Design of IoT based Vending Cart

Gayathri. N
Dept of Electrical and Electronics Engineering
Saranathan College of Engineering
Trichy, India

Preethi. P
Dept of Electrical and Electronics Engineering
Saranathan college of Engineering
Trichy, India

Ragasudha. B
Dept of Electrical and Electronics Engineering
Saranathan College of Engineering
Trichy, India

Sivapriya. S
Dept of Electrical and Electronics Engineering
Saranathan College of Engineering
Trichy, India

Stella Belicya. C
Dept of Electrical and Electronics Engineering
Saranathan College of Engineering
Trichy, India

***Abstract*:- The urbanization and industrialization there is a rapidacceleration of migration from rural are to urban area. So urban centers are unable to provide employment to all workforce, so they have to find other opportunities for the settlement in informal sector. Within this informal sector, vendors sell their goods in competitive market. An attempt of developing a mobile vegetable vending cart with a solar powered refrigerated chamber for short period (4-7 days) storage of vegetables is made. Provision was also made to mount and fix the refrigerator on a cart to make it mobile for the convenience of vegetable vendor. Freshness can be checked by various factors including humidity, temperature, oxygen, and carbon dioxide. We use a sensor for monitoring these gases. Image processing technique is also used to review quality analysis of fruits and vegetables. Image processing is usually the first step in detecting the quality of fruits. The process starts by capturing the image of the fruits using raspberry pi. It helps to segregate the fruits based on the quality such as good, moderate and rotten fruit. The existing system can only separate the fruits into good and rotten one withaccuracy of 87.4% but our proposed system is capable of separating the fruits into good, moderate and rotten one with accuracy of 94.12%.**

Keywords:- Mobile vegetable vending cart, sensors, image processing

I. INTRODUCTION

In today's world, everything in agriculture is getting automated and manual interference in the system becomes non-commercial solution as well as time consuming task. The quality of fruit must be checked before it is used for making food products. In agriculture, the quality of fruit is somewhat dependent on the water availability, soil type, proper usage of fertilizers, etc. In olddays, more manpower is required used for selection of quality fruits and vegetable for the production purpose in industries. In recent years many automated systems were invented and that are used for identification of quality fruits. The existing system finds the quality of fruits and display the message as good or rotten fruits, as it takes more time to predict the fruits quality with an average accuracy of 94.12%. Our proposed system is capable of finding the quality of fruit by using the classification algorithm of image processing technique in a short span of time with high accuracy. These features are used to classifythe fruits into different categories like good, moderate androtten fruits. It classifies the fruits by using the shape, color and size features provided at the time of training and also the extracted features of fruit and provides the result by comparing these features.[1] Finally, the fruits are categorized as a good, moderate and rotten one.

Street vendors are often those who are unable to get regular jobs in the remunerative formal sector on account of their low level of education and skills. They try to solve their livelihoods problems through their own meagre financial resource. [2-3] They are the main distribution channel for a large variety of products of daily consumption like fruits, vegetables. If they were to be eliminated from the urban markets, it would lead to a severe crisis for fruit and vegetable farmers, as well as small scale industries which cannot afford to retail their products through expensive distribution networks in the formal sector.

In order to retain the freshness of the horticultural produce and to fetch a good market value among thevendors, various chemicals are usually sprayed on the vegetables which are not only unhygienic but also pollute the environment by emitting different greenhouse gases. The vendors are forced to follow this practice in order to keep the produce in saleable form for a short period and to get a good market price. There is, therefore, the necessity of a small-scale cooling device which could be reliable, environment-friendly and be used at individual level for short-term storage of vegetables without depending upon the community based cool chain facilities which are located far away from the production area and are very limited in number. The shelf-life of vegetables was enhanced to 12 days during summer season by maintaining temperatures in the range of 14-16^{0}C and humidity in the range of 83-94 % in the cool chamber (solar refrigerator) which is developed.

