

PLANNING AND ECONOMIC PERSPECTIVE OF MATERIAL FLOW

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doi:10.22306/al.v5i1.88

Received: 28 Mar. 2018

Accepted: 31 Mar. 2018

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Keywords: material flow, planning, costs, economic perspective

Abstract: The production is usually divided into quite a number of handling, control and technological operations in the production enterprise, and these are realized at different workplaces. Parts, semi-finished goods, raw materials and products need to be relocated. For this reason, material flow is created. The material flow is an organized movement of material in the production process or circulation of products. It is characterized by the intensity, frequency, direction, performance, structure, character of the transported material and used technique (transport and handling).

1 Introduction

The term “material flow” represents an organised movement of material in the manufacturing process or product circulation. It is characterised by the direction, intensity, frequency, length and performance, structure, character of transported material and transporting and handling equipment used [1].

As arises from the definition, the material flow includes:

- Material unloading in the plant premises;
- Material movement through production stock warehouses, production shops, production operations, intermediate warehouses and finished product warehouses;
- Dispatch of finished products or waste from plants;

It includes the entire material movement starting with its supply to the plant through all the phases of storage, production and transportation process and ending with their dispatch or with warehouses of business organisations [8].

1.1 The intensity of material flows

The intensity of material flows in the circulation is influenced by factors, of which we can mainly state [4]:

- Diversification process as a process extending diversity of elements of the manufacturing process and with it corresponding tendencies, which, apart from the intensity, have also an impact on material consumption;

- Raw material base of the national economy and its regional distribution;

- Irregularity of the rhythm of production;
- Long-term fluctuation of material flow demands;
- Level of information flow management;
- Level of supplier-customer relations, especially selection of suppliers and their determination for selected materials, and integrity and promptness of deliveries;
- Level of organisation management and provision of materials and technologies;

The material flow consists of two basic groups of elements:

- Passive elements of the material flow i.e. materials, raw materials, semi-finished products and finished products;
- Active elements of the material flow, i.e. transport, handling and storage operations [4].

In enterprises, the material flow is formed by the flow of all kinds of working objects (passive elements) such as:

- Raw materials and basic materials;
- Work in progress;
- Finished products;
- Waste;
- Purchased products and semi-finished products;
- Auxiliary material (lubricants, cleaning agents);
- Spare parts;
- Packages;
- Small items and non-durable goods [2].

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The most significant group, which, at the same time, forms the most relevant part of the material flow are raw and other materials and corporate work in progress and finished products. All the types of working objects are used throughout enterprises in certain amounts, internal structure, and direction with certain frequency [3].

2 A standard material flow planning process

A) Activity: Planning of raw materials - verification of disposition of raw materials, creation of appeals (call-off) and orders (activities 010,020,030,040) (Figure 1).

Description of the activity:

1. After actualization of the production plan in the system SAP and data transferring to *MAP xr*, the raw material scheduler checks the requirements of all needed raw materials (for suppliers outside the EDA). The production plan is updated weekly on Tuesday. Requirements for materials are checked on a daily basis.

2. In parallel to the point 1, the raw material scheduler checks the state of raw materials supply in the raw material store (including the consignment store) for the next 4 weeks. This time period may be extended depending on the agreed delivery times.

3. In the case of need (negative stock supply, level of supplies under the safe limit, supplies exceeded maximal available level), the scheduler of raw materials realizes modifications in the *MAP xr* system.

- Modify the amount of the current call-off,
- Create a new call-off,
- Cancel the actual call-off,
- Modify the date of the actual call-off,
- Create a new order (only in the case of suppliers who deliver fixed quantities),
- Generate a list of call-off and send to suppliers.

Output: Updated schedule of raw material delivery in the *MAP xr*, list of call-off, orders (created in SAP).

B) Activity: Assurance of raw materials supply (activities 050,060,070,080) (Figure 1).

Description of the activity:

1. After receipt of positive feedback from suppliers, the raw material scheduler assures the material transport according to the confirmed date of loading. Transport is realized by the forwarding company, contractors of the enterprise. This applies to EXW supplies.

2. The scheduler of raw materials monitors the deliveries (quantity and time) and determines the priorities for unloading if it is necessary. Two automatically generated daily reports sending by e-mail present a tool: critical deliveries and warning list.

Output: Delivery, call-off, confirmation of the order by suppliers, plan of transport.

C) Activity: Actualization of the planning system (*MAP xr*) in the case of suppliers who have EDA (activities 100,110,120,130) (Figure 1).

Description of the activity:

1. After the production plan actualization in the SAP and data transferring to *MAP xr*, the responsible person by supplier checks the requirements for each material. By agreement, this is done once a week, after receipt of a suggestion from the raw materials planner.

2. In parallel with the point 1, the responsible person by supplier checks the availability of raw materials in the local store (including the consignment store) for the determined period which may vary according to the agreed delivery times.

