A tool to determine the quantity of components needed taking into consideration reject: application in a small agro-company

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***Abstract*— This project presents the realization of a tool to determine the raw material needs for small companies in the agricultural sector in Cameroon. The objective is to; eliminate stocking perishable raw materials by ordering the right quantities and just on time too. To attain this objective, we integrate technical and commercial information as well as consider damages (loss) in input and end products. We then apply this tool to a small enterprise that produces fruit juice.**

Keywords*— *Calculating needs Material Requirement Planning, nomenclature, dependent products, independent products, damages.

I. INTRODUCTION

In a competitive environment companies are looking for ways to reduce production cost, notably by ameliorating their policy to manage stock and orders. For this reason, products should be supplied in time and in the exact quantity needed for the production. This products could either be; bought in this case the product is said to be independent or fabricated by the company in which case it's said to be dependent. This is the principle Orlicky of [1]. This article gives a presentation of the method "MRP" (Material Requirement Planning) a tool used to determine the quantity of components needed. It is conceived to satisfy the request for finished products in a specific environment. Our work is constituted of the following: the context of the study, the hypotheses on which the application is developed, the algorithm to determine the quantities needed and an industrial application.

II. CONTEXT OF THE STUDY

Many companies in Cameroon are small sized. They are specialized in transformation and commercialization of agricultural products. Their man power is modest, in orders of twenties with a turn over of about 100000US$ to 200000US$. We are far off from big companies of the same sector. For these small enterprises, it's difficult to afford production soft wares for MRP [2,3]. The cost is usually too heavy for the budget to support it and these soft wares are sometimes complex to manipulate. More over, the seasonal nature of the input products make them subjected to climate and therefore a rigorous ordering policy for raw materials has to be put in place in order not to impact stock of finish products negatively. It's necessary to precise everything as Wasim [4] because what interest users of an application is the performance which has a significant impact on its value. To add, it's the customer's satisfaction with respect to his needs that justifies the tool he's using.

III. CALCULATING THE QUANTITIES OF THE COMPONENTS NEEDED

The first applications using MRP were done 60 years ago. Very easy at the start, it has evolved and attained a high level of functionality and integration in companies. Today MRP is classified into three categories depending on its functionalities:

- MRP0: we calculate the quantity needed based on steady commands and we estimate finished products and the level of the present stocks. The production capacities are not considered.
- MRP1: calculations on charges incurred on production tools are added to MRP0.
- MRP2: we integrate calculations on production cost to MRP1 and adjustments on load-capacity are made.

Numerous studies are consecrated to the problem of calculating the quantities of components needed, such as tactical method of planning in the domain of production management [5]. This problem is approached in a hierarchical manner using three main plans: industrial and commercial plan (ICP), production director's plan (PDP) and material requirement planning (MRP) which is the subject of our article. Some works on MRP are based on mathematical models which take into consideration technical and commercial data and integrate parameters of estimated capacities [6]. Yet, as underlined by many authors, evaluations made are not quite real because they do not reflect correctly the complex use of these resources. For us, complexity is materialized by non-linearity of work load on the machines usually as a result of emergence of uncertain events such as breakdown of machines and absence of personnel. Divers strategies have been developed to eliminate these problems.

An approach integrates uniquely to the planning model [7] operational constraints. This was revised by Wolosewizc [8] who adds time parameters to re configure the system without estimating the capacity of the system.

Another approach, illustrated by Byrne and al. [9] is based on coupling a mathematic model of planning and a simulation model considered to best describe the functioning of the workshop. The system changes parameters from the mathematical model to the simulation model. Then we carry out a correction of the results before obtaining an optimal and realizable plan.

In brief, we present much elaborated approaches. Unfortunately, they are adapted for the industrial context of our study and do not integrate explicitly the quality of inputs which is primordial for agro industries.

A. Hypotheses of the study

Our work is based on the following hypotheses:

- There is a Production Director Plan (PDP) which determines for a given planning horizon, the estimated demand for each product.
- There is a complete nomenclature of products used. It permits us to obtain for each product, the constituents as well as the quantities needed for its assembling.
- There is a weak information system on the state of stock of a product.
- There is a record on delay in deliveries. This is essential to calculate dates to place fabrication and buy orders for products of dependent and independent needs respectively.
- There is data on products rejected. This information are taken in consideration either at reception (buys or production) or it's related to losses incurred during usage in the production process. This permits us to refine the results of calculations obtained and to understand that a production system is not 100% reliable.
- The production is of the type flow shop with the number of work post a bit higher, without amount of fabrication.

