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Rough-Cut Capacity Planning By Using the Overall Planning Factors Method: An Applied Study in the Leather Clothes Factory / Textile and Leather Industries Company

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Abstract

Most Iraqi industrial companies and factories suffer from a weakness in the capacity planning process because of their lack of reliance on scientific foundations in the rough-cut capacity planning process. One of those methods is the overall planning factors method. The research problem focused on explaining how overall Planning factors are used in the rough-cut capacity planning; therefore, the aim of the research is to apply the overall factors in the rough-cut capacity planning through preparing logical steps for the rough-cut capacity planning process by using overall Planning factors. To implement the steps, the mathematical equations have been formulated so that the steps and equations can be used usefully in many industrial companies, and determined the capacity needs for both direct labor time, machine time and for each type of product and the time periods that are specified, as well as determined the capacity needs of each of the work centers. For the purpose of applying the research, the leather garment factory affiliated to the Textile and Leather Industries Company was chosen which produces four types of leather garment (men's jacket, men's vest, women's jacket, and women's coat). The researcher conducted many field visits and interviews to obtain the main data of scheduling the production as well as historical data related to production quantities and times related to the direct labor and machine and for each type of product. The research concluded that the management of the leather garment factory is not accomplishing the preparation of the master production scheduling accurately, and also not using any scientific method in the rough-cut capacity planning. The research also concluded that the process of manufacturing leather garment depends on the direct labor times, which ratio reached to (0.69),

while the machine times reached (0.31). Therefore, the research recommends for preparing the master production scheduling accurately, as well as relying on the overall Planning factors in the rough-cut capacity planning, and finally the use of the tailor-made machines in the tailor-made center which will help reducing the required time to implement the tailor-made process and thus it reduces the manufacturing time.
Key words: Master Production Scheduling, Capacity, Capacity Planning , Rough-Cut Capacity Planning, Overall Planning Factors.

Planificación de la capacidad de corte áspero mediante el método de factores de planificación general: un estudio aplicado en la fábrica de ropa de cuero / Textil and Leather Industries Company

Resumen
La mayoría de las empresas y fábricas industriales iraquíes sufren de debilidad en el proceso de planificación de la capacidad debido a su falta de confianza en los fundamentos científicos en el proceso de planificación de la capacidad general. Uno de esos métodos es el método de factores de planificación general. El problema de investigación se centró en explicar cómo se utilizan los factores de planificación generales en la planificación general de la capacidad; por lo tanto, el objetivo de la investigación es aplicar los factores generales en la planificación de la capacidad general mediante la preparación de pasos lógicos para el proceso de planificación de la capacidad general mediante el uso de factores de planificación generales. Para implementar los pasos, las ecuaciones matemáticas se han formulado de modo que los pasos y las ecuaciones se puedan usar de manera útil en muchas empresas industriales, y se determinaron las necesidades de capacidad tanto para el tiempo de trabajo directo, el tiempo de máquina y para cada tipo de producto y los períodos de tiempo que se especifican, así como se determinan las necesidades de capacidad de cada uno de los centros de trabajo. Con el fin de aplicar la investigación, se eligió la fábrica de prendas de cuero afiliada a Textile and Leather Industries Company, que produce cuatro tipos de prendas de cuero (chaqueta de hombre, chaleco de hombre, chaqueta de mujer y abrigo de mujer). El investigador realizó muchas visitas de campo y entrevistas para obtener los datos principales de

la programación de la producción, así como datos históricos relacionados con las cantidades y tiempos de producción relacionados con la mano de obra directa y la máquina y para cada tipo de producto. La investigación concluyó que la administración de la fábrica de prendas de cuero no está logrando la preparación de la programación maestra de producción con precisión, y tampoco está utilizando ningún método científico en la planificación de la capacidad general. La investigación también concluyó que el proceso de fabricación de prendas de cuero depende de los tiempos de mano de obra directa, proporción que alcanzó a (0,69), mientras que los tiempos de la máquina alcanzaron (0,31). Por lo tanto, la investigación recomienda preparar con precisión la programación maestra de producción, así como confiar en los factores de planificación generales en la planificación de la capacidad general y, finalmente, el uso de máquinas a medida en el centro a medida que ayudará a reducir el tiempo requerido para implementar el proceso a medida y, por lo tanto, reduce el tiempo de fabricación.

