Universidad de Valladolid

ESCUELA DE INGENIERÍAS INDUSTRIALES

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Grado en Ingeniería en Organización Industrial

# ERP SUPPORT FOR LEAN MANUFACTURING


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TÍTULO: ERP SUPPORT FOR LEAN MANUFACTURING

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**Resumen**

¿Puede una empresa aprovecharse de las características de los ERPs, sin dejar de utilizar Lean manufacturing? Durante este proyecto haré una introducción de ambos, las diferencias entre ellos y hablaré de cómo hay mucha gente que opina que estos sistemas son totalmente opuestos, pero veremos que lo mejor para la compañía será utilizarlos juntos. Veremos cómo trabajando con ERPs y Lena Manufacturing Unidos Podemos mejorar la productividad basándonos en juntar producciones push y pull. Por último, introduciré técnicas Lean que hoy en día son apoyadas por ERPs, y que ofrecen los proveedores de ERP al mundo Lean.

**Palabras clave**

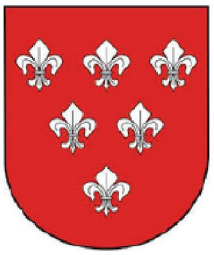
Lean, Manufacturing, ERP, Pull, Push.

**Abstract**

Can ERP and Lean Manufacturing match in the same company? During this project I will do an introduction for both of them, the differences between them and how, many people would say that these are systems totally opposites, but we will see that the best for the company is to match both and work together. On this way, we will see how ERP and Lean Manufacturing working together can improve the productivity and how pull and push production can match in a company. In addition, I will introduce some of Lean techniques that nowadays are been supported by ERP, and what can ERP vendors offer to the Lean world.

**Key words**

Lean, Manufacturing, ERP, Pull, Push.

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# ERP SUPPORT FOR LEAN MANUFACTURING

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**GREETMENTS**

To everyone from who I have learnt something in this stage of my life.

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# Contents

## 1. INTRODUCTION

First of all, it is important to introduce the relation between an ERP and Lean Manufacturing. Both, Lean Manufacturing and Enterprise Resource Planning belongs to two important fields of a company, Manufacturing and Operations Management.

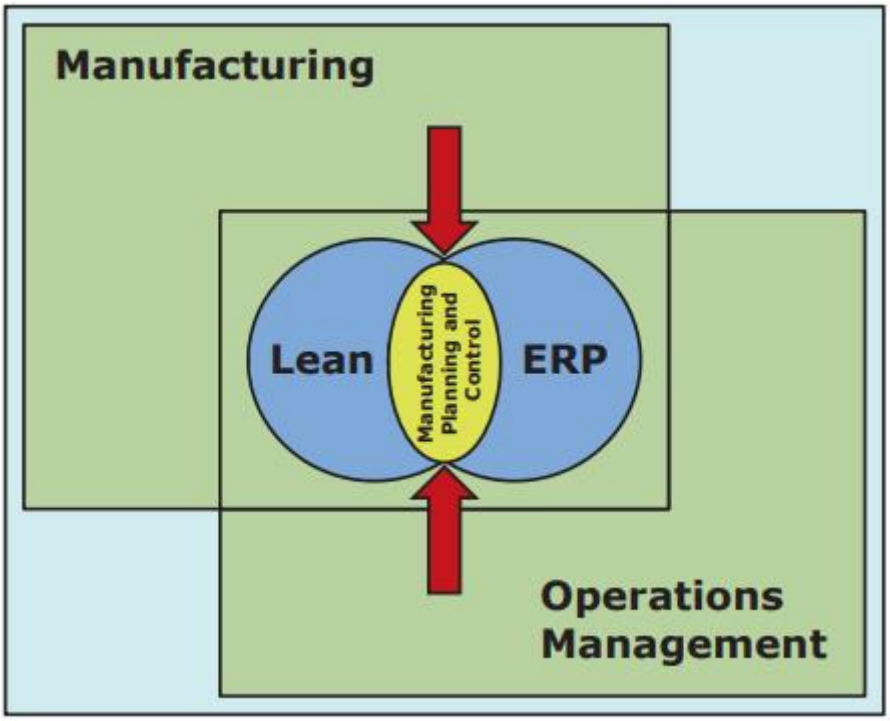


**Fig. 1. Relation between ERP and Lean Manufacturing (Powell, 2012)**

### a. ENTERPRISE RESOURCE PLANNING

An ERP (Enterprise Resource Planning) is a complex system which contains many modules in him. The finally of an ERP is to help in all the activities that a company can have. From Human Resources to Production Control or Logistics. Webopedia provides a generalized definition of ERP as "a business management system that integrates all facets of the business, including planning, manufacturing, sales, and marketing."

i. Main parts of an ERP

- Finances
- Human Resources
- Projects
- CRM (Customer Relationship Management)
- Stock Control
- Supply Chain
- Production Chain
- Business Intelligence
- Quality
- Trading

An ERP has a Central Data Base. All data are kept in common

### ii. Main characteristics of ERP systems

1. It has to be integral. All departments of the company have to be able to exchange information between them. Doing all the process in the more efficient way, without duplicating information. When we do not have an exchange of information in real time, we are going to have problems between departments, and the company will have problems.

2. It has to be modular. An ERP is divided in different modules, and each person from a company will have access to certain modules. Each company is different, so the needs of one company will be different of another company. Each company will have his own modules, and each module will be different for each company, so, there are not two ERP equals for two different companies.

3. It has to be adaptable. For the reason that each company is different, an ERP has to be able to do the tasks a company wants it to. Each company will have certain modules with certain characteristics.

### iii. Advantages

1. Improving the decision-making process. Having a common data base implies that different departments can share real-time information, and information is "power". With all this information the different departments are able to take decisions in real time doing it more credible.

2. Real planning of future situations. Having information, we can predict what is going to happen in certain situations in the future. For this reason, we will be able to have a good reaction to future problems.

3. Not having duplicities. Companies which don't have an ERP can have problems with having same informs in different departments, and that's a loss of efficiency.

4. ERP Systems are composed of different modules. Each module has a group of tasks. The modules are independent between them, but they share information for doing easy the work for the company.

5. ERP's are adapted to the company needs. All the companies are different, so they have different needs, so they can choose the modules that they want.

6. Control and traceability. From a company buy a raw material to when they send the final product, they have the control of it in every moment.

7. Integration of member of the supply chain. Now, both customer and suppliers are integrated to the company. There is an active communication between the company and the suppliers, which makes the company choose designs in new products. Talking about customers, the company is able to adjust the production to the customer needs.

8. Improving intern communication. An ERP makes easier the communication. A company with an ERP does not need almost meetings because of the sharing real-time information.

9. Tasks automation. Many repetitive tasks now are done by ERPs in many companies, saving much money in salaries and in time.

10. Reducing costs. Reducing costs mean being more competitive, and that have to be the first objective in a company. Reducing unitary cost means, increasing gains, reducing prices or both of them.

11. ROI. Thanks to all these ten advantages we could have a smaller ROI and increase cost effectiveness. So, in a large piece of time we will recover the initial investment and we will improve the gains.

iv. Disadvantages -

1. An ERP is not going to run successfully in all the companies

2. The implementation of an ERP is very slow. In a company

3. The implementation is more expensive than the software

4. A half of companies that implanted an ERP will never receive the gains that they expected. One of the biggest problems is being impatient, good results are not immediately.

v. Historical outline.

In the evolution of the ERP we can find five different steps:

1. 1960s: The ERP were created to do easier the stock's control. Many companies started using centralized computing systems to automatize the stock's control using "Inventory Control Packages" whose programming languages are almost always COBOL, ALGOL, FORTRAN. The activities of "Inventory Control Packages" included knowing inventory requirements, reach targets and monitoring item's waste.

2. 1970s: The MRP (Material Requirements Planning) was developed. At this time, the MRP had only the function of doing the planification of final products and, also, they could know the needed of raw materials based on production requirements, the inventory levels, the structure of the production.

3. 1980s: It is invented a second generation of MRP, called MRP II. MRP II continued doing the same tasks than MRP. However, MRP II had more tasks. The MRP II was made with the objective of optimizing management processes. New areas are included in this second generation, Human Resources, Project Management, Finance and Engineering.

4. 1990s: The first time we heard about the word ERP was on the late 80s and early 90s. The first ERP included all the improvements that the MRP II had and, also its integrated Distribution, Accounting, Service and maintenance, providing a great vison of the company.

5. 2000s: In the last 90s and 2000s ERP continued improving until having an extended version. These changes included Advanced Planning and Scheduling (APS), Supply Chain Management (SCM) and Customer Relationship Management (CRM).

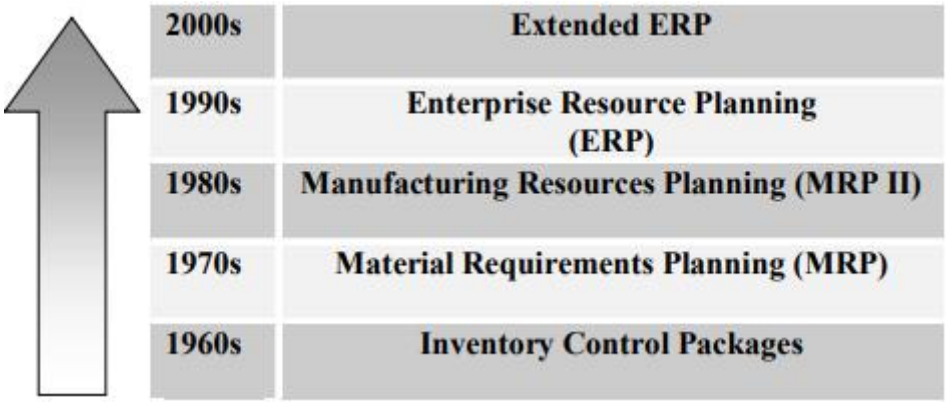


**Fig. 2. Evolution of ERP System (Mohammad A. Rashid)**

vi. Basic architecture of an ERP

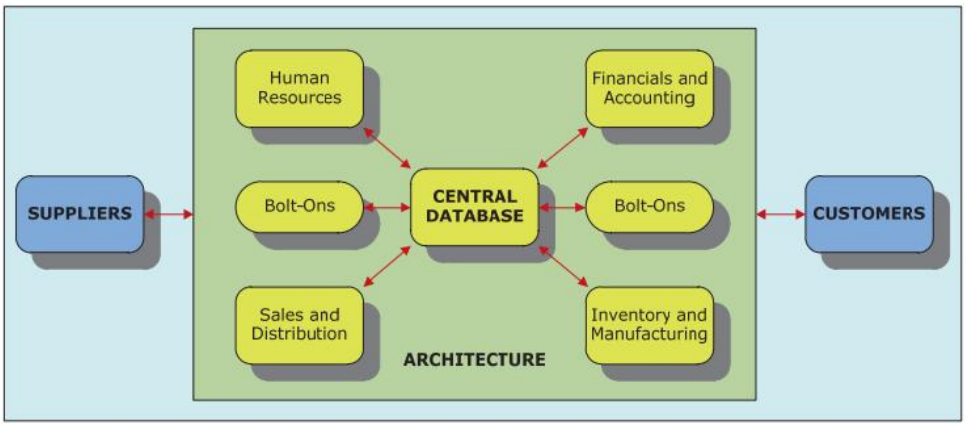


**Fig. 3. An Overview of an ERP System (adapted from Mabert et al., 2001)**

1. Distribution:

   - Activities of selling and distribution of the products to the customer. With activities like doing offers or controlling stocks.
   - It is implicated in Main Functional Areas like Commercial, Transport and Stocks.
   - We are able to know orders state, analysis of selling or invoice control.

2. Finances. It allows us to control:

   - Bills to pay.
   - Bills to claim.
   - Sources cost.
   - Treasury.
   - Payroll.
   - Financial analysis.

3. Production Planification:

   - Master Production Schedule (MPS). It is able to anticipate bottleneck in the production. It is able to anticipate the needed for next orders.
   - Material Resource Planning (MRP). It helps in deciding when the company has to ask for raw materials and components, and also it calculates when the raw materials are going to finish.

- Capacity Requirements Planning (CRP). It can calculate the workload rely to the factory in specific conditions. It allows to plan many things like overtime or preventive maintenance

4. Supply Chain Management

   Group of process related to vendors with the purpose of satisficing to the customer. The final purpose is to integer customer, vendors, factory, stocks and transporters.

5. Customer Relationship Management (CRM)

   Analysis of the selling, marketing and post selling services with the purposes of:
   a. Avoid losing customers.
   b. Increasing benefits.
   c. Increasing customer satisfaction.
   d. Increasing fidelity.

### b. LEAN MANUFACTURING

Jorge-Luis García Alcaraz defines Lean Manufacturing in his book "Lean Manufacturing in the Developing World" like: "Lean manufacturing can be defined as a combination of multiple tools to help eliminate activities that do not add value to the product, service and/or process by increasing the value of each activity, aimed to eliminate or reduce waste and improve operations.". In addition, he describes waste like: "Anything other than the absolute minimum of time and resources to add value to the product and get the highest quality". It is important to understand that Lean Manufacturing is not a goal, it is a path of improving forever. Lean Manufacturing is a philosophy of life.

i. History

Improves has been always an important part of the human life, from the discovery of the first wheel made of stone. That improves were introduced in a factory when Taylor introduced the mass production in 1900s, but it was not very important until Henry Ford in 1920s introduced the mass production in a car factory in which the cars were moving in a line while the workers were putting components to the cars creating the term "Assembly line". However, the beginning of "Lean Manufacturing" were in Japan by Sakichi Toyoda when he introduced the concept of "Jidoka". Toyoda invented a system which was able to stop a loom when one of the threads broke, with this invent he created the first machine with a little help from a human, in this way a human could take care of some machines in the same time, which made the company having less

money wasting. At about twenty years later Kiichiro Toyoda introduced the technic of JIT (Just in Time). JIT is a technic in which the factory has the needed stock, the factory asks the suppliers only the amount they need to produce certain time. Consequently, the factory has only the products they are going to sell. With this technic the factory wastes less money in having stocks.

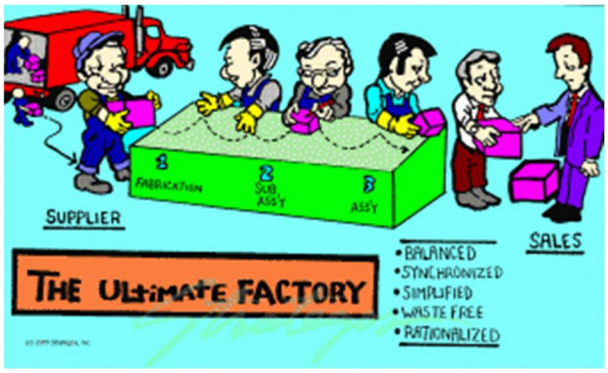


**Fig. 4. Description of a modern factory (https://comunidad.iebschool.com/innovate2day/2015/05/05/jit/)**

When the II World War finished, Eiji Toyoda and Taiichi Ohno created the "Toyota Production System" (TPS), which is a method to apply Lean Manufacturing to a factory based on technics like JIT or Jidoka. In the 1970s The TPS was extended in all the Japanese's factories and it started to translate to different languages starting with English. In the finish of 1970s Toyoda and Ohno started to do meetings around the world explaining their TPS. In 1983 TPS arrived at the first factory in United States, to "New United Motors Manufacturing Inc.". After that the concept "Lean Manufacturing" started to be in factories around the world.

