Design and Fabrication of a Prototype Automated Instant Noodle Vending Machine

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***Abstract*—The project aims to help people especially those who are working in call centres to enjoy eating noodles easily and quickly during their short breaks. The unique feature of this instant noodle vending machine is that it eliminates the use of plastic or paper cups during dispensing. Instead, cooked noodle mix is directly dispensed into the mug provided by the user. The working prototype is flexible to dispense crushed noodles, four different flavours to choose from, and hot water. The dispensing process is sequential which starts from the detection of the cup, crushed noodles dispensing, seasoning dispensing based on the desired flavour, and lastly, the water injection. The researchers were able to design and fabricate the machine based on set standards with an acceptable percent error which are within the tolerance limits. The working prototype was fabricated, and statistical results showed an acceptable range of values.**

***Index Terms*—Instant Noodle; Vending Machine; Automated Prototype.**

I. INTRODUCTION

The world is rapidly changing from the traditional millennia into a world of new materials, processes, and innovations. People continue to seek for convenience which emerges greater challenges for scientist, inventors, and engineers. More and more technologies are invented to address the insatiable needs and wants of the people. One of these technologies is the vending machine. A vending machine is a machine that dispenses products such as snacks, beverages, tickets, etc. automatically, to the user after inserting currency or credit to the machine. Vending machines come in different types which suits different purposes. Nowadays, vending machines are widely used in many public areas such as schools, malls, markets, and even beside public streets [1-3].

Cup noodles can be considered as lifesavers when hunger strikes or when the fridge is empty. Instant noodles provide a good alternative to quick in-between-meals or break time snacks in many kinds of daily life situations. Unfortunately, instant noodles cannot be bought when shops and stores are already beyond business hours. With this, the researchers have found an alternative way in which people can buy cup noodles at any desired time. The introduction of the cup noodle vending machine is the solution found to keep cup noodles available at any given time. The cup noodle vending machine has proven its importance throughout the years for providing a quick snack that is sometimes substituted for breakfast, lunch, or dinner [7].

The noodle vending machine is one variety of vending machines that dispense noodles and hot water after inserting currency into the machine. However, the currently existing type of this machine is a manually unpacked cup noodle vending machine [7]. Cup noodle vending machines do not dispense crushed noodles directly into the cup. In this type, a certain amount of noodles is initially packed into a sealed plastic cup like the ones that can be bought from the supermarket which is the one dispensed. The user manually unseals the cup; then the hot water will dispense. This process can be quiet tedious for some users due to the extra time spent during the unsealing process [7].

The Business Process Outsourcing (BPO) sector is one of the booming industries in the Philippines today. BPO involves in the contracting of the operations and responsibilities of many business functions to a third-party service provider. In the Philippines, the call centre sector comprises 80% of the total BPO industry.

Call centre agents are one of the busiest people in the workplace [6]. The stressful and hassle time they experience in their work sometimes disables them to take their meals properly. According to [4], Filipinos love to eat noodles as a substitute for rice or snacks especially during the peak hours of their work. Cup noodles have been a famous snack in the country especially to people who work all day and do not have time anymore to buy in fast food chains with longs lines of waiting customers [4,6]. Call centre agents do not have the luxury of a long time to rest or eat during their break time.

Night shift call centre agents experience worse for most stores are probably closed and considering that buying is done manually [5], there is a need for an automatic product vending machine An automated instant noodle vending machine is necessary for the BPO industry especially in call centres. The availability of these machines in the pantry of each call centre office not only saves time for the employee but also saves money because it is affordable.

The development of an automated instant noodle vending machine eliminates the hassle of buying food outside and is even made more comfortable because of the elimination of the unpacking process of the noodles. In here, the customer may bring their own cup and dispense the desired flavour of noodle mix.

The general purpose of this study is to design and fabricate an automated instant noodle vending machine to provide faster and quality food service for call centre workers who do not have the luxury to buy food outside the office during break time. The proposed design wishes to eliminate the cup that comes with the vending process. Instead, crushed noodles are directly vended into the mug or cup owned by the user.