Palabras clave: programación maestra de producción, capacidad, planificación de la capacidad, planificación de la capacidad general, factores generales de planificación.

1. Introduction

The master production scheduling is considered as a segmentation of the aggregate production plan, for the master production scheduling is considered as an announcement of what the company expects to manufacture in terms of types and quantities of products in the specified dates. Thus, the master production scheduling makes it easier for us to realize what the requirements to be done are. Also, the review of the master production scheduling is ensured that there are no clear capacity constraints required the change of the scheduling. The master production scheduling details are usually on a monthly, weekly, or daily basis, and in order to implement the master production scheduling, the capacity is required. The rough-cut capacity planning includes the ensuring of the machinery availability, equipment facilities and workforce that exist with the required production plans for the products that have been identified in the master production scheduling. Therefore, the rough-cut capacity planning process requires the preparation to know the required resources that are producing each product as well as the required capacity levels in each time period. There are several methods for rough-cut capacity planning, which are the capacity list, the resource portfolio, the overall Planning factors method that focus on the direct labor and machine time required by work centers. The overall Planning factors method relies on historical data related to the production quantities and production times of the direct labor and machine times so that the overall Planning factors can be calculated. It also requires preparing the proposed master production scheduling for the coming period accurately.

2. Research methodology

2.1. Research problem

The decision of capacity planning is considered as one of the important decisions that industrial companies must pay sufficient attention to. The research problem focused on how to accomplish rough-cut capacity planning by using overall Planning factors method through the preparation of logical steps that included the formulation of mathematical equations to apply the steps.

2.2. Research aim

The research aims to:-

1. Using overall Planning factors method in rough-cut capacity planning.
2. Preparing logical steps for the process of using the overall Planning factors method in rough-cut capacity planning.
3. Formulating mathematical equations related to how to apply the steps of using the overall Planning factors method in rough-cut capacity planning.

2.3. Research procedural scheme

The proposed research scheme has been prepared, for the purpose of applying the practical steps of using the overall Planning factors method in rough-cut capacity planning, and figure (1) shows the proposed research schema.

2.4. Research methods

2.4.1. Field visits and interviews

Several interviews and field visits were conducted to the leather garment factory of the General Company for Textile and Leather Industries to get acquainted with the reality of production as well as capacity planning too. Several interviews were also held with the manager of the leather garment factory, besides the engineers and workers in the work centers. The directors of marketing, research and development and of planning and follow-up departments in the company have been participated in these interviews, for the purpose of obtaining data and information related to the production quantities for previous periods, direct labor times, the times of the machine required in the manufacture of leather garment for previous periods, and the time in work centers, as well as preparing the master production scheduling

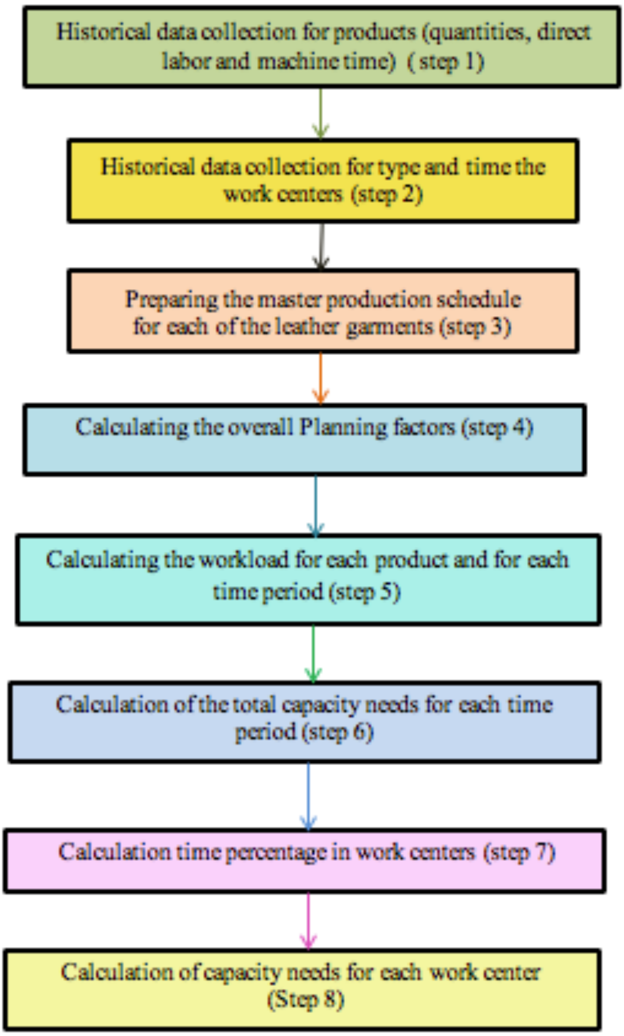

Figure (1): The proposed research schema.