3. In the case of need (deficiency of supplies, supplier under the level of safe limit, supplies exceeded maximal available level), the supplier realizes modifications in the system *MAP xr*:

- Modify the amount of the current call-off (reference),
- Create a new call-off,
- Cancel the actual call-off,
- Modify the date of the actual call-off.

Output: Updated delivery plan of the material in the *MAP xr* (date of reference = ETA).

D) Activity: Control of raw material delivery by the supplier (activity 150) (Figure 1).

Description of the activity:

1. The supplier organizes the transport in accordance with agreed rules (minimal and maximal supplies) by the state of supplies.

2. The supplier sends to customer and delivery enterprise (if the material is stored in external store) notification of details of transport at least one day before the delivery.

E) Activity: Control of risks of material supply (activity 160,170,180,200) (Figure 1).

Description of the activity:

1. The scheduler of raw materials is in contact with the supplier about the actual state of the critical delivery (quantity, time).

2. The scheduler of raw materials is also in contact with scheduler of production about possible modifications in the production plan, alternative solutions are prepared. If it is necessary, the scheduler of raw materials will contact other suppliers to provide a replacement solution.

3. The scheduler of raw materials negotiates with the supplier, transporter about data and information about the quantity and time, who takes responsibility for losses, demands remedial actions as to the future.

4. The scheduler of production modifies the production plan according to the latest information.

Output: Updated production plan. Invoice for the production failure. Recording with corrective actions.

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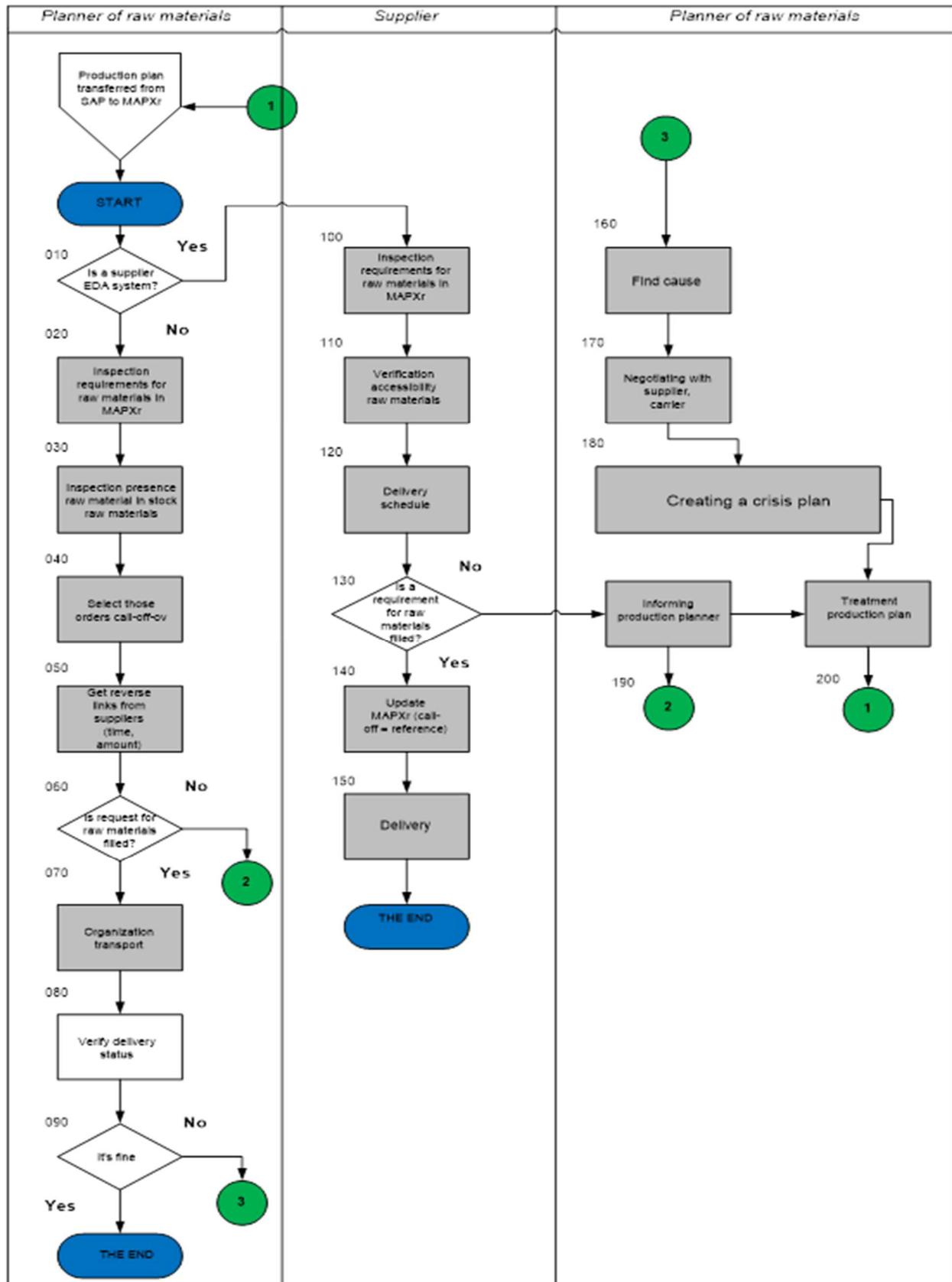