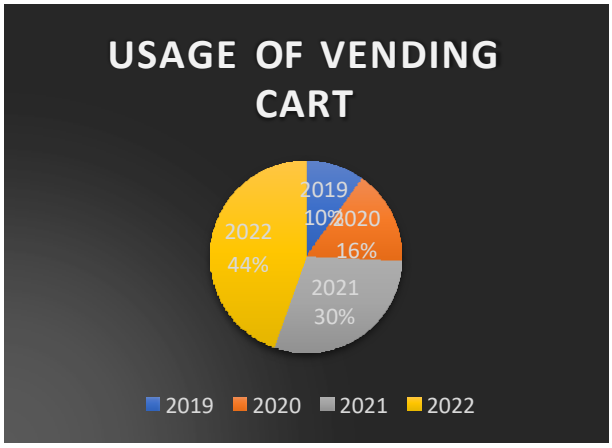

Fig. 1 usage of cart

Fruits and vegetables account for 92.3% of the total horticultural production in India. Around 2.1% of the production is used by processing industries; the remaining produce is either consumed soon after harvest or stored for later use in fresh form. It is therefore important that effective exploitation of the export capability of fruits and vegetables is ensured. Since fruits and vegetables are perishable, their magnitude of loss is estimated at 35–40% due to poor post- harvest management resulting in huge financial loss each year. India wastes fruits and vegetables each year equivalent to the annual consumption of the United Kingdom. Absence of sufficient storage facilities after harvest results in deterioration in the quality in fruits and vegetables that reachthe market. This has an immediate impact on the distribution and availability of the required amount for human consumption. The most imperative parameters influencing the post-harvest life and quality of horticultural produce are temperature and relative humidity (RH). The deterioration in quality of produce after harvest is the result of physical, biochemical, physiological and biological processes, the rates of which are influenced primarily by product temperature (at harvesting) and RH in the vicinity. Rate of spoilage increases 2–3-fold with each 10^0C rise in temperature. The vital activities of tissues, for example, transpiration, respiration, ripening, etc. take place even after harvest. Fresh produce needs low temperature and high RH during storage. Immediate cooling is important to minimizequality loss.

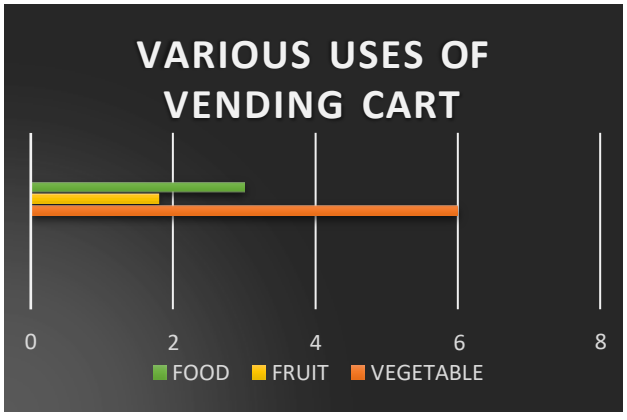

Fig 2. Uses of cart

The above Fig 1 and Fig 2 shows the annual usage of vending cart along with the various uses of the vending cart Literature survey Evolution is the progression from one form to another in a specific matter over a period. Technological and technical evolution happens based on evolving nature of humans and technology, depending on the needs. As human civilization progressed, there have been drastic changes, improvements, and advancements in the technology and techniques that have been continuously used. Similarly, there have been drastic improvements and upgrades in controlling, manufacturing, and utilizing vegetable carts. Humans have evolved over the period and have drastically improved their way of living. Accordingly, based on their convenience, they have continuously researched and developed many alternative ways of improving their technology.[6] Similarly, drastic improvements and advancements have been made in controlling, manufacturing, and utilizing vegetable carts. Humans have evolved over the period and have drastically improved their way of living. Accordingly, based on their convenience, they have continuously researched and developed many alternative ways of improving their technology. Consequently, there have been many improvements in controlling the driving mechanism of the vegetable pushing and vending carts. Based on literature review and practical applications, we have come across several journal papers and practical applications; the several advancements and types in vegetable vending and pushing carts. Below we have discussed a few types of vegetable vending carts according to their generation of evolution.

The requirement of water ranged between 16.5 and 20.0 litre/day during summer. Researchers note that there was considerable effect on physiological loss in weight of different vegetables kept either inside or outside the mobile chamber. The freshness and shelf-life of vegetables increased substantially after storage in the evaporatively cooled cart. The evaporatively cooled cart can keep fruits and vegetables fresh for two to five days compared to conventional carts where most vegetables spoil in less than two days.[7]