2.4.2. Research tool

For the purpose of the rough-cut capacity planning by using the overall planning factors method, several steps were presented besides the formulation of several equations to implement these steps. A program has been used x- stata to perform calculations and the equations are:-

$$FL_i = L_i / Q_i \quad ----(1)$$

$$FM_i = M_i / Q_i \quad ----(2)$$

$$LH_{ij} = FL_i \bullet MPS_{ij} \quad ----(3)$$

$$MH_{ij} = FM_i \bullet MPS_{ij} \quad ----(4)$$

$$TLH_k = \sum_{i=1}^{n} \sum_{j=1}^{m} LH_{ij} \quad ----(5)$$

$$TMH_k = \sum_{i=1}^{n} \sum_{j=1}^{m} MH_{ij} \quad ----(6)$$

$$PDL_w = LH_i / TH \quad ----(7)$$

$$PMT_w = MH_i / TH \quad ----(8)$$

$$DLC_w = TLH_k \bullet PDL_w \quad ----(9)$$

$$MTC_w = TMH_k \bullet PMT_w \quad ----(10)$$

Index:
i: products type 1,2,3,4
j: Number of weeks 1,2,3,4,5,6,7,8,9,10,11,12
k: All products together (1,2,3,4)
w: Number of work centers 1,2,3.

Variables:
FLi: Direct labor factor for product i
Li : Direct labor for product i
Qi: Production quantity for product i
FMi: Machine time factor for product i
Mi: Machine time for product i
LHij : Direct labor required for product i during a period j
MPSij : Master production scheduling for product i during a period j
MHij : Machine time required for product i during a period j
TLHk: Sum of direct labor of all products to together k
TMHk: Sum of machine time of all products together k
PDLw: The percentage of direct labor in work centers w
LHi: Direct labor in work centers w
TH: Total time for work centers w
PMTw: The percentage of machine time in work centers w
MHi: Machine time in work centers w
DLCw: Total direct labor for work centers w for products k
MTCw: Total Machine time for work centers w for products k

3. Theoretical framework

3.1. Master production scheduling

The master production scheduling depends on the aggregate production plan that unifies the product families in groups, and then these families are divided into individual types according to the desire of the customer (Dilworth, 2000:540). The master production scheduling provides the quantities and dates of the final products, and they are often stable in the short term (one year to eight weeks). Moreover, the master production scheduling is dependent on the product, market, and resource plans that are identified in the aggregate production plan (Davis et.al, 2003:572).

The master production scheduling is considered as a medium-term plan that takes into account the required lead times for ordering the raw materials, components, manufacture parts in the factory, assemble parts, and testing of the final products depending on the type of product. These lead times can extend from several months to more than a year, and although the master production scheduling deals with a medium-term horizon, it is a dynamic plan that is usually modified in the short term (Groover, 2010: 962). The master production scheduling also defines the final elements that the company expects to manufacture every period, and consequently, the final elements are either finished products or elements including final assemblies (Benton, 2014, 78).

The master scheduling time horizon depends, however, on the type of product, the volume of production, the component's lead time. It can be weeks, months, or a mixture, but the scheduling should usually extend long enough in the future so that it could include the lead time for all components that have been purchased and adequately assembled (Kumar and Suresh, 2009: 203). The master production scheduling is working as a tool of senior management in controlling manufacturing resources. The development of the master production scheduling is no longer a simple task because it requires studying the multiple goals such as reducing the inventory, achieving the maxim customer satisfaction, and maximizing the resource use. Therefore, the scheduler must ensure that the proposed master production scheduling is valid and realistic for the implementation prior to its release to the actual manufacturing system (Radhika et.al, 2013: 164).

The creation of master production scheduling includes the following steps:- (Benton, 2014: 103)

1. Obtaining the necessary informational inputs.
2. Preparing the initial draft of the main production scheduling.
3. Developing the initial capacity requirements plan.
4. If necessary, increase the capacity or review the initial draft of the master production scheduling to obtain a meaningful scheduling.

