 secs • Time Taken from Surface sander to glue machine = 50 secs • Glue machine to sewing machine= 20 secs • Sewing machine to hydlaulic pressing machine time = 30 secs • Hydraulic pressing machine to veneer pressing machine time = 40 secs • Veneer pressing machine to double fix = 20 secs • Total time consumed during transportation = 387 secs

Fig 6.3: Time Consumed In Old Layout

TOTAL TME CONSUMED IN OLD LAYOUT OF PAK-GERMAN WOOD WORKING INDUSTRY

= 387 sec

= 6.45 minutes

3- LAYOUT (SUGGESTED)

Fig 6.4: Machining Area (Cell No.1)

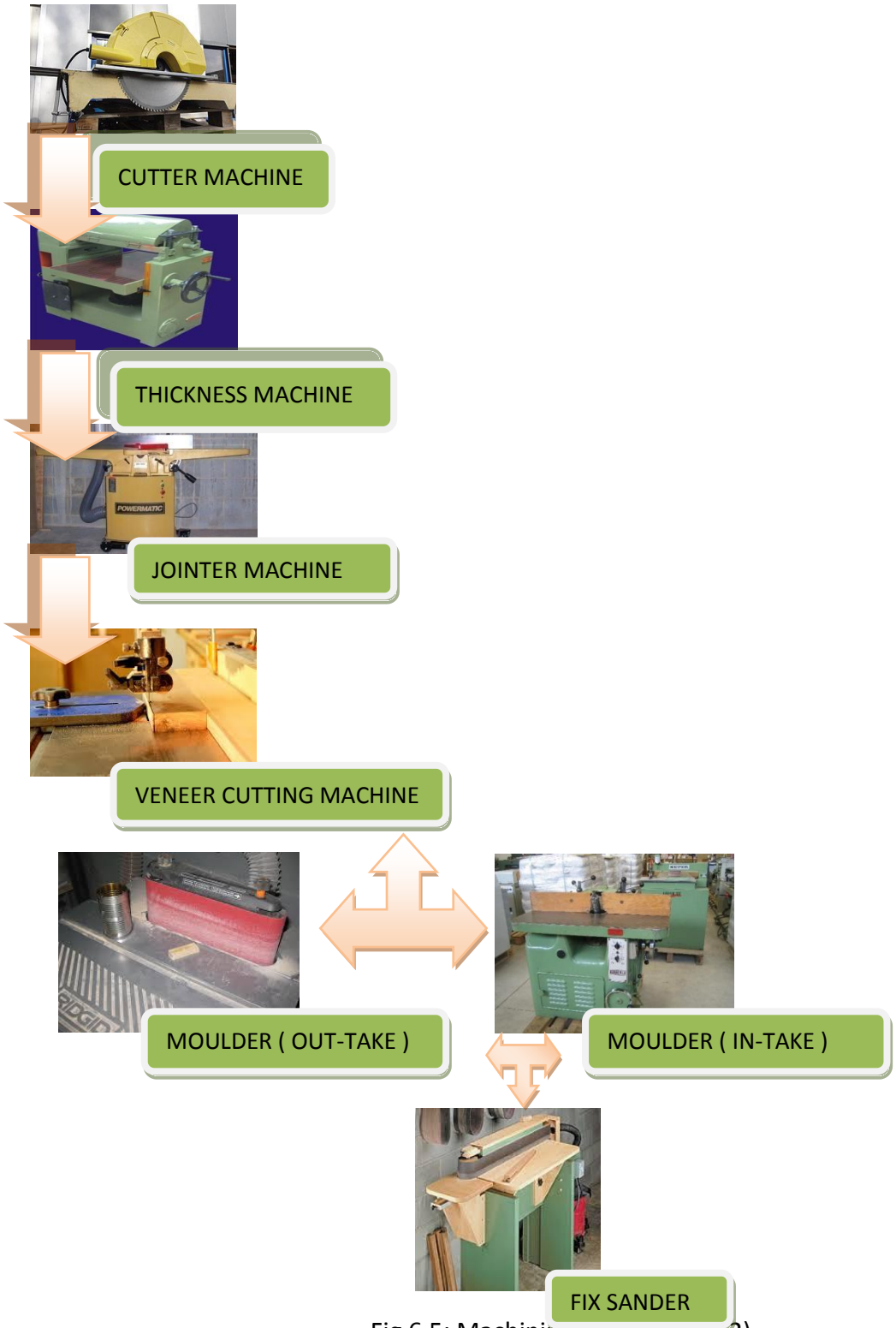


Fig 6.5: Machining Area (Cell no.2)