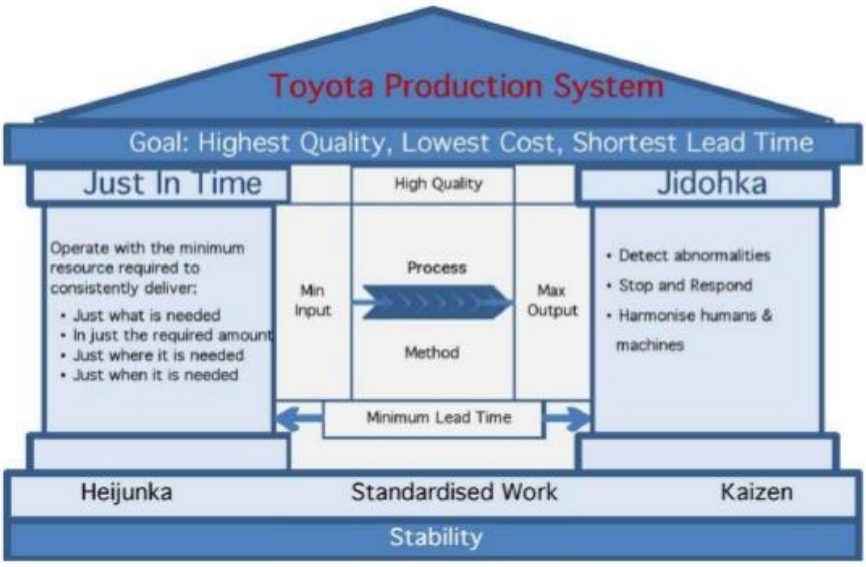


**Fig. 5. Description of Toyota Production System (https://www.scoop.it/t/manufactura-esbelta)**

ii. Values

“It is not solely the automobile industry that has been experiencing changes in operational practices. In fact, nowadays all industries exposed to global competition and changing technological possibilities are facing similar pressures to transform their practices in ways that are better attuned to the changing environment” (Kochan et al., 1997).

We use the fundamental principles of lean manufacturing identified by Womack and Jones (1996): “precisely specify value by specific product; identify the value stream for each product; make value flow without interruptions; let the customer pull value from the producer; and pursue perfection” (Hines, 2010).

- “Value”, for the customer’s point of view.

  “The critical starting point for lean thinking is value. Value can only be defined by the ultimate customer. And it’s only meaningful when expressed in terms of a specific product (a good or a service, and often both at once), which meets the customer’s needs at a specific price at a specific time” (Womack and Jones, 1996 p.16). The problem that we can see in many companies in that the immediately needed of the shareholder and the thinking financial-economical of the directives are above tan creating value for the customer, and the customer has to be the first thinking for a directive. It is interesting how Womack and James described how in Germany not so many years ago who decided how much value had a product from a company were the engineers of the same company. Many times, that was a disaster because the things they designed were not as popular as they though. In addition, the airplane’s companies many times has big airplanes to move thousands of people in large distances, when many people only need to go from one city to another n the same country. To sum up, knowing the real value of our product or service is the best way to have a satisfied customer.

- Know the “value-stream” and eliminate wastes.

  “The value stream is the set of all the specific actions required to bring a specific product through the problem solving task from concept through detailed design and engineering to production launch, the information management task running from order taking through detailed scheduling to delivery, and the physical transformation task proceeding from raw materials to a finished product to the hands of the customer” (Womack and Jones, 1996 p.19)

  Attending to Womack and Jones the value-stream has three different stages:

  - Stage of problem solving: From the fist idea, the design of the product to the start of the production.

- Stage of the management of the information: From the request of a customer of a product, the send to the arrival of the product.
- Stage of physical transformation: From the raw material to the final product arriving to the customer

Studying the value-stream of a company can reveal us a big quantity of "Muda"

- Make value flow.

  "Once value has been precisely defined, the value stream for a specific product family fully mapped by the lean enterprise, and obviously wasteful steps eliminated, it's time for the next step in lean thinking…make the remaining, value-creating steps flow" (Womack and Jones, 1996 p.21)

  Womack and James wanted to point in that flow production is always more rentable than production by steps, first one operation, later the other ones for an amount of products

- Working with a pull system.

  "Pull in simplest terms means that no one upstream should produce a good or service until the customer downstream asks for it" (Womack and Jones, 1996 p.67)

  Working with a flow system have done that the products which took years in being designed now it takes like months, the orders that took days in being delivered now it takes like a few hours, activities that in the past took years and months in physical production now, it takes days or minutes.

- Improvement has to be continuous.

  "As organizations begin to accurately specify value, identify the entire value stream, make the value-creating steps for specific products flow continuously, and let customers pull value from the enterprise, something very odd begins to happen…suddenly perfection doesn't seem like a crazy idea" (Womack and Jones, 1996 p.25).

  Applying the last four principles, the company will see that there is no limit in the reduction of effort, time, space, cost and failures, while they are offering a product which is nearer to the real value for the customer. The perfection is not as far as the company thought.

iii. Objectives

Lean Manufacturing is a management method to reduce wastage in the production of something or in offering a service. This wastage is called in Japanese with three words Mura, Muri, Muda:

- Mura: Any irregularity in the production. When the factory has a “Mura” the system is not in balance.
- Muri: Muri means overload. If the factory is doing any no needed activity. Probably if the factory had an overload it would be bottlenecks or breakdowns. A factory can avoid it if they standardize operations.
- Muda: Muda means waste. Any consumption of resources without increasing the value of the product for the customer.

iv. Tools

For archiving the objective of the customer satisfaction, a company should use the next tools:

1. 5S’s

The tool of 5 S was invented by Hiroyuki Hirano in 1960 with the purpose of keeping the working place well-organized and cleaned for having a better working environment and improving the production, doing it more efficient. Finally, the 5S’s technic is a method for engaging the workers with the company objectives and having a stronger company culture. The 5S are:

- Classification (Seiri): Place all the materials for their use and take no-needed materials out of the working place. Advantages:
    - Having additional space.
    - No having no-used materials.
    - Decreasing non-value movements.
    - Decreasing the waste of time in stocks.
    - Decreasing the waste of materials.
- Order (Seiton): Place the needed materials organized. Advantages:
    - Decreasing searching time.
    - Decreasing changing time.
    - Occupying less space.
    - Avoiding interruptions in the production.

- Clean (Seiso): Keep the working place cleaned, deleting all the dirty sources. Advantages:

    - Increasing worker's motivation.
    - Increasing the life of the tools.
    - Increasing the quality of the production.
    - Increasing the satisfaction of the customer.

- Standardize (Seiketsu): Each material has to be on its position. When the worker has the perfect location for each material, he has to keep it, if the worker changes the place, that will not be as good as it could be.

- Keep (Shitkuse): The most difficult and important step. The worker has to keep the work place like the standard if not, 5s will have not any advantages.

### 2. KAIZEN

Kaizen is not a tool at all, Kaizen is a philosophy of "continuous improvement". It requires that all employers engage with the company and they look for new ways to improve production and decreasing wasting of materials. It is very important to know very well the objectives of the company. One difficulty of Kaizen is to keep the positive attitude in the working environment.

Kaizen has three important statements:

- Thinking People System:
- 5 Whys: Analysis method based in doing five questions to study the cause-effect relations. The final objective is to determinate a defect root to solve a production problem.
- 5S

### 3. POKA YOKE

A "Poka Yoke" is a quality tool which is used to avoid mistakes in manipulation a system. A well-known example could be an USB, introducing an USB into the computer you can only put it in one position, because it will not entry if you try by the wrong way.

It has two mean objectives:

i. To avoid having human mistakes, for example with energy connections.
ii. To understand that something is wrong in one way for the worker.

## 4. JUST IN TIME

Just in time is the main element of the "Toyota Production System". Sugimori et al. (1977) defined JIT like a method which allows "all processes to produce the necessary parts at the necessary time and have on hand only the minimum stock necessary to hold the processes together" and Sugimori explained JIT with three characteristics:

iii. Levelling of production (Heijunka)

Heijunka is a Japanese word which means smoothing of the production program using like reference the production volume and the different products made in a determinate time.

It is a great way to deaden the variations of the demand producing some products in the same production line working in small batch.

One method to apply it is Heijunka's box by calculating the cycle time, how much time it takes to make an item.

iv. One-piece production and conveyance

The second rule of JIT explains that while we are producing an item, we should be conveying another one for not having stocks and for not having machines without use. Obviously, that only can be used when the time in set up is almost zero.

## 5. KANBAN

Kanban is an information system based in cards, which controls the quantity and the time of the production of needed products in each process inside and outside the factory

The Kanban cards are like witness in the production process. The workers stuck them in the material's containers and they take them off when the container is used

The main types of Kanban are:

- Production Kanban: These cards are production orders. The main information they contain is, the production center, the

item, the number of pieces and the place where it is going to be stocked.

- Transport Kanban: These cards order a material transport to a working place. These cards contain the item, number of pieces, number of orders, working place.
- Supply Kanban: Theses card rely the reception center of the raw material with the production center.
- Urgent Kanban: In the case of a great necessity of material.

The items must be transported in a container.

The Kanban cards have to be taken until a special box for them.

v. 6 Wasting types

1. PRODUCT DEFAULTS
    a. Reprocessing products
    b. Wasting raw materials
2. OVERPRODUCTION
    a. Wasting energy and workforce
    b. Excess of stocks
    c. Hiding production problems
3. NO-NEEDED PROCESS
    a. Great increasing of costs
4. NO-NEEDED WORKER'S MOVEMENTS
    a. Stopping the production line
    b. Movements without increasing product value
5. NO-NEEDED OBJECTS TRANSPORT
    a. Store up in intermediate deport
    b. Too much manipulation
6. WAITS
    a. Avoiding take advantage of resources
7. STOCKS
    a. Hiding production problems
    b. Hiding efficiency
    c. Hiding capacity problems
    d. Increasing financial cost

vi. Lean Steps

The Lean Philosophy can be understood from different points of view. On the one hand, the different tools can be applied in isolated processes, or else it can be used as a complete system already defined in the strategic plan of the documentation center or library. There are no

standardized laws of the techniques that form Lean, much less those that should be applied in the field under study. It is a very flexible methodology that adapts to different situations and types of organizations. Once the management has become aware of the need to implement the Lean system, employees will be informed of its start, and then proceed with the diagnosis of the organization. The stages that maximize the value for the user while reducing waste, according to Womack and Jones (2012) are:

1. Identify the value

This point will be defined by the user, both internally and externally. The values that are going to be identified usually correspond to the strategic axes of the centers, depending on the characteristics of the organization and the Mission and Vision that it has. Different examples of values would be: promoting the library as a cultural center of reference to the user; identify and complete the bibliographic and documentary heritage of a region; develop and preserve the collection; improve the promotion of reading; or improve information, accessibility and visibility of the local section, etc.

2. Know the flow of value

Once the values of the library or documentation center have been determined, they must be measured and analyzed to know how they are developed in the organization. We must start with the needs of the client and then go backwards in the analysis of the process. The fact of finding the waste is the first step and fundamental factor in choosing the tools that eliminate it, going on to standardize the work with added value to restart the improvement cycle. It develops sequentially. You can set the stages at a very generic level in the Lean application:

- Find waste in the process.
- Once the right tools have been selected, eliminate the waste.
- Standardize work with added value.
- Restart the improvement cycle.

Some of the tools that are going to be used for this are VSM, Balanced Scorecard, or radar chart, whose explanation will be made within the tools section in the evaluation phase.

3. Set Pull

This is a production system in which only what is demanded is done. It serves to improve and control the processes and their standardization. Unlike industrial production, and similar to the management of health centers, the library has products and services that cannot be offered upon request, requiring Push management, which is performed when a

work is based on the forecasts of the demand. However, there are some processes in which Pull management can be applied and reduce significant costs, such as the acquisition of documents on demand or the creation of certain information products, such as bibliographies, etc. Search perfection It is necessary that the previous steps are repeated again and again until achieving perfection, like the PDCA cycle or Deming wheel. This tool establishes a cyclic process with the following stages: plan, carry out, verify and act. In this way, it is easier to eliminate more waste, and the more they are eliminated, the more quality products and services will have. Among the Lean tools that we can apply in this phase is Shojinka or polyvalence of workers in different processes or parts of them. If workers have a more global and complete knowledge of all the processes, they can contribute data that reduce waste and at the same time it can be useful in reducing bottlenecks. It is a tool that develops self-quality, among other advantages. For example, you can train an assistant, so that, in addition to doing functions of entry or assignment of signatures, you can do cataloging functions when in this process there is an excess of inventory, cover a position in special cases, etc.

## 2. MODERN ERP SYSTEMS AND THEIR IMPORTANCE IN IMPLEMENTING LM PRINCIPES

### a. MODERN ERP SYSTEMS

The near saturation of ERP sales in large organizations has encouraged software vendors to seek additional venues for development and growth. SMEs provide a natural fit for a new focus of ERP software development. A problem in marketing software within this arena has been the widespread focus on Lean manufacturing used by many SMEs. This problem becomes complicated since most ERP software is based on push methodologies and Lean practice revolves around pull methodologies. Software vendors have addressed this through a variety of new software modules and ERP add-ons. This in turn has encouraged additional manufacturers to adopt Lean practices and experience the synergy offered by using Lean-enabled ERP software. However, manufacturers face a variety of issues when making the transition to Lean. Although the primary question, can ERP software be used to support Lean has been answered by a variety of organizations with their software solutions (See table 1), many Lean purists believe only visual signals and shop floor implementation provide a true implementation of this philosophy and the added functionality of ERP flies in the face of basic Lean premises. Others believe ERP systems provide additional transactional foundations and historical data collection and analyses that can further improve Lean practices. Added then are benefits associated with having business software integrated and tied to the same database. ERP vendors are competing with best-of-breed software vendors to understand and offer solutions to support best practice implementations of Lean production (Michel, 2002). A Lean-enabled ERP implementation must necessarily include a variety of new modules, procedures, practices and toolsets to add new functions to existing ERP software (Nakashima, 2000). These modules often include: value stream analysis, value stream mapping, lean engineering, lean material flow, line design and sequencing, backwash capability, kanban management, and others. A variety of software packages and functionality have emerged. Table adapted from Halgeri (2008) provides a glimpse at these crosses referenced with the three vendor solutions this article explored in more depth. Certainly, the future of ERP systems will include more Lean-enabled tools and continue to capitalize on the synergy derived from the using best Lean practices within an environment of automatic data collection and access. SMEs will continue to derive benefits from appropriate scaled versions of ERP systems without losing their edge in terms of nimbleness and ability to react to their customers' needs. Larger organizations will gain greater access to the methods developed in smaller organizations and will find closer links and better communication along the entire supply chain possible. More ERP vendors will add Lean tools and continue to improve those already in use.

| Lean Initiative | Oracle Flow Manufacturing (Turbide, 2005) | TTW's Winman (Wheatley, 2007) | Pelion systems Demad Flow (Bragg, 2004; Pelion, 2008) |
|---|---|---|---|
| *Analysis Tools* | √ | - | √ |
| *Mapping Tools* | √ | - | √ |
| *JIT Procurement Support* | √ | √ | √ |
| ***Kanban Control*** | √ | √ | √ |
| *Sequencing* | √ | √ | √ |
| *Demand Smoothing* | √ | √ | √ |

**Table 1. Comparation between suppliers of ERP Systems (Halgeri, 2008)**

Powell et al. (2012) wrote about the ways in which ERP's were going to improve. They were:

i. Reduction in cost and implementation time

Nowadays all companies are continuously looking for ways to reduce wasting money. ERP helps in nine ways:

1. Implementing an integrated solution

The ERP keeps all the data in only a single platform, providing access to the workers and improving communication between workers. The ERP is flexible too, it can change for each business depending on the needed. Improves the workflow.