II. MATERIAL AND METHODS

This research aims to design and fabricate an automated instant noodle vending machine to provide faster and quality food service. The design of the mechanical parts of the proposed is implemented using AutoCAD software. The internal and external layout was made after considering all the mechanical and electrical components to be used and were based on the vending process description. Figure 1 shows the 3D design of the machine both internal and external.

Figure 1: 3D Model of the Machine

The machine chassis was made from aluminium angle bars 3 cm x 3 cm and acts as the support or framework of the whole machine. It consists of four vertical pillars, which are fixed from the bottom and the top with two 25 cm x 25 cm square trays as well as the middle tray. The Upper Tray is a 25" x 32" rectangular tray with a thickness of 1.3mm made from galvanised iron sheets. It is one of the major trays since it houses the boiler, the refill/reserve tank, the microcontroller, and the water supply. The tray was bent at a 90-degree angle across the 20-inch mark to allow for the placement of the refill tank. The elevation of the refill tank was to allow the water to flow freely into the heater through gravity. The middle tray is a 25"x25" square tray with 1.3 mm thickness made from galvanised iron sheets. The middle tray houses the noodle and seasoning dispensing unit. These include the noodle and seasoning canisters and the DC geared motors which drive the canisters. Since the shaft of the motor is different from the driver shaft regarding size, each DC motor is directly coupled to a coupling which transmits the power from the motor shaft into the drive shaft which is then to the screw conveyor inside each canister. Also, ½ inch folds along the sides to accommodate rivets on the machine chassis. The lower tray is a 25"x25" square tray with 1.3 mm thickness made from a galvanised iron sheet. It serves as the base of the whole machine, and it also houses the 12V stepper motor which drives the rotating disk. Also, rollers were installed inside the square which is near the midpoint of the sides. The roller helps the disk to rotate freely and makes sure that the disk is balanced. The rotating disk was made from an aluminium sheet with a dimension of 23 cm radius and 1.5 mm thickness. Aluminium sheet was used instead of a GI sheet for the rotating disk so that the stepper motor would exert a higher torque. The machine casing is panels made from galvanised iron sheets with a thickness of 1.3 mm. The front panel contains openings for the "LED" indicators and pushes buttons. It also contains an opening for the cup placement on the disk. The back panel contains an opening for the canister placement and maintenance. The left and right panels are identical. It has an opening for the canister opening and maintenance. The top cover is a simple square panel with a 4 ½ inch hole located at the upper middle portion of the panel. The opening is to for the water tank to enter the reserve tank located inside the machine.

The internal part of the machine comprised of mechanical systems such as the boiler and water injection system, noodle and seasoning dispensing canisters, ventilation system, roller supports, electronics and control systems.

The instant noodles vending machine offers options for three different flavours to choose from namely Beef, Chicken, and Spicy Beef. Crushed noodles are used instead of regular noodles to eliminate the use of spoon and fork. Instead, the noodle mix can be eaten directly just be drinking from the mug.

The following are some of the features incorporated into the machine.

- Up to 3 choices of flavours and is flexible of adding one more flavour in the future if needed.
- Sequential Vending Process
- Water Tank Flow Meter
- The process does not start unless the cup sensor senses a cup placed.
- Noodle and seasoning availability manual monitoring.
- Faster vending process compared to existing noodle vending machines.
- Heater Security Temperature Sensor
- Electric Fuse is installed as well
- Ease of operation

Special Feature:

Eco-friendly and Time-saver- the machine does not use plastic or paper cups for the dispensing. Instead, users are prompted to provide their own mug. Also, compared to existing noodle vending machines where the user manually opens a pre-packed noodle mix, it saves time and effort. Figure 2 illustrates the vending process flow.