The master production scheduling (MPS) gives the formalization of the production plan and translates it into specific requirements for the final product over a medium to short planning horizon. Thus, the end products are divided by the materials requirements planning system (MRP) and capacity requirements planning (CRP), and then the master production scheduling leads the production system and inventory (Kumar and Suresh, 2009: 202).

3.2. Capacity Planning

The capacity is defined as the maximum output that can be produced within a specified time period, such as a day, week, or year (Schroeder and Goldstein, 2018:217) or the maximum quantity any system can produce with current resources and at a specific time period (Dos, 2016:310) or it is the maximum load that the operating unit can handle, while the capacity planning is considered the major strategic component for the system design (Stevenson,2018:188). Thus, the capacity planning is the set of managerial decisions that determine the general level of a company's productive resources, that is, it is the set of decisions that address the number of units that the company must be able to process (Leseure,2010:93). Moreover, the capacity is influenced by product mixture, resource allocation, technology choice, and factory size (Russell and Taylor, 2011: 663).

The primary goal of planning the production capacity to meet the demand is considered as the determination of the appropriate level of the production capacity, which is determined by selecting and determining the appropriate mixture of the machines, technological equipment, and required workforce to meet the expected future demand (Krajewski et.al, 2016: 156). The issue of capacity availability is not only a strategic issue but rather an issue centered in all operations, as it happens minute by minute, day by day, month by month, etc. (Slack and Lewis, 2017: 122). The capacity will be at three levels as shown in the table (1).

Table (1): Three levels of capacity decision

Level	Time-scale	Decisions concern Provision of	Span of decisions	Starting point of decision
Strategic capacity decisions	Years–Months	Buildings and facilities Process Technology	All parts of the Business	Probable markets to be served in the future Current capacity Configuration
Medium-term capacity decisions	Months–Weeks	Aggregate number of people Degree of subcontracted resources	Business – site	Market forecasts Physical capacity Constraints
Short-term capacity decisions	Weeks–hours–minutes	Individual staff within the operation Loading of -individual- facilities	Site Department	Current demand Current available capacity

Source: Slack, N., and Lewis M., (2017), *Operations Strategy*, 4th edition, Pearson education limited, England, P: 123

The production managers are concerned with the capacity for the following reasons (Kumar and Suresh, 2009: 55):-

1. The required sufficient capacity to meet customers' demand in a timely manner.
2. The capacity affects the cost- efficiency of operations.
3. The capacity affects scheduling system.
4. The capacity building requires investment.

3.3. Rough-cut capacity planning

After dividing the aggregate production plan into the master production scheduling, it is necessary to verify the availability of the required capacity (raw materials, workforce, machines, and stores) to implement it through the rough-cut capacity planning (RCCP) (Smunt, 1996: 335).

The rough-cut capacity planning is concerned with the determination of the labor requirements and necessary equipment to fulfill the master production scheduling. It is also interested in identifying the company's future long-term capacity needs. The capacity planning is also working on determining the production resources constraints so that the main production scheduling can be realistically planned. The realistic master production scheduling must take into account the manufacturing capabilities of the factory that makes the products. The company must also be aware of its production capacity and work to plan for the measures of changes in the capacity in order to meet the changing production requirements set out in the master production scheduling (Groover, 2010: 968),(Gaither and Frazier, 2002: 334).

the rough-cut capacity planning (RCCP) has been defined by the Operations Management Association (APICS) as the process of converting the master production scheduling into requirements for major resources, including labor, machines, warehouse capacity, suppliers capacity and many other issues (Benton, 2014: 221).

(Dilworth, 2000) defines it as a widely detailed method used to estimate more accurately the required capacity to encounter the master production scheduling (Dilworth, 2000:355). While (Reid and Sanders, 2011) defines it as the process of converting the master production scheduling into requirements for major resources such as labor and machine time (Reid and Sanders, 2011: 759). Therefore, rough-cut capacity planning is a means of identifying the existed capacity in certain centers to implement the master production scheduling (White and Vondermbs, 2004: 291). The rough-cut capacity planning methods focus on the planes of the detailed work centers, therefore, it tries to verify the feasibility of the master production scheduling (MPS) before implementing the work center plans (Benton, 2014,: 221).

