Waste Elimination on a Printing Process

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Abstract — *This project was focused on eliminating the MUDA or waste found (non-value added) in the Offset machines printing process. The DMAIC methodology was used. DMAIC is an acronym for a series of steps used to measure defects in business processes and improve profitability. The term DMAIC stands for the five main steps in the process; Define, Measure, Analyze, Improve and Control. DMAIC methodology brings a structure and the tools to improve a process by optimizing it.*

Keywords *– DMAIC, Lean, MUDA, Offset, Quick Wins.*

INTRODUCTION

The main objective of the project is to eliminate all activities that do not allow task to be done as smoothly flow as possible. These activities in the printing process identified are low number of orders completed daily (2 orders completed per day), Drying time of the product (it takes more than 4 hours), duplicates of tasks (printing and machine set-up) and high quantity of scrap produced (250 units minimum produced per order).

DMAIC

The results obtained through the five phases of the DMAIC methodology are as follows.

Define

Within this phase of defining the problem, the problem usually comes from a VoC (Voice of the Customer). Which is when a person within the work area (Supervisors and/or employees) brings a concern that an area or process where they work can be improved.

On this occasion, the requirement to improve the process came from what is known as VoB (Voice of the Business) - this requirement may be because the market is turning in to another direction or that the cost per unit produced among other things must be reduced). The Finance department said that according to the daily production reports in SAP (a program used in the company that connects the different departments of the factory) it shows that in the Folder (Offset) machines there is a low number of orders run per day. In addition to that situation, the Finance department also says that a high number of scrap is produced compared to the corporate goal (5%). (See Figure 1)

The required area has (2) AB Dick machines, of two colors each of the machines, Offset printing style.

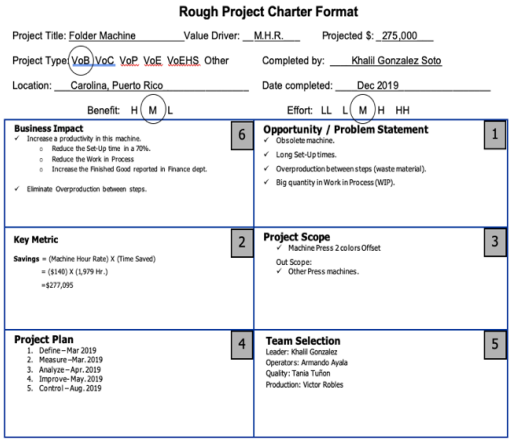


Figure 1
Project Charter

"Offset printing technology uses plates, usually made from aluminum, which are used to transfer an image onto a rubber "blanket", and then rolling that image onto a sheet of paper. It is called offset because the ink is not transferred directly onto the paper". [1]

The benefits (the goal to be achieved) of this project (or Key Metric) will be measured based on the time saved. When we talk about the time saved, we must think about the time it took to run the orders less the time it takes to run them after the improvement is made to the process. That result will be multiplied by the Machine Hour Rate (M.H.R.) (in dollars). (See Figure 1) This project will only take into consideration (Scope In) the 3-color press machine (Offset) and will leave out (Scope Out) the printing machines of more than three colors.

Measure

MEASURE involves more numerical studies and data analysis than the Define phase. This phase focuses on measurement system validation and gathering root causes. [2]

Before presenting the numbers of this process, we need to know first the steps that need to be done to produce an order. (See Figure 2)

Although the process consists of two machines, each process works one impression at a time. It starts with machine 360 that prints two color and after finishing it is passed to machine 361 that prints only one color. In the machine 360, you start by opening the order given in the SAP system (these orders are positioned as planned by the Planning Department).

The first task to do once the order is opened is to change the machine status (from Set-Up to Make Ready). In this order screen, you have some sub-screen that have information to print. It contains information about the numbers of the plates, colors, and quantity to be printed.

Knowing this information, the set-up of the machine continues installing the plates and the colors and leaving it in condition to run. After verification of your impression (compared with the drawing), if it is correct, the operator changes the status of the machine in the SAP (Run-Run_ system and continues to run unless the printing error has to be adjusted. When the machine is running, all printed material must be placed on the scale because it is the only way to know how much material is available, ach group (bundle) contains 250 units. Each time the complete bundle is taken, it is taken to the area where the box is held (the boxes have a maximum capacity of 2,500 units). The operator prints 200 units more (backup) just in case there is a printing problem in the next step. At the end of the order, this product is left drying for no less than 4 hours before being worked on machine 361.