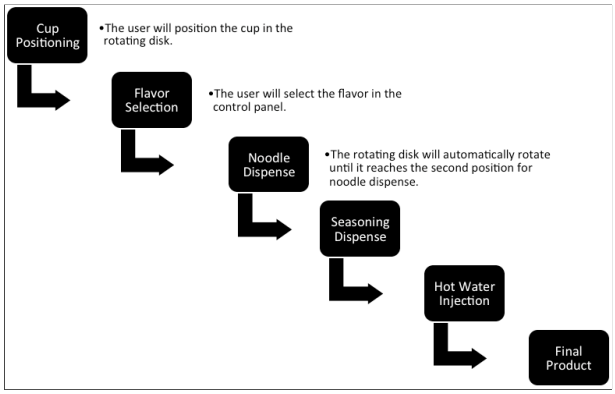

Figure 2: Vending Process Flowchart

III. RESULTS AND DISCUSSIONS

This section details the testing that was made to calibrate the dispensing amount and time for the noodles, seasoning, and water injection. Proper dispensing measurements accuracy is required so that the noodle mix will have a definite proportion of ingredients for good taste. The number of noodles dispensed was calibrated by measuring the time required to dispense 10 grams of noodles. A digital balance was used to measure 10 grams at each specific time duration. Table 1 shows the amount of noodles manual calibration results.

Table 1
Amount of Noodles Manual Calibration Results

Trial	Time (s)	Quantity(g)
1	5.6	10.1
2	6.1	11
3	5.6	10.4
4	5.1	9.8
5	5.2	9.8
6	5.2	10
7	4.8	10
8	6.2	10.5
9	5.1	9.8
10	5.1	10.1
Average	5.4 s	10.15 g

From the data collected from the test, it was seen that the average amount of noodles is 10.15 grams which are within the ±3% tolerance set by the company. The percent error is 1.5% which is within the tolerance limit. The standard deviation is 0.364 and a variance of 0.1325. Median is 10.05, and the correlation coefficient is 0.83385. A lower standard deviation indicates that the data points or samples are closed to the expected value. Variance measures how far a set of data points is spread out. A value of variance nearer to zero means how the value is identical or consistent. Therefore, 5.4 seconds of dispensing time are within the acceptable duration to dispense the needed amount which is 10 grams.

The result reflected in Table 1 is based on actual testing. The theoretical approach was not applied in the noodle calibration since the bulk modulus of the noodles gives a high source of error. The spaces between the noodles mean that multiple spaces are present in the dispensing process. The researchers had decided not to involve the theoretical approach because of a high chance of error in the computation. The noodle amount dispensing calibration were all based on the actual experiment. The DC gear driver motor rotates at 25 RPM.

It is seen from Figure 3 that the number of noodles varies in different time durations. The average amount of noodles is 10.15 grams in an average time of 5.4 seconds. Therefore, 5.4 seconds was programmed into the microcontroller that determined the total amount of time that the DC gear motor runs for the noodle dispensing. Figure 4 illustrates how the noodle amount for each trial deviates from the 10-gram standard. The relationship is linear which means that as the number of time increases, the dispensed amount also increases. The correlation coefficient indicates a value nearer to one which means that the relationship between the two parameters measured is almost linear.