To consider losses or reject, it's necessary to undermine the quantity to place in production or to supply so as to know the quantity of ordered products expected having a reject ratio R:

The quantity of ordered product Q_{bp} is equal to the quantity to order Q_{PL} multiplied by (1-R):

$$Q_{bp} = Q_{pL} x(1-R)$$

Where:

$$Q_{pL} = Q_{bp}/(1-R)$$

B. Methodology

Calculating the needs is a technique of iterative simulation which permits us to define production plan [10] and ordering of sub components and components which assures the realization of a production plan. It's based on an arborescent decomposition of the products (see Fig.1). The products are treated on an ascending order of the nomenclature, so that the calculations of the needs are done in a cascade manner.

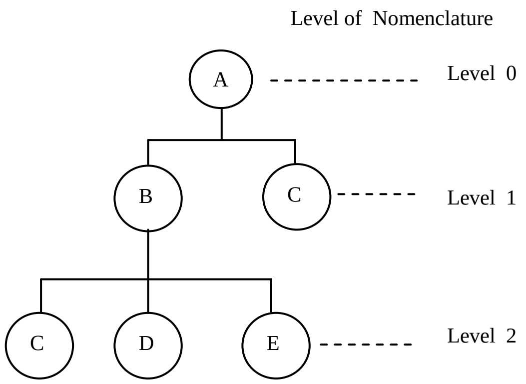

Fig. 1. Example of a product having 3 levels of nomenclature

Time is divided into periods of fixed lengths, parameterized into 1 day, 1 week or 1 month.
We adopt the following notations:

i: is the indices of the period considered when determining the quantities needed for the article given
Fab:is a product fabricated
Achat: is a product bought
Del: delay before delivery of the product (Lead Time) or delay in fabrication or supply depending on the type of product.
Ss: stock for security
Stk: quantity in stock

Principles in conducting the items
"LT1": "lot technique 1"
"LT2": "lot technique 2"
These are the supply rules (constraint) on products, indivisible quantity of buy or fabrication.
"Borne": below this value, buys or productions are done in multiples of LT1. Above this value buys and productions are done in multiples of LT2. The value of "borne" has to be a multiple of LT1.
"Q_{maxi}": the maximum quantity in stock. It's the maximum quantity of the item permitted in stock.
"Q_{min}": minimum quantity of supply. It is the quantity above which supply will be very penalizing financially for the company.
"Rebut R": ratio of reject defined previously. It takes into account the quantity of products rejected or damaged due to a supply or production error.

Outstanding data
"OLi": corresponds to production or supply orders already passed but delivery has not yet been done.

"BBi": gross requirement for period i. If it's an independent requirement, it corresponds to demand from the customer or a request by PDP. If it's a dependent requirement, it corresponds to a fabrication order.

Calculated variables
Rg: rank for calculation of the net requirement of a product. It's the result of calculations made internally to the system.
Livi: estimate to enter into stock during period i. It's an intermediate result of calculation.
DPSi: estimated availability of stock for period i. It's an intermediate result of calculation.
BNi: net requirement for period i.
Propi: quantity proposed to be fabricated or bought for the period i, in order to cover up requirements taking into consideration the type of management.
Atti: quantity expected in stock taking into considering proposition and eventual damages.
Si: stock which can be made available at the end of period i.
Sugi: delivery suggestion for fabrication or supplies of a product for the period i.

Apply the reasoning to the gross requirement (BBi) of a product in a period.
We determine as a function of stock S(i-1) and OLi for each product which has a dependent requirement, the missing quantity BNi in order to determine gross demand BBi. It's therefore possible to deduce the

corresponding fabrication and supply suggestion and to simulate the state of stock Si at the end of the period studied. Fig. 2 presents the principle of calculating requirements.

