CHAPTER 2

LITERATURE REVIEW

Before getting into the details of the project, the understanding about the concept and some terminology are very important. This section will discuss about the literature review and significance of the proposed work.

2.1 Conceptual Model

Identify what happens in the company from a conceptual point of view is very helpful to gain a better understanding of the system and, consequently, to detect irregularities and suggest improvements. The conceptual models, mainly of the graphical type, are used to represent the static phenomena (objects and their properties) as well as dynamic phenomena (events and processes) related to the corresponding domain. The conceptual model should achieve four objectives to: (i) enable communication among the developers and the users; (ii) help to understand the domain; (iii) provide the starting points necessary for designing the process; and (iv) document the requirements for future references. A working framework within which the aspects needed for the conceptual modeling process are structured and are based on grammar methods; written models and the context [2].

2.2 Conceptual modeling methodology

The methodology establishes a way of doing things with the main idea of standardizing the procedures related with a certain activity, thereby achieving a better degree of understanding of the actions to be carried out and of the results to be presented. In this section, a conceptual modeling methodology for the production planning processes is described. This methodology is based on flows modeling, and is fully aligned with the perspective of process oriented modeling. Its objective is for a specific process to be represented, and for it to be easily understood by the different entities implied in the process. The methodology proposed is based on 7 main blocks. These blocks establish the phases to be considered when a conceptual processes model is developed. Fig. 2.1 presents a diagram based on a semi-formal modeling language where the phases to be taken into account in the modeling methodology are illustrated. Phases 1 (Visualisation), 2 (Analysis), 3 (Conceptualisation), 4 (Modelling), 5 (Validation), 6 (Proposal) and C (Correction) shown in Fig. 1 are represented by a rectangle, while the question to learn whether any correction is needed is represented by a decision rhomboid. Therefore, this methodology is oriented to carry out the identification and analysis of the inputs, outputs, processes and sub-processes of material requirement planning processes of the automobile sector [3].