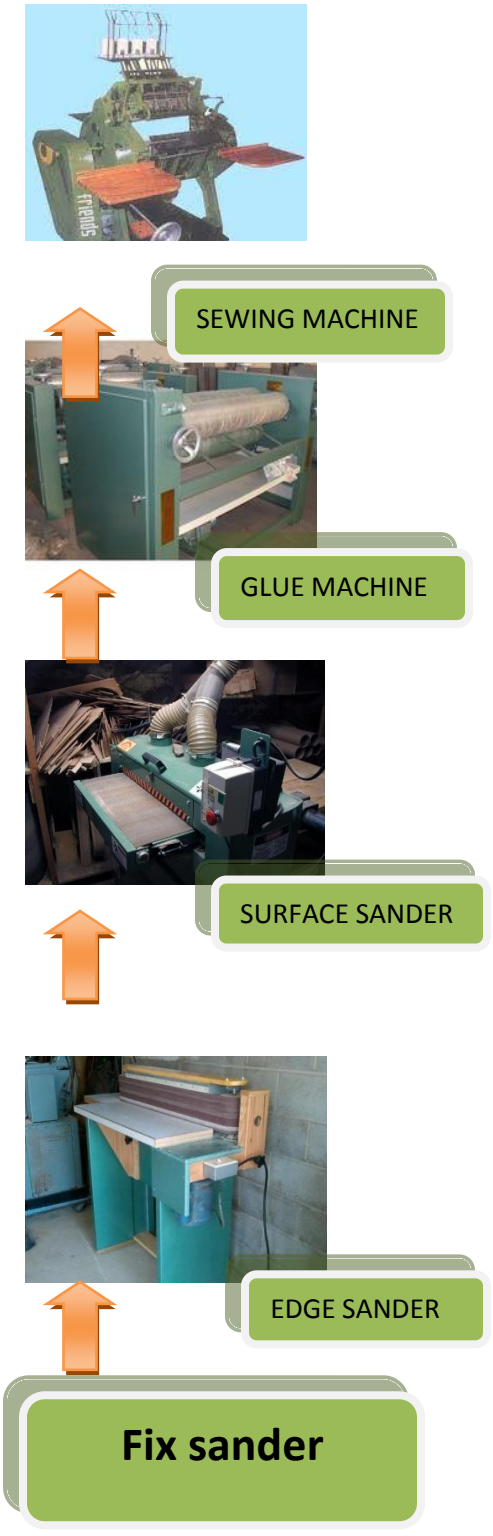


Fig 6.6: Machining Area (Cell no.3)

