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INTRODUCTION

Context

Origins:

Japan, the fifties. JIT develops and expands throughout the second half of the twentieth century, transforming the automobile industry and moving on to other service sectors. Its basic principles are still valid and applicable to other sectors in the twenty-first century.

The *mass production model* is not viable in Japan; thus a new model is needed:

- A small and vulnerable domestic market, with a variable demand;
- Local labour force (Japan) and strong union position;
- Post-war economy, few possibilities to acquire technological capital.

Key to success:

The Japanese government prohibits foreign investment in the motorcar industry. This gives an opportunity to test the potential of the model developed by Eiji Toyoda and Taiichi Ono (familiar with mass production practices and influenced by concepts of quality developed by W.E Denning).

A philosophy, a process

Philosophy:

This type of management consists of a combination of organizational techniques and practices of production aimed at serving the customers at the desired time and with the amount and the quality that is required. It is based on the following techniques:

- elimination of all functions that are unnecessary for the operation and do not bring any added value to the customer (eliminate wastage);
- production of the different products, services and components at the correct time, in the desired quantity and with the maximum quality.

Objectives:

Eliminate costs from unnecessary functions or poor quality.
- Zero breakdowns
- Zero stocks
- Zero wasted time ocioso
- Zero bureaucracy

Process:

In order to achieve these objectives, progress must be made one step at a time. 'Kaizen' is a Japanese word that means continuous improvement involving all the employees.
JIT: from push to pull

One of the fundamental aspects of JIT is the change from the push system to the pull one.

The push system is so called because the previously planned manufactured lots 'push' the production.

In contrast, in the pull system (from 'pull', or decentralized information) each process or customer takes the product or the parts from the previous process as and when they are needed. In this way, a work or service centre only works when the next process communicates to it the need to do so.

This system uses Kanban in order to function. Kanban is the authorization to produce or adjust stock, at the same time providing control and information.

It is used to regulate the level of stocks and the speed of production by lowering or raising either the number or the size of Kanbans. If there is no Kanban, the system comes to a standstill. It facilitates visual control and reduces bureaucracy. It establishes a maximum, which is the highest stock possible, and it is calculated on the basis of the requirements of the situation. The Kanban involves the stock; the objective is to reduce it to the optimum point possible.

This type of management has an affect on the balance of the production variations and on flexibility. JIT requires the flow of operations to be as uniform as possible, so that it can be both constant and stable. Mechanisms have to be used which reduce variations in the short term in order to achieve synchronization of the production process. The levelling out of the production is based on manufacturing varieties of products which are then adjusted to the demand, rather than producing large series. Great flexibility is needed both in the equipment used, which must have a number of different uses and permit the production of short series efficiently, and the manpower, which should be able to perform several tasks and have experience in a variety of operations.

<table>
<thead>
<tr>
<th>Traditional process (push)</th>
<th>Just in time process (pull)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The push system is so called because the previously planned manufactured lots 'push' the production.</td>
<td>In the pull system (from 'pull', or decentralized information) each process or customer takes the product or the parts from the previous process as and when they are needed. In this way, a work or service centre only works when the next process communicates to it the need to do so.</td>
</tr>
<tr>
<td>The customers come and take away their orders, but the warehouse sends the orders according to the planning of materials</td>
<td>The customers start the process: as they take away the goods the warehouse sends new orders to the plant. If the clients do not act, neither does the warehouse</td>
</tr>
<tr>
<td>Materials planning establishes the stocks for each work position, and each one works independently of the others</td>
<td>The work positions do not hold stock; they depend on each other to continue with the production</td>
</tr>
</tbody>
</table>
### Lower purchasing speed

<table>
<thead>
<tr>
<th>Traditional process (push)</th>
<th>Just in time process (pull)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A lower demand from the customers could produce an excessive accumulation of stocks. One way to avoid this is by 'flooding' the channel</td>
<td>The customer activates the process. If the demand drops, the whole process slows down</td>
</tr>
<tr>
<td>The suppliers and the warehouse maintain their normal rhythm of work, following the production plan</td>
<td>The work positions adjust their speed to the new demand, avoiding unnecessary stocks</td>
</tr>
</tbody>
</table>

### Higher purchasing speed

<table>
<thead>
<tr>
<th>Traditional process (push)</th>
<th>Just in time process (pull)</th>
</tr>
</thead>
<tbody>
<tr>
<td>An increase in demand from the customers produces a drop in stocks. It might lead to a shortfall situation</td>
<td>The customer activates the process. If the demands increases, the whole process speeds up, beginning with the supplier</td>
</tr>
<tr>
<td>The suppliers and the warehouse maintain their normal rhythm of work, following the production plan independently of the pull of the demand</td>
<td>The work positions adjust their speed to the new demand, avoiding running out of supplies</td>
</tr>
</tbody>
</table>

