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Abstract

The process of manufacturing handcrafted 18ct gold wedding rings is a method widely used by small scale and self-employed manufacturers, this manufacturing method has low investment in labor, equipment, tools and physical space, but this method becomes a both outdated when improvements are needed, in this case the alliance manufacturing process through micro-casting and machining is considered to be one of the efficient ways to produce on a medium scale and requires a slightly larger investment in equipment, and tools that eliminate some processes. idle, generating a higher production volume and a superior finish compared to the artisanal production method.

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1. Introduction

According to [1], the artisan process of making wedding rings is a process that does not require a high financial investment in tools, equipment and physical space. It is possible to manufacture these parts in a physical space of at least 2m², and can hold all the material and equipment in a special furniture for goldsmith called bench. The necessary tools are considered conventional tools in the jewelry industry, some can even be found in hardware stores, such as files, files, drills etc ...

However this craft process is advisable only for a small factory is limited to an average production of a maximum of 20 pieces produced daily by each professional, because this process requires a manual finishing, which no matter how skillful the goldsmith has, is limited due to the time devoted to finishing an alliance.

According to [2] this process of micro casting and machining for alliances is already considered old, but still widely used by medium-sized companies and some self-employed professionals because it does not require a large amount of raw material to make the rings and to It is a much faster and more practical process, with a much higher production volume, while still allowing a high quality final product, without welds and without sandpaper finish on some models. This process is very simple because its tools and manufacturing method are also simple and very efficient. However, its investment in equipment is not very expensive, compared to the large-scale production process, because it is durable equipment, simple maintenance and because it is aimed at a very small audience. 18 carat gold is the main raw material used in this process.

First of all, the whole structure for the workshop should be assembled in a large and airy place, because it is working with high temperatures and with pyrophoric and flammable materials. Safety equipment should be worn such as: scrape apron, scrape gloves or heat resistant fabric, goggles, ear protector and boots with protection at the foot of the shoe. Basic knowledge of mechanical lathe operation, use of calipers, micrometer, gauge, gas torch handling, casting knowledge and precision balance handling is also required.

2 Bibliographic Review

2.1. Foundation for the Preparation of Languages

This process is standard for craft production, micro casting and machining. According to [3], the trader receives a certain amount of 18 karat gold material, duly checked in relation to the quantity and quality of the material and then will be melted in a crucible (ceramic container that can withstand temperatures above 1,000ºC), the material will be placed inside this tool and with the use of a blowtorch will be melted or melted at a temperature of approximately 1,000ºC. Material deposited inside the crucible will continue to receive this torch heat for approximately 10 minutes until it reaches its full melting point and is in its liquid state where it will be poured or deposited on a tool called billet which has a rectangular shape to the extent determined. by the professional. Material poured into the billet hardens in a short time of approximately 10 seconds and the billet is ready.

According to [4], NR-32, occupational safety is very important in this process. The following PPE must also be worn: Leather scrape apron, dark goggles, leather boots and leather scrape gloves. Some professional skill is also required after having undergone all tool and material handling training.

2.2. Lamination Process

After the manufacture of ingots, comes this rolling phase, which according to [5] is a mechanical forming process most used in the industry because it has high productivity, precision and low cost. In this process the ingot or bar passes through a rolling mill which is an equipment with 2 opposite steel rollers or rollers, mounted in a cage driven by a strong electric motor, which compresses the ingot until it reaches its desired thickness. strips) in order to adjust it to the desired measures. In this process the use of leather scrap gloves is indispensable, because despite this process being called cold rolling, the material becomes very hot because it is suffering high compressive stresses resulting from the pressing action of the rollers. Attention is also important in this process as the rolling mill is a device that has great traction capacity that can

mutilate if the operator does not take proper care of its handling.

2.3 Craft Manufacturing Process

At this stage of the process, according to [6] the laminated material will be worked on a goldsmith's bench that has a drawer only to collect the gold residues that remain after cutting, with the help of a ruler the material is cut to the desired extent by the professional with the aid of a hand saw for metals, as this tool does not throw gold residue or dust if a power saw is used, and can be further purified and reused for another jewelry. According to [1] after cutting, these rectangular pieces in their certain measurements will be manually bent with the help of pliers in the shape of a circle, tightly joining the ends of the piece. Now these joined ends will be fixed by welding. The next step is the performance of the formed ring, with the aid of a goldsmith's hammer and a tool called tribulé, the professional turns this ring into a perfect circle. Now with the use of a specific file the professional will shape this ring until forming the alliance in its shape, size and approximate weight, then the piece is finished using a mini rectify or known in jewelry as "whip motor", A small fine metal sandpaper roll is fitted to its mandrel, removing the marks left by the file and adjusting the weight and exact measurement of the ring. Then using a polishing machine and its tools, according to [7] the alliances go through the polishing process to completely remove the sandpaper marks and let them shine. In this process of sanded alliances, there is a small loss of material in the process of removing the sandpaper marks, but some of this material can be recovered using purification.