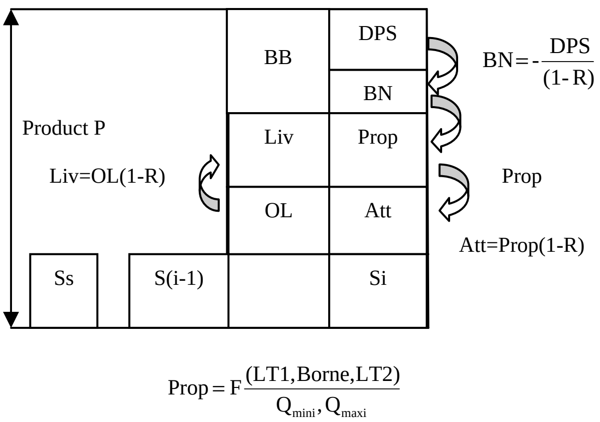

Fig. 2. Principle of calculation for MRP

C. Algorithm to calculate requirements

This algorithm unfolds in two stages:

The first is looking for the rank of the products. It consists of normalizing the nomenclature. That is ensuring that each product appears only at a single level in all the nomenclatures. The rank of the product is equal to the value of the maximum level in which the product appears in all the nomenclatures. For a product bought, it’s possible to attribute calculated ranks or the value of the maximum level in which bought products appear in all of the nomenclatures. The maximum rank of the nomenclatures determines the number of passes in the calculation of the requirements.

The second stage is the calculation of net requirements (BN).

The algorithm is shown below:

For each product;
 If product_rank=passe then (calculate net requirements)
  For i=start_of _horizon to end_of_horizon
   DPS(i)=(S(i-1)-Ss)+Liv(i)-BBi
 If DPS(i)<0
  Then

$$BN(i) = -\frac{DPS(i)}{1-R}$$

   Prop(i)=BN(i) Modulo [‘Lots Technique’, ‘principle of management’]
   Att(i)=Prop(i)x(1-R)
   Sug(i-dél)=Prop(i)
   Update the suggestion calendar
   If product is fabricated Then (rupture of the nomenclature)

(Looking for net requirements induced by this suggestion)
   For each link of the product

$$BB(i-del) = \frac{Sug(i-delay)xQuantity\ in\ the\ link}{1-R}$$ End for

  End if
 If not
  BN(i)=Prop(i)=Att(i)=0
 End if
 S(i)=S(i-1)+Liv(i)+Att(i)-BB(i)
 End for
 End if
 End for
End for

IV. PRESENTATION OF THE APPLICATION

The previous algorithm implements an MRP which treats many products and the components. It’s based on the following architecture:

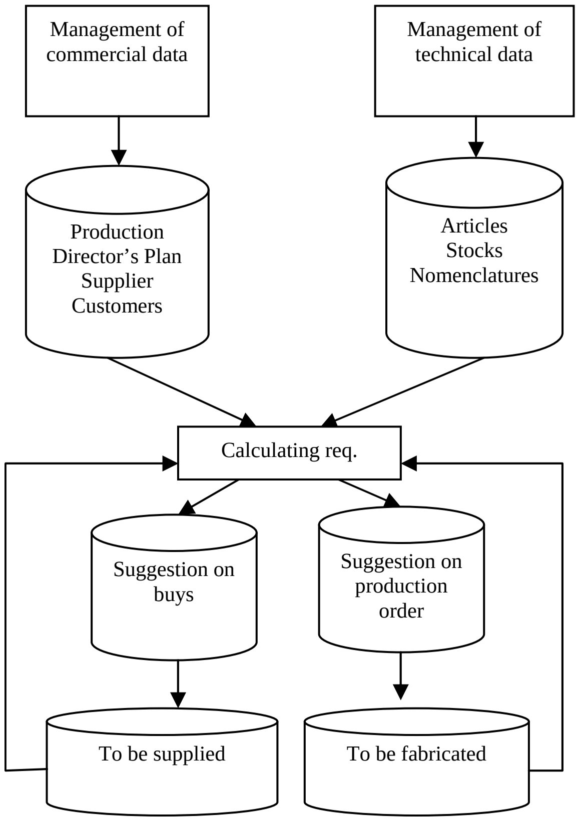

Fig. 3. Architecture of the application

We’ve developed our language tool by laying emphasis on conviviality of the graphical user interface which is presented in the form of unfolding menus from which we orient the diverse functionality of the application. It permits us to return technical and commercial information (Fig. 4 and Fig. 5).

