

PLC word Document A1

by Nathan Evans

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Literature review of PLC's

During this report, the student will cover the development of PLC's and where they are used. It will also cover the complexity of PLC's talking about the pros and cons in table format. The factoryIO system is also included with picture evidence describing each network and what the function of the network is.

A PLC (Programmable logic controller) is an industrial used computer designed for automation processes typically in manufacturing and production. They do have other uses in other areas. PLC'S have blasted industrial automation into a new level purely based on there capabilities, offering the users total reliability, flexibility, and huge savings in costs as they can operate at high speeds efficiently. Throughout this literature review, PLC'S will be discussed and will also have some real life examples and their pros and cons.[1]

Key features of plc's

- **Real time operations** – PLC'S Allow for real time data inputs and exicture inputted data to esnure realiability while being time and cost effective
- **Versitile** – PLC's can be progreammed in various different languages which means they are highly versilte catering to different peoples needs
- **Factory Ready** – PLC's are to be sued in harsh environemtns such as factorys. These kinds of places hold risks that could be detremental to fragile epices of equipment. Making a PLC robust is essntial top stop things such as falling objects, water ingress, dust etc from dmaging the plc at poetianlly causeing catastrofic consicuenes

PLCS are sued havily in industrys all around the world providing comapnis with long lasting robsut and efficant computers. They will be seen in manufacturing lines to controll conveyour belts, robotics and sorting systems. They will also be seen in indstrys that process oil and gas where they will monitor tempratures and flow rates. The Energy also use PLCs to manage power distrubution such as wind turbines and water treatment plants. PLC's are also seen in the public transporation indstury, heavily used for railway signaling traffic light controll and airport baggae systems.[2]

Plc's are heavily used in other areas around the globe proving to be a vital tool for many peoples day to day work. They can bee found in artificial intelegence to optimise the process by learning from historical data. They can also be seen in the cyber security industry. They are seen as a vital tool in this industry as they ensure safe communication and protection against cyber attacks.

HMI Screens

HMI (Human machine interface) is a screen that allows users to interact with plcs and systems. The user can essentially operate a factory from a safe distance, eliminating any risks of being close to moveing machinery. A HMI will typically display data about the system and offer a range of controlls and system status updates.[3] This allows the user to moinitor the various bits iof infomrmation that are crucial to have while maintaining a factory operation. Things such as start and stop buttons, the temprature of things, the weight of pacjkages etc. HMI's can also log data and store it for futture use. Having an alarm statergy is essntial for any facotry operation, HMI's cater for this as they are capable of holding alarms and notiflcavtions for users to detct any problems that arise. [4]

All of these things provide a list of benefits. These include, system efficacy, meaning the user can operate and debug in real time, fixing issues quickly so the system can resume. A user friendly interface is also a benefit of HMI screen is the userfriendly interface. These interfaces assist users by simplifying complex system interactions providing easy access control. The final benefit is remote monitoring. This allows factory workers to monitor data such as temperature and system state from remote locations. [5]

Ladder Logic PLC programmable language

This report contains specifically ladder logic language used to programme the factory. Ladder Logic is one of the most widely used languages for programming PLC's. Choosing this language makes the factory design more easier as there is a lot of information to assist in the learning curve. It works off simple electronic relay diagrams which any electrician could learn with their current skill set in electronic circuit diagrams. [6]

Once the user has an understanding of the operation of the relays, it then becomes simple to begin programming basic level automated systems.