The rough-cut capacity planning calculates an approximate estimate of the workload placed on vital resources by the proposed master production scheduling. This workload compares with the demonstrated capacity of each critical resource, and this comparison enables the master scheduler to develop a feasible master production scheduling (Reid and Sanders, 2013:806). The rough-cut capacity planning can also be accomplished by using several methods, and the table (2) shows the opinions of the authors and researchers.

Table (2):Rough-Cut Capacity Planning Methods

No	Author and year	Methods
1	Jonsson and Mattisson,2002	1-Overall Factors Method 2-Capacity Bill Method 3-Resource Profiles
2	Benton,2014	1-Rough-Cut Capacity Using Routings 2-Rough-Cut Capacity and Production Volume (RCV) 3- Rough-Cut Capacity Check Using Overall Factors
3	Reid and Sanders,2013	1-Rough-Cut Capacity planning Using Overall Planning Factors

Source: The author

In this research, the overall planning factors method will be adopted, as it fits with the nature of the products of the research sample factory.

3.4. Overall Planning Factors Method

The capacity planning with overall Planning factors is the simplest way to rough-cut capacity planning, and this depends on the planning factors derived from the final products as well as on the planning factors derived from the final products. The overall planning factors can be used successfully when products are homogeneous from a manufacturing standpoint (Jonsson and Mattisson,2002:1-2) and to determine the capacity requirements for each work center, the planning factor for each resource can be developed on the basis of historical data. The planning factor shows the required amount of resources for one integrated unit (Smunt,1996,339),(-Reid and Sanders,2013:779) presented procedures related to overall planning factors:-

1. Determining the appropriate planning factors by using the historical data.
2. Multiply the master production scheduling quantities according to the appropriate planning factor.
3. The total capacity requirements for each resource according to the time period.
4. Assigning capacity requirements to individual work centers based on historical percentages.
5. Dividing the workload in each supplier to verify the validity of the master production scheduling.

The rough-cut capacity requirements can be expressed with the overall Planning factors in terms of the number of units produced, machine hours, direct labor hours, product size, or product value (Jonsson and Mattisson, 2002,5).

The overall Planning factors are divided into two parts: direct labor and machine times. The figure (2) shows overall Planning factors.

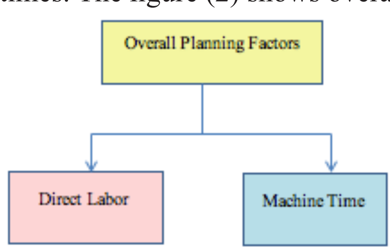

Figure (2): Overall Planning Factors

4. Practical framework

4.1. Research sample description (leather garment factory)

The State Company of Textile and Leathers Industries is one of the formations of the Ministry of Industries and Minerals. The leather garment factory was chosen as a sample for research, as this factory produces four types of leather garment, which include men's jacket, men's vest, women's jacket and women's coat. In fact, the demand for leather garments is seasonal. The leather garment factory includes three work centers, which are: the tailor-made center, the sewing center, and the quality control center. The tailor-made process is done in the tailor-made center manually, whereas, the sewing center has two processes which one is related to the other, as for the folding process is done manually, while the sewing process is depended on the machines. The work is done in the quality control center for final all products inspection manually. The figure (3) shows the working centers in the leather garment factory.

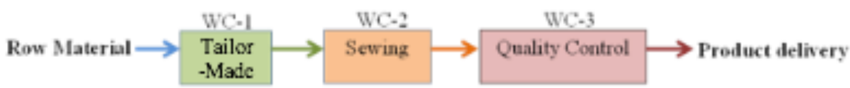

Figure (3): Work centers in factory

4.2. Data processing and discussion

1. Historical data collection for products

The data has been collected on production quantities and times related to the direct labor and machine that are required manufacturing the leather garment for the past three years 2017, 2018, 2019. The table (3) shows the types of leather garment, the quantities of their production, and the times of their manufacture for the three years.

Table (3): Types of leather garment, quantities and times

No	Products Type	Quantity	Direct Labor	Machine Time
1	men's jacket	4070	9565	5088
2	men's vest	1320	2640	1320
3	women's jacket	3410	10230	5286
4	women's coat	2200	5830	1650

Source: From the factory and company records

2. Historical data collection for work centers

Collecting times related to direct labor and machine times required by each work center and for all products. The table (4) shows time in work centers.