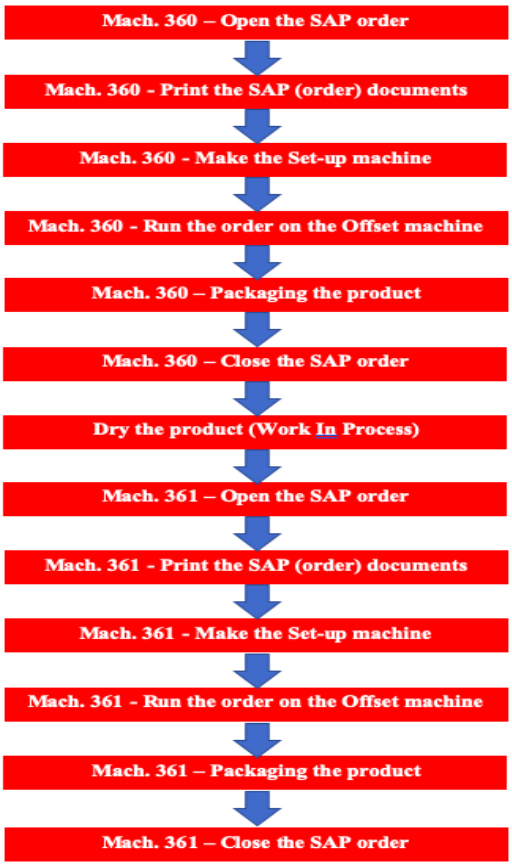


Figure 2
Process Diagram

After drying, continue the printing of the last color on machine 361. The SAP order will require scan the material number, and this material number starts with the number two because it is a job in process. This order will work the same as it was done in the first step (machine 360), the only difference is that only one color is printed and once finished they become a finished product (See Figure 2).

The best way to recreate the route (distance) of the operator on what we have detailed previously in Figure 2: Process Diagram, is using the tool called the Spaghetti Diagram. In the spaghetti diagram, a line is drawn for each distance movement done by the operator during the execution of the order.

Creating a spaghetti diagram is the visual creation of actual flow. The keyword is ACTUAL, not what it should be or perceived to be. It is a snapshot in time so it may not include all what-if and special scenarios, but these do warrant discussion as the team progresses [3].

In the spaghetti diagram, we can see several lines that are darker than others, or places where the operator goes repeatedly as is the case between the ink cabinets and the machine. In Figure 3, we could see long distances traveled when the operator walks to find or leave the product to the pallets.

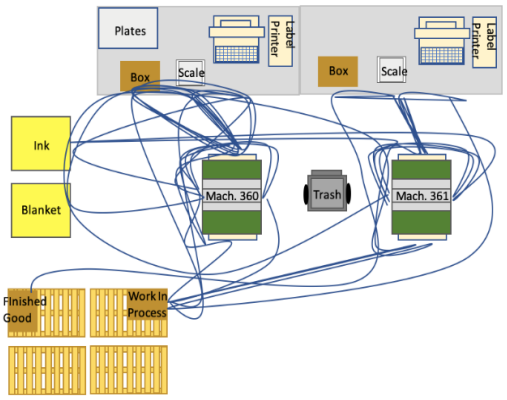


Figure 3
Spaguetti Diagram

After knowing the process through which the product passes and the distances traveled by the operator, we must now know the numbers that the Finance Department sees in the SAP system, and that rise a red flag of the situation in the area Offset machines.

In Table 1, it shows details of how much the machines ran during the last year (number of orders and units run). Starting with these two mentioned above, last year 377 orders were issued on these machines (the order counts when it starts on machine 360 and ends on machine 361) and more than 1.3 million units were run.