2. Automating and standardizing the operational processes

Having an ERP which does its tasks automat avoid us having human mistakes than doing it manually. Automating all the process allow the company to improve the productivity

3. Improving the purchasing process

Only with a little mistake an employee can cancel a big purchase, for that reason is important not to have mistaken because it will affect to the relationship with the customer too. With an ERP an employee can easily generate purchase orders.

4. Track costs in detail

With an ERP the employers can see every moment the actual cost of their products and If the company is going well with the budgets. Also, budgets can be structured in many ways, geographical, departmental or in projects.

5. Optimize stocks

Stocks are one of the main problems in all the companies. It is important having stocks, but it is a waste of money. With an ERP the company will have very much control in their stocks than not having it.

6. Manage warehouses more effectively

An ERP facilitate the communication between Headquarters and warehouses, also, the space will be used better, which is a really good advantage.

7. Improving the analysis and reporting process

Nowadays Business Intelligence is introducing in the ERP world, which creates a great advantage in analysis providing an overview of all the costs the business generates.

ii. Consolidation

Nowadays it is normal to for a medium-big company to work with an ERP System, the more well-known systems are SAP, Oracle, Sage or Infor. That systems are getting more and more important for the companies. The ERP is well consolidated in nowadays market, but in a few years, it will be more if it is possible

iii. Vertical solutions

One big difference between traditional and modern ERP's is that traditional ERP's are very static and not easy to fit with all the companies. The traditional ERP's only had "horizontal attributes", these attributes are the main part of the ERP, like finances, human resources or supply chain. However, Modern ERP's include vertical attributes for specific industries like manufacturing, distribution or retail.

iv. A move towards SMEs

The suppliers of ERP are not having big earns with big companies. The suppliers of modern ERP's are focused in Small and Medium companies. SMEs market is being bigger and bigger, and they are buying more and more ERP's systems.

v. Customizable ERP

Modern ERP's are being more and more flexible, traditional ERP's were not customizable, but now, each company have a different ERP depending on their activities, employees, products or suppliers. In addition, modern ERP's modules can be added or deleted in the company's life easily.

vi. Collaborative ERP

One of the main characteristics of ERP is the share real-time information between all the departments in a company. Traditional ERPs were not as collaborative as modern one, which was very important to improve. Finally, if an employer is going to take an important decision, he has to have all the information of the company in real time.

vii. Software as a service (SaaS) and Cloud Computing

Nowadays, a great improvement of ERPs is that all the information is keeping in the Internet. That is a great advantage because having a data base all the employees can upload the data, and if the company suffer any problem, the data is still in the data base. However, there are not only advantages, when I was working in Spanish' company which worked with SAP one day all the internet went down, and the factory was a chaos, the product went out without identification, there were not a quantity control and many raw materials were wasted.

viii. Web-enabled ERP

Web-enabled is a great advantage to the company's stakeholders who can access to the company information whenever they want by the Internet. The real definition is "Web enabled refers to a product or service that can be used through, or in conjunction with, the World Wide Web. A Web-enabled product may be accessed through a Web browser or be able to connect to other Web-based applications in order to synchronize data."

ix. Mobile ERP

Nowadays it is very common to work out of a work place, home, travelling. ERP for mobiles is helping to manage a company wherever you are with a mobile phone, in which you can do the same work you would do in your work place at the factory. That advantage it is doing vendors to earn lot of money, the companies want the most facilities they can do to their employers.

x. Real-time ERP

I have talked many times about the importance of real-time information, to take important decisions, to have a general view of the company and even to control the work of the employees. Having this make modern ERP have a great advantage from traditional ERPs

## b. WHY IS IT NECEARY TO IMPLEMENT LM PRINCIPES?

### i. Push systems

The technique that an ERP uses to do a control of inventory is Push technique. Push technique consists in forecast the inventory needs predicting the company's customer demand. The company has a team of demand planner who are studying the market continuously. The demand planner looking at the demand of lasts months, the time of the year and having a safety percentage of demand is able to create a forecast of the demand for next months with what the company is going to work. Many customers do not ask for products until two or three day before receiving it, so if the demand forecast is wrong the company will have a very big problem. Sales many times are unpredictable, also they are changing very much between the season of the year, the month and also the week. Push systems have another great disadvantage, because of the unknowing demand, the stock of raw material and products have to be as much as necessary, which is a very big waste of money. The advantage is that, having the enough stock is very difficult not to serve a customer when they want.

As a personal experience, I have been working in a Spanish company called "Grupo Siro" as supply chain technical. That company works only with one company, supermarket company suppling baked goods, the supermarket is one of the most-known in Spain and it has a very strict treat with the suppliers. They told my company the orders with two days to product it. In my company we worked with an ERP (SAP) but, when a mate was in holidays, I had to do some demand planner tasks. Each month, the demand planner of the factory did a forecast for the next month, with this forecast all the factory worked. My supply chain boss asked for raw materials looking to the demand plan, so if there was a problem with the demand plan or we were wasting many raw materials there was situations in which the production had to stop because of the lack of raw materials. That stop of the production were a big waste of money and I saw more than three times. These stops of productions were very dangerous because one or two times my company fail a customer order, and that is not good for the relationship with the customers

To sum up, push systems could be a good option if the company is working in a market in which the demand is very similar between months because if not, the company will have to have a lot of inventories, production stops and in the worst case the impossibility of serving to the customer.

### ii. Pull systems

A pull order system seeks to receive products only when they are really needed while trying to reduce existing inventory to the maximum. In the Toyota model,

under the pull systems is the ideal state of just-in-time manufacturing: deliver the customer what they want, when they want it and in the quantity they want.

An example that we have all seen from a pull system are the majority of supermarkets. These have a small amount of inventory in an interior warehouse based on historical purchases and predictions of future demand. Customers are consuming the products they want from the shelves of the "visible" area of the supermarket and a person in charge of the replacement goes over time to time to see what products are missing and replaces them from the interior warehouse. So far everything seems logical, however, the key to the system comes with the following. The worker not only worries about filling the shelves, he asks the supplier for the products too, he has used to fill the shelves so that daily (or more often according to the supermarket) the supermarket receives exactly what customers have consumed. A clear example of a pull system.

Toyota's system works in a very similar way to this example. It is not a completely null inventory system but depends on small controlled warehouses that are filled by a pull system. These small inventories, despite the fact that the lean philosophy seeks to eliminate them, are necessary due to the natural interruptions of the flow from the transformation of raw material to the finished product.

This seems simple if we think of a supermarket in which a worker does not take more than a couple of hours or three hours to go through all the shelves scoring and replacing what customers have consumed. However, when it comes to large factories where suppliers may be located far from the production line, a system is needed to indicate when a piece has been used and what type it was. At this moment is when the so-called cards (containers, cars, ...) appear a Kanban.

A Kanban card is the signal that indicates that you have to fill a piece or a set of pieces that have been consumed, but I will talk about it in more detail in the next entry, for now we are left with what is the method that allows us to manage a pull system.

iii. Comparation between pull and push

| Lean | ERP |
|---|---|
| Production based on consumption (Pull) | Production based on forecasts and machine utilization (Push) |
| Decentralized control & empowerment (Bottom-up approach) | Centralized planning and control (Top-down approach) |
| Rate-based, mixed model production | Time-phased, batch production |
| Focus on maintaining flow | Focus on tracking material movements |

**Table 2. The Lean-ERP paradox (Powell and Strandhagen, 2011)**

1. Pull vs push: ERP vs lean

Now that we know what Pull and Push is, we know the management of an ERP and the management of Lean, we are going to compare them, we are going to see which characteristics can help between them. First of all, it is important to know that both of them are tools with what a company wants to take advantage to their competitors. However, ERP systems have been regarded as tools with what the company is wasting resources. Nowadays, the ERPs are used to improve the manufacturing planning, in this way lean manufacturing can help, because the target is the same. However, the question is, when we want to eliminate non-value-added actions should we use ERP, Lean or both?

Benton and Shin (1998) said that "there is a common agreement among researchers that a lean, kanban controlled production system functions as a pull system, whereas those systems using MRP logic are predominantly push."

Rother and Shook (2003) said that "to qualify as pull, parts must not be produced or conveyed when there is no kanban, and the quantity produced must be the same as specified on the kanban."

Olhager and Östland, (1990) said that "When defined in terms of information flow, in a pull system, the physical flow of materials is triggered by the local demand from the subsequent customer. On the contrary, a push system uses global and centralized information stored within the central ERP system in order to drive all production stages." Reading Olhager and Östland we can find another big difference between ERP and Lean. While ERP suggest a centralized information control

There is another way of thinking that ERP systems are not capable to control in real time the production.

Reading all these authors we can take one common thing in their thoughts. The ERP systems are systems made for working in a medium-large period of time, for example with the raw materials, the company has to take the control for minimum one-week production, because if not, it could be that they will not have enough raw material for the production. While the ERP is a medium-large planning, Lean Manufacturing is a short time solution, it is continuously searching for the best way to produce and applying it as soon as possible.

2. Bottom-up and Top-down

Top-down and bottom-up methods strategies of information processing and knowledge ordering are two different ways to control stocks. Instead of both methods are really different, both have the same target, identify when the stocks are bigger than they should be.

The top-down is a method with what the company focus on the market characteristics They will also look at the performance of sectors or industries. These investors believe that if the sector is doing well, chances are, the stocks in those industries will also do well.

Top-down investment analysis includes:

- Studying the growth of the market in which the company is moving.
- Monetary policy.
- Inflation and the price of commodities.
- Bond prices and yields.

The bottom-up strategy focus on little pieces together to create more complex systems investing. They will focus less on market conditions, macroeconomic indicators, and industry fundamentals.

Bottom-up analysis focus includes:

- Financial ratios, current ratio, return on equity, and net profit margin.
- Earnings growth including future expected earnings.
- Revenue and sales growth.
- Financial analysis of a company's financial statements.
- Cash flow and free cash flow.
- Management's leadership and performance.
- A company's products, market dominance, and market share.

The bottom-up approach invests in stocks where the above factors are positive for the company, regardless of how the overall market may be doing.

3. Rated-based model & Time-phased mode
4. Maintaining flow & Tracking material movements

iv. Hybrid System Pull Push

These production systems that combine both push and pull characteristics are called hybrid systems. Describes the push and pull systems as operational paradigms. In a push system, a machine produces parts without waiting for a request to the next machine. On the other hand, in a pull system, a machine produced only after receiving a request from the previous machine. It was widely accepted that pull systems are better than push systems. Generally, pull systems reduce or eliminate ongoing work, while the push systems incur buffer stocks leading to higher operational costs. Think that every system is characterized by the information used to make it work. They conclude that in a deterministic world, a push system is based on forecasts and anticipated events

motivated by considerations of effectiveness. Centralized control of ERP system uses global information essential for this mode of operation, which will dominate a pull system using only local information. Pull is reflected in more decentralized and participatory management, while providing a better service, but a higher cost in a world where random events occur. Finally, pull is a common concept in Japanese environments (Kanban) and push is considered an American approach (MRP). The concept of ERP systems is based on best practices, providing a mechanism for the standardization of business processes. These motivations and benefits are clearly aligned with the principles of Lean. In addition, many companies are now using Lean approaches based on ERP to communicate the request through the supply chain to facilitate the just in time delivery. For example, Nissan Motors (UK) communicates its demand for carpets to its supplier electronically; the supplier then produces products to the specification and the correct sequence and delivers them directly to the production line in 20 minutes. Unsurprisingly,

## 3. SOLUTIONS IN ERP SYSTEMS THAT CAN SUPPORT LEAN MANUFACTURING TECHNIQUES

While a business can implement lean initiatives without aid of an ERP system, doing so may not optimize key processes:

Lean is designed to eliminate waste across the board, from labor to raw materials and equipment capacity. ERP can support these efforts by accurately predicting production trends, allowing manufacturers to review analytics and accurately project anticipated production spikes, staffing needs, machinery run times, and needed inventory.

Manufacturers have to be at the top of their game to stay competitive in crowded markets. One-way companies choose to do that is by installing an enterprise resource planning (ERP) application. ERP can help organizations improve operations and stay competitive, even when competition is tight. Here are five ways in which an ERP can help Lean Manufacturing to reduce wasting.

### 1. Improving Inventory Management

There are two types of management inventory. First, there's raw materials management—the processes that go from the reception of raw material until the raw material is used. In addition, there's product inventory—the products that are produced through the manufacturing process and how they are moved to customers. The right ERP application can help on both types of that inventory equation by advising to the company when they have to ask for raw material for the manufacturing process, for not having less raw material than the needed and that the production levels are correct, and the levels of product are enough to satisfy customers.

More than half of all new businesses will fail within the first five years of setting up operations. A further 30 percent of the businesses will not enter their 10th year of operation. While there are a significant number of reasons for businesses to fail, one of the most striking, and avoidable, reason is poor inventory management. Companies unable to manage their inventory either have too much of a stock in one place or not enough where there is a demand for it. They could also be saddled with excess inventory and not be aware of it.

However, this is one reason that can easily be avoided by simply having an ERP solution in place to manage inventory. The following are the different ways an ERP helps manage inventory:

- **Tracking**: The right ERP solution will track inventory levels throughout the organization, irrespective of the number of facilities you have. Take the example of a company with multiple locations across the country. Implementing an ERP empowered their sales teams to access centralized inventory control to check for stock levels across various locations. So even if they were not carrying a particular product, they could still close the sale and get it delivered to the client from the location it was available. Additionally, you can track expenses and profits related to inventory sales using ERP, providing you with actionable financial data.

ERPs are a very efficient method to improve the tracking. However, there are a lot of changes to do in ERPs to improve tracking. These are some examples:

- Link Customer Orders to Production Orders and Raw Materials

Many ERP systems do not provide a direct link between customer sales orders and the associated work order or job. This link is vital in providing a view of the manufacturing process and potential purchased parts necessary to satisfy each and every customer order. When I was working in my company last summer, the orders arrived at the logistic department two days before the product sending. That order was put into SAP, and then SAP created new necessities. In my opinion, the process was very wrong, if a worker forgets to look the necessities, or introduces wrongly the orders, the production will be wrong, and the company could fail an order. If the ERP receive the orders and on his own creates the production orders and we can avoid the human mistake.