HYDRAULIC PRESSING MACHINE

VENEER PRESING MACHINE

DOUBLE FIX

LOG AREA FOR ASSEMBLY OF SMALL PARTS AND PRODUCTS

1- TOTAL SUGGESTED LAYOUT OF PAK-GERMAN WOOD WORKING INDUSTRY

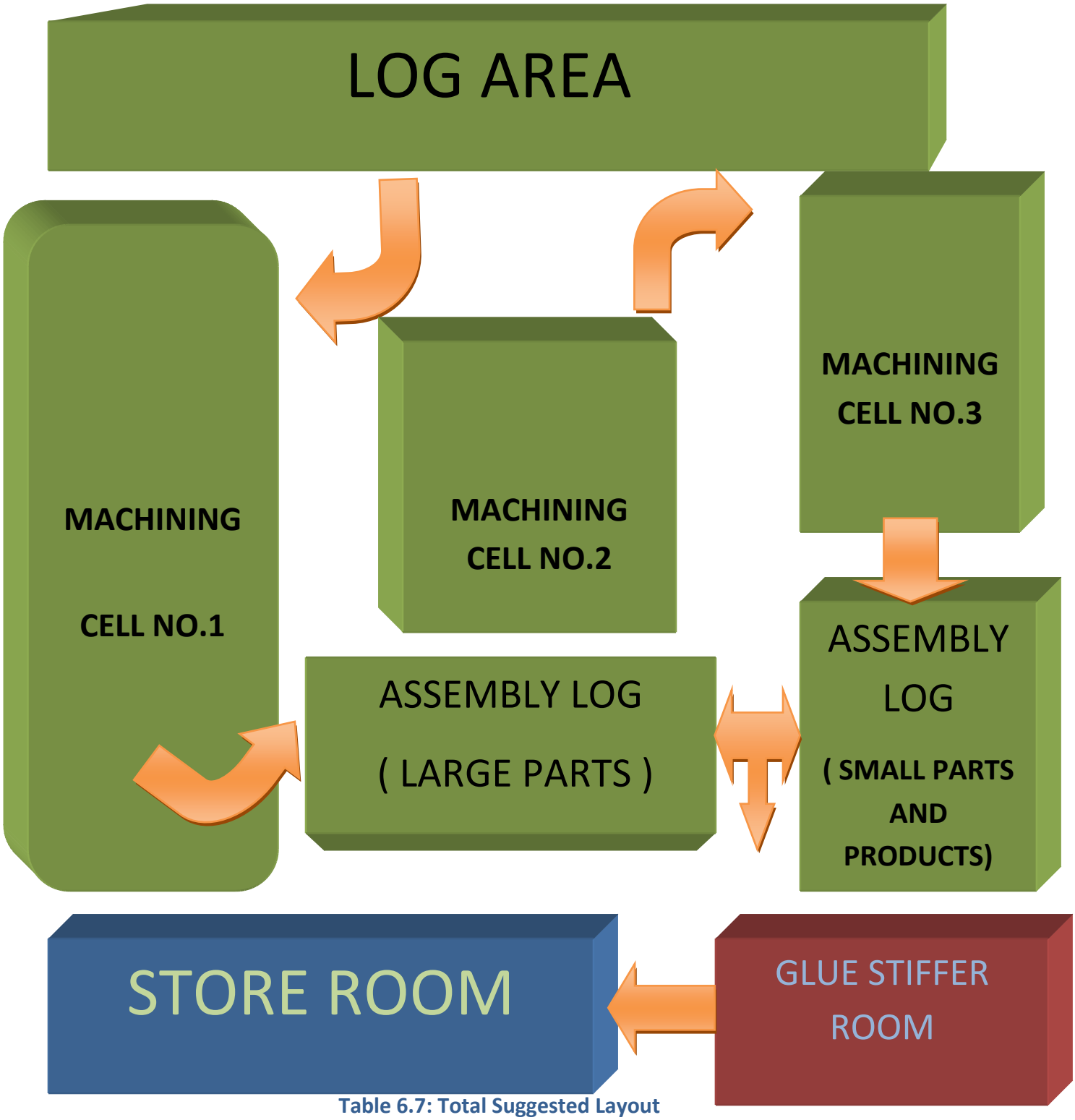


Table 6.7: Total Suggested Layout

2- TOTAL TIME CONSUMED IN NEW SUGGESTED LAYOUT OF PAK-GERMAN WOOD WORKING INDUSTRY

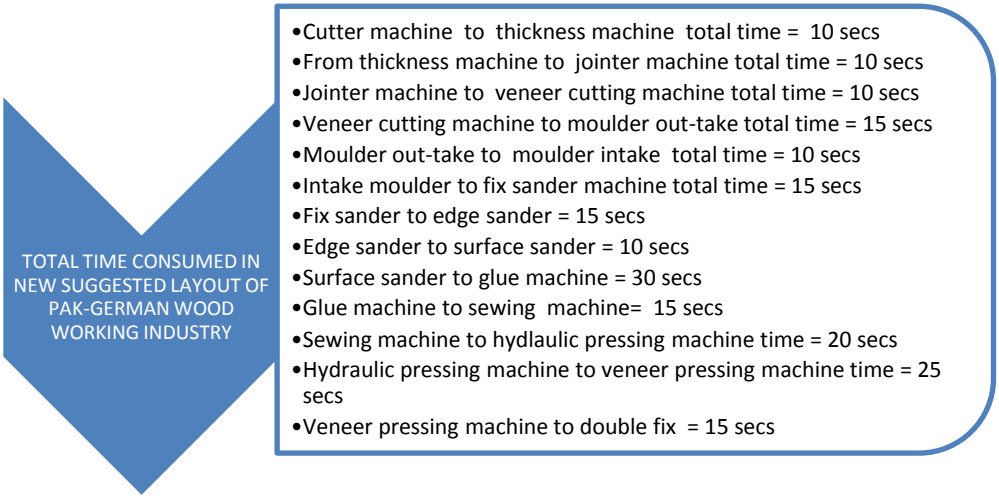


Fig 6.8: Total Time Consumed In New Suggested Layout of Pak-German Wood Working Industry

TOTAL TIME CONSUMED IN NEW SUGGESTED LAYOUT OF PAK-GERMAN WOOD WORKING INDUSTRY