### Stoppage of a work position

<table>
<thead>
<tr>
<th>Traditional process (push)</th>
<th>Just in time process (pull)</th>
</tr>
</thead>
<tbody>
<tr>
<td>If there is a stoppage in one of the positions the others continue their work at full speed, accumulating stock. The chain continues and the problem grows</td>
<td>A stoppage in one of the work positions means the other positions are not given work, so the process is halted and stocks are not increased. The whole chain stops and priority is given to repairing the position and putting it to work again</td>
</tr>
</tbody>
</table>

### Supply problems

<table>
<thead>
<tr>
<th>Traditional process (push)</th>
<th>Just in time process (pull)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Purchasing department puts on pressure to solve the problem and grants part of the contract to another supplier</td>
<td>The system might be halted while the plant collaborates with the supplier to solve the problem</td>
</tr>
<tr>
<td>One supplier suffers problems and his stock piles up. The other increases his supplies to avoid running out of stocks</td>
<td>When a problem arises, the supplier informs the production chain and production is halted. The customers are supplied from the security stock</td>
</tr>
</tbody>
</table>


**STEPS IN A JIT PROCESS**

1. **Introduce speed**

   Speed is introduced at the beginning of the process, after establishing the objectives of JIT and designing the overall vision, which helps us acquire the skills to stay in the business or reach that desired 'competitive edge'.

   Just as in all processes of change, support from all levels of the organisation is essential, as is the participation of an interdisciplinary team to introduce it, and the participation and training of all the staff. It is also necessary to understand and support the system, and to know how, when and why the changes are being made, and the expected benefits.

2. **Reduce or eliminate stock**

   JIT does not perceive the stock as a convertible asset, but as an expenditure that does not add any value, and represents a symptom of deficient management. JIT considers that the stock hides problems that should be solved. This expenditure can be gradually eliminated by reducing stocks and solving the deeper problems that make their existence necessary.

3. **Examples of Kanban**

   Kanban is a form of control, and one of the bases of a pull system. It consists of an authorization to produce or change the stocks. Without Kanban the system halts. A Kanban might be a container, a card, or a companion's empty glass (in a restaurant). It involves a customer and a supplier, and the aim is to satisfy the customer's needs.

4. **Design of the plant**

   The idea consists of arranging the machinery, the activities and the people in such a way as to create an optimum flow of harmonious production, thus minimizing variation and accumulation of stock. This concept, together with the reduction of the lot size (Kanban) (until L=1) facilitates both process automation and increased speed.

5. **Reducing and avoiding set-ups**

   A set-up is the overhaul of a system so that it can continue producing (changing the wheels in a Formula 1 car, changing the cash-desk shifts in a supermarket, etc). It involves a number of operations and a non-operative period. The objective is to make stoppages unnecessary, or if that is not possible, to reduce to the minimum their effect on the time and the production as a whole.

   One of the keys lies in the preventive maintenance programmes carried out by the employees.
6. Preventive maintenance

The techniques of preventive maintenance, in combination with the efforts to adapt, modify and adjust the teams, increase flexibility, reduce handling of the material and foster continuous flows.

**Definition of preventive maintenance**

Maintenance based primarily on detecting a flaw before it occurs, thus giving time to fix it without negative effects on the service, detentions in the production, etc. These checks may be carried out from time to time or continuously, according to the type of equipment, the productive system, etc. They use diagnostic instruments, non-destructive apparatus and tests, such as lubricant analysis, temperature checks on electrical equipment, etc.

**Advantages of preventive maintenance**

- Reduces stoppage time.
- Permits the study of the development of a defect through time.
- Optimises the organisation of maintenance staff.
- Verification of the condition of the machinery, whether on a periodical basis or by chance, permits the creation of a file on the history of the mechanical performance.
- Allows the exact calculation of the maximum performance time before an unforeseen problem could occur.
- Facilitates the taking of decisions with regard to a stoppage in a line of machines at a critical moment.
- Fosters the creation of internal forms of working, or purchasing of new equipment.
- Permits familiarity with performance records, to be used for corrective maintenance.
- Facilitates analysis of breakdowns.
- Permits statistical analysis of the system.

7. Reducing or eliminating defects

The automatic check on defects (Jidoka) consists of using production equipment with automatic mechanisms of carryback-carryforward which detect the defects and halt, thus permitting the cause of the error to be corrected and preventing defective products from going any further.

**Poka-Yoke.** This is Japanese for 'test-error'. The concept is simple. If errors are not permitted to enter the production line, then the quality will be high and the reprocessing will be low. This leads to greater customer satisfaction and reduced costs. One example of Poka-Yoke would be always giving back the credit card after the customer has signed the bill.

