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Automatic shoe embossing machine integrated with real-time data cloud system to improve SMEs footwear productivity

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Abstract. The primary function of the automatic shoe embossing machine integrated with a real-time data cloud system is to enhance the shoe manufacturing process by imprinting designs onto leather shoes, while simultaneously collecting and transmitting production data for monitoring and analysis. This research project aims to design and develop a cutting-edge shoe embossing machine. To achieve this, we employ a Raspberry Pi-based cloud system to gather and store production data in a database format, allowing for real-time monitoring and operator feedback. The research methodology encompasses several stages, including design, manufacturing, assembly, operational testing, performance evaluation, and data analysis. In conclusion, this research project demonstrates the successful development of an automatic shoe embossing machine integrated with a real-time data cloud system. This innovation streamlines the shoe manufacturing process, ensuring high-quality embossing while providing valuable real-time production data for enhanced control and decision-making.

1 Introduction

After several centuries of industrial progress, the era of Industry 4.0 has arrived in modern times. In 2011, the idea of Industry 4.0 was first put forth to help the German economy grow [1]. The first industrial revolution was typified by mechanical production plants using steam and water power at the end of the 18th century. The second industrial revolution was typified by mass labor production using electrical energy at the beginning of the 20th century. The third industrial revolution was typified by automatic production using electronics and internet technology in the 1970s. Currently, the fourth industrial revolution, known as Industry 4.0, is underway, with the features of cyber-physical systems (CPS) production based on heterogeneous data and knowledge integration [2]. CPS's primary responsibilities are to increase the efficacy and efficiency of the whole sector while meeting the flexible and dynamic demands of production [3]. Cloud-based manufacturing, the Internet of Things

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(IoT), RFID, ERP, cloud-based radio frequency identification, and social product development are just a few of the technologies and related paradigms that are included in Industry 4.0 [4].

The manufacturing industry is becoming more competitive than it has ever been, and manufacturing organizations are facing a variety of challenges as a result of sophisticated markets, shifting consumer preferences, and international rivalry [5]. Multinational corporations and imports compete with Indonesian industry in the country's markets. Manufacturers must possess a variety of skills in the globalized market, including quality, delivery, flexibility, and pricing [6]. Companies must focus on this crucial component if they want to maintain a competitive edge in the manufacturing sector, which is the efficient and effective management of resources and operations. Manufacturing companies are beginning to recognize and use productivity improvement (PI) as a competitive strategy. Productivity is a concern for organizations involved in manufacturing [7]. Consequently, manufacturing organizations are placing a greater emphasis on productivity and PI as a means of competing [8].

Small and medium-sized businesses, or SMEs, are the backbone of the manufacturing sector in developed nations like our own [9]. As of right now, SMEs are thought of as the foundation of the Indonesian economy. 99% of all businesses in Indonesia are SMEs, and they make up a significant portion of the country's revenue. This accounts for up to 97% of workers and more than 50% of Indonesia's GDP overall [10]. According to data from SME (2011) and the Ministry of Cooperation, there are 55.530.000 SMEs in Indonesia. Thus, maintaining the SME sector's competitiveness is crucial for the nation's economy as a whole as well as the manufacturing sector's overall growth. For SMEs, globalization offers both opportunities and challenges [11]. SMEs must become more competitive to thrive in an environment where tariff protection is fast eroding. SMEs that are internationally competitive enough to gain admission into the global value chain can take advantage of growth opportunities in a global marketplace [12]. If the others are to survive, they will have to change how they operate and become more competitive to face the difficulties [13].

An increasing number of SMEs are businesses that sustain the Indonesian economy on an annual basis. The Indonesian Ministry of Cooperatives and SMEs report that from 2015 to 2019, SMEs' growth rate increased [14]. The data does not accurately represent the total number of SMEs because the number of SMEs listed is an approximation. This is because there are a lot of SMEs and it is challenging to record them because the majority of them have not yet registered their businesses.