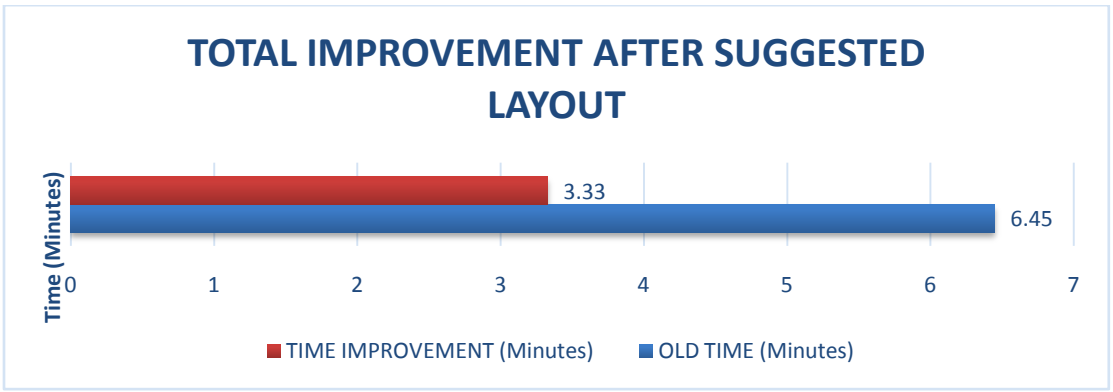
= 200 sec = 3.33 minutes

= TOTAL IMPROVEMENT AFTER SUGGESTED LAYOUTS:

% IMPROVEMENT IN TOTAL TIME CONSUMED IN NEW SUGGESTED LAYOUT OF PAK-GERMAN WOOD WORKING INDUSTRY

= (6.45 – 3.33) / 6.45

= 0.4837 = 48.37 %



Graph 6.4: Total Improvement in Time after suggestion

4- USE OF SIMUATION TO ASSERTAIN OUR RESULTS

Product taken

1- **Chair**
2- **Table**

1- CHAIR BATCH PRODUCTION:

The old chair production processsing scenerio :