Table 1
Baseline

Order Yr	377
Units per Yr	*1,306,130*
Days per Yr	250
Effective Minutes Available	348
Units per day	5,225
Takt Time	0.07
Unit per minute	15
MHR	$ 140.00
	Normal Process
Avg. Order Qty	2,000
SetUp (Hr)	*1.01*
Run Time (Hr)	*4.83*
Dryer Time (Hr)	*6*
EA/HR	*414*
Hrs. need work daily (Units per day / (EA/HR))	12.62 Hr
Hrs. need work yearly (Units per Yr./ (EA/HR))	3154.39 Hr
PLATES	
Used Yrly.	*300*
Price/Plate	*$ 1.80*
Price/Box	
Roll/Box	
Plates/Roll	
Colors Used	
Operation Expenses	*$ 540.00*

In this company, only 250 days are worked per year and a shift is 8 hours (480 minutes), of which after subtracting the 45 minutes of lunch and breaks, they remain with 435 minutes to be able to work. From this time, it is assumed that only 80 percent of the time they are dedicated to working (the other 20% assume that operators go to the bathroom or perform non-work-related tasks). With these details we can calculate, how many units were run daily (Unit per day). The Unit per year is divided between the days worked yearly, and it is there when the total is 5,225 units, that if we evaluate with the average quantity for orders produced that are 2,000 units. Now we can understand the Finance Department because only two orders are produced per day. These details were the red flag that initiate to do the project because when you take it to units per minute it is only 15 units per minute. This quantity does not cover the hourly fee that represents the machine hour rate (MHR) of $140. When we breakdown the orders, we see the severity of the matter presented by the Finance Department, the machine settings are one

hour, and the run time is 4.83 hours. These times are without losing perspective that the product is given 6 hours of drying, so the product release is delayed further. This means that to complete the units per day (5,225 units) at this rate it takes 12.62 Hr. to complete (at the rate of 414 EA/Hr.). Therefore, to complete this quantity you need more than one shift (overtime) to satisfy the customer demand which would add more expenses to the operation.

Analyze

The Analyze phase of DMAIC helps project teams identify problems in the production process that cause product defects. [4]

I met with the team members, to analyze the data we obtained in the Measure phase, we thought we would do it through a Fishbone Diagram, use the 5 Why's, or simply analyzing the 7 wastes (MUDA).

Everyone commented there are (2) major wastes, over process (because we have to make 2 machine set-up, not in parallel and print the instructions of both of them twice when we could do it at once. In addition to the drying time that we did it not because there was a study for that but because of tradition (it has always been done in the same way) and Overproduction (because we have to run over 200 more units in the first machine 360 in case there are printing problems in the second machine 361.

Having identified these two wastes, the whole team reached a consensus that there is no need to extend so much time to solve the problem or invest capital so you can find a quick solution and have a faster impact on the company. So, we decided to explore the opportunity to make a Quick Wins project.

"A Quick Win or "Just-Do-It" project involves the implementation of a simple solution to a known problem. This type of effort addresses a known root cause and is generally contained within one department or workspace." [5]

Doing the Quick Wins allows us to pass from the Measure phase to pass directly to the Improve phase.

Improve

"The goal of the DMAIC Improve phase is to identify a solution to the problem that the project aims to address. This involves brainstorming potential solutions, selection solutions to test and evaluating the results of the implemented solutions. Often a pilot implementation is conducted prior to a full-scale rollout of improvements." [6]

We started making an Action Item Register (see Table 2) that we should fulfill to continue with the project. Each action was going to be worked individually, but they were going to be the milestone for the next task.

The first task was the supervisor of the production area who was responsible for the double task of changing status and printing the order papers on each machine will be replaced by only printing once and containing all the information of both processes. I should mention that the supervisor is not the one who performs the task, but the IT workers of the corporation's group, but he (the production supervisor) is the one in charge of following up on the task and if something is needed, he has to give the information. Finally, the change could be made but has had to find a common name (not equal to 360 and 361) that is why it appeared as machine 362 in the SAP system.

Table 2
Action Item Register (AIR)

Action	Owner	Status
Join the two SAP systems and make only one.	V. Robles / IT	Completed
Make drying test.	K. Gonzalez / A. Ayala	Completed
Compare / Approve the printing of the Finished Good with the customer drawing.	T. Tuñon	Completed

The second task was going to perform a drying test in which we know for sure what is the time needed to dry the ink and that it can be worked in the second process. Right now, we had previously said that he did as he had always done but without knowing the origin. For this test, it was going to work as follows, first, run the first step process

(print (2) colors). The time will be determined, and then the product quality will be evaluated. The pass/fail of the product will be determined by the Quality Department revising with the template of the drawing approved by the customer (the words printed are not blurry). The time was not reduced following some methodology but only a "try and error" was doing.