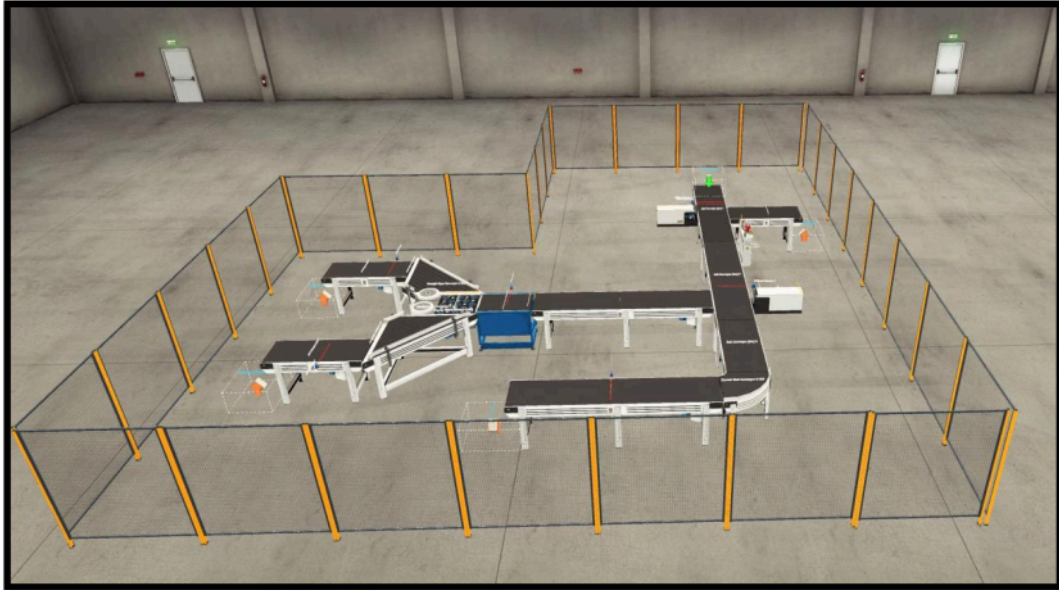
Literature review Conclusion

PLCs continue to be essential in the industrial industry assisting automation and allowing for accuracy and productivity in a variety of fields. Their development from straightforward relay replacements to intricate control systems demonstrates their versatility and ongoing significance. PLCs will remain crucial in determining the direction of automation as companies move towards smarter, more integrated systems. To realise their full potential, however, issues like cybersecurity and legacy system integration must be resolved.

PLC	Pros	Cons
Siemens s7-1200[7] 	Flexibility: Suitable for a wide range of applications. Integrated I/Os: Comes with built-in inputs and outputs. Communication: Supports various communication protocols. Scalability: Modular design allows easy expansion.	Cost: Higher initial costs compared to some entry-level PLCs. Complexity: May require specialized training for programming and maintenance.
KunbusPR100197[8] 	Versatile I/O Options: Offers both digital inputs and outputs, as well as PWM outputs, enhancing flexibility for various industrial applications. DIN Rail Mounting: Designed for easy installation on standard DIN rails, facilitating integration into existing control cabinets. Compact Dimensions: Compact dimensions mean it can be exported and installed easily	Limited Standalone Functionality: Operating Temperature Range: Maximum operating temperature is 55°C. Not suitable for high heat environments. Durability in harsh environments – while being suitable for certain industry environments, this PLC will struggle under harsh conditions making it not suitable for rugged use