8. Problem solving

Identifying problems and solving them effectively is fundamental in JIT, in order to minimize stoppages. There are a number of tools, such as the Ishikawa diagram, the Pareto diagram or the problem-solving panel, which help the specialized teams to find the root causes of the problems and plan solutions in order to prevent them from recurring in the future.
9. Simplifying the planning

The JIT system does not aim to replace an ERP or a MRP, only to simplify it in the short term and to complement it.

In a JIT environment, where the speed is increased because the lots are reduced and the workload is levelled out so that daily production depends on what is consumed, the work orders are replaced by Kanbans.

Therefore, MRP can be used for the planning, and JIT for the execution. Bearing in mind that in JIT the Kanban of the finished product is limited, guaranteeing deliveries is based on the availability of materials and in proportion to the attainable production.

10. Involving suppliers and customers

JIT means working in a team. That is why it views the suppliers as an extension of the company, connected to the pull system (deliveries of smaller lots, on time and more frequently, in the place where they are to be used, with appropriate prices and quality).

Basically, these are symbiotic relationships which require that the supplier be solvent and trustworthy, so that he can participate in the information systems, processes involving part of the design, etc. In short, JIT means that the supplier forms an integral part of the process, that both sides understand the business (the margins available) and construct the mechanisms by which they can optimise the processes, thus reducing costs and obtaining common benefits. The increased quality lowers costs, with the result that there are greater potential benefits for both customer and supplier.

11. Accounts and transactions

Management or cost accounting is affected by JIT. When the lot size is reduced and the system is speeded up, the number of transactions increases exponentially. JIT considers that paperwork
limits speed, and is an expense that does not provide the customer with extra value. JIT requires systems that add value to the process, that are capable of portraying the operational reality of the company in a simplified way, and that provide useful information for the decision-making process.

Traditional cost indicators have focused on the quantity and rhythm of production. When the rhythm of production has to be adapted to the customer's purchasing rhythm, however, many of these become meaningless and must be reviewed.

12. Developing the ‘worker with ideas’

This idea starts from the concept that the worker performing a task is usually the best source of improvements.

It is vital to use not only an employee's hands, but his head as well. The worker has to see that 'his improvements' do not cause 'lay-offs'. JIT regards the worker's needs, such as working under safe conditions, greater autonomy, being able to take part in decision-making, becoming more valuable as a result of training, working in a team with a common known objective, etc., as just as important as the objectives of increased productivity and obtaining greater flexibility and higher qualifications in the employees, a greater commitment and a source of improvements and autonomous problem solving. In short, the worker understands that he constitutes a part of the process, that he is very involved in the system, and that he will benefit if the system succeeds in a competitive market, and he is also aware that the system will look after him.

13. Visibility, order and cleanliness

A great deal of transparency is achieved through the use of panels (Andon), which supply information about the current state of the production, including statistics that foster a simple and direct manner of coordinating the operations. In JIT plants there are visual indications of the state of the operations, and the machines have lights to show if they need assistance, or if the process is halted.

Another important aspect is the organization and classification of the materials and tools in the workplaces. Equally important is the cleaning and conservation of tools and installations, with the aim of improving the working site and conditions..

Seiri (organization): classification of materials according to the criteria necessary/unnecessary.
Seiton (order): keeping all the work materials in a specific place so that anyone can find them.
Seiso (cleanliness): keeping the workplace clean.
Seiketsu (conservation): maintaining conservation, order and cleanliness.
Shitsuke (obedience): always obeying the rules correctly so that it becomes a habit.

14. Measuring the results

We have defined JIT as a process with a series of objectives. Therefore the practice must be consistent with the desired aim, and some yardsticks lose their importance, such as the number of employees being replaced because of flexibility or training.
Most important among the main yardsticks are quality (expressed in defects per million), successful deliveries, the costs of stock (in ‘returns’ of stock), productivity, transactions, speed, etc.

CONCLUSION

This graph shows the rate of JIT techniques used in different sectors throughout a given period of time.

As the graph demonstrates, at the moment the service sector is at an initial stage, with great potential for growth. The principles of the JIT theory that had been accepted are:

- Reduction of the trade offs of performance (flexibility versus productivity).
- Pull production and flow. Zero stock.
- Elimination of activities which do not add value.
- Intensification of the focus on the customer and involvement in the development of the product.
- Delegation of power among the employees.
**ANNEXE**

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<td></td>
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<td>Reduction of stock</td>
<td>X</td>
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<td>Example of Kanban in Ford</td>
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<td>Design of the plant</td>
<td>Assembly chain</td>
<td>presentation of the plant</td>
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<td>Reduce and avoid set-ups</td>
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<td>Team leader, assembly chain</td>
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<td>Trirail check Andon Notice board</td>
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<td>Solve the problems</td>
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<td>Simplify the planning</td>
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<td>Involve suppliers and customers</td>
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<tr>
<td>Analyse the results</td>
<td>José Pérez Gómez</td>
<td>Reports on: Costs, quality, morale, safety</td>
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