2.4 Mechanization of the 18ct Gold Alliance Manufacturing Process

According to [2] using more, relatively modern equipment, this process previously done by hand, or by hand, is being improved with regard to the quantity produced, quality of finished parts and better use of raw materials. In this process a centrifuge will be used to manufacture the rings, billets to determine their initial dimensions, a specific lathe for the machining of rings and their locking and cutting tools (tweezers and glass).

For this process is still used the rolling of the bars that will be cut with the help of scissors or small guillotine and form small plates, these will have their weight determined on a precision scale before being turned into rings. According to [8] with a blowtorch the plates will be melted inside a crucible that is in the centrifuge, when it is melted, the centrifuge will be turned on and the metal will be poured into the billet assuming its circular shape and two respective measures.

Ready for the ring, according to [9] this will be finished in a jewelry-specific mechanical lathe, this equipment has the functions of a traditional mechanical lathe, but with faster cutting adjustments and quick coupling tools, this makes the cutting of the rings much faster and snapping in and out of these parts. The cutting tools are also specific for gold machining, they are made of a special alloy steel that make the rings shine, and this means that the parts will not suffer major wear in the polishing process resulting in labor savings, loss of material caused by the sanding process throughout the part and less material to be purified, because according to [10] chips may be easier to purify because they are larger particles than the sandpaper residues.

The alliance mechanical lathe has an average production capacity of 200 alliances per day, depending on the complexity or not of the model, may be able to produce even more parts. It is in the machining process

that alliances will receive their definitive measurements and forms.

3. Tools and Methods

This work was performed in a jewelry manufacturing company located in Manaus - AM, where in addition to rings and pendants, 18 carat gold wedding rings are manufactured, which is the object of the study where information about the manufacturing process was acquired, but , capturing images was not allowed for security reasons to employees and in relation to company policy. It was also researched all existing theoretical material on the subject cited in the bibliography from which were collected the images that are faithful to the theme.

In the analysis of the artisanal process, data were collected from the company's reports on all parts manufactured during one week in May 2019, as well as a daily monitoring of production during the one-week study period. During this period, production capacity averaged 20 alliances per professional per day.

In the analysis of the production process by micro casting and machining, data were collected from the company's reports from all units manufactured in one week in September 2019, and this new process was monitored, the maximum production capacity reached by a professional, was an average of 200 pieces daily.

Then, information was collected from the professionals in the production area for analysis and comparison between the two production processes. During the research period, the processes were monitored and mapped through visits directly to the alliance manufacturing sector. There were interviews with the goldsmiths and the professionals responsible for controlling the production and quality of the finished products.

4. Application of Study

This project aims to present the advantages of replacing the handcrafted or manual alliance manufacturing process by the mechanized process of micro casting and machining increasing the production capacity, using new tools and production techniques, improving the quality of the manufactured product, and reducing costs. . After studying the processes and analyzing the process performance indicators mentioned here, it is evident that replacing the artisanal production process with the process by micro casting and machining is very advantageous, because the investment in these equipments will bring great results to the professional who opts. for this change.

In figure 1 follows the main steps of the craft process:

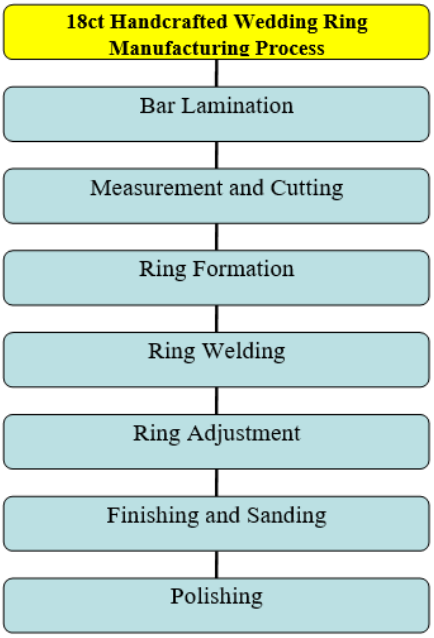


Figure 1: Organograph of the Artisan Process Steps.
Source: Author

Much of this process is carried out on a goldsmith's bench with the tools available or needed to make handcrafted wedding rings as shown in Figure 2.