Mitsubishi FX5U-32MR/ES [9] 	High-Speed Processing: Fast execution of instructions. Built-in Functions: Includes positioning and networking functions. Compact Size: Space-	Software Cost: Programming software may require additional purchase. Learning Curve: May require time to learn proprietary

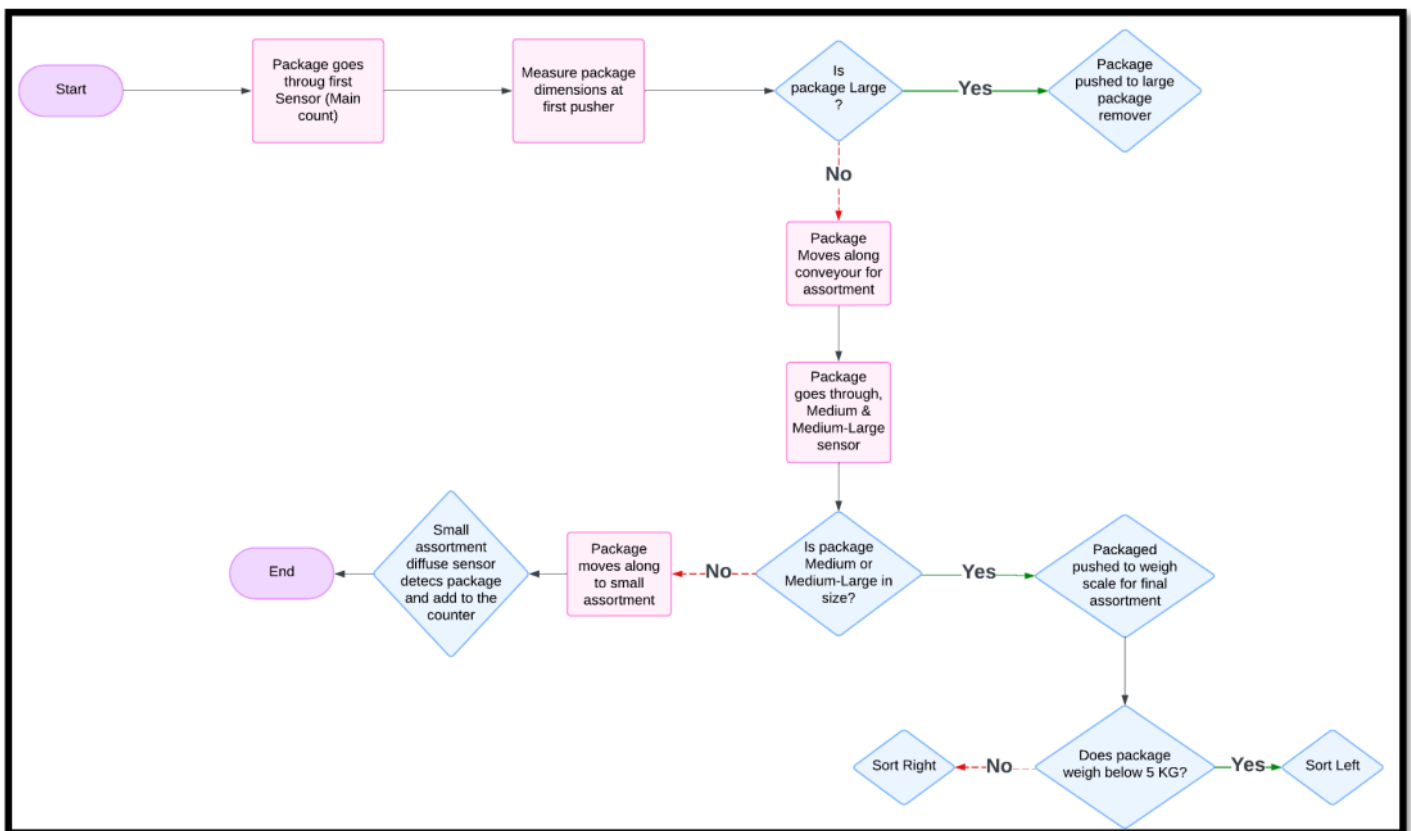
	saving design allows for the plc to be easily installed and mounted by one person. Energy Efficient: Low power consumption. User friendly programming – This PC offers a straightforward approach to programming, it supports multiple languages such as ladder logic, function block. This versatility in programming allows for engineers to easy configure and alter the PLC. It also helps them debug any issues Highly reliable -	programming environment.
RS PRO Logic Module, 12 [10] 	Versatile Input/Output Configuration: Equipped with 8 digital inputs and 4 relay outputs, allowing for flexible application in diverse control scenarios. User-Friendly Programming: Supports ladder programming with a capacity of up to 250 lines. Compact Design – This modules compact design means that a lot of space can be saved making it very suitable in control rooms/panells. It can	Limited Expansion: Supports up to 48 I/Os which may be insufficient for larger or more complex tasks. Programming Capacity Constraints- With a maximum of 250 lines of ladder programming, it may not accommodate highly complex control logic. Potential Software Limitations- While the software is user-friendly the plc lacks advanced features