We started by reducing the ink drying process to 2 hours, which ended with the same result that was normally obtained. Then it was tried with times of 1 hour, 45 minutes, 30 minutes, 20 minutes and 15 minutes. In the first 4 tests (from 1 hour to 20 minutes), we obtained the approval of the Quality department, but when we did with 15 minutes the ink, was reflected in the back of the product when it was placed in bundles, this non-conforming was capture when the operator did the fanning (see Figure 4).

Figure 4
Operator Fanning Test

In other words, we prove that we can reduce the time from 6 hours to 20 minutes. All these changes are detailed in a new Work Instruction (WI) that was submitted and approved by the different departments.

After having completed all the actions items listed, we have a new process diagram (see Figure 5) that is as follows:

The process begins by opening the order in the SAP system (this is to change the status of the screen to Set-up - Make Ready) unlike before it is now in just one computer that covers both printing machines.

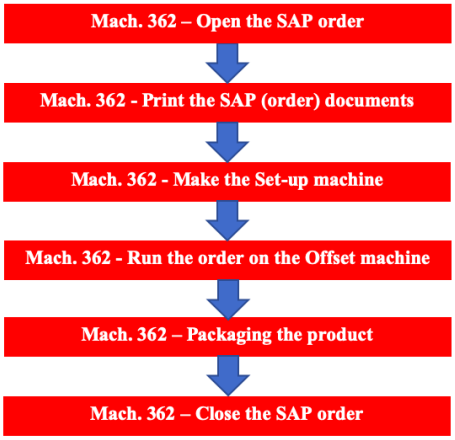


Figure 5
Process Diagram after Improvement

Then the technical printing documents are printed, just as in the previous step, only one document set is printed because both printing processes (machines) have already been included. Although the status as Set-Up was placed above it is now that we proceed to place the inks to be used for this printing along with the plates, they will be made for both machines. The position where both forms will remain will be reviewed with the drawing approved by the client and included in the documents previously printed. When you have the prints in the correct area, continue with the next step.

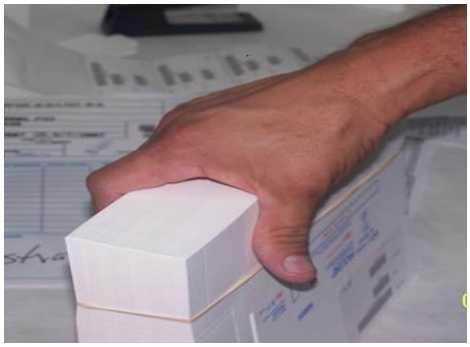


Figure 6
Bundle

This task was the part most impacted by the project. Now, after printing the product on the first machine, we place on the scale in a quantity of 500 units. The product will be placed in the cart that is shown in Figure 7, and at this moment is where the operator activates the stopwatch, so it will be done

until there is completed the 2,000 units (that are normally the orders) and fill the four squares. We assume that the 20 minutes taken by the stopwatch in the first bundle, which takes us the process of doing the others are the ones that will give us the time for the last bundles to complete their 20 minutes of drying and can be used for the second machine.

The second to last step is to place the bundles (see Figure 6) in the box located in the cart (see Figure 7) and leave in the pallet for Finished Good, and then the order is closed in the SAP system.

In Figure 7, we can see more visually through this Spaghetti Diagram this whole process improved. When we compare it with Figure 3, we can notice that this new process the movements are more continuous and shorter, so without going into numerical details, it tells us that there was an improvement in terms of Transportation waste.

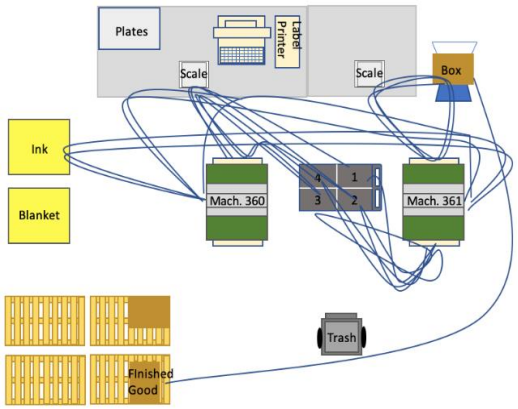


Figure 7
Spaghetti Diagram after Improvement

Considering Table 3, we can compare how the numbers were before and after the waste elimination (improvement project). These numbers were taken after two months of implementing the changes (over 80 orders run). The Set-up of machine reduced 0.17 hours (10 minutes), as for the run of the order reduced 2.61 hours on average, being the best second improvement of the project. As observed, this improvement is more than 50%, and it is because in this new process there is no double-counting of the run (they were seen as two separate orders instead of a continuation of the other) and this leads to a run time savings of more than $365 / order.