Absence of sufficient storage facilities after harvest results in deterioration in the quality in fruits and vegetables that reach the market. This has an immediate impact on the distribution and availability of the required amount for human consumption. Immediate cooling is important to minimize quality loss when the produce is harvested at high temperatures or at an advanced stage of maturity. Preservingsuch commodities to remain fresh demands that the chemical, biochemical and physiological changes are restricted to a minimum by close control on temperature andRH. The high cost involved in developing cold storage or controlled atmosphere storage on a movable cart is a major problem in India and several developing countries. Evaporative cooling is an efficient and economical means for reducing the temperature and increasing RH in an enclosure. Evaporative cooling is an environmentally friendly air conditioning system that operates using induced processes ofheat and mass transfer, where water and air are the working fluids. It provides an inexpensive, energy

efficient, environmentally benign (not requiring ozone damaging gas as in active systems) and potentially attractive cooling system. So, in our proposed model we are using a solar- powered evaporative cooling system to preserve the food at lower cost. [8-9]

The image processing circumvents the problem of processing or quantifying the photographic data mathematically. Several applications of image processing technology have been developed for the agricultural operations.[10] These applications involve implementation of camera-based hardware systems or color scanners for inputting the images. Fruit classification and fruit disease identification can be seen as an instance of image categorization. Then, images of fruits and vegetables with surface characteristics were used in classification applications with two cases two class classification and fiveclass classification. Effectiveness of method depend on the correlation between measured feature parameter and qualityfactor.

II. PHYSICAL PARAMETER CONSIDERATION FORVENDING CART

A. Temperature:

Respiration and metabolic rates are directly related toroom temperatures within a given range. The higher the rate of respiration, the faster the produce deteriorates. Lower temperatures slow respiration rates and the ripening and senescence processes, which prolongs the storage life of fruits and vegetables. Low temperatures also slow the growth of pathogenic fungi which cause spoilage of fruits and vegetablesin storage.[11]

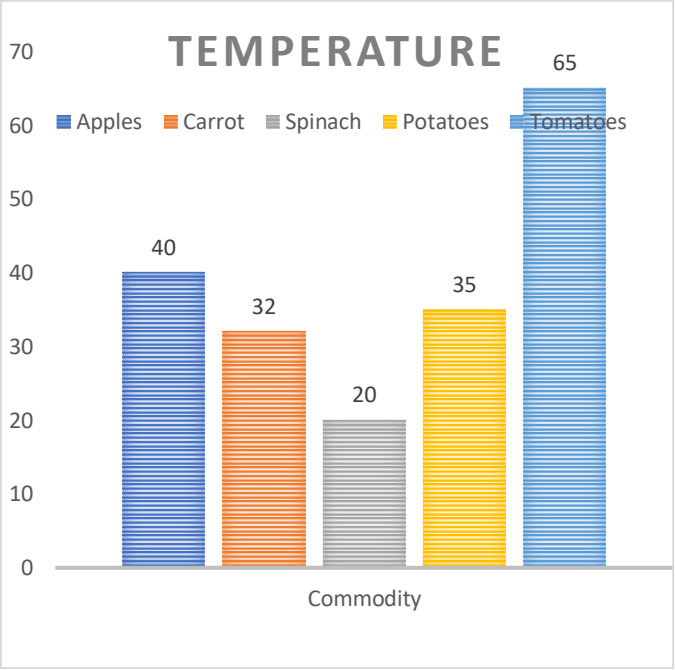

Fig 3. Optimum temperature level

Producers should give special care and attention to proper storage conditions for produce with high to extremely high respiration rates—those crops will deteriorate much more quickly. It is impossible to make a single recommendation forcool storage of all fruits and vegetables. Climate of the area where the crop originated, the plant part, the season of harvest and crop maturity at harvest are important factors in determining the optimum temperature. A general rule for vegetables is that cool-season crops should be stored at cooler temperatures (32 to 35°F), and warm-season crops should be stored at warmer temperatures (45 to 55°F). There is exception to this rule, though t*able 1* lists the optimum relative humidity for the storage of several fruits and vegetables.

The above Fig 3 shows the optimum temperaturefor the storage of various fruits and vegetables.

B. Humidity

Transpiration rates (water loss from produce) are determined by the moisture content of the air, which is usually expressed as relative humidity. At high relative humidity, produce maintains saleable weight, appearance, nutritional quality and flavour. while wilting, softening and juiciness are reduced. Leafy vegetables with high surface-to-volume ratios; injured produce; and immature fruits and vegetables have higher transpiration rates. External factors affecting transpiration rates are temperature, relative humidity, air velocity and atmospheric pressure. High temperatures, low relative humidity and high air velocity increase transpiration rates. Relative humidity needs to be monitored and controlled in storage. A hygrometer or a sling psychrometer, not the appearance of the produce, should be used to monitor humidity. *Table 1* lists the optimum relative humidity for the storage of several fruitsand vegetables.