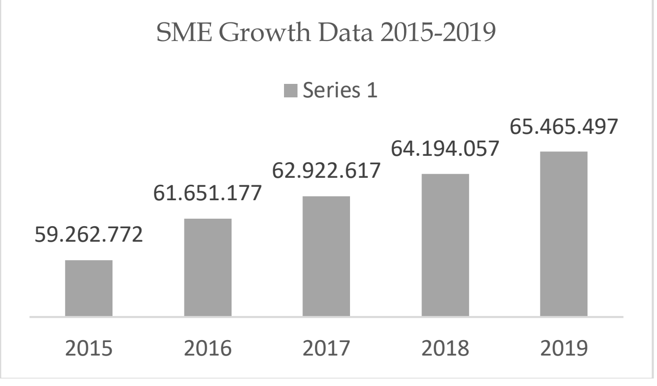

Fig. 1. SME Growth Data 2015-2019 Ministry of Cooperatives and SMEs of the Republic of Indonesia

In 2021, the government launched the Online Single Submission - Risk Based Approach (OSS RBA) platform which can be accessed via www.oss.go.id. This website is used as a medium for registering business permits in Indonesia for business actors. By 2022, the number of SMEs that have registered their businesses on the OSS platform has reached 8.71 million units. For the East Java province region, there are already 1,153,576 registered SME units. Indonesian SMEs still face numerous challenges today [15], such as funding scarcity, inadequate technology, and a lack of expertise in production and company management. Despite the existence of SMEs, this is a crucial component of economic growth. It appeared that the Indonesian government was having trouble keeping SMEs operating continuously. Although the government has launched a program to assist small and medium-sized enterprises (SMEs) with soft loans, the initiative has not yielded significant results thus far, primarily because of incomplete and inaccurate information. The research of Utomo and Dodgson (2001), which explains why the adoption of information technology in Indonesia is so slow, supports the theory that this explanation may be due to information technology hurdles that occurred in Indonesia [16]. The reason for this is that not all locations have received equal coverage from the infrastructure, which is still operating slowly.

To succeed in an environment that is changing quickly, small businesses with tight budgets need specific "tools" to be developed [17]. These tools need to be easy to use and, most importantly, they need to change the companies in a big way when they are put into use. Industry-wide technical advancements open up new avenues for businesses to undergo digital transformations and provide cutting-edge goods and services.

One of the SMEs in East Java is Footwear. This SME still lacks adequate production technology support and poor business management, especially financial management, causes the quality and quantity of products produced to be low, so that their products are less popular with consumers.

Fig. 2. Brand label manual process on the insole

One of the production aspect problems that need to be resolved immediately is the process of labeling leather shoe brands. The process of labeling shoe brands is currently done by cutting brand labels screen printed on fabric and stitching them onto the inner lining of the shoe (insole), this takes a long time, starting from cutting, sewing, and inserting the insole into the shoe takes ± 2.5 minutes, the results are not good, do not provide added value in terms of appearance, fade quickly and even fall off. This method is ineffective, inefficient, and requires higher production costs. To increase the quality and quantity of production effectively and efficiently, innovation in production technology for leather shoe brand label printers is needed, namely a semi-automatic electrical energy leather embossing press machine. To print a brand with this semi-automatic electric energy leather embossing press machine only takes ±5 seconds, the quality is very good, beautiful, and attractive, provides added value in terms of appearance, elegance, luxury, and classy, and does not fade for a long time. This can increase product competitiveness and consumer satisfaction. By using a semi-automatic leather embossing press machine with electrical energy, the production capacity for shoe brand label printing can be increased 30 times faster, with better quality.

2 Methods

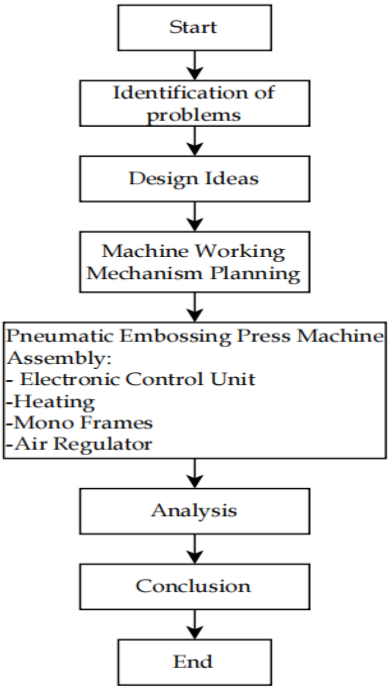

Fig. 3. Research Flowchart

The planning for making this embossing press machine was carried out in stages. This machine utilizes pneumatic power as a mattress pressure calculator whose pressure is adjusted. There is a control box to turn the heater on and off. The following is the flow of how an embossing press machine works with pneumatic power.