Table (4): Time in work centers

No.	Work Center	Work Type	Time Hours
1	Tailor-Made	Direct Labor	3.75
		Machine Time	-
2	Sewing	Direct Labor	4.80
		Machine Time	4.55
3	Quality Control	Direct Labor	1.45
		Machine Time	-
Total			14.55

Source: From the factory records

3. Prepare the master production scheduling

the researcher has done interviews with the directors of planning, follow-up, research and development departments, as well as the manager of the leather garment factory so that she could obtain a proposed accurate production scheduling of in order to obtain a proposed accurate production schedule for the first quarter of 2020 (January, February, and March). The table shows (5) the proposed master production scheduling for the first quarter of 2020.

Table (5): Proposed Master Production Schedule

No	Products	January				February				March				Total
		Weeks												
		1	2	3	4	5	6	7	8	9	10	11	12	
1	men's jacket	55	53	48	45	42	40	35	33	33	28	26	22	460
2	men's vest	10	10	10	10	12	15	18	22	24	24	20	15	190
3	women's jacket	48	45	45	42	40	36	34	32	30	26	22	20	420
4	women's coat	30	30	27	25	22	22	20	20	18	16	10	10	250

4. Calculating the overall planning factors

The overall planning factors relating to direct labor, machine times, and the four products can be calculated by the equation (1) and equation (2). Table (6) shows the overall Planning factors of the leather garment factory.

Table (6): Overall Planning Factors (hour per unit)

Overall Planning Factors (hour per unit)			
No	Products	Direct Labor	Machine Time
1	men's jacket	2.35	1.25
2	men's vest	2	1
3	women's jacket	3	1.55
4	women's coat	2.65	0.75

5. Calculating the workload for each product and for each time period
The capacity needs include the direct labor and machine times for all products and for each time period, and as it follows:-
- Calculating the direct labor needs for each product and for each week by multiplying the direct labor planning factor related to the product into the quantities of the master production scheduling for that product and according to the equation (3). The table (7) shows the results of the direct labor hours that are required for each product for a period of (12) weeks.
- Calculating the machine times needs for each product and for each week by multiplying the machine times planning factor related to the product into the quantities of the master production scheduling for that product and according to the equation (4). The table (8) shows the results of the machine times that are required for each product for a period of (12) weeks.

6. Calculation of the total capacity needs for each time period
The total capacity needs are calculated for each time period by adding the individual capacity needs for each product, and as it follows:-
- The direct labor: the need of direct labor hours for all products during the week are collected according to equation (5). The table (7) shows the total capacity needs for each time period.
- The machine time: the machine time needs for all products during the week are collected according to equation (6). The table (8) shows the total capacity needs for each time period.

7. Calculation time percentage in work centers
Collecting times related to direct labor and machine times required by each work center and for all products. The time percentage for each work center can be calculated according to equation (7) and equation (8). The table (9) shows the time percentage in work centers.

Table (9):The time percentage in work center

No.	Work Center	Work Type	Time Hours	Percentage%
1	Tailor-Made	Direct Labor	3.75	0.26
		Machine Time	-	-
2	Sewing	Direct Labor	4.80	0.33
		Machine Time	4.55	0.31
3	Quality Control	Direct Labor	1.45	0.10
		Machine Time	-	-
Total			14.55	1

Table (7): Direct Labor Hours Required

No	Product	January				February				March			
		Weeks											
		1	2	3	4	5	6	7	8	9	10	11	12
1	men's jacket	129.26	124.56	112.81	105.76	98.71	94.00	82.25	77.55	77.55	65.80	61.10	51.70
2	men's jacket	20.00	20.00	20.00	20.00	24.00	30.00	36.00	44.00	48.00	48.00	40.00	30.00
3	men's jacket	144.00	135.00	135.00	126.00	120.00	108.00	102.00	96.00	90.00	78.00	66.00	60.00
4	men's jacket	79.50	79.50	71.55	66.25	58.30	58.30	53.00	53.00	47.70	42.40	26.50	26.50
	Total	372.76	359.06	339.36	318.01	301.01	290.30	273.25	270.55	263.25	234.20	193.60	168.20