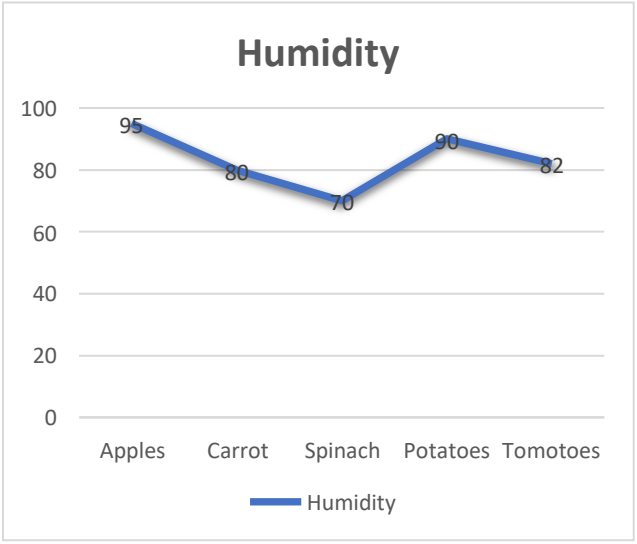

Fig 4. Optimum humidity level

The above Fig 4 shows the optimum humidity forthe storage of various fruits and vegetables.

The Control can be achieved by a variety of methods:

1.Operating a humidifier in the storage area.

2. Regulating air movement and ventilation in relation tostorage room load.

3. Maintaining refrigeration coil temperature within 2°Fof the storage room air temperature.

4. Using moisture barriers in the insulation of the

storage room or transport vehicle, and in the lining of the packing containers.

5. Wetting the storage room floor.
6. Using crushed ice to pack produce for shipment.
7. Sprinkling leafy vegetables, cool-season root Vegetables and immature fruits and vegetables with water.

C. Deterioration status

The Raspberry Pi is connected to Pi camera and motor. When the python code starts Pi camera captures image and save the image in the specified location. The feeded model will consider input from the specified location and then the predict method will predict the belonging class of the fruit and it will send back to python code and servo motor will move the fruit the good or rotten basket depends on the fruit class obtained.

COMMODITY	STORAGE LIFE	COOLING POINT
Apples	1-12 months	29.3
Carrot	2-4 weeks	29.5
Spinach	6-8 days	31.5
Potatoes	5-8 months	30.9
Tomatoes	4-7 days	31.1

III. RENEWABLE POWER SOURCE

Renewable energy is derived from renewable resources that are replenished naturally on a human timeline. Sunlight, wind, rain, tides, waves, and geothermal heat are all examples. In contrast to fossil fuels, which are depleted significantly faster than they are regenerated, renewable energy is rapidly replenished. Some renewable energy sources are not sustainable, despite the fact that the majority are. Some biomass sources, for example, are considered unsustainable at current utilization rates.

Solar power is energy from the sun that is converted into thermal or electrical energy. Solar energy is the cleanest and most abundant renewable energy source available, and the

U.S. has some of the richest solar resources in the world. Sunlight is one of our planet's most abundant and freely available energy resources. The amount of solar energy that reaches the earth's surface in one hour is more than the planet's total energy requirements for a whole year. Although it sounds like a perfect renewable energy source, the amount of solar energy use may get varies according to the time of day and the season of the year as well as geographical location. In the UK, solar energy is an increasingly popular way to supplement your energy usage. Find out if it's right for them by reading our guide to solar power.

Electricity generation, air and water heating/cooling, transportation, and rural (off-grid) energy services are all common uses of renewable energy. Renewable energy accounts for around 20% of worldwide energy consumption, including about 30% of electricity. Traditional biomass accounts for about 8% of total energy usage, but this is decreasing. Heat energy from modern renewables, such as solar water heating, accounts for over 4% of total energy consumption, while electricity accounts for over 6%. Renewable energy businesses employ around 10 million people worldwide, with solar photovoltaics being the largest renewable employer. Renewable energy systems are fast improving in efficiency and cost, and their renewable energy accounting for the vast majority of newly added power capacity worldwide. The cheapest new-build electricity in most nations is photovoltaic solar. Renewable energy already accounts for more than 20% of global energy supply, with certain countries generating more than half of their electricity from renewables.[12] In the 2020s and beyond, national renewable energy markets are expected to grow rapidly. Only a few countries use renewable energy to generate 100% of their electricity. In contrast to fossil fuels, which are concentrated in a small number of countries, renewable energy supplies are widely distributed. Energy security, climate change mitigation, and economic gains are all being realised as a result of the deployment of renewable energy and energy efficiency technologies. Renewables, on the other hand, are hampered by hundreds of billions of dollars in fossil fuel subsidies. In international public opinion polls, there is strong support for encouraging the use of renewable energy sources like solar power.