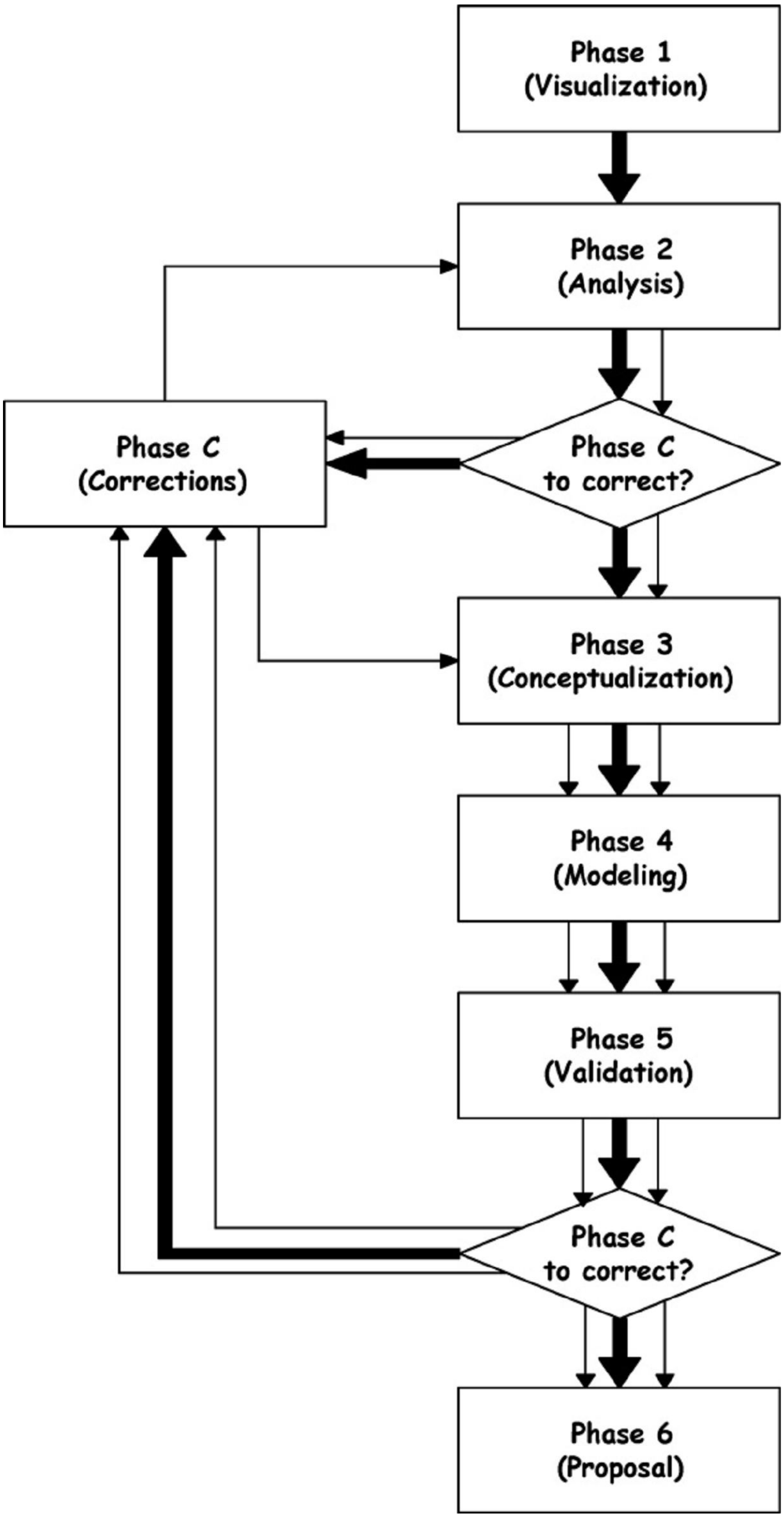

Fig. 2.1: Conceptual modeling methodology [3]

As seen in Fig. 2.1, the conceptual modeling process begins with the visualization phase. This phase consists in obtaining an adequate understanding of the processes and activities in order to obtain the model domain definition. Then Phase 2 is oriented to establish and support the analysis of the processes from the existing documents in the enterprise. These documents will support the subsequent domain definition. The study and document generation of the main techniques and tools concerning conceptual modeling are also recommended. Furthermore, this phase is oriented to establish the relationships among all internal entities (personnel of the company implied in the modeling process), external entities (customers, suppliers, etc.) and those relationships with the research team. Afterwards, the correction phase (or Phase C) takes place in the modeling methodology process where the last two phases are reviewed and validated. Therefore, if the visualization and analysis phases are in line with the company's real situation, the modeling process continues its course. Otherwise, the modeling process returns to the beginning by taking into account the changes established in the correction phase. Once Phase C is finished, the conceptualization phase begins, where a number of definitions or glossary is established through the identification of the static and dynamic aspects of the problem to facilitate communication and interviews among the people who are developing the conceptual model. Then, the fourth phase is oriented to support the modeling of the collected conceptual ideas from each document already fulfilled. Afterwards, the validation phase begins whose aim is to check the model according to the parameters established in the analysis phase and to know how these represent the behavior of the internal entities, the additional internal entities and the domain business processes. Should any inconsistency be detected, this phase will lead to a review process (Phase C).Finally the last phase (the proposal phase) is oriented to either propose improvements or apply other modeling techniques for the current system representation which could afford it a better understanding by considering other domain problems or aspects. In this phase, the experimentation concept is used to propose and test new alternatives that can provide solutions to the problems detected in the previous phases. Each proposal may be represented by any modeling technique that the modeler considers adequate [3].