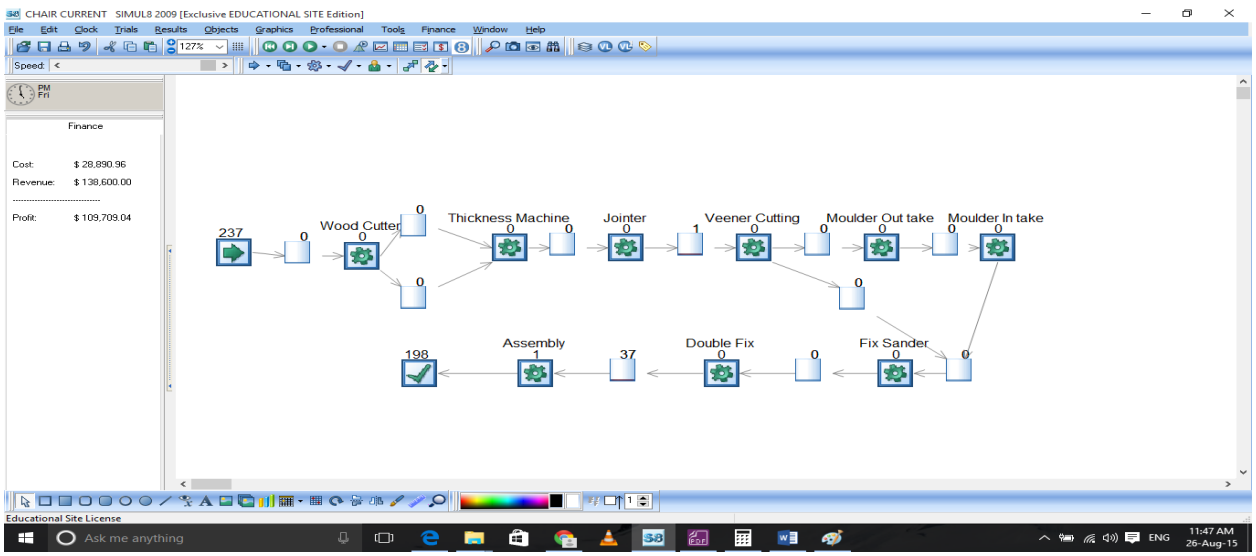


Fig 6.9: Chair old Batch Production

The new chair production processsing scenerio

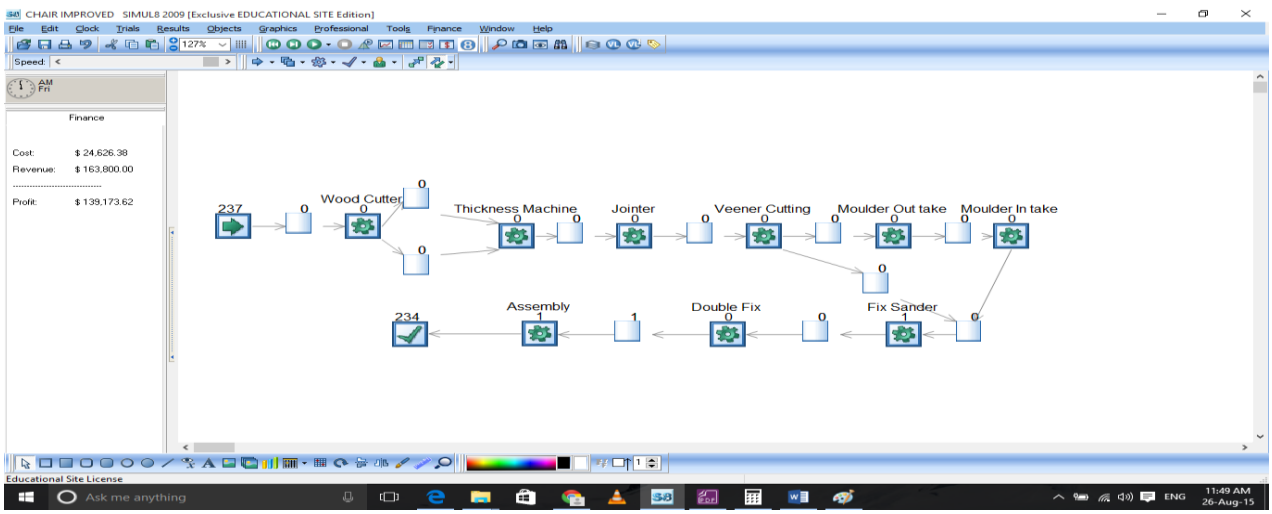


Fig 6.10: Chair New Batch Production

2- TABLE BATCH PRODUCTION :

The old table production processsing scenerio :