- Digitize Your Tooling Inventory

Tooling is a critical input to most production operations, and most ERP systems ignore it when it comes to work scheduling in production operations.

Simply putting tooling in a separate desktop database or a spreadsheet doesn't cut it when it comes to improving work scheduling.

- Be Clear About Priorities

The best way to manage work scheduling effectively is to be sure production priorities are clear. Prioritize work orders needed to fulfill customer demand over orders that are supporting forecasts.

Most ERP systems at best provide loose links between shop orders and customer sales orders, making it hard to keep priorities in line with customer expectations. They also make no distinction between production orders released to fill forecast and those needed for actual customer sales order demand. Relying on paper routings makes it difficult for shop personnel to reorganize the floor part sequencing with changes in due dates that reflect the constant changes in demand. In addition, the infinite MRP planning used by most ERP systems almost guarantees you will have orders that aren't required for immediate customer demands, but it will prioritize them over other orders with real demand.

A solution can be using both forecasted and actual demand, but actual demand (Customer Sales Orders) can be linked to finished good jobs for clarity of resource usage and visibility to expected due dates. And it schedules shop orders based on your factory floor constraints (machines/shifts/tools/labor) for realistic schedules that help maximize revenue and on time delivery to customers.

- Simplify Setups Whenever Possible

The best way to minimize downtime whether planned or unplanned. You already know that keeping up with recommended preventive maintenance schedules will help but simplifying setups can help by getting the most production process "performance" time out of your equipment on a shift-by-shift basis.

One of the best ways to simplify setups is to run jobs with similar setups consecutively so that you can take advantage of the common raw materials and/or tooling and setup elements already in place. It's extremely difficult to sequence jobs manually, and most ERP systems don't even try, and it a great improving way.

- Cross Train

It's wasteful to have a job already to go only to discover that you don't have a skilled operator available to run the job. Even if your ERP system allows you to put a skills code on a routing step, most don't do anything with the information when it comes to scheduling.

It is important to understand that operator skills are required input to an operation, and real-time labor reporting will help provide visibility into operator availability as the shift wears on.

A cross-training program helps improve quality, operational flexibility and employee loyalty. Employees enjoy learning new skills, and your most skilled operators can be energized by teaching newcomers or rising stars.

- Implement Scheduling Software the Right Way

Scheduling software should be implemented with a production tracking software, such as, a MES. It will increase the effectiveness and improve the productivity on your shop floor by enhancing visibility through the real-time labor reporting and improved visibility. In addition, these solutions help increase schedule accuracy because they can schedule to much finer increments than ERP scheduling solutions, which usually have a day or a shift as the smallest schedule increment.

- Reports: ERP generates real-time accurate and thorough reports on inventory levels, purchases and accounting. This enables your staff to maintain optimum inventory levels based on actual demand. It takes the guessing out of ordering supplies.

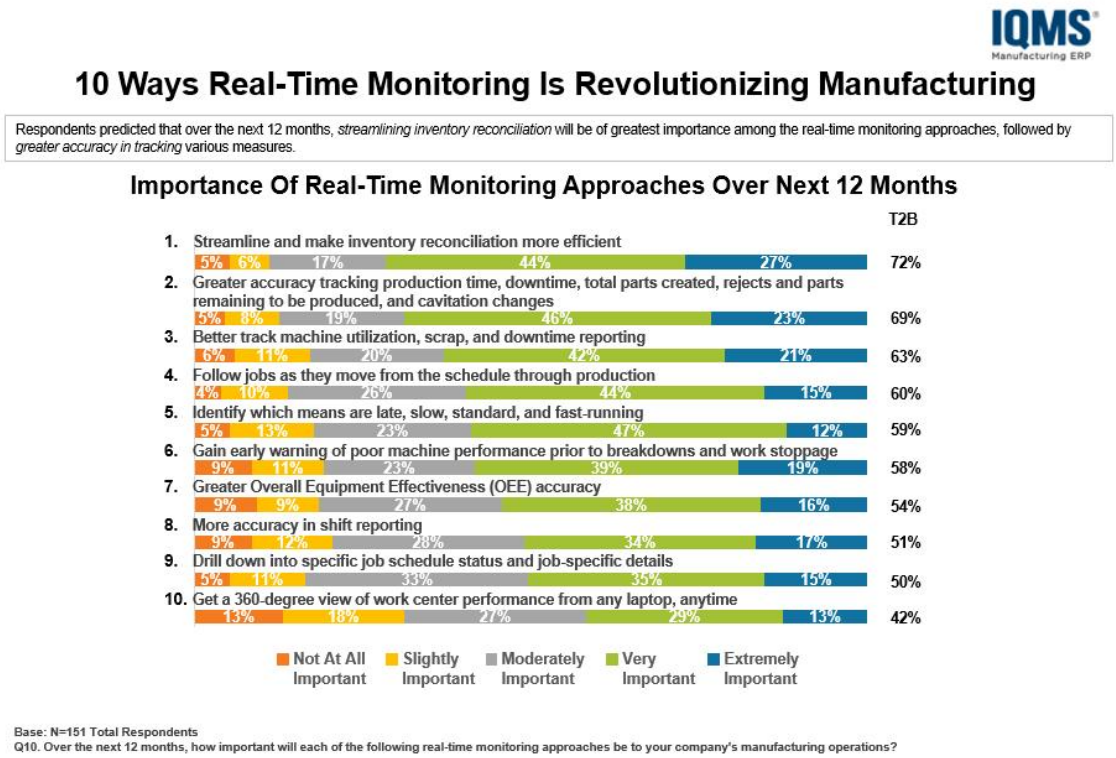


**Fig. 6. Importance of Real-Time monitoring (https://erpblog.iqms.com/real-time-monitoring-revolutionizing-manufacturing/)**

- Shipping and Logistics: The shipping process is streamlined from receipt of materials to manufacturing, transport, storage and delivery of products. ERP also records the time and costs associated with storage and transportation. This automation saves you time and expenses while increasing efficiency of your resources and maximizing staff time.

**Characteristics of ERP which are important to the transport**

With transportation management in ERP, you can accurately forecast demand and shipment volumes, enhance freight management, consolidate orders, maximize the return on your transportation spend, and gain real-time visibility into domestic and international shipping across all transportation modes – basically achieve all of your transportation goals. Let's look at some key features:

- Requirements management
  With transport management in ERP, you can simplify the requirements management process by integrating the processing of your transport orders with the cash order and order to payment processes and obtaining the required visibility. By centralizing transportation management requirements, you can reduce redundant tasks and concentrate on value-added activities.

- Optimize shipments

Plan, consolidate and optimize shipments while considering restrictions, costs and penalties. Address the requirements of international trade and restricted asset management and reduce expenses while maintaining the required levels of customer service.

- Carrier Booking
  Collaborate with carriers, reserve capacity for shipments, change reservation confirmations and shipping instructions, and better coordinate transportation activities. When delivering orders to one or many operators, you can choose the preferred supplier for your shipments based on optimization and classification techniques.

- Effectively monitor transportation
  Manage communication with carriers, send and track freight orders and maintain the necessary documentation. The complete integration to your warehouse management system allows a faster, more dynamic and responsive logistic execution and a better handling of the load.

- Route planning
  With ERP transport management, you can evaluate a set of orders and determine the optimal transport mode, route and provider to minimize expenses within the required customer service level restrictions.

- Schedule appointments
  Check availability of springs for loading and unloading elements. You can receive notifications for scheduled appointments and avoid problems when more than one carrier arrives at a particular location at a certain time.

- Dispatch Planning
  ERP transport management helps in effective planning for shipment; You can send material from multiple sales orders and achieve the flexibility to plan the shipment and load effectively.

- Financial support
  With ERP transport management, you can easily and efficiently manage the actual cash exchange between your company and cost or revenue centers, such as freight billing and accounting, reduce errors in paid invoices and guarantee qualifications. more accurate freight.

- KPI identification
  With ERP transport management, you can obtain information on key performance indicators (KPI), such as the percentage of timely collection, the percentage of punctual delivery, the cost per metric, the productivity in operational or monetary terms and the percentage utilization.

- Transport Follow-Up

  Carry out the physical or administrative operation required in relation to transportation: event traceability event by event, customs clearance, billing, delivery of the shipment and configuration alerts.

- Key benefits of transportation management

  Carry out the physical or administrative operation required in relation to transportation: event traceability event by event, customs clearance, billing, delivery of the shipment and configuration alerts.

  Going one step further, let's say you have all the key functions mentioned above, and now what? Transport management in ERP can even improve the profitability of the business, by offering the following benefits:

  - Improved accountability and visibility in the transport chain. Reduction of costs thanks to better route planning and load optimization.
  - Consolidated and optimized shipments of entry, exit, national and international
  - Improved transport logistics that guarantees on-time deliveries and expected levels of customer service
  - Configuration of optimal qualification structures based on charges such as fuel and tolls.
  - Effective management of large volumes of transport and logistics data through state-of-the-art analysis and planning.
  - Easy identification of the fastest route or the cheapest rate for a shipment
  - Strategic purchase and sale of freight capacity with centralized order management.
  - Efficient management of all expenses associated with the operation of transport vehicles.

- Improvement of transport efficiency

  Since ERP transport management systems are a complicated collection of functionalities, it is important that you understand your transport process and identify the critical requirements. Next, you can select the required transport functionalities and make sure that the ERP transport management system you choose is solid in all the areas that are key to your success, and help you improve transportation efficiency.

- Inventory control: ERP optimizes all inventory control processes, regardless of the size of your business, the number of facilities or the amount of inventory. You can use ERP

to easily manage stock levels in several ways, including automating the ordering of products and materials based on pre-established time intervals or stock levels, as well as inventory analysis reports. ERP offers management functions for product recalls, as well as complete product traceability. ERP's expense and profit management capabilities allow you to track expenses and product availability over time and compare costs among suppliers. You can easily monitor prices, allowing the administration of profits and expenses in one installation, product or unit.

How can ERP technology impact inventory control? After offering process improvement services during several projects, here are three points of reflection:

- Methods to improve data entry: through modern barcode scanners or other devices that reduce data entry errors, accelerate data collection and prompt timely information and integrate warehouse data into the system ERP
- Reports in real time and throughout the company: to obtain the ability to access sales / work orders in real time, purchase orders and inventory information that would flow smoothly between the warehouse and the ERP system as they are made the processes.
- Integration with ERP, which is essential to achieve the desired future state. As an example, it is essential for the improvement of business processes to integrate the transfer of data between the warehouse and the ERP to obtain accurate and timely data for billing, payment of the purchase order and tracking and inventory management, all without manual input of keyboard data.

Ways in which ERP can improve inventory management

“Inventory control backed by ERP technology drives the shop floor, supports materials handling and is what helps drive an organization's revenue,” notes Andres Richter, CEO of ERP solutions provider, Priority Software.

ERP can help manufacturers with a wide range of inventory control functions, from parts management, bills of material and inventory counts to label printing, warehouse control, inventory transactions and delivery tracking. The effective use of ERP is what separates good inventory control from bad.

Are you taking full advantage of your ERP system for inventory? Here are five ways you should use the ERP for better inventory management.

1. Use the sensors for error-free tracking

The monitoring and manual updating of inventory and materials in the production plant is a recipe for inefficiency and inventory error. Bar code scanners linked directly to a company's ERP system are a necessity even for small manufacturers, as they automate much of the inventory tracking process and ensure accurate counts throughout the production process.

"Modern barcode scanners or other devices can reduce data entry errors, accelerate data collection and prompt timely information and integration of warehouse data into the ERP system," says Jeff Carr, founder of the company. business technology consultant Ultra Consultants.

"Where ERP technology is really increasing inventory, control is implementing sensors to 'test' the production floor, taking ERP to a whole new level of efficiency and productivity," Richter adds in Priority Software. "For example, whenever a raw material is used in the manufacturing process, dedicated sensors can alert / report the exact amount displayed."

A good example is Wisco Industries, a metal stamper and manufacturer that produces components for the food industry and that is used to manage inventory manually. The company had approximately 9,000 inventory labels and hand-adjusted inventory, a process that took more than a full month to audit completely every year. But after adapting the barcode scanners and linking them directly to your ERP system, the company has automated inventory tracking, reducing the end-of-year audit process from weeks to a few hours. An additional advantage: Wisco reduced its inventory by 20 percent.

2. Real-time inventory tracking

Real-time reports are a second way you can improve inventory control with your ERP. Now that ERP systems have moved largely to the cloud, there are new opportunities to update inventory movements in real time and also to monitor inventory through production panel panels and mobile devices.

“ERP generates accurate and thorough reports, ensuring information regarding inventory levels, purchases, accounting and employee time management is readily available,” said Richter.

If you do not have inventory visibility in real time, you are not taking advantage of your ERP technology.

3. Manage end-to-end inventory

The monitoring of the inventory at each stage of the manufacturing process not only provides greater visibility and control of costs, but also a better capacity to respond to changes in the demand for manufacturing and adjustments of change in supply. Even if you use several different systems for inventory management, you can connect them all to your centralized ERP system for end-to-end tracking and management.

“ERP improves inventory control by providing the ability to efficiently manage all stages of the product lifecycle,” says Richter. “An ERP system enables users to manage

inventory levels and maintain tight controls on inventory replenishment, minimizing excess stock and ensuring timely order fulfillment."

With end-to-end management, manufacturers can also better track production, deliveries, orders, stock adjustments, and inventory transfers between facilities.

4. Reduce system silos

A challenge for the efficient control of inventory is to manage the various silos through which the inventory passes throughout its journey from the workshop to the final consumer.
ERP can play a fundamental role in the automation of data exchange between these systems and in the creation of a centralized system or registry, which provides greater visibility and control.

Cloud-based ERP is particularly good at decomposing silos within a company and in a manufacturer's supplier network through EDI and system APIs.

"Integration with ERP is critical to achieve desired future states," suggests Carr at Ultra Consulting. "As an example, it's critical for business process improvement to integrate data transfer between the warehouse and ERP for timely and accurate data for invoicing, purchase order payment and inventory tracking and management, all without manual keyboard data entry."

Your inventory control still needs work if you do not have visibility of your supplier network and movement or inventory to the customer.

5. Accurately predict demand and replenishment

Finally, ERP can help with inventory control by predicting demand and replacement needs continuously.

"A robust ERP system with an integrated MRP (Material Requirements Planning) module automatically verifies the amount of material in stock, and via predictive analysis (also part of the ERP), a prediction can made as to when new material needs to be ordered/replenished," says Richter.

Recent advances in artificial intelligence are making these predictions more accurate than ever, and now they often include external factors such as climate and the variability of local demand in forecasts. Sophisticated, fast and in-memory simulations can combine demand, supply, inventory and production data that can then be adjusted by sales, operations and those working in the supply chain.

This forecast information can help manufacturers make critical improvements in acquisitions, storage and movement of inventory, among other areas.