Fig. 4. Welcome page of the application

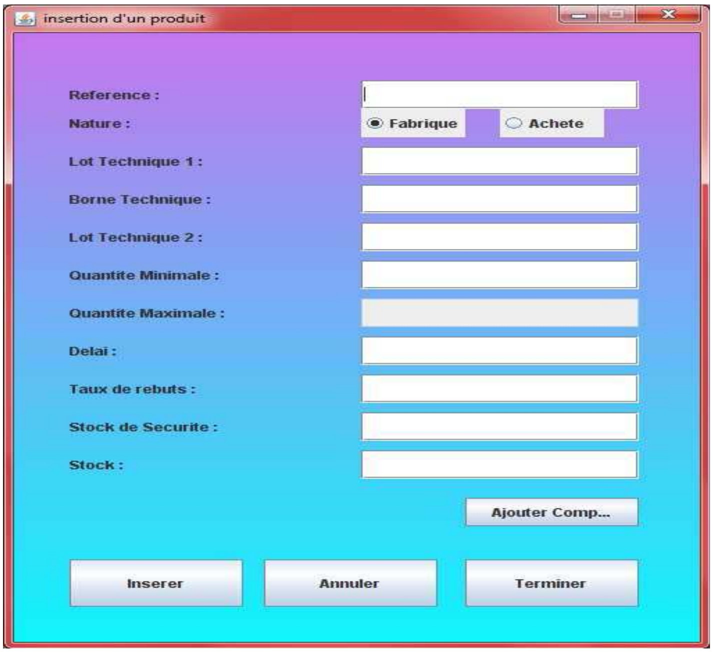

Fig. 5. Window to insert product

The result of the calculation is displaced as table in which the products to be bought and products to be fabricated by the company are indicated as well as the respective periods in order to meet up with the exigency of the Production Director's Plan (PDP).

V. CASE STUDY

The small agro industry we considered as our case study is specialized in fabrication of mango juice purposely for hotels. This juice is packaged in 1 L (product A) and 0.5 L (product B). Fig. 6 presents the nomenclature for a 1L package.

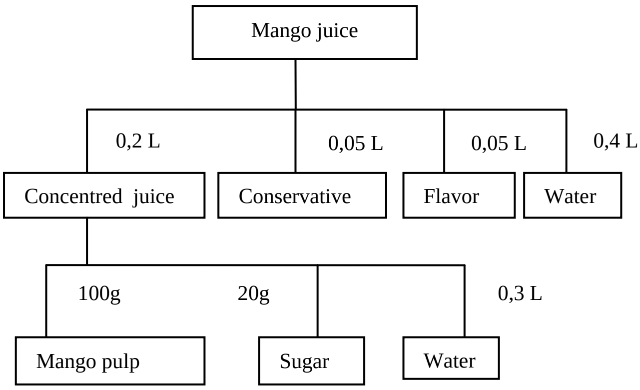

Fig. 6. Nomenclature of mango juice

Considering the small size of the enterprise and the fact that the production is of type flow shop where in the equipments are positioned to permit a flux to be conveyed in transit systematically by the same sequence of work posts, the question of capacity and load is not considered as our major parameter. In the process of daily production, once it's launched, it goes right up to the end. The horizon of planning is week.

The company works 5 days on 7 fabricating 1000 products of type A and 1500 products of type B per week or 200 A and 300 B per day. Table 1 gives relative information on stock, on delay, on damages and thus on quantities to be supplied.

TABLE 1
DATA ON THE PRODUCTS

Product	Pulp (g)	Sugar (g)	Water (L)	conservative Agent (L)	Flavour (L)	Concentrated juice(l)	Mango juice (L)
Fab/Ach	A	A	A	A	A	F	F
LT1	50	50	1	0,025	0,025	0,1	6
Borne	100	20	1	0,05	0,05	0,2	6
LT2	50	10	1	0,025	0,025	0,1	6
Qmin	1000	200	3	0,5	0,5	2	10
Qmaxi	-	-	-	-	-	-	-
Reject (%)	9	0	0	0	0	0	0
Délai (jour)	7	2	1	4	2	1	1
Stock s	60	120	6,9	0,5	0,5	3	20
Stock	21060	8520	532	70,5	35,5	108	370

Equally, information on standby deliveries is made available:

- 18L of conservative agent
- 18L of flavor
- 4200g of sugar

The algorithm for calculating net requirements gives us the following results presented in Fig 7 below for planning horizon of 15 days.