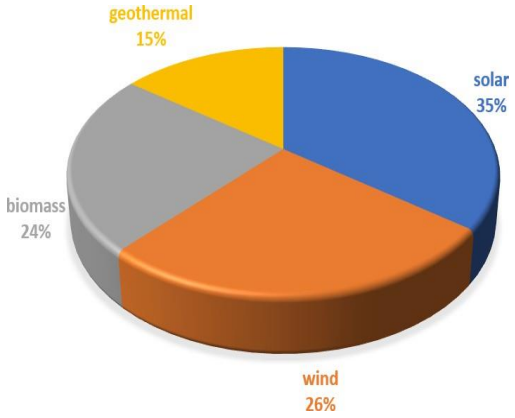

Fig 5. Renewable energy consumption

The above diagram figure 5 shows the average renewable energy consumption where the solar energy tops the chart by 35%. As per this chart solar is the renewable energy used at most.

IV. DESIGN AND IMPLEMENTATION

A 12V AH battery stores solar energy during the day and is utilized to power the system at night or on cloudy days.[13] When solar radiation is insufficient, the battery's stored charge is used to power the vegetable vending cart's cooling system and other associated systems. Where solar energy is used to keep the temperature cool for storage purposes. Another way that solar energy is used in this cart is to store it in the battery and use it to power the electrical components like sensors and for image processing.[14] In the summer, the solar panel can be used to create a cooling effect utilising a Peltier cooling system. The Peltier cooling

system operates on the Peltier effect principle. By transmitting heat between two electrical junctions, the effect causes a temperature differential. To generate an electric current, a voltage is supplied across linked conductors. Heat is evacuated from one junction and cooling occurs when current travels through the junctions of the two conductors. [15]

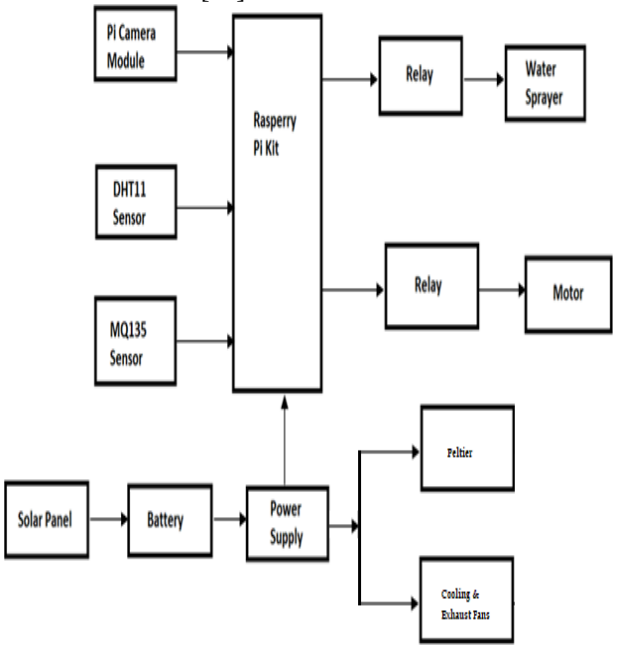

Fig 6. Block diagram

The block diagram of the Iot based vegetable vendingcart is shown above in the figure 6.

The basic digital temperature and humidity sensor with a modest price tag is utilised. It measures the ambient air with a capacitive humidity sensor and a thermistor and outputs a digital signal on the data pin (no analogue input pins needed).The temperature and humidity of the veggies in the cart are sensed by this sensor. [16-17] Another sensor utilised is the gas sensor, which detects ethylene, a chemical emitted by fruits and vegetables that causes them to ripen more quickly. Ethylene affects some fruits and vegetables more than others. [18-20] The centralized controller that can be used to process digital images. It contains a dedicated camera input connector that allows users to record HD video and high-resolution photographs. Users can construct programmes that take photographs and video and analyse them in real time or save them for later processing using Python and particular libraries written for the Pi. Here the 5MP pi camera v1.3 is used in this tutorial to take images and analyse them with Python. [21-22]This kit is also powered by solar energy. Finally, a live online portal displays all of the sensor and image processing outputs.