Inventory control is a key component of the manufacturing process. Companies must fully utilize their ERP system to ensure that the management of their inventory is working as efficiently as the production team in their shop.

Replenishment planning: inventory management allows you to correctly plan replenishment orders. The ERP inventory management system allows you to sort the pieces, so you can order the correct quantity. An item is requested only when there is a specific demand in the exact amount to meet the demand. Another item is ordered when at a lower cost and is easily acquired. Optimizing replenishments means fewer transactions and that leads to better inventory accuracy.

Features and benefits of automated inventory planning:

- Reduce forecasting errors with seamless integration of ERP (learn more about ERP integrations)
- Spend less time validating data and more time in business operations
- Allow integrated generation of orders in multiple locations and suppliers simultaneously
- Buy only what is needed while improving service levels
- Automatically identify items in excess or will soon be in excess
- Achieve higher service levels through dynamic inventory classification
- Complete replacement according to the company's objectives.
- Generate more sales anticipating better the demand and properly storing the warehouses to satisfy the demand.
- Receive notifications of several high priority problems, including stockouts, surpluses, forecasting errors, and variations in delivery time.
- Establish objectives and automate a plan to achieve them (multidimensional ABC classification)

Organizations that use these points of inventory planning solution have:

- 3-5% increase in income and profits, through reductions in stocks and greater customer satisfaction
- 10-30% Inventory reductions - significantly reducing costs
- Faster inventory turns: significantly improves profitability
- Greater customer satisfaction: with automated service levels that help to avoid depletion and loss of sales
- Decrease in stock outflows, excess stock and lost sales: reduced costs and higher sales volume
- Increase in employee productivity: increase of 50-70% through process automation
- Better support for critical decisions: by adding an automated system that helps meet the demanding objectives of unity, income and profits

- Surplus inventory management: you can see and react to the surplus inventory in real time. There are options you have when the surplus is quickly found, and the reaction is immediate. Delay may mean that you have to discard the surplus, thus losing money.

  The inventory of surplus is when the inventory of a company has an amount in excess of what is needed, either for the development of the product or an excess of products for the established limit of the company itself. While some managers of the company will see an inventory surplus as something positive, the items they sell with an expiration date may see an inventory surplus as negative, since the surplus is essentially a waste if it is not sold on time.

    - Identification of surplus

    An inventory surplus can be defined in several ways. If the inventory has an established limit of items in the inventory, the limit can be compared with the actual quantity in the inventory. The inventory is in surplus, if the quantity in stock exceeds the limit established by the company. Another way to identify the surplus is to look at the stock space. Some inventories are full, if the shelves are stored properly. If the items are on the floor or hidden, the inventory may also be in surplus. Finally, the inventory manager can examine the inventory purchasing budget to see if the company has requested more than usual. This method only works if the purchasing budget is consistent each month and the products ordered are identical for each order.

    - The surplus as an asset

    Since the items stored in an inventory have a certain monetary value, a surplus of inventory can be considered an asset for a company. This is the case if the items in the inventory can be sold for months or do not have an expiration date. For example, electronic equipment is a positive surplus, since it can increase the overall value of inventory, which can increase the value of assets. Electronic equipment must be in demand and capable of being sold to be considered a valuable surplus.

    - Surplus as Liability

    An inventory surplus can be a costly issue, especially if the items in the inventory have an expiration date or should be used before a certain date. For example, a restaurant with a surplus of meat or dairy products cannot sell dishes with meats or dairy products after the expiration date. This is a health and safety problem for customers.

    - Handling negative surpluses

Companies that are in a situation where they have a surplus of items must find a productive way to use the surplus to avoid having a monetary waste. Many companies will use surplus raw materials to create more products and have a sale that benefits the end user. This can include buying a purchase to obtain a free purchase or simply buying products at a discounted price. The ultimate goal is to make a profit despite having a surplus.

- Reduce costs: an ERP system can help an organization avoid having too little or too much stock available and allow better management and optimization of inventory by avoiding bottlenecks, making accurate predictions, establishing reliable delivery times and accurate prices at suppliers, which ultimately results in better offers. By understanding costs and margins, a company can have a clearer picture of profitable prices and return them to suppliers during negotiations. And with historical sales volumes on hand, inventory managers can take projections to suppliers and take advantage of the best prices by backing them up with indisputable data. Companies can also identify items that can be sold through special orders or direct shipments instead of having them on the site and integrate purchase and sales information in the product data. By knowing exactly how much stock to maintain and when, companies can manage and optimize warehouse space, reducing the overhead of their inventory operations.

  An ERP system can help an organization gain visibility into the reward rates and margins of each item that remains in stock, monitor expiring and slow-moving items, anticipate future needs by reviewing accurate data on historical demands and reducing costs when comparing offers and effective negotiation with suppliers.

- One of the most important aspects of an ERP system is its ability to accumulate and produce easily digestible data throughout the organization. This allows stakeholders to harness the power of that data to evaluate key performance indicators, provide cost-to-benefit analysis, improve productivity and share information with stakeholders, suppliers, customers and staff members. This access to data can help the whole operation to develop more smoothly and combine competing initiatives into a coherent global strategy that provides optimal inventory supplies at an optimal cost.

**2. Improving Manufacturing Efficiencies**

Part of ensuring that the right materials are available for the manufacturing process is incorporating the efficiency in the manufacturing process. Lean manufacturing is no longer an option for manufacturing organizations: it is a requirement. An ERP system can help an organization ensure that the right materials are available at the right time for the projected production runs. Do you have problems with a supplier that does not meet the delivery deadlines? ERP can also help solve this problem by keeping your organization connected to a provider network that will deliver on time.

There are 8 ways in which an ERP helps improving manufacturing efficiencies:

1. Decreasing the waste of raw material

   Waste is a broad term, and may refer to materials, energy, hours of work or space. One of the biggest and most expensive waste is the waste of material. Here are some ideas to reduce it:

   - ❖ Focus on the design. The best way to reduce material waste is to use less material from the beginning. The design of parts using methodologies such as value engineering and design for manufacturability (DFM) can drastically improve performance.
   - ❖ Recycle scrap and factory returns. Even if you cannot use the recycled material yourself, you can sell it to a factory that can, turning waste into profits.
   - ❖ Optimize processes to use all available material. Could you use more of that sheet before you throw it away? Can you sharpen and reuse those tool tips instead of throwing them away? Each scrap of discarded material represents an opportunity to improve the efficiency of the process.
   - ❖ Take a look at your shipping department. The shipping materials are cheap compared to other manufacturing inputs, but their costs accrue. Kimray, Inc. of Oklahoma adjusted its shipping process and was able to reduce its expenses in fill bags by 50%, which resulted in significant savings.

2. Improve training

   There is no substitute for practical training in the real world. Take stock of your employees by training them in multiple processes; In that way, they can help each other solve problems, act as substitutes and provide relief during repetitive tasks. Also, if everyone in the factory has a good knowledge of the whole process from the beginning to the end, they will have a better understanding of their roles within that process.

3. Quantify everything

   Assign a value in points, or better yet, a dollar value, to every aspect of your manufacturing process. The costs of the materials are obvious, but take into account the hours of work, the wear and tear of the equipment and the programmed obsolescence to quantify even more the production. By assigning numbers to every aspect of manufacturing, it will make it much easier to see which areas need immediate attention.

4. Organize everything

   The organization is key to an efficient workspace. Take a look around your factory. Are the hand tools easy to find? Are waste products accumulating in the corner? All tools,

parts, materials and instructions must have a home, and each employee must know where that home is.

5. Standardize work

   Everyone has their own approach to things, but in the world of manufacturing, there is not much room for individuality. Even the simplest tasks must be standardized to maximize efficiency. Begin by making a checklist and placing it in each work area. Then, make sure that each employee who does a job in that workspace follows the checklist. This simple act can reduce downtime and improve the overall quality of the product.

6. Implement Cell Manufacturing

   Taken directly from the playbook of Lean Manufacturing, cellular manufacturing is a method to improve efficiency by grouping similar processes. The methodology involves dividing work spaces into cells and assigning to each cell a standardized set of tasks. Machines (and employees) in each cell may be able to perform a wide variety of jobs but allowing them to focus on a single job reduces downtime for tasks such as recalibration and installation of tools, while improving consistency and the quality. Cell manufacturing also requires you to consider your overall manufacturing process as a series of separate steps, allowing you to focus on opportunities to reduce waste. It also makes the quantification of each part of the process much easier.

7. Proactively manage equipment failures

   We all know that a toothbrush is much cheaper than a root canal, but not everyone brings this wisdom to the making. Preventive maintenance is the practice of carrying out maintenance tasks based on the wear program known for a particular tool. The idea is to provide maintenance before it is necessary, but not so often that it interferes with other tasks. Decide on the correct calendar by consulting tool manufacturers or considering the time between past failures.

8. Strengthen your supply base

   When quantifying your manufacturing process, be sure to observe your suppliers closely. If you realize that some always provide you with better materials, parts or tools, reward them by giving them more of your business. This is another place where quantification is useful: the price of the label is not an accurate indication of the actual cost of an entry. You may also find that customer service attitudes vary a lot between providers. To maximize efficiency, it is recommended to work with suppliers that have a customer attitude first. They will be much quicker to respond if something goes wrong, and much more willing to solve a problem, while minimizing their losses.

9. Involve your employees

   If your process is plagued with inactivity, look for answers in your employees. It is logical that the person responsible for carrying out a job has some ideas to make the process more efficient. On the other hand, it is easy for executives and management, who are used to seeing the big picture, to lose smaller improvement opportunities. It is important to open communication channels so that employees can communicate effectively in the chain, provided they have suggestions, comments or complaints.

### 3. Improving Employee Productivity

Organizations that are still trying to run their manufacturing business through the use of manual processes are likely to have high labor costs, but the same can be said of some lean manufacturers. Even in a poor environment, indirect labor costs can be a problem. A good ERP application will help organizations improve process efficiency so that less work time is required to complete the same amount of work. In addition, ERP can automate processes that were manually completed manually, releasing even more work hours that can then be redirected to higher performance activities.

While it is a convenient way to capture transactions and costs, a company's ERP system actually improves employee productivity in a number of ways that are not easy to quantify. While all improvements in productivity contribute to the ROI of investment in ERP, some companies overlook these productivity gains.

1. Improvement of communication.

   With built-in exception reports and workflow alerts, modern ERP systems help ensure fast and accurate communication when problems occur or priorities change. The system sends the sales order changes to the warehouse or workshop immediately, to avoid shipping errors or overproduction. It also notifies suppliers of changes in demand and helps teams coordinate complex projects or orders.

2. Reduced "busy work"

   Without a modern ERP system, companies are forced to use non-value-added tasks, such as matching and stapling invoices with the receipt paperwork, presenting the acknowledgments of sales orders or copying the documentation and procedures with each order of the plant.

   When these tasks are eliminated without added value, people can devote their time and attention to more productive tasks, such as improving relations with customers and suppliers. The result is not only more productive employees, but also happier employees, which reduces employee turnover.

3. Industry best practices.

   Modern ERP systems have been successfully implemented in hundreds, if not thousands, of companies. As a result, the standard business process flows integrated into the system reflect industry best practices and generally eliminate additional steps. By adopting these integrated best practices, the company often enjoys a large increase in productivity with little or no investment in business process engineering and analysis.

   This is especially important for small and medium enterprises, which should be squeezed every drop of productivity they can from their investments to compete with larger companies that have more resources.

4. Supports decisions based on facts

   Without an ERP system, employees are forced to rely on conjecture or general rules when they need to make decisions. To protect themselves, employees often spend a lot of time creating and maintaining personal spreadsheets that they expect to provide the information they need at a critical time.

   Unfortunately, unlike an ERP system, which provides the real-time status information needed with just a few keystrokes, relying on spreadsheets leaves the company without access to the latest information. As a result, employees can make suboptimal decisions. Worse still, different employees may have different information in their spreadsheets, which results in a waste of time while reconciling the variations.

5. Delete duplicate data.

   Trust in spreadsheets not only wastes employees' time in creating and maintaining data, as mentioned above, but the variations also accumulate in spreadsheets that are updated at different times, from different sources or different calculations. As a result, employees spend much of their time reconciling and coordinating their different spreadsheets.

   Even if the company relies on automated systems for parts of its business, there may be the problem of maintaining duplicate data. Customer records must be maintained in accounting systems to manage accounts receivable, and the same data must be maintained in order management systems. The same is valid for provider information. Item records and ledger account lists generally must be maintained on all systems, resulting in a nightmare of discrepant records.

   The use of an ERP system automatically provides the necessary information to all areas of the company through a single data repository. Along with the other elements of this list, it is clear that ERP improves employee productivity in countless ways.

4. **Improving Manufacturing Processes**

The dynamics of the market forces it to meet the delivery and cost objectives, while collaborating more closely than ever.

Its competitors are marketing their products faster than ever and improving quality while keeping their costs under control. To keep up with the demands of customers in a competitive environment, it must be on an equal footing or, preferably, a big step forward.

The visibility of the supply chain is key to reduce operating costs and reduce your time to market without compromising quality. This is where you can really leverage your ERP technology to increase agility and collaborative success and make a difference in your results.

Here are three ways in which your ERP can significantly improve manufacturing process:

1. Enhance your strategy with Big Data analytics

   Does everyone in your business understand and work to your strategic objectives?

   A quality ERP system can translate what happens in the boardroom into actionable directives on a unified platform. The SLA of the client and supplier, the forecast and the planning of operations can be accessible in one place. ERP can help you make informed decisions about what to produce, at what volume and when, and to manage customer expectations.

   Of course, we all like to believe that we already do, but an intelligent ERP will do all the work for you and will do it much faster than a manufacturer that is reviewing manual or legacy reporting tools. You can even include big data analysis and use those lessons to inform and feedback your strategy, thus closing the loop in the optimization of continuous operational efficiency.

   The Big Data analysis can take a large amount of information about orders, inventories, purchase cycles, supply chain reports and a multitude of other data points and convert them into clear and actionable information. A simple use case for such data could be to inform you about predictions of falling demand and, therefore, when scheduled maintenance would cause the least interruption. With the advent of IoT, you can take advantage of even more exciting developments to inform business decisions. For example, IoT allows manufacturers to communicate with their own products and learn, among other things, how and when their products are being used, if there are malfunctions and if inventory is running low in distribution centers. The successful implementation of Big Data in real time with your ERP means not only eliminating almost impossible manual reports, but also reducing the time it takes to receive vital information.

2. Automate your supply chain and transform it into a strategic asset

   The integration of a supply chain management solution in your ERP not only improves transparency between a manufacturer and its suppliers, but it can also provide its customers with greater visibility of their activities. Being able to track the status of orders, define specifications, have crystal clarity in compliance and contractual expectations can save on costly mistakes and penalties along the chain. Human error is an important factor in quality problems. By having an ERP automate multiple processes, you can eliminate many of the mistakes made in a complex chain. This, in turn, frees up your talent to devote time to the things that require human creativity and also takes away some of the less interesting parts of a job. Your ERP can not only increase efficiency, but your automation capability can help reduce labor costs and have a significant and positive impact on your results.