This improvement increases the running capacity of the machines (EA / HR line) from 414 EA / Hr. to 901 EA / Hr. (54% more). For this reason, to achieve the goal of 5,225 units it would take us only 5.8 hours of work, which was 12.62 hours of work. If we want to see it annually, to achieve the 1,300,000 units thrown the previous year in 3,154.39 hours it would take us less than half the time (1,450 hours).

The biggest impact this project had was what we mentioned about ink drying, which was reduced from more than 4 hours to only 20 minutes. In this improvement annually, the company would be saving around $300,000, plus the $ 9,000 of the machine set- up, and the $25,000 of the product that we did not throw away would be a savings project of $334,000.

Table 3
Saving Table

	Normal Process	Lean Process
Avg. Order Qty	2,000	2,000
SetUp (Hr)	*1.01*	*0.84*
Run Time (Hr)	*4.83*	*2.22*
Dryer Time (Hr)	*6*	*0.33*
EA/HR	*414*	*901*
Hrs. need work daily (Units per day / (EA/HR))	12.62 Hr	5.80 Hr
Hrs. need work yearly (Units per Yr./ (EA/HR))	3154.39 Hr	1450.00 Hr
PLATES		
Used Yrly.	*300*	*300*
Price/Plate	*$ 1.80*	*$ 1.80*
Price/Box		
Roll/Box		
Plates/Roll		
Colors Used		
Operation Expenses	*$ 540.00*	*$ 540.00*
WASTE		
Saving Waste (EA)		*79,170*
Saving Waste ($)		*$ 25,730.25*
Savings ($)	$ -	$ 334,092.85
SetUp ($)		*$ 9,100.00*
Dryer Time ($)		*$ 299,262.60*
Run Time ($)		
Monthly ($)		*$ 24,938.55*

Figure 8
Presstek 34DI

Although I also proposed to the company to explore buying a new offset model, which would leave them twice the savings of which they will present with the project. For example, this Presstek 34Di model (see Figure 8) which is just 0.25 hours (15 minutes) performs a machine set-up because it saves the recipes and the drawing in a memory that runs it when selected. Another advantage of a machine is that it runs at a capacity of 7,000 EA / Hr. (94% faster than originally run and 87% faster after the improvement project). This means, that the 5,225 units that run in one day originally at about 12.62 Hr., and after the project at 5.8 Hr., now it would be running at 0.75 Hr.

This machine would bring savings (see Table 4) in machine set-up of $40,000, plus $316,000 of the drying time that would not have, to be made over $415,000 at run time, it would be a project that exceeds $780,000.

Table 4
Saving Table with a New Machine

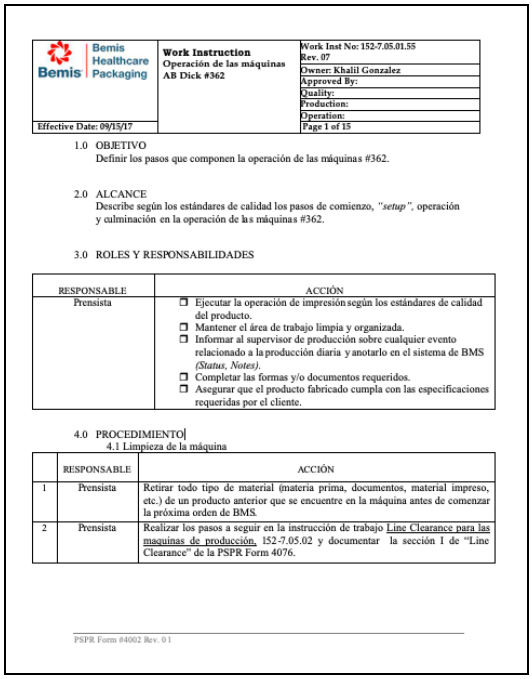
	Normal Process	Lean Process	New Machine
Avg. Order Qty	2,000	2,000	2,000
SetUp (Hr)	*1.01*	*0.84*	*0.25*
Run Time (Hr)	*4.83*	*2.22*	*0.29*
Dryer Time (Hr)	*6*	*0.33*	*0*
EA/HR	*414*	*901*	*7,000*
Hrs. need work daily (Units per day / (EA/HR))	12.62 Hr	5.80 Hr	0.75 Hr
Hrs. need work yearly (Units per Yr./ (EA/HR))	3154.39 Hr	1450.00 Hr	186.59 Hr
PLATES			
Used Yrly.	*300*	*300*	
Price/Plate	*$ 1.80*	*$ 1.80*	
Price/Box			*$ 850*
Roll/Box			*4*
Plates/Roll			*28*
Colors Used			*3*
Operation Expenses	*$ 540.00*	*$ 540.00*	*$ 8,583.48*
WASTE			
Saving Waste (EA)		*79,170*	*50,141*
Saving Waste ($)		*$ 25,730.25*	*$ 16,295.83*
Savings ($)	$ -	$ 334,092.85	$ 780,664.54
SetUp ($)		*$ 9,100.00*	*$ 40,240.20*
Dryer Time ($)		*$ 299,262.60*	*$ 316,680.00*
Run Time ($)			*$ 415,492.00*
Monthly ($)		*$ 24,938.55*	*$ 65,055.38*