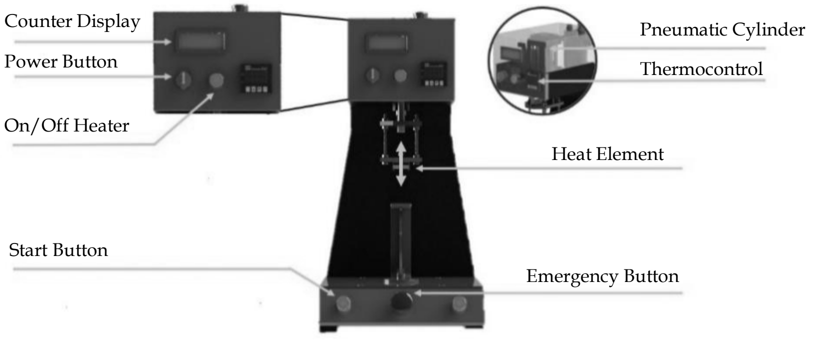

Fig. 4. Machine Mechanism

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1. The Heater button turns on the heating element according to the set temperature (+/-10 minutes before use)
2. The start button is used to activate the actuator (cylinder pusher) to press down and hold it for the pre-set time, then the pressing profile will return to its initial position.
3. The heating element can move up and down driven by a pneumatic cylinder. The number of 1x embossing processes will be calculated and displayed on the counter display screen

Our focus is on the problems related to collecting, delivering, and analyzing critical machine-embroidered data. We suggest that the time-consuming manual note-based solutions are in use today. Furthermore, it creates a barrier to real-time data access, making monitoring and troubleshooting more difficult. Additionally, we have provided a method that uses the Raspberry Pi cloud to automate this process, from data gathering to information display. The Raspberry Pi serves as the entry point for processing the sensor data [18, 19]. All of the current equipment is linked to sensors. Afterwards, exchange services are connected to these devices. When the data is accessible on the cloud, expert systems can process it or send it to the LED Display for review.