2.3 MRP approach

2.3.1 The basic principles of MRP systems

Material requirement planning (MRP) is a well-known approach to inventory management of dependent demand items. Items that are independently demanded are typically finished goods, while dependently demanded items are typically components and subassemblies that are related to an end item by a bill of materials. Thus, MRP is a hierarchical system that provides key information to planners for developing (1) lot-sizing techniques for lower-level components and purchased items, (2) capacity decisions, and (3) sequencing decisions for open orders, while the master production schedule is the main input to an MRP system. [4]

The major objective of MRP systems is to generate time-phased requirements for components or raw material. The three major inputs of an MRP system are master production schedule, inventory status records, and bill of material (product structure). We emphasize the importance of MPS as an input to MRP. It is the main input to the MRP system, because the major objective of this system is to translate end-product time-phased requirements into individual component requirements. Inventory status records contain the status of all items in inventory. The record is kept up to date by accounting for all inventory transactions-receipt, withdrawal of an item from or to inventory. Bill of material (BOM) is sometimes also called the product structure. Product structure is a diagram that shows the sequence in which raw material, purchased parts, and subassemblies are manufactured and assembled to form the end-items [5].

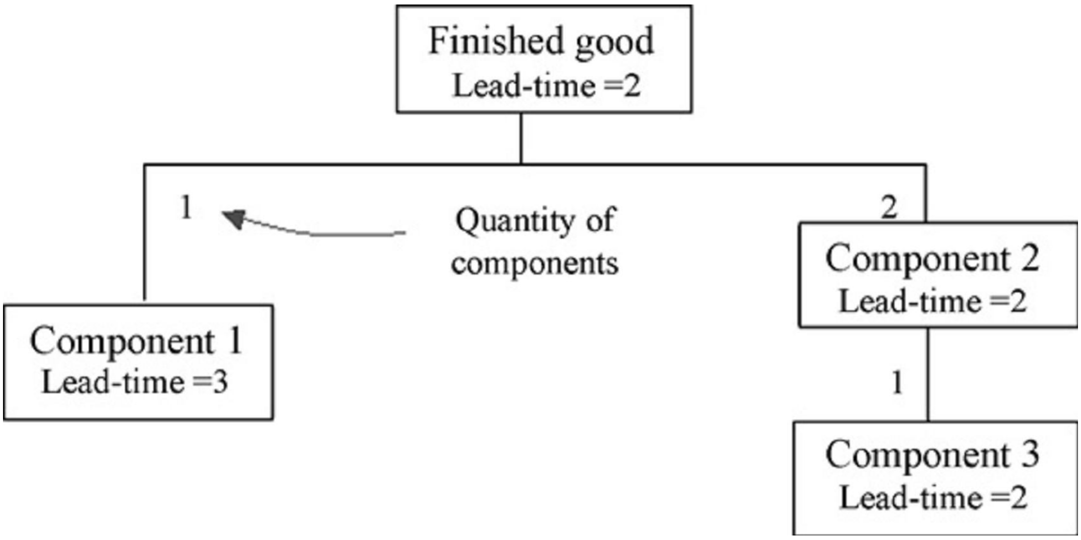

Fig. 2.2: Bills of material [6]

Finally, if the production of the finished product needs several successive operations, the system is said multi-stage. The needs for the finished product are given by the Master Production Schedule (MPS) (Fig. 2.3), and the ones for the components are deduced from pegging.

	Period	1	2	3	4	5	6	7	8	9	10
Level 0 Finished good Lead time = 2	Gross need (MPS)	0	0	0	50	10	40	20	30	50	60
	Available inventory	20	20	20	20	0	0	0	0	0	0
	Net need	-20	-20	-20	30	10	40	20	30	50	60
	Manufacturing/order	0	30	10	40	20	30	50	60	0	0

Quantity = 1

	Period	1	2	3	4	5	6	7	8		
Level 1 Component1 Lead time = 3	Gross need (MPS)	0	30	10	40	20	30	50	60		
	Available inventory	100	100	70	60	20	0	0	0		
	Net need	-100	-70	-60	-20	0	30	50	60		
	Manufacturing/order	0	0	30	50	60	0	0	0		