Figure 2: Golden Workbase With Tools.
Source: [11]

4.1.1 Bar Lamination

In bar rolling, the trader adjusts this material to the desired dimensions on a 2-roll electric rolling mill, as shown in Figure 3, which will compress the bar until it becomes a strip in the dimensions desired by the trader. This rolling mill has some slits at the ends, with different sizes on both rolls, specific to perform the lamination reaching the desired shape and measurements in this process.

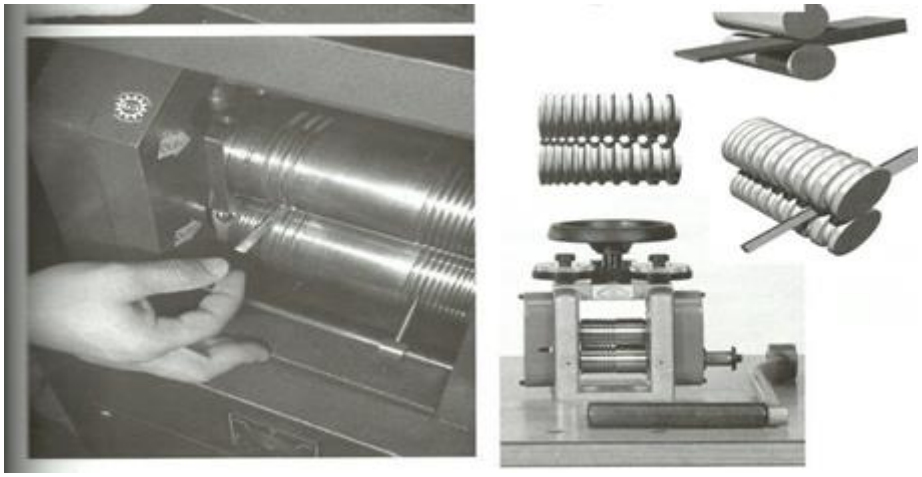


Figure 3: Bar Laminator.
Source: [6]

4.1.2 Measurement and cutting

In the measurement and cutting step, the professional will cut the previously laminated material to the desired measurements, with the help of a ruler or caliper will make the measurement and with a specific saw for goldsmith will perform the cut, as shown in figure 4.

Figure 4: Laminated and Cut Bar.
Source: [2]

4.1.3 Ring Formation

With the material in the desired dimensions, according to figure 5. Now it will be bent with the help of a tribulé and pliers. The goal here is to make this material rounded.

Figure 5: Ring Being Adjusted.
Source: [2]

4.1.4 Ring Welding

In the next step this ring design will have its ends joined by the welding process, using a gas torch and a specific metal alloy, to perform 18 carat gold welding, as shown in Figure 6.

Figure 6: Ring Receiving Welding.
Source: [2]

4.1.5 Ring Adjustment

As shown in figure 7, the adjustment of the ring after welding is intended to make this ring as round as possible using a wooden treble and hammer.

Figure 7: Folding Ring.
Source: [12]

4.1.6 Finishing and Sanding

In this process of finishing by grinding and sanding, is where the alliance will have its final shape defined, as shown in figure 8, this is a longer part of the process, where it requires a lot of skill of the professional, both for the quality of the part, as to be careful about the loss of material that will be reused.

Figure 8: Cleaning and Sanding Finish.
Source: [2]

This process requires great skill from the professional, so as not to lose the dimensions of the pieces, it is also important to be careful with the material being removed from the rings, because it is a raw material of great value, and the material needs to be reused to the maximum. On the workbench the goldsmith has a lined drawer for the allocation of all the waste removed from the rings, to be later purified and reused, as shown in figure 9.

Figure 9: Residue of Resource Material.
Source: [2]

4.1.7 Polishing

Finally comes the polishing process, according to figure 10, the piece is polished with a wear wax on a felt cone inside, then polished on the side gear and everywhere by a felt wheel. then it is cleaned by a cloth wheel and finally polished with a polishing wax with another cloth wheel.

Figure 10: Alliance Being Polished.
Source: [2]

This process ensures the brilliance of ready-made wedding rings. In the case of handcrafted pieces, a slightly more intense polishing is necessary, as all sanding marks left on the pieces must be removed, as a result of this, a greater loss of material in the wedding ring.