	also be easily mounted by one person. Cost effective – This PLC can be considered as cost effective being a budget friendly option to those who need a PLC for basic operational tasks making it suitable for small scale factories that don't want to compromise on functionality.	found in higher-end PLC programming. Display Absence in Some Models- Certain models lack an LCD screen, which could hinder on-site monitoring and adjustments without additional equipment.
Schnider Modicon M221 [11] 	Ease of Use: Intuitive programming with EcoStruxure Machine Expert - Basic. Connectivity: Ethernet and serial ports for communication. Compact: Designed for small machines and simple automation tasks. Affordable: Cost-effective solution for basic applications.	Limited Advanced Features: May not be suitable for complex automation tasks. Expansion Constraints: Limited expansion options compared to higher-end models.

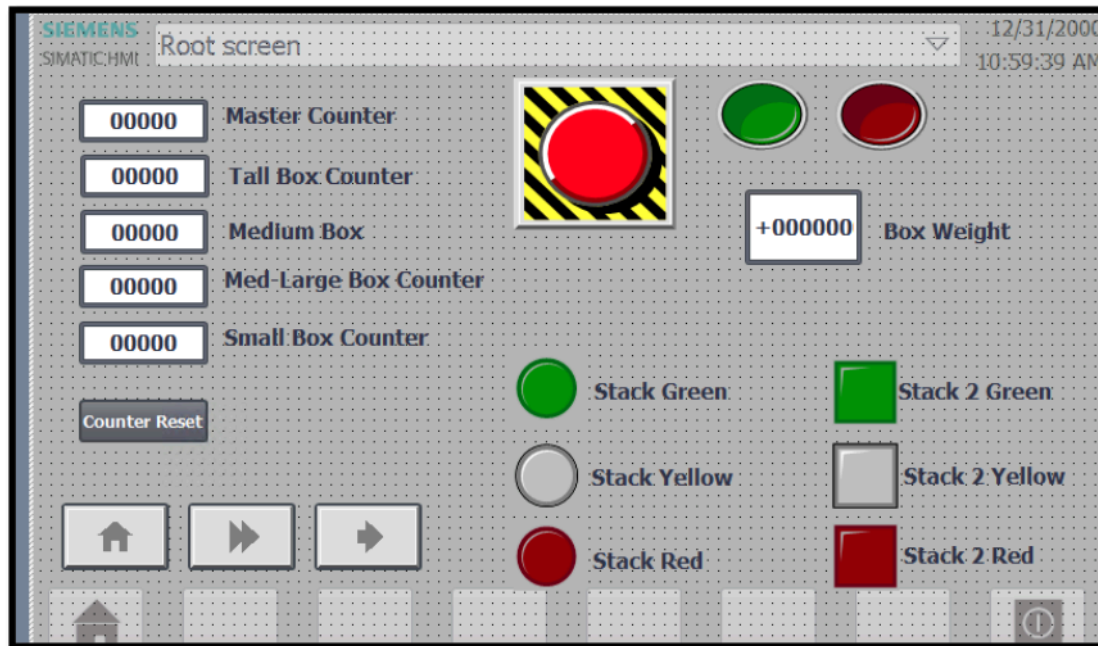


This factory emits and sorts 4 different packages based on their size and weight. The factory starts by emitting the packages randomly, small, medium, medium-large and large. These 4 packages are to be sorted and distributed into their own separate collector. The medium and medium large packages specifically are to be weighed at the scale and the disbursed left and right depending on their weight. The sorting system is simple. Every package will first pass through an emitter which controls the master count. Once passing through, it will then pass the large sorting system, if the box is large it will trigger the emitter set at a high point which then triggers the pusher to push all of the large packages into the large box sorting receiver. This leave 3 other packages to pass through the large sorting system. The 3 other sized packages will then pass through a medium and medium large sorting system. Again these packages are sorted based on height to begin with so if they trigger the high placed diffuse sensor, they will then be pushed to the weigh scale, where each package weight depends where the package sorter send them. This would be left or right. Finally all of the small packages would have slipped under the diffuse sensors which would send them directly to the small package receive where all packages would be counted via a sensor placed just before the packages are received.

The flowchart bellow depicts the operation of the circuit in a step-by-step format



The HMI Screens



The above figure shows the main HMI screen. This screen has various functions and data that is important for the operation of the factory.

Counters - On the left side there are a list of counters. These counters are important for the user to have so they can logs of all the packages that have successfully gone through the factory. The user also has the option to reset all of the counters using the counter reset button below the counters.

System Control Buttons -The main screen holds two control buttons to start (green) and stop (red) the system.

Emergency Stop Button - The screen also hosts a virtual emergency stop button which allows for the immediate stoppage of the factory notifying users there has been a stoppage due to an emergency.

Stack Light Replication - The screen also hosts a virtual replication of the stack lights. The stack lights are visual indicators to all, indicating the current state of the factory. Green means that the factory is operational, red means the factory has stopped and red and amber indicate that the factory has stopped due to the emergency button being pressed

Weight Display - The Main screen also shows the weight of each box as it passes over the scale, this is needed so the system can sort the packages to their correct destination.

Alarm warning Strategy

The screenshot displays a control interface with a dotted background. It is divided into two main sections by a horizontal line. The left section, titled 'Counter Exceeded Warning', contains four red square indicators, each with a label to its right: 'Large', 'Medium', 'Medium-Large', and 'Small'. The right section, titled 'Preset Counter Warning Input', contains four white rectangular input fields, each displaying the value '00000'. At the bottom center, there are two navigation buttons: a home button (house icon) and a next button (right arrow icon).

Counter Exceeded Warning		Preset Counter Warning Input	
	Large	00000	
	Medium	00000	
	Medium-Large	00000	
	Small	00000	

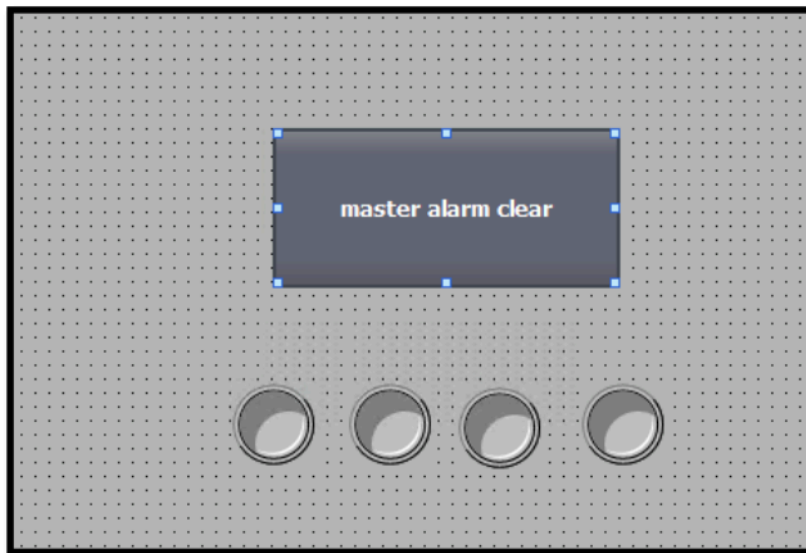
Navigation buttons:

The counter warning screen shows two sets of data.