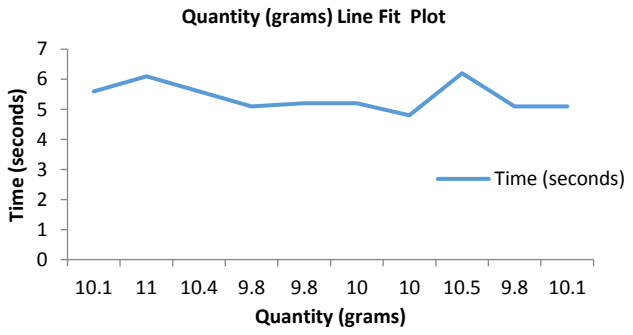

Figure 3: Noodle Quantity and Time Variation Plot

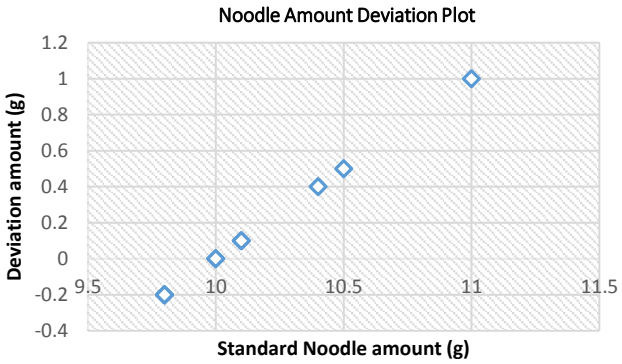

Figure 4: Noodle Amount Deviation from the Standard Amount of 10 grams

The amount of powdered seasoning to be dispensed in each canister was measured by computing the capacity of the screw feeder and comparing it with the actual experiment. 3.75 grams of seasoning is needed to be dispensed in each serving. In the actual testing, a digital balance was used to measure 3.75 grams of powder at each specific time duration. Table 2 shows the amount of seasoning manual calibration results.

Table 2
Amount of Seasoning Manual Calibration Results

Trial	Time (s)	Quantity(g)
1	2.4	3.5
2	2.5	3.5
3	2.5	3.6
4	2.7	3.6
5	2.6	3.7
6	2.8	3.8
7	2.8	3.8
8	2.7	3.6
9	2.6	3.7
10	2.5	3.5
Average	2.61 s	3.63 grams

From the results in Table 2, it was indicated that the average amount of seasoning is 3.63 grams which are within the ±3-4% tolerance limit set by the company. The percent error is 3.2% which is within the tolerance limit. The standard deviation is 0.11, and the variance is 0.0121. The median is 3.6, and the correlation coefficient is 0.8181 This value indicates that the data samples are close to the expected value since both gave a lower value. Therefore, 2.61 seconds of dispensing time were within the acceptable duration to dispense the needed amount which is 3.75 grams. The DC gear drive motor for the seasoning canister rotates at 25 RPM as well.

The capacity of the screw feeder from the theoretical approach was 1.13 grams/ sec while the capacity from the actual testing is 1.39 grams /sec. The percentage difference of 20.63%. The percent difference in the flow rate may be accounted for the spacing between the granules of the seasoning. The researchers expected the result since the seasoning is not very compact during the actual dispensing.

It was seen from Figure 5 that the amount of seasoning varies in different time durations. The average amount of noodles is 3.63 grams in an average time of 2.61 seconds. Therefore, 2.61 seconds is the one programmed into the microcontroller that determines the total amount of time that the DC gear motor will run for the seasoning dispensing. Figure 6 illustrates how the seasoning amount for each trial

deviates from the 3.75-gram standard. The relationship is linear which means that as the number of time increases, the dispensed amount also increases. The correlation coefficient indicates a value nearer to one which means that the relationship between the two parameters measured is almost linear.