A water sprinkler, which is used to water the fruits and vegetables in the carts, has been placed. They're also utilised to keep things cool and keep dust out of the air. Sprinklers are a type of water application that is comparable to rain in that it is applied in a regulated manner. Pumps, valves, pipes, and sprinklers may be used to disperse the water. Sprinklers are made up of perpendicular pipes with rotating nozzles at regular intervals that are connected to the main pipeline. Water escapes from the revolving nozzles when it is pressured through the main pipe. It's strewn acrossthe crop. Water is piped to one or more central sites inside the field and distributed by overhead high-pressure irrigationin sprinkler or overhead irrigation. These sprinklers are regulated by the outputs of the sensors to maintain the fruits/vegetables in a optimum temperature to avoid spoilage of fruits/vegetables.

fig 7. Vegetable vending cart

The three-dimensional view of the Iot based low-cost vegetable vending cart is shown in the figure 7.

V. EFFICIENCY COMPARISON BETWEEN EXISTINGSYSTEM

Fig 8. Deteriorated fruit

As shown in figure 8 it, is a ordinary vending cart where the fruits or vegetables lose about 10 per cent of their weight through heat-driven moisture loss, they wilt, look bad and keep customers away.[23] Vendors are forced to lower prices as vegetables approach spoilage and discard spoilt produce, this leads losing income and made them a money lenders.

Eighteen per cent of India’s fruit and vegetable production valued at Rs 13,300 crore is wasted annually. [24-25]

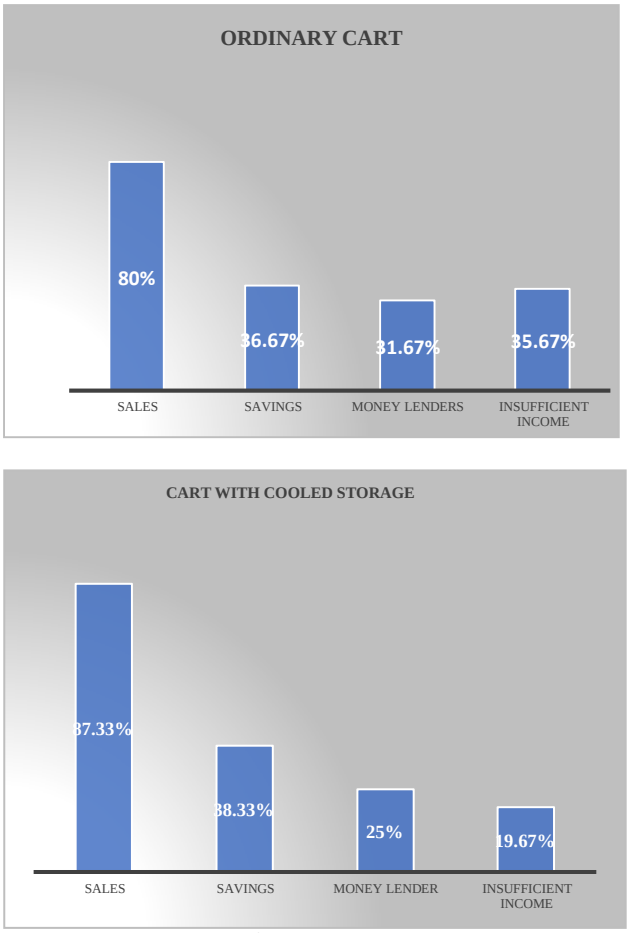

Fig 9. Comparison of existing vs proposed system

As shown in figure 9 On an average day, the vendors sell 80% of the inventory and make a profit of ₹3000, all in cash. It has 66.67% of the vendors saved the money in monthly Rs 100- 500 Out of 100% of the vendors and 36.67% of the vendors Monthly Income is sufficient. This can be reduced only by implementing a proper storage in the vegetable cart. The freshness and shelf-life of vegetables and fruits increased substantially after storage in the evaporatively cooled cart. The evaporatively cooled cart can keep fruits and vegetables fresh for two to five days compared to conventional carts where most vegetables and fruits spoil in less than two days.