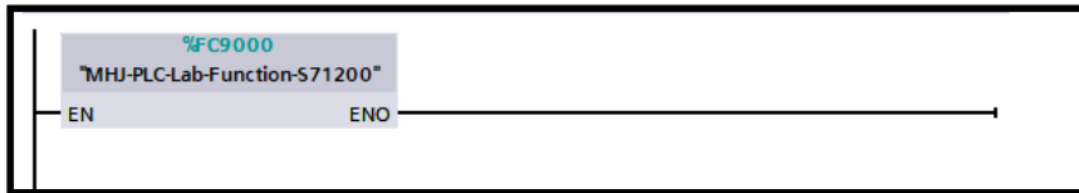
Counter warning Exceeded lights – The counter warning exceeded lights are highly important as they tell the user when there has been enough of a certain package passed through the system. If the users only wanted 15 packages, then these lights are essential to notify the user when 15 packages have been received.

Preset Counter warning input values – The preset counter warnings allow the users to enter a variable counter warning value while the program is operational. For example, if the user wanted 3 large packages to pass before triggering a warning, the user could input the value 3 into the large preset counter warning input and this would trigger the alarm after 3 packages have passed. This demonstrates a versatile system design allowing users to input data in real time to achieve a desired output.

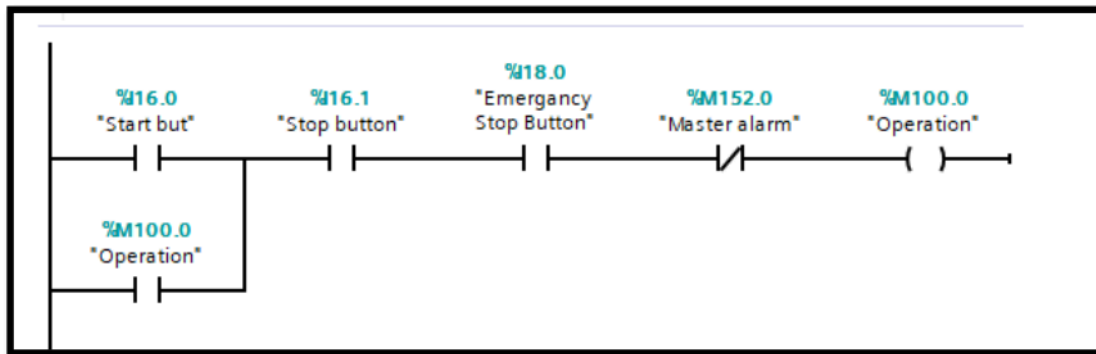
Once the emergency stop button is clicked, the user needs to clear the master alarm before the project can resume running.



Ladder Logic Program and Comments

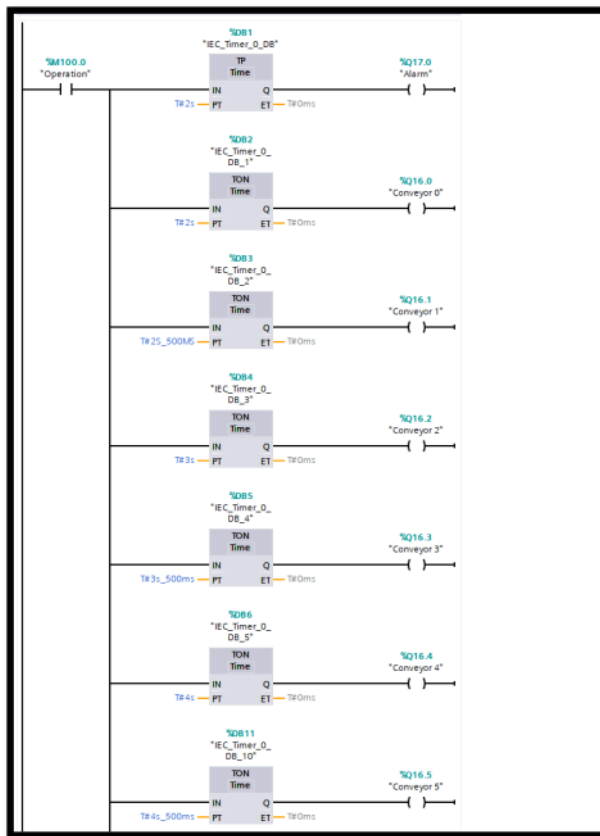


Compact and versatile PLC perfect for industry automation. This makes it a perfect match for the factory design simulation that I have created.