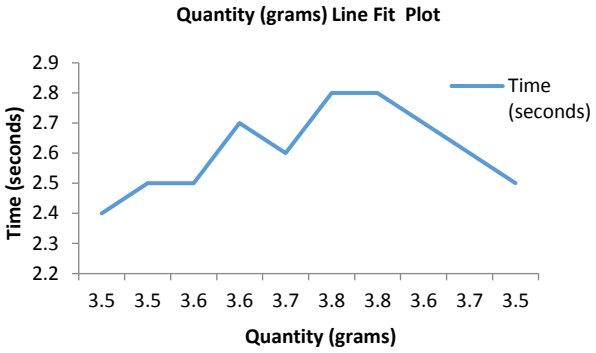

Figure 5: Seasoning Quantity and Time Variation Plot

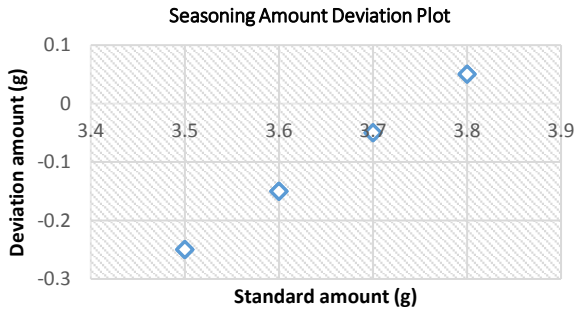

Figure 6: Seasoning Amount Deviation from the Standard Amount of 3.75 grams

The preset temperature for the thermostat used is 94ºC which is 2ºC higher than the required temperature. The experiment was done by taking the time it takes for a 220VAC incandescent light bulb connected in parallel with the heater to turn off. When the light bulb turned off, it was assumed ideally that the temperature of the water inside the heater had already reached a temperature of approximately 92-94ºC. The ideal time to heat warm water at approximately 29ºC to 94ºC using 1.5 KW heating capacity of the heater is 6.04 minutes. Table 3 shows water heating calibration results.

Table 3
Water Heating Calibration Results

Trial	Time (minutes)	Temperature (ºC)
1	7.25	88
2	8.10	87
3	8.40	90
4	6.9	88
5	8.5	89
Average	7.83 min	88.4 ºC

The percent error was determined to be 3.91%. The power supplied to the heater cuts off at an average time of 7.83 minutes which was 1.79 minutes greater than the ideal time for heating. The result may be accounted for the heat transfer that occurred between the surface of the heater casing and the water inside the heater. Before the thermostat had sensed its preset temperature, the water temperature was already higher than the preset temperature. Also, an error was observed regarding the thermostat functionality. The thermostat already cut off the power before reaching its preset temperature. As seen from Table 3, the average temperature of the water was 88.4ºC which was 5.6ºC lower than the preset temperature of the thermostat. Figure 7 illustrates that the relationship between time and temperature is linear.

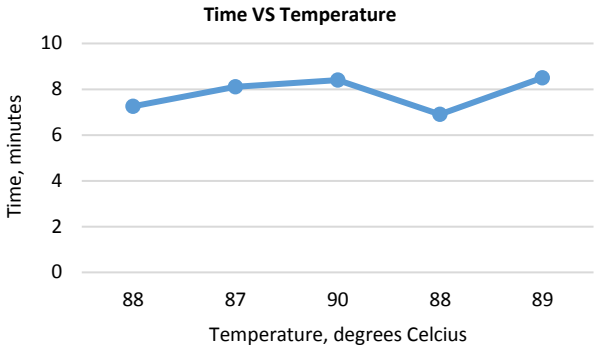

Figure 7: Time and Temperature Relationship Plot

The centrifugal pump and solenoid valve located after the outlet of the heater are synchronised. Whenever the solenoid valve opens, the centrifugal pump activates to increase the velocity of the water injecting into the cup. The calibration for the water injection system was done by measuring the time it takes for the water to inject into the cup using a timer and a graduated cylinder to measure 200mL of hot water. As observed by the researchers, there was a delay in the flow of water since the tube is long and it required a specific head in order to travel into the tube. Table 4 shows the amount of water injected manual calibration results.

Table 4
Amount of Water Injected Manual Calibration Results

Trial	Time (Seconds)
1	11
2	10
3	11
4	12
5	11
6	11
7	10.5
8	11
9	11
10	11
Average	11.4 sec

Results from the testing show that an average time of 11.4 seconds was needed to inject the water into the cup. The delay in the time of travel was caused by friction losses, elbows, and the pressure deficiency

IV. Conclusion

From different types of vending machines, this project is unique since this kind of machine currently does not exist in the Philippines. This type of instant noodle machine cannot be found in malls, side streets, and offices. This project aims to introduce a new vending machine that can provide up to four different flavours of noodles and serve them half-cooked. It eliminates the hustle of unpacking existing cup noodles especially in call centres where time is of great essence. A simple process of pressing two buttons namely "FLAVOR" and "START" do the job. The machine is a

prototype meaning it is widely subjected to significant and special improvements. Overall, the researchers were able to accomplish the objectives of the project successfully. The researchers were able to design and fabricate a working prototype of an automated instant noodle vending machine.

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