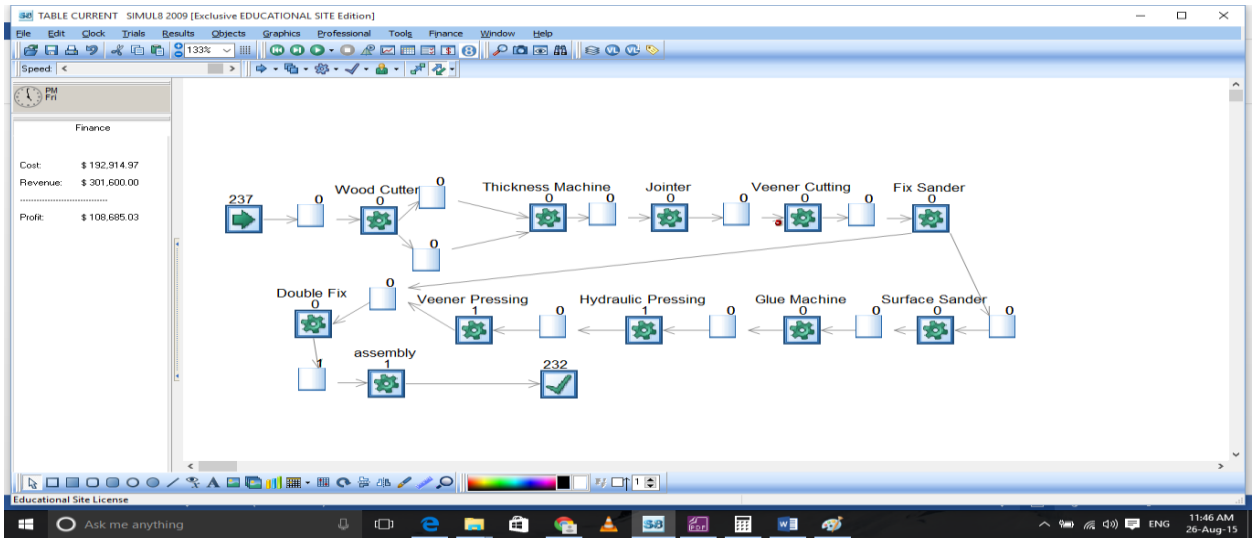


Fig 6.11: Table Old Batch Production

The New Table Production Processsing Scenerio :

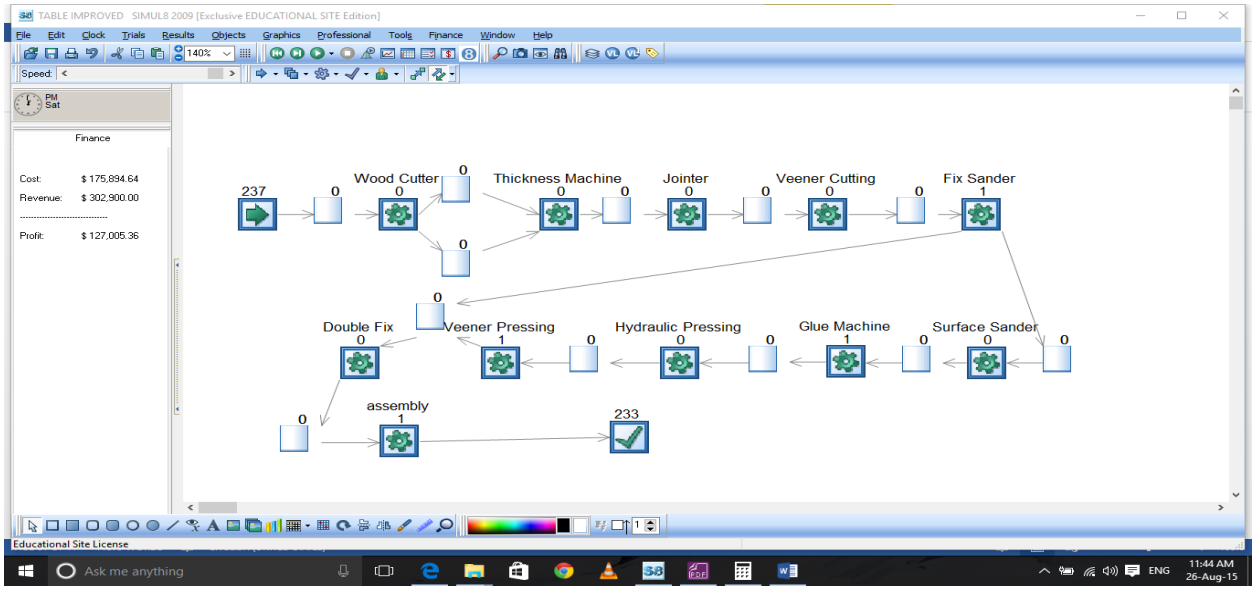


Fig 6.12: Table Batch Production

5- THE MATHETICALLY EXPLANATIONS OF THE ABOVE SIMULATIONS :