FUTURE SCOPE

Evaporatively cooled storage has proved to be useful for short-term storage of fruits and vegetables in hot and dry regions. It has been extensively used for enhancing the shelf- life of the fruits and the vegetables in the vendors cart, which is essential for maintaining the freshness of the commodities. Evaporative cooling is an environmentally friendly air- conditioning system that operates using induced processes of heat and mass transfer, where water and air are the working fluids. It provides an inexpensive, energy efficient, environmentally benign (not requiring ozone damaging gas as in active systems) and potentially attractive cooling system. The evaporative cooling system is a very efficient and comparatively low-cost cooled storage system for a short term. There is a desire for autonomous technology for vegetable vendors to possess a efficient vegetables/fruit management.

This proposed solar vegetable vending cart with various sensors and image processing unit for accurate observation of fruits and vegetables. And renewable energy is used as a power source. Due to the short shelf life of thesecrops, it is estimated that about 30 to 35% of total fruits and vegetables is lost during transport and distribution in a year which reduces the vendors share. Hence, there is a need for maximum commercial utilisation of fruits and vegetables. Therefore, there is a need to evolve a marketing system where benefit is prevailed to both vendors and consumers. The fruits and vegetables, being perishable, need optimum condition provided cooled storage to reduce the microbial load and increase their shelf life, which can be achieved by storing them at low temperature and high relative humidity conditions. These conditions are usually achieved in evaporative cold storages.

VI. CONCLUSION

The main aim of our project is to standardize the outlook of public toward the street vendors by providing a cart that contains facility like various sensors and water sprayer along with a cooling system. Traditional cart uses human effort to find the deteriorated fruits/vegetables. Vendors are the medium between the farmers and consumer who cannot afford their products to sale in big market. So, the unemployment can be reduced by targeting the mid- range people involve in this type of business. As the cost of cart is high but it can get reduced if it is for a mass production and government provide the subsidy. Government can provide different identification system to manage the vendors and to manage the business.

Most of the people are aware about non-renewable energy resources. Solar energy has become increase more popular due to their economic benefits. By on Battery Backup,Solar Energy can even provide Electricity 24x7, even on cloudy days and at night. This also used with inter-grid Systemwith Continuously Power supply. It has more benefits compared to other forms of energy like fossils fuels and petroleum deposits. It is an alternative which is promise and consistent to meet the high energy demand. Research on solar cell and solar energy is promise has a future worldwide. After thoroughly researching and finding the solution that a compactly designed the solar operated vegetable cart, which uses a solar panel of 12V and a brushless dc motor of 0.5 hp and a 12-volt battery setup installed on a vegetable cart. The developed solar operated vegetable cart is eco-friendly it relies on renewable source of energy so that it can be used externally. However, initial cost is high but very low maintenance.

REFERENCES

[1] Sonawane S.T, Problems and Solutions of Vendors – A Case StudyInternational Journal of Innovative Research in Science, Engineering and Technology, Vol.6, 2017, Pp. 940-943.
[2] Naik, "Contextualising Urban Livelihoods: Street Vending in India", SSRN Electronic Journal, 2013
[3] Ajay N. Ingale, Saurabh R. Kubade, Agrasen D. Dighade, Chandrajeet K. Ingle, Sagar G. Chandankhede, Snehal V. Chambhare, Darshan K. Raut, Arvind K. Yadav, "Design and fabrication of solar powered fresh vegetable vending cart", pp121-123 Vol-4 Issue-2, IJARIIE-ISSN(O)-2395-4396,2018