Figure 1 Process flowchart: A standard material flow planning process

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3 Economic perspective of material flow

From the economic perspective costs connected with material flow execution cover [6]:

1. Payroll expenses related to wages and salaries of handling performing employees working in the field of in-house transportation, warehouse management or management of packaging and a part of salaries of individual and other workers, who deal with material handling in their working time;
2. Fuel and power expenses;
3. Package costs and costs of long-time consumer goods used up for handling;
4. Maintenance costs and repairs of machinery designed for material handling;
5. Depreciations of sites, buildings and equipment designed for material handling;
6. Other costs such as administrative costs, lighting and heating costs etc. [5].

The amount of the above costs directly relates to the level of material flow, its length and the volume of material under transport.

The level of material flow and with that connected costs are both influenced by a large group of space, production, organisation and personnel-related factors, of which the most important are:

1. Enterprise territorial location in relation to its suppliers, customers, governing bodies, transport networks (railway, roads, water courses), power and water supply etc.;
2. Layout of buildings in enterprises' premises;
3. Network of horizontal and vertical character between and inside buildings;
4. Power and utilities, including water, steam and power supply etc.;
5. Buildings and their properties such as shape, area they take up, layout of doors, beams etc.
6. Produced amount and product mix – amount and mix of produced parts, purchased parts and batch sizes;
7. Type of production – piece, batch or mass production;
8. Character of machinery – number, character and use of machines, degree of mechanising and automation;
9. Arrangement of workplaces – object, technological, site production etc.
10. Handling equipment – number, character, use and degree of mechanising and automation;
11. Technological procedure specifying the progress of certain product manufacturing;
12. Ergonomic, hygienic, safety and other requirements [7].

4 Results and discussion

All these factors influence the spatial structure of manufacturing process and level of material flow, whether in a positive or negative way [9]. An element, which is

important or even inevitable for the execution of material analysis module is the need to have available or to prepare operational production records [10].

1. Recording the actual progress of manufacturing process;
2. Provided data:
 - Actual issued product amounts;
 - Periods of individual operations and products implementation;
 - Labour and material consumption;
 - Deviations, failures and their causes;
3. Activities connected with the provision of production records:
 - List of production documents;
 - Corporate own recording and processing of data on the actual progress of manufacturing process;
4. System of production documents:
 - Technical documents (drawing, bill of materials, technological procedures...);
 - Documents for work progress management (work sheets, identification sheets, deadline sheets..);
 - Issue documents (issue slips);
 - Handover documents (handover sheet);
5. System of initial documents:
 - Identification sheet;
 - Work sheet;
 - Handover sheet;
 - Material issue slip;

The production program must take into consideration the size of production capacity and the chain of consecutive, branching and parallel processes from the perspective of IPO (input-process-output) schemes that make it possible to specify inputs required (basic raw and other materials, semi-finished products and components, auxiliary materials, power and utilities etc.) stated both in material volumes and monetary values [11].

Examples of fundamental factors that have to be considered for the purposes of material analysis of the manufacturing process [5]:

- Availability of given basic materials;
- Possibility to substitute given materials should those be not available;
- Quality of raw and other materials is examined using a set of physical and chemical properties;
- Distance of material (raw material) sources that influences the amount of transportation costs;
- Level of the risk connected with the provision of given raw and other materials;
- Price level of raw and other materials that is directly shown in production costs;

The price cannot be considered separately but in its relation to quality – the higher the quality of raw materials the lower the specific consumption. This might lead to reduced production costs compared to the use of raw materials of lower quality [8].

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5 Conclusions

Great attention needs to be paid to power and utilities demands. Demands related to material and power and utilities inputs make it possible to determine some cost parameters (or parameters, on which these costs depend) that form part of input data for the purpose of economic efficiency assessment. A well-arranged summary of cost quantities related to material inputs and power and utilities should contain:

- Names of material inputs or power and utilities and their units of measure;
- Standard of consumption per unit of manufactured products;
- Expected purchase prices per unit of material inputs or powers or utilities;
- Expected costs per unit of production;
- Expected costs per assumed (scheduled) production volume;

Calculations of material input and power and utilities demands make it possible to specify the level of material inventory with its impact on the economic side of the model (not only do material inventories hold funds in a long run but they also require storage, for which storage capacities need to be established) [11].

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Review process

Single-blind peer review process.