In figure 11, follows the main steps of the mechanized process:

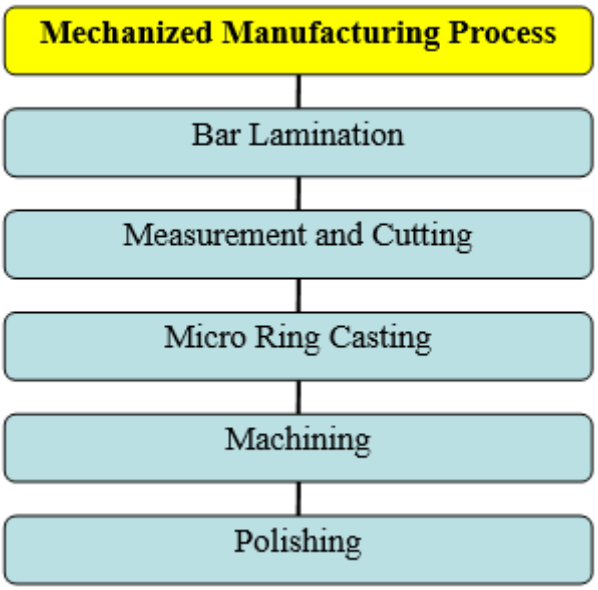


Figure 11: Organogram of Steps of Mechanized Process.
Source: Author

The mechanized process was the main study material here, it is in this process that there is a medium investment in equipment (lathe for rings and centrifuge for rings) as shown in Figure 12, compared to the artisanal process, but there is a great evolution in the process in which it concerns the quantity produced, product quality, labor economy and raw material economy. Following are the process steps for machining and micro casting.

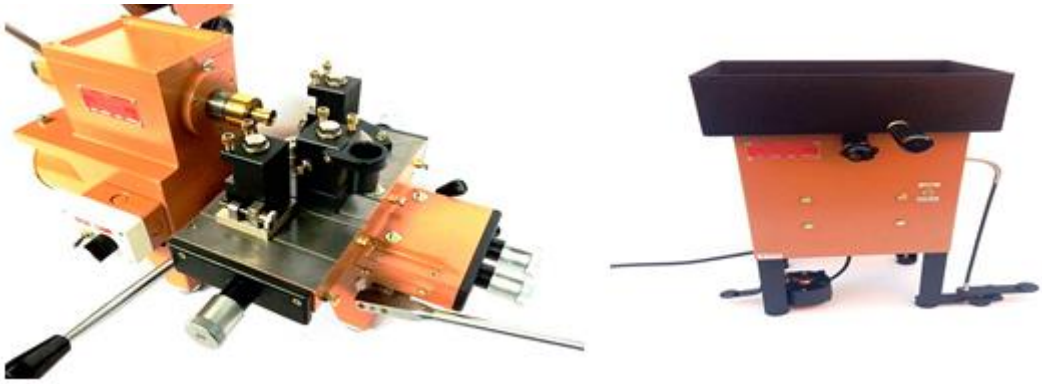


Figure 12: Mechanical Make and Centrifuga.
Source: [11]

4.2.1 Bar Lamination

As the bars are already ready-made as 18K gold in the process, our process already begins to laminate the bars, with the intention of making them thinner for easier cutting and adjusting the small plates formed to the correct weight. In this case the dimensions of the laminated strip do not need to be exact, because in this case, the important thing will be the weight that the pieces will be cut. The bars will be rolled between two rollers of the electric rolling mill shown in figure 13, the smooth part of the rollers will be used in the middle part.

Figure 13: Laminator and Laminda Plate.
Source: [12]

4.2.2 Measurement and Cutting

In this process the laminated bar that is in the shape of a large strip will be cut and with the help of scissors or a small guillotine shown in figure 14. A precision balance will also be used to measure the weight of the plates to be transformed into hoops in the next process.

Figure 14: Cutting Scissors for Sheets.
Source: Mechanic 2019 Store

4.2.3 Micro Ring Casting

This process is where the previously cut plates will be fused into a crucible in the centrifuge, the torch is used to melt the sheet metal when it is melted, the centrifuge is turned on and the molten metal is thrown into the billets, where it will receive the ring shape as shown in figure 15, in their respective measurements. The advantages of this process are that the rings are produced faster, with a perfect shape, where no adjustments will be necessary, no imperfections in the molten metal (pores) and no welding required.