Table (8): Machine Time Hours Required

No	Product	January				February				March			
		Weeks											
		1	2	3	4	5	6	7	8	9	10	11	12
1	men's jacket	68.76	66.26	60.01	56.26	52.51	50.00	43.75	41.25	41.25	35.00	32.50	27.50
2	men's jacket	10	10	10	10	12	15	18	22	24	24	20	15
3	men's jacket	74.41	69.76	69.76	65.11	62.01	55.81	52.70	49.60	46.50	40.30	34.10	31.00
4	men's jacket	22.5	22.5	20.25	18.75	16.5	16.5	15	15	13.5	12	7.5	7.5
	Total	175.7	168.5	160.0	150.1	143.0	137.3	129.5	127.9	125.3	111.3	94.1	81.0

8. Calculation of capacity needs for each work center

The capacity needs for each work center can be calculated by calculation of the direct labor time only for all work centers, and of machine times only for all work centers and as it follows:-

- Calculating the need of the direct labor time for the work centers

The direct labor time needs for each work center is calculated according to equation (9) by multiplying the total direct labor for all products (the four products) in each time period that was calculated in step (6) by the percentage of each direct labor center that was calculated for the direct labor centers in step (7).

- Calculating machine time need for work centers

The machine time need for each work center is calculated according to equation (10) by multiplying the total machine times for all products (the four products) in each time period that was calculated in step (6) by the percentage of each machine time center that was calculated for the machine time of the work centers in the step (7).

In the leather garment factory, there are three work centers (tailor-made, sewing, and Quality Control), and the fact that the factory does not use a tailor-made machine in the tailor-made center, and also does not use any inspection device in the quality control center. Therefore, the ratio (0.26) represents the time of direct labor only in the tailor-made center just as the ratio (0.10) represents the time of direct labor in the quality control center. As for the sewing center, the work is done manually as well as mechanically, and the percentage of direct labor time is (0.33), while the time of the machine is (0.31).

The calculation of the capacity needs of the work centers in the leather garment factory for each of the direct labor of the three centers, and the machine time for sewing work center, As shown in the table (10).

Thus, the ratio of direct labor reached (0.69) of the total capacity need in all three work centers (tailor-made, sewing, and quality control) for all four types of products, while the ratio of machine time reached (0.31) to the sewing work center and for all four types of products.

Table (10): Direct Labor and machine time by work centers

No	Work Center	Work type	%	January				February				March			
				Weeks											
				1	2	3	4	5	6	7	8	9	10	11	12
1	Tailor-Made	Direct Labor	0.26	96.07	92.54	87.46	81.96	77.58	74.82	70.43	69.73	67.85	60.36	49.90	43. 35
		Machine Time	-	0	0	0	0	0	0	0	0	0	0	0	0
2	Sewing	Direct Labor	0.33	122.97	118.45	111.95	104.91	99.30	95.77	90.15	89.25	86.85	77.26	63.87	55.49
		Machine Time	0.31	54.93	52.70	49.63	50.04	46.94	44.72	42.94	40.48	39.17	34.81	29.43	25.33
3	Quality Control	Direct Labor	0.10	37.15	35.78	33.82	31.69	30.0	28.93	27.23	26.96	26.23	23.34	19.29	16. 76
		Machine Time	-	0	0	0	0	0	0	0	0	0	0	0	0

5. Conclusions

There are several methods for rough-cut planning, including the list of capacity, resource portfolio, and overall planning factors method. For the overall planning factors method depends on historical data related to the production quantities of the products, as well as the direct labor times and the machine times, it is considered as a simple method that can be applied in many industrial companies. The use of overall planning factors requires preparing a proposed master production scheduling for the period for which the factory wishes to plan the capacity. Much research has addressed the capacity planning by using overall planning factors, but without providing detailed steps on how to use these overall planning factors in the rough-cut capacity planning. Therefore, this research aims to provide logical steps for the rough-cut capacity planning process by using overall planning factors, so that it helps factory managers and production planners in many industrial companies to determine capacity requirements for both direct labor times and machine times, for many types of products and the required time periods, so that these steps can be applied by formulating ten mathematical equations. The research also confirms that the master production scheduling must be accurate so that the results of capacity planning can be accurate too. The current research also shows that all work centers do not include the direct labor time and machine time together. A work center may depend on the direct labor or machine time, depending on the method used to manufacture the products in factory. The researcher suggests tabulating the steps to reach the results as a package using a program R language.

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