Control

"The focus of this stage is to make sure that the action item created in the Improve phase is well-implemented and maintained." [7]

This last phase sees that all the proposed work changes and that we only have to leave them in writing within the work instructions (see Figure 9) so that no operator currently or in the future can alter it.

These work instructions are written from how to operate each button of the machine to how to get a label for the boxes packed with Finished Good. Then, each employee who will work with this machine is trained as supervisors and area manager. After training each supervisor, then, as a project leader, give him the responsibility of complying with the savings proposed to them. Although, I would keep auditing to certify that it is being done as approved.



Bemis Healthcare Packaging

Work Instruction
Operación de las máquinas AB Dick #362

Work Inst No: 152-7.05.01.55
Rev. 07
Owner: Khalil Gonzalez
Approved By:
Quality:
Production:
Operation:
Effective Date: 09/15/17
Page 1 of 15

1.0 OBJETIVO
Definir los pasos que componen la operación de las máquinas #362.

2.0 ALCANCE
Describe según los estándares de calidad los pasos de comienzo, *"setup"*, operación y culminación en la operación de las máquinas #362.

3.0 ROLES Y RESPONSABILIDADES

RESPONSABLE	ACCIÓN
Prensista	❒ Ejecutar la operación de impresión según los estándares de calidad del producto. ❒ Mantener el área de trabajo limpia y organizada. ❒ Informar al supervisor de producción sobre cualquier evento relacionado a la producción diaria y anotarlo en el sistema de BMS *(Status, Notes)*. ❒ Completar las formas y/o documentos requeridos. ❒ Asegurar que el producto fabricado cumpla con las especificaciones requeridas por el cliente.

4.0 PROCEDIMIENTO
4.1 Limpieza de la máquina

	RESPONSABLE	ACCIÓN
1	Prensista	Retirar todo tipo de material (materia prima, documentos, material impreso, etc.) de un producto anterior que se encuentre en la máquina antes de comenzar la próxima orden de BMS.
2	Prensista	Realizar los pasos a seguir en la instrucción de trabajo Line Clearance para las maquinas de producción, 152-7.05.02 y documentar la sección I de "Line Clearance" de la PSPR Form 4076.

PSPR Form #4002 Rev. 0 1

Figure 9
Work Instructions for the New Process

CONCLUSION

After completing this project, the first thing I should highlight is that this project had no capital invested, the same resources were used but in a

better way to benefit the business. We eliminated 3 wastes in the process (Transportation, Overproduction, and Over processing). This elimination results in an improvement of more than 50% in process times (over $300,000) to the company. They must define a time where the processes must be audited by the process engineer to eliminate the waste. They may have within these processes and re-adjust standard times.

It was also possible to fulfill another of the objectives obtained from VoB (Voice of the Business), which was to end the Work In Process (WIP) that took visibility away from the Finance Department whether there was production or not.

We can also talk about the obsolete of the machine, which often provides downtime that is not caused by the operator but occurs during its shift. That is why the search for a new machine that could improve both the process and the quality of impression that the customer wants in your products.

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