Figure 15: Centrifugal ring cast.
SOURCE: [2]

As shown in figure 16, billets are small iron blocks in circular shapes that have different sizes, where the trader uses the extent to which the alliance will be made. A cup called a shell is also used, which is fitted to the top of the billet that serves to channel the molten metal, shape the side of the piece and is where the finished ring is removed.

Figure 16: Turbs and Shells.
Source: [2]

4.2.4 Machining

The process in which the rings are made by machining, the ring that was produced in the previous process will now be worked on a specific lathe for machining these rings, as shown in figure 17, it will first be fitted to the outer collet for wear. The inner part of the ring, with the intention of roughing the piece, is then cut by a video on the side to determine its dimensions, then the internal cut is made to leave the piece in the right shape and size of the ring and then cut. by a video on the side to determine its dimensions, then the internal cut is made to leave the piece in the right shape and size of the ring.

Figure 17: External Pipe and Ring on the Pipe.
Source: [2]

Ready this step of machining, now this ring will be fitted into an internal clamp to do the work on its outside, where it will receive its weight and final shape. An external video will be used to cut this part as shown in Figure 18. A precision scale will be used to measure the weight of this ring.

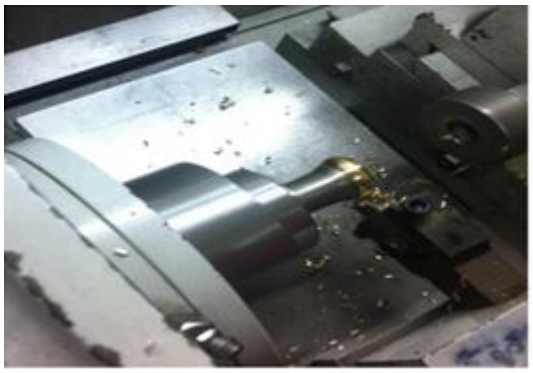


Figure 18: External Videos and Internal Pins.
Source: [2]

As we can see in figure 19, the machining process also allows the professional to perform more uniform finishes on alliances such as channels or combinations of shapes that in the artisanal process, are even possible, but do not have the same aesthetic quality and the execution time is longer. much longer.

Figure 19: Ring Being Machined.
Source: [2]

4.2.5 Polishing

The polishing process here is not very different from the piece that is manufactured in handcrafted format, because the same tools and techniques will be used to perform this process, as we can see in figure 20.

Figure 20: Alliance Being Polished.
Source: [2]

The machined alliance has the advantage of not being sanded and requires less intense polishing, which means that the loss of matter will be shorter and the work execution time will be shorter.

5. Results and Discussions

The results obtained during the study period were evaluated the performance indicators of each process compared and analyzed, and this work aims, through these process indicators, to highlight the advantages obtained in the mechanized production process compared to the artisanal process, with respect to the quality of parts, quantity produced, raw material savings and process costs. The results were acquired from the research cited here, books and a jewelry company. Analyzes and comparisons of both processes, manufacturing time, tools used, tool investment, quality of parts manufactured, and economy of raw material.

The mechanization of the 18ct gold ring manufacturing process proved to be very positive, regardless of whether the investment value is somewhat higher compared to the artisan process, the return is a short time given its advantages, because with the use From this new technique it was possible to increase the production of wedding rings from an average of 20 pieces to 200 pieces manufactured daily by each person over a period of 8 hours as shown by a chrono analysis performed within a week of production. Alliances that once had a solder point now do not have this need, even because a solder point, with the wearing time of the alliance, tends to be a different color from the rest of the piece because its alloy is different from 18k gold alloy. Another positive point is that the machining of the rings leave chip-like residues that are easier to reuse the material, since in the process of grinding and sanding, the residues are more difficult to recover and have a definite loss of material much higher than in the process. Machining Another point is the advantage of eliminating the use of sandpaper on the parts because the cutting tools already let these rings shine, which will facilitate the process of polishing in relation to process and material loss.

A comparison of both methods of producing the alliances was performed over a week, and the result

represented by a graph was obtained.

Table 1: Manufacturing Time by Craft Process per Minute Each 20 Pieces.

CRAFT PROCESS	QUANTITY OF PARTS	PROCESS TIME FOR MINUTES
LAMINATION	20 PCS	40 MINUTES
MEASUREMENT AND CUTTING	20 PCS	20 MINUTES
RING FORMATION	20 PCS	40 MINUTES
WELDING	20 PCS	30 MINUTES
RING ADJUSTMENT	20 PCS	60 MINUTES
CLEANING AND SANDING	20 PCS	260 MINUTES
POLISHING	20 PCS	30 MINUTES
7 PROCESSES	20 PCS	480 MINUTES

Source: Author

Table 2: Manufacturing Time by Process Mechanized For Minutes Each 200 Pieces.