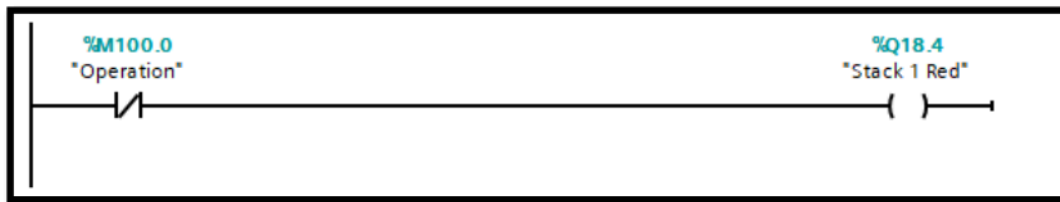
This Network contains a variety of operations, those being:

- Start Button: This is programmed via a normally open contact which allows for the button to be toggled on and off either via FactoryIO or via the HMI screen
- Stop Button: This is programmed via a normally open contact which allows for the button to be toggled on and off either via FactoryIO or via the HMI screen
- Emergency stop button: This is programmed via a normally open contact which allows for the button to be toggled on and off either via FactoryIO or via the HMI screen. This button differs from the start and stop buttons as once this button is toggled, it must be un-toggled for the system to reset, meaning someone must actively acknowledge that the emergency has been taken care of before restarting the system.

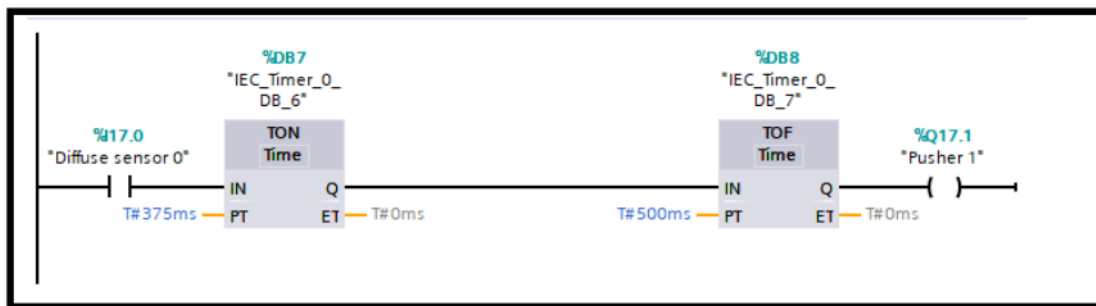


This network controls all time-dependent operations for the conveyor system and related peripherals, including conveyors, sirens, sorters, amber warning lights, and spurs. It ensures synchronized operation for efficient and safe material handling. Each of these rungs have open assignments attached to the end meaning that the network is always operation until told otherwise. Things like the main stop and emergency stop have the capabilities to override this network.

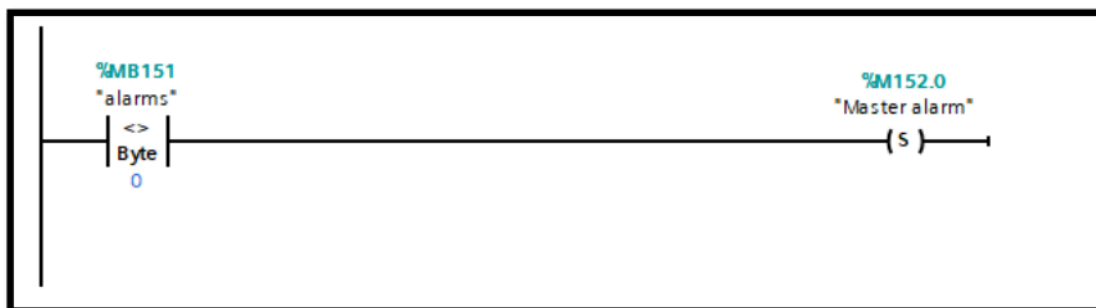
This network is compact and well made to perform various operations all in one network, providing a neat appearance.



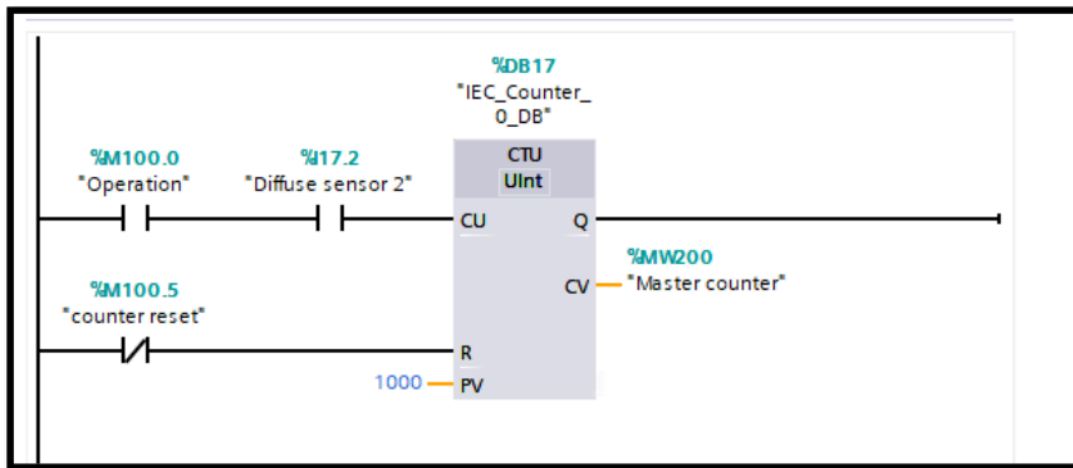
This network is for the operation of the stack light. The stack light is essential for the factory so users can see when the factory is running, when it stops and if the factory is stopped due to an issue.