3. Get your products in the market faster through global access to

   Automation is not the only way that your ERP can increase a manufacturer's efficiency. To improve your time to market, all members of your supply chain need access to relevant information, such as production deadlines, lists of materials and shipping instructions. If these can be provided in real time at global locations, suppliers, customers and internal stakeholders, a manufacturer can react and adapt according to new opportunities or potential risks, such as stock control, quality problems or logistical threats.

**5. Improving Product Quality**

In manufacturing, quality is always a consideration. A well-integrated ERP system can help an organization to monitor the quality of production. If a problem arises, it is usually detected earlier, and adjustments can be made to improve any aspect of the quality that went wrong. Organizations no longer have to find out about quality problems after it's too late to do anything about it. Now, a manufacturer can detect and respond to problems before.

An ERP system is a 24/7 assurance that lean guidelines are maintained, particularly that of continuous improvement. The ongoing gathering, monitoring, and evaluation of data not only identifies quality anomalies, it builds context around the issue and allows lean practitioners to drill into cause-effect relationships and align actions and desired results in continuous improvement fashion. Repair/replace decisions can be made on initial metrics, and new data can be pulled once adjustments are made to study impact, monitor progress, and immediately react to defects or other warning signs before a run is ruined.

To stay in the game, companies need all the efficiencies they can get. They must be lean and have as few problems as possible during the design, manufacturing and distribution processes, and they must do all this while reducing labor costs and producing the highest quality products

possible. In other words, today's manufacturers must have ERP to help improve manufacturing operations.

ERP manufacturing systems provide multiple quality management tools that process, and discrete manufacturers can use to optimize their processes and deliver high quality products at competitive prices. The quality modules included in most ERP packages are fully configurable, allowing users to implement quality control functionality in a flexible manner, simply by enabling or disabling a wide variety of features and parameters. Do you wonder how an ERP system can help with the management of product quality? If so, here are five ways you can use such a system to improve the quality of your products.

1. Address variations: Manufacturing variations, ranging from ingredients, recipe and formula to variations in temperature, humidity, ventilation and pressure, can greatly affect the quality of the product. Not only ERP systems allow manufacturers to monitor and maintain variations within defined limits, but also facilitate real-time equipment monitoring, machine analysis and remote data acquisition to ensure the best possible quality. By configuring ERP systems to track all variations, send alerts before deviations exceed pre-set values, and automatically take certain corrective actions, you can expect to produce higher quality products over time.

2. Plan: The quality of the product starts with a plan. The use of an ERP manufacturing solution to develop a quality plan will ensure that all your employees follow the same route, from the acquisition of the raw material during production to delivery. In addition, new features and functions of ERP have been developed to block inventory during and after the planning phase, allowing you to reserve the necessary resources (for example, materials, documents, samples, instruments, areas, etc.) and Avoid the use of non-approved materials. Inventory. Manufacturers can also include various requirements in their plans, ranging from compliance certificates, product specifications, employee IDs and transaction IDs to other essential details to achieve a certain level of quality.

3. Ensure data accuracy: Consistently manufacturing high quality products is impossible without timely, accurate and complete ERP data. Since the final products reflect any quality problem that may arise during the manufacturing process, capturing and synchronizing the information as accurately as possible, while adding new data, is essential to ensure that it meets certain quality criteria and regulatory standards. Thanks to advanced ERP systems, collecting and accessing accurate and sufficient information is no longer a challenge for manufacturers.

4. Manage documents: when it comes to product quality, document management is another important aspect. The manufacture of ERP packages allows users to attach files to projects and reports. For example, an administrator can attach PDF files, Word documents, Excel reports, PowerPoint presentations, images and other documents to projects and work orders to provide a more detailed view of product specifications, lists

of materials, recipes, formulas, inventory, etc. Since data accuracy has a significant influence on operational efficiency, having a system that allows you to efficiently manage documents and maintain data integrity when transferring information between applications can help you improve the quality of your products.

5. Test: ERP systems can also be used to define quality guidelines, predefine tests for materials and finished products, create quality orders that specify the tests that must be performed for particular products, record multiple test results and then compare them with predefined values. By managing nonconforming materials or products, manufacturers can create reports and orders of non-conformance, include explanatory notes, link nonconformance orders with each other to identify and explore the interconnections between quality problems and estimate the additional costs resulting from non-conformance. conformities. In addition, the best ERP solutions allow companies to trace problems to their origins, select the best solutions to problems, manage the response times of non-conforming products, connect test results to appropriate corrective or preventive actions, and even schedule automated tasks to correct certain problems.

The identification of items with quality problems is essential for a company concerned with improving the quality of the product. But more important than this is to determine and understand the underlying sources of quality problems. The fact that most manufacturing ERP systems give manufacturers access to critical information related to the sources of quality problems, which allows them not only to determine if a non-conformity was due to an incorrect number of the work order, low quality materials, defect codes or incorrect recipes or formulas, but also to prevent future recurrences, is what makes these software solutions really valuable.

6. **Improving Customer Service**

Customers are increasingly involved in the manufacturing process, from collaborative design through product customization. As a result, their expectations surrounding delivery speed and value are very high, and they have no tolerance for mistakes—they can and will go elsewhere if expectations aren't met. An ERP solution does the heavy lifting for manufacturers when it comes to details. It automates tracking and makes any information the customer wants or needs—like delivery dates or current invoices—readily accessible. By taking care of the data points and customer relationship building, ERP supports lean initiatives by freeing manufacturers to focus on and efficiently produce quality products.
Whether you're running lean or considering lean implementation, an ERP solution can enhance your efforts by providing the data needed to support minimal-waste process decisions on the floor.

Eliminating the wastes above can be achieved through the implementation of Lean and the various tools further supported by ERP. Implementing Lean should not be completed with removing waste as the goal but implementing the principles and the pull based on the

customer's needs. If the implementing of Lean is from the wastes and not the principles it can often result in non-value-added process made better and the business getting better at delivering what the customer may not want. Lean Principles implemented will result in the wastage reduced.

Along with the Lean benefits identified through the principles above, ERP Solutions that support Lean manufacturing with key benefits:

- Efficiency– Removal of manual and time-consuming tasks.
- Real Reporting – Improved business Intel enables "Better Business Decisions".
- Mobility – Conduct your business anywhere.
- Improved Customer Service – streamlined processes improve customer time lines.
- Agility – business should have the ability to change with the moving global markets.
- Improved Data Security – better user permission settings keeping all sensitive information protected.
- Collaboration – enhanced collaboration across the organization driving improvements continuously.
- Global – Multi site, multi country and multi-currency ERP solutions.

ERP systems serve as the nerve center for business, sit at the center of many critical data silos and help front-line managers and employees understand the dynamics that occur in and around their company.

One of these areas that is fundamental to understanding business dynamics is the interaction with the client. This covers sales and marketing, but also customer service. In a world where competition is often only a few clicks away for a company's customers, good customer service makes a big difference.

Companies that can leverage their customer data effectively have a decisive advantage when it comes to meeting customer needs. And ERP plays a role in creating this advantage.

Here are five ways in which ERP systems can improve customer service in a company.

1. Provide a holistic view of interactions with customers

   All the companies are clients in their foundation, so basically each part of a company returns to the client directly or indirectly. ERP systems, which are at the center of a company, can help provide a much more comprehensive and global vision of the customer's journey. And that helps with the support.

   "The beauty of modern ERP is that there can be valuable data collected with every integrated transaction, and with modern analysis, these data can be easily useful," says Peter Santaniello, senior consultant at Pemeco Consulting.

   "From analyzing the compliance of the customer's products and services to the performance of the supplier, billing and customer service, a comprehensive and holistic

ERP data set can help you understand your client's perceptions of the added value of its operations, "he says.

2. Improve the response of the customer service

   ERP is about collecting the data. Therefore, through multiple data flows, an organization can proactively understand a customer's problems for the optimal solution during support calls, according to Kevin Nicholas, vice president of global business and marketing software products for the ERP maker, Sage. "This includes less time to reach a resolution, free up resources and improve NPS scores," he says.

   ERP also helps track the performance of customer service.

   "You cannot improve what you cannot measure, so ERP analyzes help you track your goals against key performance indicators," says Joseph Micara, director of Grassi Consulting. "Looking at a 360 degree view with the analysis in mind allows you to identify additional areas of improvement, and therefore, improve customer satisfaction."

3. Help with superior sales opportunities

   Since ERP systems have an overview, they can provide additional sales opportunities before, during and after interactions with customer service through analysis and notices to customer service representatives. Representatives do not necessarily need to see additional sales opportunities, because the system can handle this discovery of opportunities for them.

   "The opportunities for cross-selling and wholesale can be identified and channeled with an increase in the propensity of the customer to buy and channel the generation for marketing tracking, all captured in a view at the customer level and together," he says. Nicholas in Sage.

4. Streamline customer service processes

   Operational intelligence is increasingly important in the ERP world. Real-time data, advanced analysis, the best dashboard and artificial intelligence come together to make ERP systems an assistant for decision making, not just a system or record. With improved operational intelligence and automation, companies can iterate their customer service operations based on up-to-date changes in customer interactions

5. Best self-service

   With the prevalence of mobile devices and online shopping, customers now often prefer to manage their own customer service needs whenever possible.

This presents an opportunity for more efficient and profitable customer service through self-service portals and knowledge bases. But only if the companies have the infrastructure for it.

The ERP can play an important role in the construction of these knowledge bases and in the delivery of answers directly to the clients without the need of interactions with the agent live; Customers can extract data directly from the ERP system through interfaces as diverse as web pages, interactive voice response or even chat bots. If a customer wants the order history, shipping information, production times or product specifications, for example, ERP is well placed to deliver this information directly to customers without an intermediary.

This can play a very important role in better customer service and save money to a company in the process.

ERP is at the intersection of two trends: greater reliance on data-driven business processes and decision making for faster adjustment and more efficient execution, and the need for better customer service beyond of what was needed 10 years ago.

Customers are more demanding than ever, and ERP can help meet the needs of these demanding customers.

So, while ERP is not the first thing that comes to mind when most of us think of customer service, it has a central place in customer service in general.

**¿What an ERP should do for lean?**

We have seen how ERP can improve the effect of Lean in the production. Now we are going hoe ERP can enhance the principles of Lean Manufacturing one by one following the study of Hamilton in 2009.

We have seen the main different characteristics between Lean and ERP. However, like all, we can so a mix of methods, not only taking ERP or Lean. So, looking at that possibility, the best way to have a mix for having the best production results, we can search what does an ERP need to can be fixed with Lean Manufacturing. The best way to that I to take the fundamental principles of Lean Manufacturing and search how can we integrate the principles in an ERP:

| No | Principle | An ERP system for lean production should: | Reference: |
|---|---|---|---|
| 1 | Value | Support customer relationship management | (Chen and Popovich, 2003) |
| 2 | | Automate necessary non-value adding activities (e.g. backflushing) | (Hamilton, 2009) |
| 3 | Value stream | Enable process-modelling to support standard work processes | (IFS, 2008, Prediktor, 2010) |
| 4 | | Provide a source for easy-to-find product drawings and standard work instructions | (Houy, 2005, Tjahjono, 2009) |
| 5 | | Support information sharing across the supply chain | (Bjorklund, 2009, Koh et al., 2008) |
| 6 | Flow | Create synchronized and streamlined data flow (internal & external) | (Hamilton, 2003) |
| 7 | | Support line balancing | (Steger-Jensen and Hvolby, 2008) |
| 8 | | Support demand levelling | (Hamilton, 2009) |
| 9 | | Support orderless rate-based planning (e.g. takt-time) | (IFS, 2010) |
| 10 | | Provide decision support for shop floor decision making | (Hamilton, 2009) |
| 11 | Pull | Support kanban control | (Hamilton, 2009, Masson and Jacobson, 2007) |
| 12 | | Support production levelling (Heijunka) | (Masson and Jacobson, 2007) |
| 13 | | Support JIT procurement | (Masson and Jacobson, 2007) |
| 14 | Perfection | Provide a system to support root-cause analysis and for the logging and follow-up of quality problems | (Bjorklund, 2009) |
| 15 | | Provide highly visual and transparent operational measures (e.g. real time status against plan) | (Prediktor, 2010) |

**Table 3. Investigating ERP Support for Lean Production (Hamilton, 2009)**

## 4. EXAMPLES OF LEAN MANUFACTURING TECHNIQUES SUPPORTED BY ERP

### a. JIT (JUST IN TIME)

A key difference between the implementation of ERP and Lean manufacturing has been the production approach. Since the ERP system has traditionally used a push production system, adopting a pull production philosophy has been a challenge. Many ERP providers have begun to add the JIT toolset to their best practice procedures as a step in this direction. A core functionality of this tool extends momentum throughout the supply chain from suppliers to customers. Of course, incorporating flexible features just in time, small deliveries of parts and materials without the need for traditional purchase orders and this can be difficult to implement in an ERP system (Nakashima, 2000). One vendor, Oracle and its Flow Manufacturing software, includes multiple component replacement routines that support multiple component demand patterns. This flexible approach to the acquisition of JIT helps eliminate stockouts. The software automates material replacement processes by creating a self-regulating extraction production system. Oracle also offers feedline line synchronization processes that can create specific JIT schedules for a complex and dependent demand to ensure parts are delivered when necessary. This is ideal for products that must be built specifically for customer orders, or are highly customized or variable. By using additional functions, the required components and parts can be requested to ensure the delivery at the perfect time so that they are available during production. Stable and predictable demand can use the Kanban administration processes, but the more complex demand can access the ERP data and use the JIT concepts for delivery (Oracle, 2006).

### b. KANBAN

1. Traditional Kanban System

Kanban is a signal of the demand for a specific product, in specific quantities of elements or raw materials (Kumar and Panneerselvam, 2007, Muris et Moacir, 2010), to be delivered to a specific process (Mayilsamy et Pawan, 2014). It is a material movement management system, including an information system, based on kanban cards that allows to activate the movement from one operation to another (Ramnath et al., 2009).