1- CHAIR BATCH PRODUCTION:

Chair	Current	Improved
Cost	28,290	24,626
REVENUE	1,38600	1,63880
PROFIT	11,0210	139254

Table 6.2: Chair Batch Production

- Increase In Profit In Rupees = 139254 – 110210 = 29044
- Increase In Profit In % = 29044 / 110210 = 0.2635

= 26.35%

- Total Improvement In Efficiency
- Old Efficiency = 198 / 237

= 0.8354

= 83.54 %

- New Efficiency = 234 / 237

= 0.9873

= **98.73%**

➢ **Improvement In Efficiency Comparing Current And Improved** = 98.73 – 83.54

= 15.19 %

1- TABLE BATCH PRODUCTIONS:

TABLE	Current	Improved
Cost	192914	175894
REVENUE	301600	302900
PROFIT	108685	127005

Table 6.3: Table Batch Productions

- Increase In Profit In Rupees = 127005 – 108685
  = **18320**

- Increase In Profit In % = 18320 / 108685
  = 16 %

- **Total Improvement In Efficiency**

- Old Efficiency = 232 / 237

  = 0.9789

  = **97.89 %**

- New Efficiency = 233 / 237

  = 0.9833

  = 98.33%

Improvement in Efficiency Comparing Current and Improved

= 98.33 – 97.89

= **0.987 %**

2- YEARLY BATCH RECORD

3- CONCLUSION:

- Expenditure Of Machines Suggested Up gradations
  = Rs 9, 85000
- Total Weekly Improved Profit Combining Chair (234 Units) And Table (233)
  = 29044 + 18320
  =**RS 4,7364**
- Total Improved Profit Of Each Chair Unit = 29044 / 234

  =**Rs 124.11**

- Total Yearly Profit Combining Chair (10000 Units)
  = 124.11*10000
  = Rs 1,24,1100

- Total Improved Profit Of Each Table Unit = 18320 / 233

= **Rs 78.62**

- Total Yearly Profit Combining Table (10000 Units)= 78.62*10000
  = Rs 786200

- Total Yearly Profit Combining Chair (10000 Units) And Table (10,000)
  = 786200 + 1241100

  = **Rs 2,027,300**

- Per Day Profit = 2027300 / 365

= Rs 5,554.2466

Covering Up Of Expenditures = 985000 / 5554.2466

= **177.341 Days**

= 5.99

= **6 Months**

Months Will Be Required To Cover-Up the Expenditure Due To the Suggestions Made In Machines with the Net Profit Of

= 2027300 – 985000

= **Rs 1,042,300**

CHAPTER 7

CONCLUSION AND FUTURE WORK:

This research has presented a concise occurring process. It has also eradicated other problems. In this research more than 20 machine processing and layout has been used for the analysis based on the production environment. . The advantage of using these techniques is that , we have reduced process time of the machines from 4.11 hours to 3.07 hours which is up to 34 % less machining time than the current machining time. Whereas, using job shop technique we have reduced the layout timing up to 48 %. These results have enhanced the whole process and directly reduce s the whole manufacturing process cost as well as time.

Future work:

For future work, a lot can be done in machine wise improvement and also in layout in order to reduce the production cost as well as timing of the batch productions. Techniques such as, one shop bottle neck heuristic, make span minimization , FIFO , LIFO , SPT and LPT can also help in the cost of production and in production flow.

This research can also be implemented and applicable on other small and large manufacturing industries such as, steel manufacturing industries, auto mobile industries and other type of manufacturing industries.

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