3 Results and discussion

3.1 Design and specification of emboss press machine

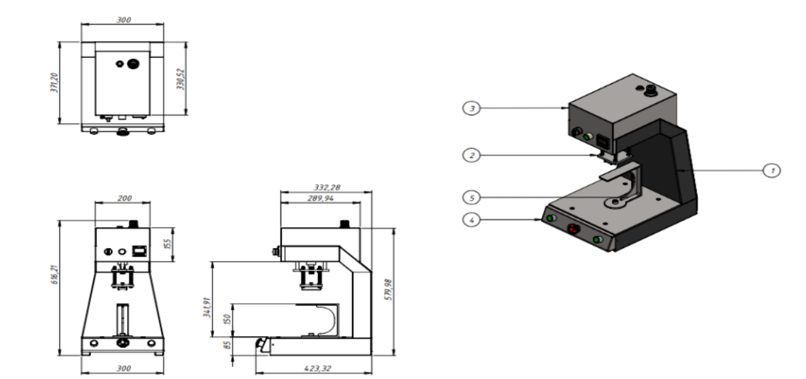

Fig. 5. Drawing of Emboss Press Machine

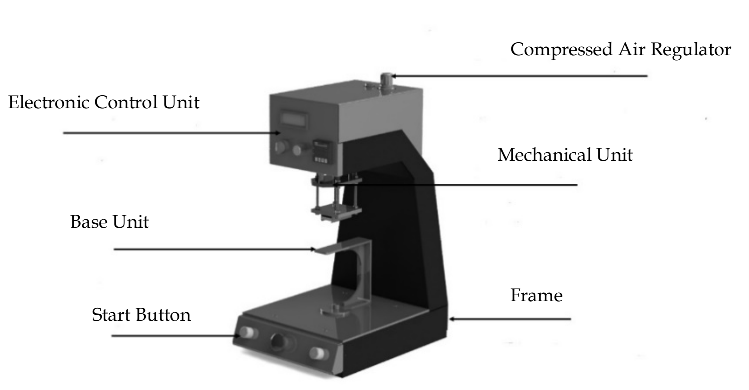

Fig. 6. Specification Machine

1. Air Regulator: Regulates pressure and separates water content from compressed air input
2. Electronic Control Unit: Regulates the temperature and time of the embossing process
3. Mechanical Unit: Heating profile pressing actuator that can be adjusted for pressing distance
4. Base Unit: Place to place the material that will be embossed
5. Frame Unit: Mono frame as a mount for each machine component
6. Start Button: Active button for the embossing process

The following are specifications for engine dimensions, weight, capacity, working temperature, engine power and air pressure:

Table 1. Specifications

Nu	Description	Grade	unit
1	Dimension	425x300x620	mm
2	Weight	19.5	kg
3	Print Capacity	+/- 12	Print/min
4	Temperature	Up to 210	°C
5	Engine Power	250	Watt
6	Air Pressure	<1	Bar

The Internet of Things, or IoT, is a network of electronically connected physical items. The term "thing" in the Internet of Things refers to objects that have been given an IP address and are able to gather and send data across a network without the need for human aid or intervention [20]. Examples of such devices include people wearing heart monitors or cars with built-in sensors. Decisions are influenced by the items' ability to interact with their internal states and external surroundings thanks to embedded technology. Here, the notion of the Internet of Things is combined with two distinct ecosystems: Arduino and LED Display.

Ultimately, these are to be used in the development of a digital color controller. The goal of this project is to create a smart mirror that can display information such as displays the number of times the machine has embossed the leather. Use of the Raspberry Pi is required for all these clever features. The use of a smart mirror allows for time savings. 1.2GHz quad-core 64-bit Broadcom BCM2837 CPU with 1GB RAM This BCM43438 features an on-board 40-pin extended GPIO (General Purpose I/O) with wireless LAN and Bluetooth Low Energy (BLE); four USB 2.0 ports, four-pole stereo output, and a composite video port for analog video transmission; full-size HDMI (High Definition Multimedia Interface); a CSI (Camera Serial Interface) display port for connecting a Raspberry Pi touchscreen display; a

Micro SD port for storing data and loading your operating system; upgraded to a 2.5A switched Micro USB power source.

3.2 SMEs productivity

To anticipate complaints of musculoskeletal disorders (MSDs) among MSME footwear workers, prepare tools that meet comfort or ergonomic standards to carry out the work process. Ergonomic approaches and evaluations have been applied in many ways. An example is in designing products, laying out layouts, work facilities, and workplaces with the main aim of being more effective, comfortable, safe, healthy, and efficient (ENASE). With this embossing press machine, workers do not need a long time in the label-making process. The increase in the number of assets obtained from the addition of 1 unit of embossing press machine means that the assets of partner shoe SMEs will increase/increase. Turnover increases. By using a manual system (the label needs to be sewn on first and then placed on the shoe) you can only print a label on one shoe in ± 3 minutes or 10 pairs of shoes per hour. The production capacity of this embossing press machine is 12 labels per minute in one embossing process or can emboss 360 shoe labels/hour. So, this automatic embossing press machine is able to increase production capacity ± 36 times greater than the manual labeling method with a sewing machine.

4 Conclusion

A type of heat press machine for printing brands on shoe leather, the electric energy semi-automatic leather embossing press machine (also known as a shoe stamping machine) has a pneumatic cylinder that is outfitted with a temperature controller (Thermocontrol) and an embossing heating element (heat embossing). With a 220 Volt electrical source, the temperature of the analog thermometer used in this machine can be raised to a maximum of 210°C. For example, this Semi-Automatic Leather Embossing Press Machine uses electric energy to print brand labels in ±5 seconds, which is 36 times faster than screen printing, cutting, and sewing using a sewing machine to create shoe brands. This works well and efficiently.

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