These Kanban cards have an inventory number attached to part of the production, which contains all the information and details necessary for each step, from production to the assembly of a product (Kumar et Panneerselvam, 2007; Mayilsamy et Pawan, 2014). They are used to communicate effectively with internal and external operations on issues

such as production schedules, delivery time and stock information (Apreutesei et al., 2010). Table 4 shows a model of a kanban identification card, knowing that there are several types of kanban cards, which are editable and flexible according to the needs of each company.

| Kanban identification card | |
|---|---|
| product ID | |
| Description / Specifications of Product | |
| Provider | |
| Customer | |
| Quantity / Weight Received | |
| Container number | |
| Destination | |

**Table 4. Kanban identification card (Mariam Houti 2017)**

Know that each workstation produces or supplies products or components, only when it receives a Kanban card from the previous work station (Suprasith et al., 2011), which is considered a production order. In other words, work is done only when necessary (Suprasith et al., 2011). The kanban system is still easy to implement at a low cost, it helps production units respond quickly to changes in the supply chain by transferring accurate and automatic production information (Suprasith et al., 2011), so there is a continuous flow control of production. and actions (Kumar and Panneerselvam, 2007). In order to carry it out successfully, some basic operating rules must be followed; For example: production should start only when the customer initiates an order (Ramnath et al., 2009); Kanban boxes must be checked regularly and treated in accordance with the first-in principle (Ramnath et al., 2009); The number of Kanban cards needed for each product must be verified (Mayilsamy et Pawan, 2014). Manufacturing companies that adopt the traditional Kanban system generally use a Kanban table to visualize the movement of materials in a manufacturing / production facility. Table 5 shows an example of a Kanban table proposed for the demand to prepare a machine in a sewing workshop to formalize the communication between the various stakeholders, it also gives a visibility on the progress of the preparations of the sewing machines by all interested persons (Houti et al., 2014).

| Seam line | Demand of preparation machine | Machine is waiting accessories | Machine being set | Machine Ready to use |
|---|---|---|---|---|
| MM01 | | | | |
| MM02 | | | | |
| … | | | | |
| MM16 | | | | |

**Table 5. Kanban preparing machine card (Mariam Houti 2017)**

Many companies use a system such as Kanban because the material is controlled by documents, for example, at the production department level. The control is done through calendar sheets, material list or product structure; Therefore, there is a series of works in which the term kanban is used but without discernment (Muris et Moacir, 2010). Therefore, the Kanban system is not suitable for all companies, especially those with fluctuating demand, low quality production processes or having a relatively wide variety of products. (Suprasith et al., 2011) The decrease or increase in demand for sudden products can also cause problems for a traditional kanban system. In addition, this is the case of manufacturing processes that involve multiple parts or mergers of products, which can increase the complexity of a traditional Kanban system, which in turn can lead to a system failure (Suprasith et al., 2011).

2. Electronic Kanban System

A traditional kanban system with cards has some limitations, due to the unproductive work caused by the manipulation of the cards, but it can be corrected with a computerized system (Drickhamer, 2005). The movement of kanban cards always has some irregularities, since they do not move at the exact moment that the consumption of materials (Drickhamer, 2005), while the pace of manufacturing operations increases and the size of the production lot, the number of movements of the cards. it also increases; For this reason, the cards are lost or lost at times, which causes immediate problems in the production just in time (Kumar and Panneerselvam, 2007). The kanban system is still difficult to adapt to changes in mixed production, since the cards must be collected and replaced by new ones (Mertins and Lewandrowski, 1999). The most optimal solution is the use of a computerized system such as the Kanban electronic system that offers many advantages over the traditional Kanban system. This is why many companies have installed ERP systems: planning of business resources to improve interactions and communications between their clients and their suppliers (Mabert et al., 2001), thus improving the response capacity and the quality of the information, by integrating data and information throughout the organization., accelerating the response time and making decisions faster (Graves et al., 1995). ERP can be considered as a great software system to link all parts of the company to promote the best practices of standardized business processes, following a Push approach (Adam et al., 2012). Lean Manufacturing is one of these best practices focused mainly on manufacturing, oriented towards an attractive approach (Cruz-Cunha, 2010). This shows a productive way of seeing the synergy that can arise from a marriage of the two methodologies, offering a Lean ERP system (Cruz-Cunha, 2010). Lean ERP includes database elements, tool sets and changes

in business processes through a variety of new modules, mainly Lean, implemented in the ERP system as (Cruz-Cunha, 2010):

- Production smoothing;
- Just in time;
- Value stream mapping "VSM";
- Electronic Kanban.

Many companies have chosen to apply the Lean ERP system by installing different Lean ERP modules, such as the electronic kanban system, which represents several advantages over the traditional kanban system. A traditional kanban system has some limitations, due to the unproductive work caused by the manipulation of the cards, but it can be corrected with a computerized system (Drickhamer, 2005). The movement of kanban cards always has some irregularities, since they do not move at the exact moment in which the consumption of the products (Drickhamer, 2005), while the pace of manufacturing operations increases and the size of the production lot , the number of cards The movements also increase; Then, the cards are lost or lost at times, which causes immediate problems in the production just in time (Kumar et Panneerselvam, 2007). The kanban system is still difficult to adapt to changes in mixed production, since the cards must be collected and replaced by new ones (Mertins and Lewandrowski, 1999). The most optimal solution is the use of a computerized system such as the Kanban electronic system. The Kanban electronic system (also called E-Kanban) is a signaling system that uses a combination of technology to trigger the movement of materials within a manufacturing or production plant (Surendra et al., 1999). Kanban is more reliable (Graves et al., 2008), and uses technology to replace traditional elements such as Kanban cards with bar codes, RFID "Radio Frequency Identification" and electronic messages (Surendra et al., 1999). It has fewer errors in the management of the card and in decision making (Graves et al., 2008). Therefore, a description of the electronic kanban system, the principles and ideas on its design, which can be presented as follows (Graves et al., 2008):

• First, the electronic kanban must follow the principle of the kanban system based on traditional cards. These principles include, for example, smoothed and leveled production, mixed model sequencing, stable material flow, close synchronization of operations (waiting time calculations) and extraction signals generated by the inventory status or production system.

• Secondly, the electronic kanban system must support the continuous improvement that many authors consider as one of the most powerful characteristics of the kanban system. The traditional

kanban system is used to reduce inventories and minimize production batches until hidden problems are revealed. Once problems are corrected, inventories and lot sizes are reduced to reveal new problems. This improvement approach should be included in the kanban system to obtain most of the advantages of the traction production system. An electronic kanban system should also support the improvement of operations by collecting and reporting data on manufacturing operations and the movement and storage of materials.

• Third, the system must be easy to use, and the system interface must be well designed. Despite all the possibilities offered by information technology, the system should be as simple as possible from the point of view of the operator.

• Fourth, the system can be used to solve card problems. Mixed production, process visibility, system speed and improved reliability are important challenges for investment in the E-Kanban system. These functions must be taken into account when planning the control software.

• Fifth, E-kanban will help fill gaps in the manufacturing process, such as machine failures, quality problems or material flow problems. E-Kanban acts as a "command panel", which allows real-time visibility of demand signals and offers an overview of the status of each workstation in the system (Muris et Moacir, 2010). All information related to the transaction is automatically collected and analyzed at different stages of the manufacturing process to control and make decisions regarding the size of the production lots, hence the definition of the time of passage of the products (Graves et al.., 2008; Muris and Moacir, 2010). The E-Kanban system can also help implement a Pull production system in a manufacturing environment where the traditional kanban system would face difficulties (Graves et al., 2008). It can be used with a mixed production that evolves constantly according to the needs of the clients, since the location and size of each batch is known and the change of the kanban cards is done automatically in the computer system (Graves et al., 2008 ), which reacts as a basis for mutual communication (Muris et Moacir, 2010) with the stakeholders of the company: customers and suppliers and, therefore, communication is clearer. Quality problems or machine failures can also be included in the logic of the computer system, so that the influence of faults or quality problems is minimized, and the recovery is carried out in a controlled manner (Graves et al., 2008). Therefore, an E-Kanban system can provide visibility and improvement of the production

and management of materials in an arrangement in which the operations are dispersed and, therefore, if it is implemented with care, it can work in an environment where a Kanban-based card would not work. adequately (Graves et al., 2008). In other words, the E-Kanban system can be integrated into enterprise resource planning systems that adopt the Lean (Lean ERP) philosophy (Mertins et Lewandrowski, 1999), thanks to its centralized database that collects all data from the company.

3. In which case use kanban or E-kanban?

The E-kanban system is the new generation of the traditional classical kanban system. It has many advantages, such as the history of operations performed, which allows to verify if employees use the Kanban system correctly or not. Which is the opposite of the traditional Kanban system that does not collect all the historical data.

There is also a multiplicity of advantages compared to the traditional system mentioned (Graves et al., 2008; Mayilsamy et Pawan, 2014):

- Reduction of manual card handling and order entry activities;
- Eliminating the problem of lost letters;
- Fast and efficient optimization of kanban cards;
- Improves the visibility of signals in real time;
- Accurate communication with suppliers;
- The efficiency of suppliers is always analyzed.
- The efficiency of analysis and adjustment of Kanban quantities;
- A delivery of the request at the appropriate time;
- Minimization of the shortage of materials;
- Improvement of the transparency of the supply chain.

Therefore, there are still areas where traditional Kanban can be better than E-Kanban; This occurs when there is no appropriate information in the Lean ERP system in relation to the quantity of products produced per day, and depending on the demand, whether stable or not. What is more detailed in Figure 8 that shows the comfort zones for each kanban system.

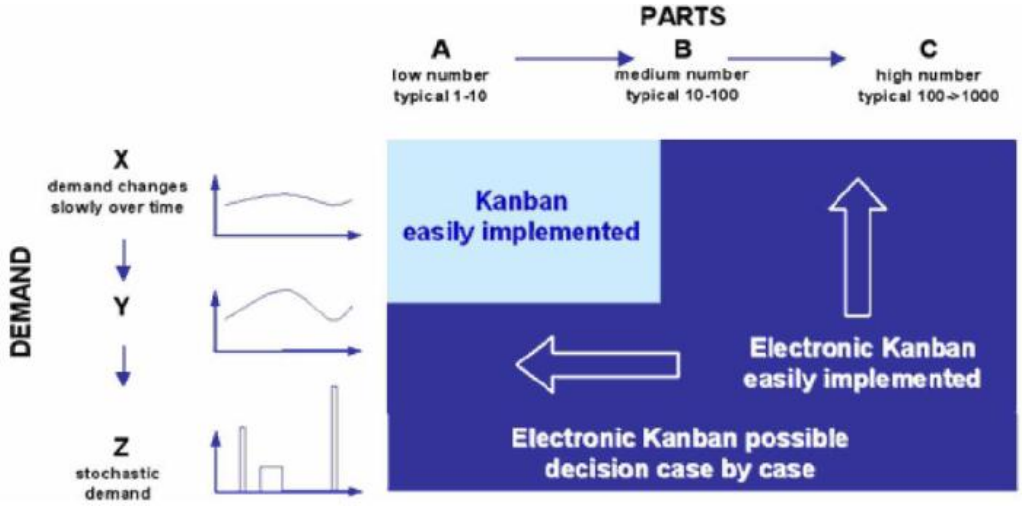


**Fig. 7. Bests ways to use each Kanban system (Mariam Houti 2017)**

As shown in the Figure, with a growing number of materials circulating in the company, it is very difficult to use the traditional card system, because it is impossible to control the large number of Kanban cards that circulate but with the speed of the changes that can be made. When done at the level of the E-Kanban system there is a better applicability. The same in the case of a variable or random demand, the traditional system becomes unstable, since it cannot operate in a mixed mode variable. Therefore, an electronic Kanban system is more suitable for a variable or even random demand for products, or for a large number of materials circulating in the workshop; Knowing that it can work even for a stable demand and a small amount of materials, except that the cost of its installation is still high compared to this type of production, so it is recommended to install the traditional Kanban system that adapts perfectly to a unit Require that you change slightly over time or with a quantity of materials that is not very large. Hence the need for a comparison between the different Kanban systems in order to extract the maximum from each production system, which is summarized in Table 9, which brings together the points of view of the author of the article and Olga, M.

| | Card Kanban | E-kanban |
|---|---|---|
| Transparent Material flow | ✓ | ✓ |
| Control of ordered material level | ✓ | ✓ |
| Easier and faster ordering of material | ✓ | ✓ |
| Easier work for handlers with material | ✓ | ✓ |
| Regulation and optimization of stock | ✓ | ✓ |
| Simplification of production planning | ✓ | ✓ |
| Works with high amount of materials | | ✓ |
| Long distances between stations | | ✓ |
| Quick and precise info | | ✓ |
| Big financial investment | | ✓ |

**Table 6. Comparation between Card Kanban and E-Kanban (https://www.extension.iastate.edu/agdm/wholefarm/html/c6-60.html)**

A comparison between the two Kanban production systems shows that the Kanban electronic system includes some characteristics of the traditional Kanban system with cards, with the exception of the following characteristics that exist in the traditional Kanban system and not in E-Kanban according to Olga, M. to know:

- Visualization of production problems.
- Setting priorities.
- Improvement of the flexibility of the production line.
- Improved quality (by lot size).

But these functionalities are also part of the Kanban electronic system, which is quite logical, since it is almost the same basic system, but the difference results in the computerization of the system as examples:

- The visualization of production problems can be done with E-Kanban, the only difference between the two systems is that the problem will be displayed in the computer tool compared to the traditional system where the operator detects the problem and informs it.
- The definition of priorities is usually carried out by the person in charge of the Kanban system, which defines the priorities for the passage of Kanban cards according to the instructions received from the departments concerned, which can also be done by E-Kanban according to the data seizures in the computer tool.
- The improvement of the flexibility of the production line is more manageable with an E-Kanban system in the case of mixed or variable production or with a large number of products circulating in the workshop, since the traditional system has some limitations in this situation.
- Improved quality, you can define the same lot size for both systems and, therefore, you can do the same quality control in both systems.

4. Results of the application of E-Kanban system

Literature review

In the literature there are several articles that study the traditional Kanban system in all its aspects, and as regards the electronic Kanban system, there are few articles that deal with it, especially those that study the results of its implementation, gains and limits. generated for the company itself and for its different stakeholders: customers and suppliers.

So, we thought about reviewing the literature of different articles dealing with the implementation of the E-Kanban system in their companies and being interested in their different stakeholders, which has been grouped in the table 7:

| Articles | Stakeholders | | |
|---|---|---|---|
| | Enterprises | Customers | Suppliers |
| (Drickhamer, D., 2005) | Reduction of waste and NVA at the supply chain level. | | |
| (Kouri, I.A., Salmimaa, T.J., and Vilpola, I.H., 2008) | Acceptance of E-Kanban by employees using an UCD model. | | |
| (Olga, M., 2008) | The various problems encountered during the installation of E-Kanban system. | | |
| (Lee-Mortimer, A., 2008) | Explanation of the functioning of E-Kanban in the enterprise, and the planned stages of evolution of the system. | | |
| (Suprasith, J., Andrew, P.C., Thaloengsak, C., and Chayanun, K.,2011) | Gain generated at the supply chain level. | | |
| (Rong, H., Fei, G., and Cheng, G., 2012) | Optimization of the assembly line space, stock of materials, quality problems solved, and cost saved. | | |
| (Al-Hawari, T., Aqlan, F., 2012) | Reduction of production and work time in process inventory. | | |
| (Raju, N.M., Vijaya, E.K., Upender, G.B., 2013) | Minimization of operational and logistical problems. | | Calculation the number of E-Kanban cards for the supplier. |
| (Mayilsamy, T., Pawan, K.E, 2014) | | | Use of barcodes on containers. |
| (Grant, M., Maneesh, K., Vikas, K., and Ann, E., 2014) | | | Benefits and risks of implementing E-Kanban. |

**Table 7. Articles describing each stakeholder (Mariam Houti 2017)**

The implementation of the E-Kanban system.