Quantity = 2

	Period	1	2	3	4	5	6	7	8		
Level 1 Component 2 Lead time = 2	Gross need (MPS)	0	60	20	80	40	60	100	120		
	Available inventory	140	140	80	60	0	0	0	0		
	Net need	-140	-80	-60	20	40	60	100	120		
	Manufacturing/order	0	20	40	60	100	120	0	0		

Quantity = 1

Fig. 2.3: Master Production Schedule [6]

2.3.2 MRP Process

The heart of MRP system is the process that transforms input into output. Transforming inputs to outputs is done systematically, using a sequence of steps called explosion, netting, offsetting, and lot sizing (see Fig. 2.4). In the explosion method process we simulate the disassembly of end product into its components. During the netting process, gross requirements are adjusted to account for on-hand inventory or quantity on order.

This adjustment is done at every level of the BOM and for each time bucket. In other words, at each level of the BOM, gross requirements are netted before exploding into requirements at the next lower level. If there is no on-hand inventory and no order quantity, then net requirement is equal to gross requirement. The last two steps in the MRP process are offsetting and lot sizing. In offsetting, the timing of order released is determined. In order to meet net requirements, an order release is offset by the production lead time or supplier delivery time. Finally, the lot sizing is the step in which the batch size to be purchased or produced is determined.[5]

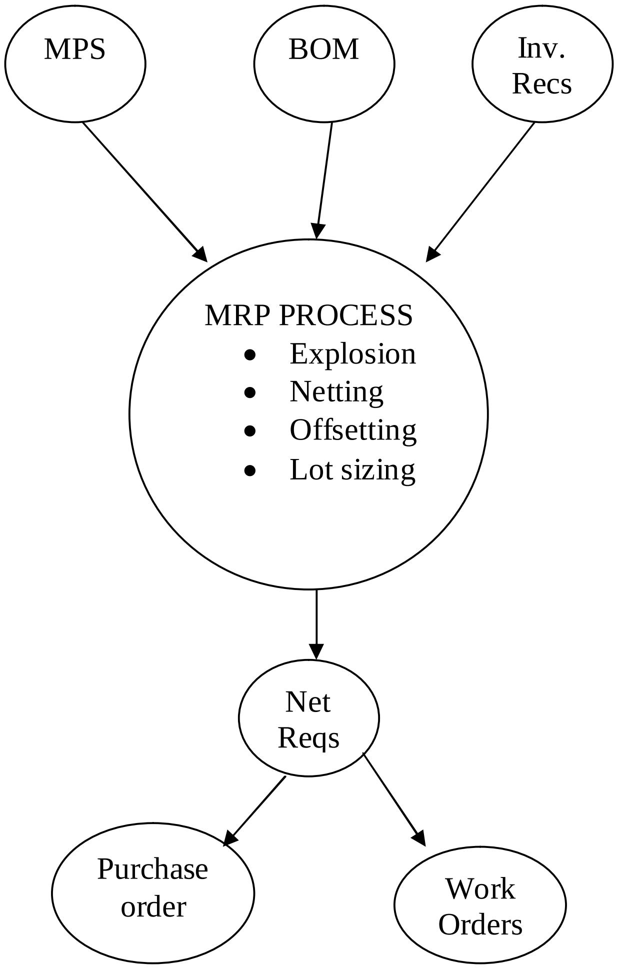

Fig. 2.4: MRP process [5]

2.4 MRP Parameters

The basic MRP rules work well for a deterministic environment. To adapt the method for uncertain environment, some parameters should be adjusted (see Fig. 2.5). Parameters that might soften the effects of these uncertainties are the following ones:

- Safety stock
- Safety lead time/ planned lead time
- Lot-sizing rules
- Freezing the MPS
- Planning horizon