CRAFT PROCESS	QUANTITY OF PARTS	PROCESS TIME FOR MINUTES
LAMINATION OF BARS	200 PCS	50 MINUTES
MEASUREMENT AND CUTTING	200 PCS	60 MINUTES
MICRO FOUNDRY	200 PCS	90 MINUTES
MACHINING	200 PCS	100 MINUTES
POLISHING	200 PCS	180 MINUTES
5 PROCESSES	200 PCS	480 MINUTES

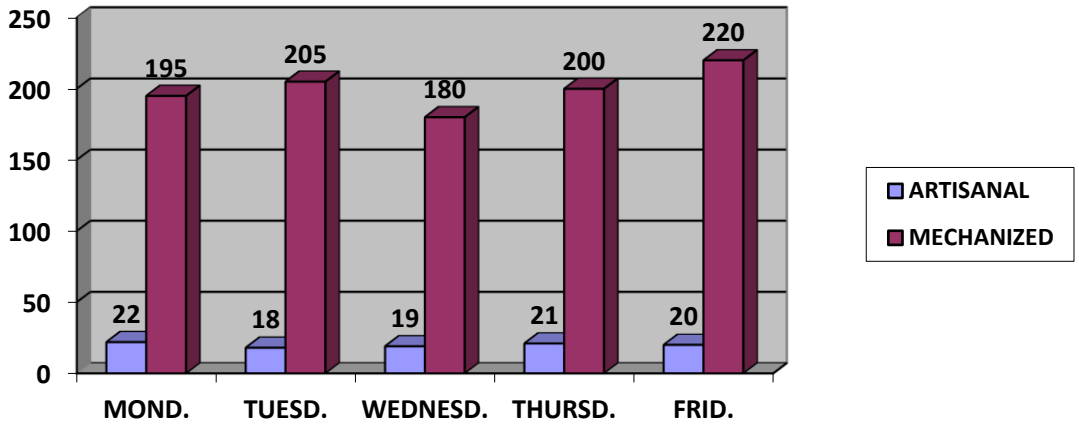
Source: Author

The table 3 below represents the handmade and mechanized comparison of the production of 18ct gold wedding rings in the period of 1 week. From then on the average was taken from the weekly production, and the result of the comparison by the handmade process of 20 pieces daily and the mechanized of 200 pieces daily.

Table 2: Production week

METHOD	DAY 1	DAY 2	DAY 3	DAY 4	TOTAL WEEK	AVERAGE
	MOND.	TUESD.	WEDNESD.	THURSD.		
ARTISANAL	22 PCS	18 PCS	19 PCS	21 PCS	100 PCS	20 PCS
MECHANIZED	195 PCS	205 PCS	180 PCS	200 PCS	1,000 PC	200 PCS

In graph 1, it is possible to verify the comparison of both production methods, a big difference that brings a productive result, very positive for the company.



Graph 1: Comparative Between Daily Production in Artisanal and Macanized Methods.
Source: Author

In addition to the production capacity, a comparison was also made using the 5W2H tool between the improvements that the mechanized process brought to the manufactured alliances.

DEFECTS AND IMPROVEMENTS	ARTISANAL	MECHANIZED
Welding mark	It has	Don't have
Sanding	Need	It is not necessary
Irregularity in the part	It has	Don't have
Good quality finish	Don't have	It has
Quantity produced	Low	High
Tool Investment	Low	Medium
Professional Skill	High	Medium

Table 4: Comparative Of The 2 Alliance Manufacturing Methods.
Source: Author

6. Final Considerations

Most of the time a large jewelry factory starts as a small artisan workshop, and most of the time this workshop starts in a small space at the professional's own residence, depending on the acceptance of his work in the market, this small workshop becomes a small business, and hence the need for investment in better equipment and improved techniques for the development of activities, aiming at process improvement, product quality and profitability of the company.

A small workshop usually does not have a large investment in tools, but as the business grows, new technologies and tools are adopted as the need for increased production and quality of jewelry.

In this case here, artisanal manufacturing is being replaced by a mechanized process that increases the production capacity, and with a higher quality the alliances produced by handcraft. There are more modern equipment that perform the same process as mechanized, but are much more expensive equipment and require a greater amount of raw material than the tools used in the mechanized process. Because 18k gold

is a very expensive material, the use of certain equipment would not be feasible for the manufacturing process in a midsize business.

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