[4] Ms Rupali S. Jadhav, S.S. Patil, "A Fruit Quality Management System based on Image Processing", The International Organization of Scientific Research Journals, ISSN: 2278- N 8735,pp: 01-05, 2019.
[5] K.V. Vala, F. Saiyed, and D.C. Joshi, "Evaporative Cooled Storage Structures: An Indian Scenario," Trends in post harvest technologyjournal, Vol.2,3, pp22-32,2014 6 th
[6] M. C. Ndukwu, S. I. Manuwa, "Review of research and application of evaporative cooling in preservation of fresh agricultural produce,", International journal of Agric & Biol Eng ,Vol.7, No.5, 2014 9th
[7] E.E. Anyanwu, "Design and measured performance of a porous evaporative for preservation of fruit and vegetables," Energy Conversion & management, 45, pp 2187-2195,2003 8th
[8] J.T. Liberty, B.O. Ugwuishiwu, S.A Pukuma and C.E Odo, "Principles and Application of Evaporative Cooling Systems for Fruits and Vegetables Preservation", International Journal of Current Engineering and Technology,ISSN 2277 -4106 , pp 1000- 1006,Vol.3, No.3 (August 2013) 7th
[9] Ms Rupali S. Jadhav, S.S. Patil, "A Fruit Quality Management System based on Image Processing", The International Organsation of Scientific Research Journals, ISSN: 2278-8735, pp: 01-05, 2013.10th
[10] Jiao Yan, Zhang Yan, Li Bao-guo, Hua Ze-zhao. Study on the influence of temperature and humidity changes on the storage quality of fruits and vegetables in refrigerators [J]. Low Temperature and Specialty Gases, 2001(06):18-21+30. 11th
[11] Xin Xiu-rui, Niu Ji-kai, Bai Xin-yuan, Pan Chen-guang. Development Status of cold storage and Energy Saving and Environmental Protection [J]. Journal of Appliance ScienceTechnology2018(03):22-23.
[12] Ajay N. Ingale, Saurabh R. Kubade, Agrasen D. Dighade, Chandrajeet K. Ingle, Sagar G. Chandankhede, Snehal V. Chambhare, Darshan K. Raut, Arvind K. Yadav, "Design and fabrication of solar powered fresh vegitable vending cart", pp121- 123 Vol-4 Issue-2, IJARIIE-ISSN(O)-2395-4396,2018
[13] Pravin Potdukhe, Ishwar P. Mantriwar, Neeraj S. Punekar, Vaibhav R. Lodhe, Chandrakiran G. Sharnagat,Roshan M. Mogare and Pratik A. Shamkule – "Solar Assisted Vegetable Cart" - International Research Journal of Engineering and Technology(IRJET) Volume: 05 Issue: 06 June 2018.
[14] N. J. Ogbuagu, I. A. Green, C. N. Anyanwu, and J. I. Ume,"Performance Evaluation of a Composite-Padded Evaporative Cooling Storage Bin," Nigerien journal of Technology,Vol.36, pp 302-307,2017.
[15] J.R. Camargo, C.D. Ebinuma, S. Cardoso. "Three Methods to Evaluate the use of Evaporative cooling for human thermal omofort". Proceeding of 10th Brazilian congress of thermal science and engineering—ENCIT 2004, Braz.Soc. of Mechanical science and engineering ABCM, Rio de Janeiro, Brazil, Nov29— Dec 03,2004.
[16] Chen Peng. Design and research of temperature and humidity monitoring system for Vegetable Greenhouses [J]. Industrial Instrumentation and Automation ,2018(02):127-129+132.
[17] Clifford K.Ho, Alex Robinson, David R, Miller and Mary J. Davis, Overview of sensors and Need for Environmental Monitoring, Sensors 5, 28 Feb.2005.
[18] Li, Z.G.; Liu, Y.; Dong, J.G.; Xu, R.-J.; Zhu, M.-Z. Effect of low oxygen and high carbon dioxide on the levels of ethylene and 1- aminocyclopropane-1-carboxylic acid in ripening apple fruits. J. Plant Growth Regul. 1983, 2, 81–87.
[19] Valente, J.; Almeida, R. Kooistra, L. A Comprehensive Study of the Potential Application of Flying Ethylene-Sensitive Sensors for Ripeness Detection in Apple Orchards. Sensors 2019, 19, 372.
[20] Kuswandi, B.; Wicaksono, Y.; Jayus; Abdullah, A.; Heng, L.Y.; Ahmad, M. Smart packaging: Sensors for monitoring of food quality and safety. Sens. Instrum. Food Qual. Saf. 2011, 5, 137–146.
[21] He, K.; Zhang, X.; Ren, S.; Sun, J. Deep residual learning for image recognition. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, Washington, DC, USA, 27–30 June 2016; pp. 770–778.
[22] Seema, A. Kumar, and G.S. Gill. "Automatic fruit grading and classification system using computer vision – A review" 978-1-4799-1734-1/2015 IEEE
[23] Ishangulyyev, R.Kim, S. Lee, S. Understanding Food Loss and Waste—Why Are We Losing and Wasting Food? Foods 2019, 8, 297.
[24] C. Cicatiello, S. Franco, B. Pancino, E. Blasi, L. Falasconi The dark side of retail food waste: evidences from in-store data Resour. Conserv. Recycl., 125 (Supplement C) (2017), pp. 273-281
[25] Shruti Sharma, Kamlesh Kumar Jain, Ashutosh Sharma a review on "Solar Cells: In Research and Applications",Materials Sciences and Applications, 2015, 6, 1145-1155 Published December 2015