In the company

The electronic Kanban has many advantages over the traditional Kanban system, which has been shown in several studies, hence the choice of two case studies already conducted to see the impact of its installation at the

company level. The first study was carried out for a parts supplier in the automotive industry that produces a cab module for a Japanese automaker (Suprasith et al., 2011). The work processes were examined before and after the implementation of the E-Kanban system (Suprasith et al., 2011). After the implementation of E-Kanban, the company was able to eliminate the steps of the traditional Kanban process and reduce the implementation time, which generated a significant gain in storage costs. The second study was carried out within Fork Truck at the assembly line level, the installation of the E-Kanban system allowed to automatically update the Kanban information, optimize the space of the assembly line, reduce the stock of materials in process in the factory, the resolution of quality problems and cost savings (Rong et al., 2012). The steps of the new Kanban electronic process include:

- Collection and digitization of traditional Kanban in the computer system.
- The transfer of information.
- Transparency and improving efficiency of the supply chain.

Hence the installed E-Kanban system presents the following improvements at the level:

- Real performance and cost savings (Suprasith et al., 2011; Rong et al., 2012; Raju et al., 2013; Al-Hawari et Aqlan, 2012).
- Production delays (Suprasith et al., 2011; Raju et al., 2013; Al-Hawari et Aqlan, 2012).
- Financial costs (Suprasith et al., 2011; Rong et al., 2012; Raju et al., 2013).
- Effective and efficient work processes (Suprasith et al., 2011; Rong et al., 2012; Raju et al., 2013; Al-Hawari et Aqlan, 2012),
- Reducing waste and mistakes (Suprasith et al., 2011; Rong et al., 2012; Raju et al., 2013; Al-Hawari et Aqlan, 2012).

3.2.2 For the different stakeholders:

The installation of a new system within an organization always has positive or negative consequences for the organization itself or for its stakeholders. The application of a well-implemented electronic Kanban system within an organization allows having positive points for the organism itself, provided that the system is implemented in its comfort zone: with a variable or random demand of products, or for a high number of materials that circulates in the company. Something that was confirmed in the two cases that we mentioned above, but its application can generate some problems

for customers and suppliers of the company. Knowing that for an electronic Kanban system, every time the barcode of the Kanban card is scanned or scanned, the state of the container automatically changes from "empty" to "in progress" to "in transit" to "full" (Drickhamer, 2005). When a batch size is removed from the Kanban buffer, the barcode in the container is scanned and the Kanban state changes from "full" to "empty"; a new electronic kanban signal (which translates in order) is generated in the system and sent automatically to the providers (Grant et al., 2014). The provider can receive the Kanban signal in several ways: either through a secure website or through an automatically generated email that is sent to the providers (Grant et al., 2014); therefore, from the moment of receipt of the signal, the supplier must prepare the new order of materials within a certain time (Grant et al., 2014). This usually causes problems of delays to the provider. As an example, taking the case of an "A" company that makes electrical harnesses, its "B" supplier that produces electrical cables and connectors, and its final customer "C" is an automobile manufacturer. Before the installation of the Kanban electronic system, A. was working with a traditional Kanban system, sending two types of orders to its supplier B:

- Firm orders.
- Forecasts for the following weeks, and at the beginning of each week the customer confirms his order with a firm order.

In accordance with the forecasts or firm orders issued by the customer, the supplier makes his own forecasts in turn at the level of his stock of raw material.
After the installation of the Kanban electronic system, the situation will automatically change, it will be an automation of the purchase and supply process, so the client will no longer communicate his forecasting needs to his supplier, but will be transmitted directly every day through of the email System, in the form of a Kanban signal that will be the object of a purchase order of the customer's daily requirement. So, to apply an E-Kanban system, company B must have flexibility in terms of:

- The capacity of their machines, normally calculated during the first installation of the workshop, which pushes suppliers to make extensions of their companies to meet the needs of their customers;
- The raw material will generate more stock at company level and automatically the additional costs for supplier B;
- Work teams will generate high labor costs.

As regards the final customer C., he needs the satisfaction of his need, both in the present and in the future orders in good conditions. A profit generated in the long term, in order to guarantee the durability of the supplier A., the reason why he is interested in sharing a profit between him and his provider

(in other words, it is a donation relation for the provider). and your client) to be able to perpetuate your relationship for the orders, since it is nothing more than a customer-supplier relationship, but an association between the two organizations. If the supplier A. of customer B. generates losses, it will directly lead to financial problems or even to the closure of the company. Consequently, the client B. will also have problems within his entity automatically, since he must stop his production to look for a new supplier, who must develop and, therefore, stop the production that will generate huge losses for the client.

5. CONCLUSIONS

Although the Kanban electronic system is an evolution of the traditional Kanban system, it has many advantages over the traditional classical Kanban system.

However, I have tried to identify and explore the two Kanban systems: the traditional Kanban system with cards and the new Kanban electronic system with bar codes, knowing that there is a strong link between the two systems, since the traditional Kanban adopts a purely pull while the electronic Kanban adopts the extraction approach while following the insertion approach based on Lean ERP systems. The study was based on the practical and theoretical part that showed that all the basic functionalities of the Kanban system are maintained at the level of electronic Kanban. However, an electronic Kanban system provides opportunities to solve some limitations of the existing traditional Kanban system, such as mixed production, but automatically generates additional costs for both the provider and the customer of the entity that will install it, which was demonstrated During the theoretical study, which will be specified through a practical study in future work.

## c. 5S SUPPORTED BY ERP

1. ERP AS A 5S PROCESS

In many ways, ERP is supporting 5S methodologies. We are going to analyze one by one:

**5S – Sort**

ERP brings together the right materials, and the right operation, all at the right time. This eliminates excessive inventory, and WIP and queue times at the operations. The routing also establishes the optimal process to produce

the product in the plant. All these improvements work together to reduce the work in process both in the plant and at the work area. In addition, techniques such as Group Technology can be used to sort production schedules so that full advantage it taken of common machine, and material requirements.

**5S – Set**

ERP set standards for all the materials and processes in the plant. These standards represent the best benchmarks based on current factors. ERP then prioritizes these materials and operations in the most productive way possible, and via the use of queue compression allows for flexibility needed to react to changes.

**5S – Shine**

ERP establishes maintenance schedules to ensure that all machines receive the appropriate service to increase their accuracy and uptime. The preventive maintenance schedules also ensure that the machines are cleaned and prepared for optimal use, and by linking the PM program on the start and end dates of the operation of the production program that schedule can be taken into account.

**5S – Standardize**

All ERP activities are controlled by continually updated standards. Any activity that runs outside of these standards is immediately reported to management. In the key activities, the KPIs are set up for the focused monitoring of the most important activities throughout the company, such as late completion dates, excessive waste and labor inefficiencies. ERP systems also offer business process registration functions that allow the capture of exact functions of the store's computer, to allow its use in ascending and descending work areas.

**5S – Sustain**

ERP allows continuous monitoring, maintenance and correction of all processes. Performance management systems help to link all these processes with strategic objectives and results, which turns the entire company into a 5S process.

### d. Vendors

As is evident from the list of Lean-enabled features now being supported in ERP systems, a number of vendors have begun to enter the marketplace. Table 8 provides a list of some of these vendors and their primary Lean-enabled software modules. Three of these vendors are then explored in more detail.

| Lean-Enabled Software | Vendor | Website |
|---|---|---|
| Alliance/MFG | Exact Software | www.alliancemfg.com |
| American Software Enterprise Version 3 | American Software | www.amsoftware.com |
| Demand Point | Pelion Systems | www.pelionsystems.com |
| E2 | Shoptech | www.shoptech.com |
| e-Intelliprise | American Software, Inc | www.amsoftware.com/marketing/intelliprise-home.asp |
| Fourth Shift | Softbrands Manufacturing Solutions | www.fourthshift.com |
| Global Shop | Global Shop Solutions | www.globalshopsolutions.com/product.htm |
| IFS Applications | IFS | www.ifsworld.com |
| Infor ERP VISUAL | Infor Global Solutions, Inc. | www.infor.com |
| Made2Manage | Consona | www.made2manage.com |
| MFG/PRO | QAD | www.qad.com |
| Manugistics | JAD Software Group, Inc. | www.jda.com |
| MISys | MISys | www.misysinc.com/mi2kover.htm |
| Oracle E –Business Suite | Oracle | www.oracle.com |
| PeopleSoft Enterprise | Oracle | www.oracle.com/applications/peoplesoft-enterprise.html |
| Seradex ERP Solutions | Seradex | www.seradex.com/ERP/Lean_Manufacturing_ERP.php (Seradex, 2007) |
| Sage ERP X3 | Adonix | www.adonix.com |
| SYSPRO Enterprise | SYSPRO | www.syspro.com |
| Ultriva | Ultriva (ebots) | www.ultriva.com |
| Vista | Epicor | www.epicor.com |
| WinMan | TTW | www.winmanusa.com |
| xApp | SAP | www.sap.com/solutions |

**Table 8. ERP's Vendors (Mariam Houti 2017)**

1. Oracle

Oracle is considered a leader in the implementation of Lean-manufacturing within its ERP system. According to his research, Oracle had more than 100 companies that used its flow manufacturing module, and up to four times that amount used its Kanban software (Bragg, 2004). Oracle Flow Manufacturing has been implemented as part of the Oracle E-Business Suite (Oracle, 2006). Oracle believes that Flow Manufacturing is crucial to its e-commerce strategy. Due to this, Flow Manufacturing has been promoted as effective in reducing product cycle times, inventories and process complexity. In addition, Oracle says the software will simplify production and help meet demand for production at affordable prices (Kent, 2002). Of course, none of these features would be possible without the synergy offered by the Lean coupling with the wide range of ERP business data. In addition, Oracle software allows users to create

simulations of the expected changes of the Lean environment. Several simulation tools allow experimentation with line balancing, streams of optimized products and sequencing of Heijunka (Wheatley, 2007). Oracle software not only supports kanban from the assembly to the supplier base, but also includes tools to provide users with the ability to see historical demand and optimize the size and number of kanban cards in the system (Wheatley, 2007).). Several researchers and professionals have reported great success with ERP systems enabled for Oracle (Lee & Adam, 1986; WinMan, 2006). Table 9 provides a list of several Lean-enabled tools offered by Oracle.

| Feature | Description |
|---|---|
| *Value Stream Mapping* | Identifies opportunities for improvement |
| *Value Stream Analysis* | Visualizes opportunities for improvement |
| *Line Design and Balancing* | Supports mixed model production of standard or configured products |
| *Just-in-Time Procurement* | Pull-based, kanban replenishment chain supported to improve inventory turns. Also, supports synchronized component replenishment for configured or build-to-order components. |
| *Electronic Work Methods* | Lean manufacturing execution workstation supported for operators thus enabling move toward paperless shop floor. |
| *Backflushing* | Scrap transaction generated automatically causing all components to be backflushed |
| *Kanban* | Supports kanban transactions with Mobile Supply Chain Applications (MSCA) module |
| *Orderless Flow Manufacturing* | Allows recording of completions of assemblies without having to create work orders |
| *Sequencing and Scheduling Capability* | Produces directly to customer order |

**Table 9. Oracle services description (Oracle, 2006)**

2. TTW

TTW's Windows ERP product, WinMan, is particularly suitable for the use of SMEs. This product has an integrated manufacturing management system designed specifically for the needs of small and medium enterprises. As it handles both manufacturing operations and business operations, including BOM, purchasing, material requirements planning (MRP), inventory planning and control, and production master programming (MPS), it can help control all aspects of an SME (Global Shop Solution 2008). TTW reports several success stories related to WinMan implementations, among them, Lantech is about to increase its market share of stretch wrap machinery from 35% to 50%. Capricorn Cars Parts increased its inventory turnover by 188% and increased its spare parts portfolio from 1,800 to 15,000 while experiencing a marginal increase in overall costs (WinMan, Athena Controls 2008). As many SMEs use the benefits offered with Lean practices, WinMan provides a number of related tools. Table 10 illustrates.

| Feature | Description |
|---|---|
| *Support for Just-in-Time* | External Kanban generates bar coded kanban cards for pre-selected suppliers and allows manufacturers to pull inventory on demand from the shop floor |
| *Demand Driven Manufacturing* | Eliminates non-value added activities and reduces inventory by using pull manufacturing techniques |
| *Push/Pull Flexibility* | Ability to process back to back orders in both purchasing and manufacturing and simulates the pull concept while still utilizing traditional push purchase orders and manufacture orders |
| *Line Design and Sequencing.* | Product Configuration workbench allows selection of various options on the fly during the sales order process. Guided by pre-selected logic. May offer inclusion and/or exclusion rules. |
| *Orderless Flow Manufacturing* | Uses an empty container as a signal to trigger internal replenishment. Empty containers may signal completion of finished product and trigger backflushing of the component material |
| *Backflushing* | Backflushing is deduction from inventory records of component parts used in an assembly or subassembly |

**Table 10. TTW services description (TTW Systems)**

3. Pelion Systems

Unlike other ERP vendors, the Pelion Systems suite of products is developed as third-party software to augment existing ERP applications. The main objective of the Pelion software is to reduce excessive time and batch size obstacles through the use of Lean manufacturing practices (Garwood, 2002). Pelion calls its main software the demand flow technology. The approach is to combine a kanban execution system with value flow mapping capability. Full integration occurs within the design line and balance tools within the Lean module of Pelion, Collaborative Flow Manufacturing (CFM). This offers support for the determination of the size of kanban in flow lines. Pelion provides functionality that gives users the ability to work in four time horizons simultaneously (Bragg, 2004). For example, a production planner can use an annual time horizon to develop a plant design, a quarterly horizon to implement new product introductions along with expected kanban sizes and consumption times, monthly horizons for work schedules and other plans, and finally, daily horizons to monitor the management of outgoing work (Bragg, 2004). Bragg (2004) reports a series of success stories associated with Pelion software. For example, Husqvarna reduced its inventory by more than one million dollars and was able to improve order fulfillment within a predetermined time frame of less than sixty percent to more than ninety-five percent. Brooks Automation reported an inventory reduction of twenty million dollars. Nissan Forklift reported a twenty percent reduction in direct labor from the final assembly, a forty-seven percent inventory reduction and nearly five and a half million annual savings. Table 11 offers a look at the Lean compatible tool sets provided by Pelion Systems.

| Feature | Description |
|---|---|
| *Value Stream Analysis* | EasyVSM workbench determines key breakthrough improvement opportunities, helps distinguish between value-added and non value-added activities. |
| *Value Stream Mapping* | Delivers visual roadmap of Kaizen and other improvements, increases visibility and aids in communication |
| *Lean Engineering:* | Defines flow as a means of driving Lean process layouts and aids in continuous improvement effects |
| *Lean Material Flow* | Aids in material flow design, strategic inventory decisions, stock out reductions, pull signal methods in all parts of production, inventory turnover. Supports rapid analysis of dynamic material requirements |
| *Line Design and Sequencing* | Matches product mix with demand volume (both actual and forecast) with factory resources. Provides alerts to potential resource allocation bottlenecks |
| *Kanban Control and Management* | Enables real-time coordination on dynamic demand-pull requirements; tracks fulfillment performance and ensures production goals met in effective, timely fashion |

**Table 11. Pelion services description (Pelion Systems)**

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