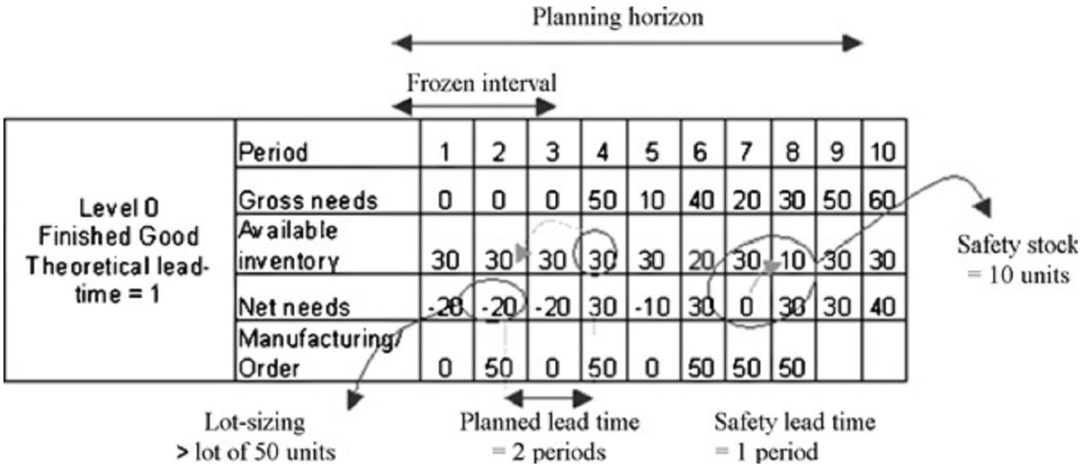

Fig. 2.5: MRP parameters. [6]

2.4.1 Safety stock and safety lead time

Safety stocks are exceptionally important for production, since they aim circumvent the random factors. Their impact is twofold: reducing the risk of shortages and increasing the holding cost. Hence, they have to be adjusted according to the following objectives:

- To minimize the shortage and holding cost;
- To guarantee a given service level.

Concerning the safety lead time, this notation is based on the same principle that the safety stock, but, instead of acting on quantities, it works on time. According to Whybark and Williams, the safety stocks should be used when there are uncertainties in quantities, and safety lead time when the problem is dealing with the estimating of the theoretical lead time. Thus, it seems that the cost of the inventory is minimized and the service level is satisfactory in a MRP system using this principle. Furthermore, these results are valid for any source of uncertainty, lot-sizing rule, level of demand, lead time, and level of uncertainty. The use of safety stock is not appropriate when the variability of the demand is low, and the time between the orders is small. [6]

2.4.2 Lot-sizing rules

It is often better to group orders together, instead of ordering by lot-for-lot rule (LFL), i.e. to order only the net needs for a single period. The LFL permits reducing the inventory but does not take into consideration economical aspects and organizational constraints. Sometimes, the ordering cost is expensive in relation to the holding cost, so lot-sizing is needed. There exist many of lot-sizing rules. The principles ones are:

- The Economic Order Quantity (EOQ);
- The Periodic Oder Quantity (POQ);
- The Wagner-Within algorithm (WW).

The Economic Order Quantity (EOQ) was introduced by Harris in 1913. It is easiest technique. It calculates a fixed quantity to order by the Wilson formula, but the time between the orders may vary. From the EOQ, it can be deduced the Periodic Order

Quantity (POQ): an optimal constant time between orders is calculated, and from the optimal constant time, the necessary quantity to order for each period is obtained.
The Wagner-Within algorithm (WW) is a procedure that determines the minimal order cost for a dynamic deterministic demand without capacity constraints. [6]

2.4.3 Master Production Schedule

The MPS is given the production plan (i.e. quantities to produce in a given future period), and is obtained by analysis on demand level, lead times, production capacity, and costs. The MPS is also a mean of communication between the departments of a company in order to coordinate their actions in space and time. The aim of the MPS is to anticipate the future needs and be able to implement actions with an acceptable lead time (supplying of components, for example), in order to minimize the total cost. The time periods when the MPS is done, is calling planning horizon. To be adapted to the production system's dynamic nature, the time horizon can be limited instead of a theoretically infinite one. Then, the time must be rolled at a certain frequency. So, there are rolling time horizon and a replanning frequency. Thus, data is periodically updated and new information can be integrated, giving a more accurate view of the production system. [6]