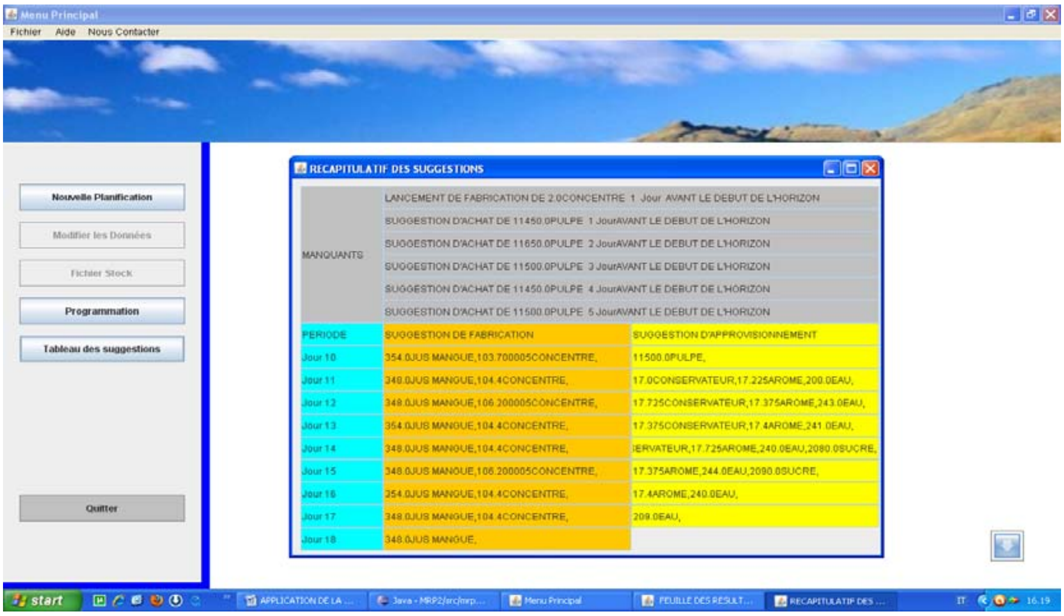

Fig. 7. Results from calculating net requirements

The previous results are re-taken below:

TABLE 2
RESULTS OF CALCULATION OF NET REQUIREMENTS

Period	Suggestion on fabrication.	Suggestion on Buys
	Missing : Fabrication of 2L of concentrated juice on day before the beginning of the horizon Buy 11 450 g of mango pulp, one day before the beginning of the horizon Buy 11 650g of mango pulp 2 days before the beginning of the horizon Buy 11 500g of mango pulp 3 days before the beginning of the horizon Buy 11 450g of mango pulp 4 days before the beginning of the horizon Buy 11 500g of mango pulp 5 days before the beginning of the horizon	
Day 10	357L of mango juice, 103,7 of concentrated juice	11 500g of mango pulp,
Day 11	348L of mango juice, 104,4L of concentrated juice	17L of conservative, 17,22L of flavor, 200L of water
Day12	348L of mango juice, 106,3L of concentrated juice	17,72L of conservative, 17,37L of flavor, 24Ll of water
Day 13	354L of mango juice, 104,4L of concentrated juice	17,37L of conservative, 17,4L of flavor, 241L of water
Day 14	348L of mango juice, 104,4L of concentrated juice	17,4L of conservative, 17,72L of flavor, 240L of water, 2080g of sugar
Day 15	348L of mango juice, 106,3L of concentrated juice	17,37L of conservative, 244L of water, 2090g of sugar
Day 16	354l of mango juice, 106,3l of concentrated juice	17,4 l of flavor, 240l pf water
Day 17	348L of mango juice, 104,4L of concentrated juice	209L of water
Day 18	348L of mango juice	

VI. CONCLUSION

This paper presents a tool to calculate net requirement which integrates considerations for damages of a flow shop type of production system for a small sized company. Next, the application realized on a company that produces fruit juice gives us satisfactory results on the quantities and the dates to make available the dependent and independent products. The simple user interface has been tested and is equally satisfactory.

This work is the first section of study in which we wish to integrate the problem of performance of human resources by modelling it in a stressful environment.

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