This network involves a diffuse sensor and a pusher working with each other to sort packages based on size. The system uses toggle-on and toggle-off timer operations to ensure precise actuation of the pusher at the right time. Below is an in-depth analysis of the network's comments and functionality.

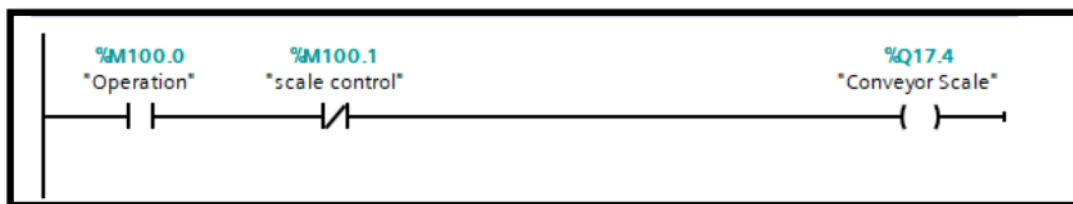


This network focuses on an assignment (s) bit that controls a master alarm. This alarm is an audio warning that the factory is under operation.

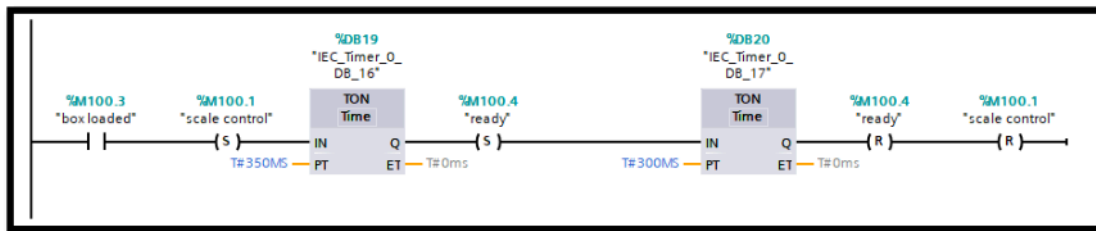


This network shows how you can use a diffuse sensor as a counting operand. This is achieved by linking the sensor to a count up operation. By setting the count up operation to UInt allows the counter to count in whole numbers which is the correct thing to do as we need to count packages.

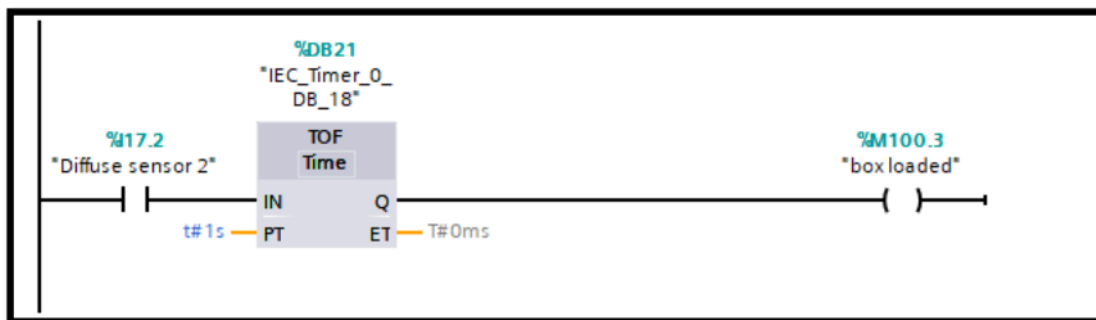
The CTU operation also allows for a counter reset option which has a normally closed operation attached to it. This is labelled as R on the CTU.



This network is for the operation of the scale control. If the scale control variable is not set then the conveyor will run as intended.

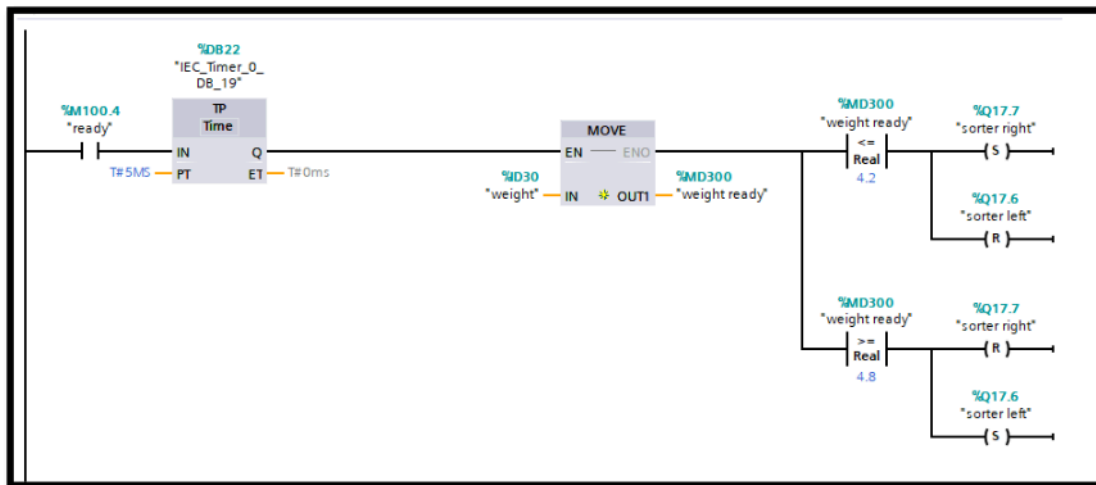


This network stops the scale once it detects a box. It then holds the box on with a delay of 350ms so the scale can take an accurate measurement of the box. The system then rests the variables that make the box stop and the system runs as normal until another box is detected.

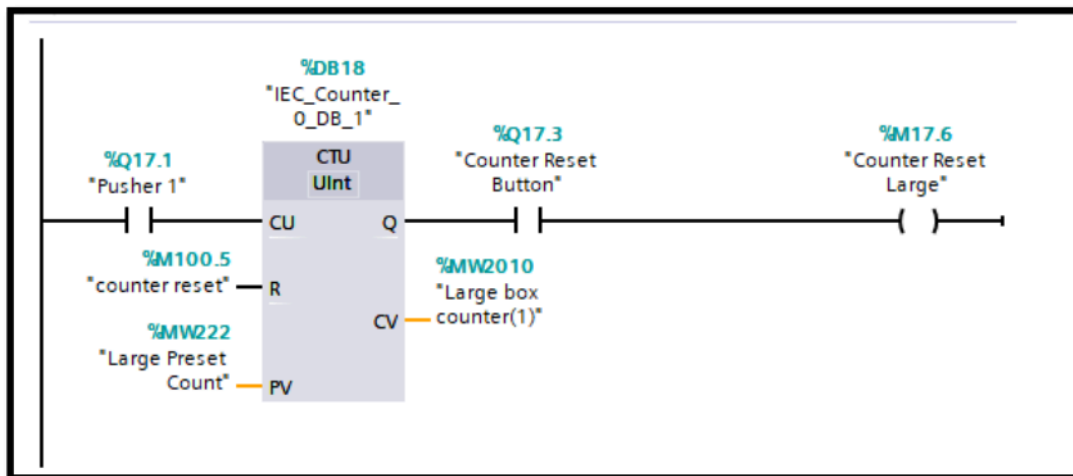


This network allows actions the diffuse sensor to control the scale. For the package to weighed accurately, the scale must stop for a suitable amount of time to take an accurate reading.

This is achieved by adding a diffuse sensor to detect when a package is over the sensor. This then triggers a timer operation to stop for 1 second for the package to be accurately measured.

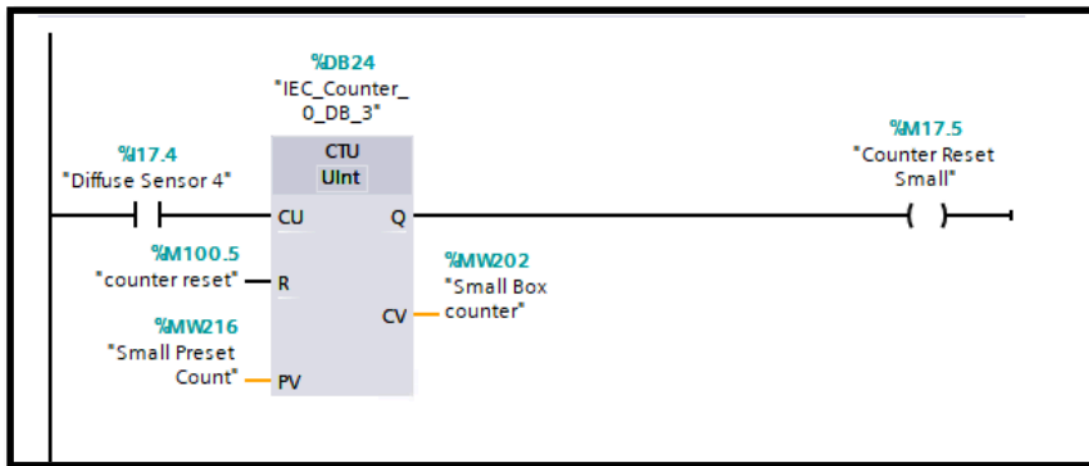


This network is crucial in understand what the scale is doing and why it sorts the packages. The network tells the scale to stop for 5ms to measure the package. the network then communicates with the sorters to tell them if they need to go left or right depending on the weight. For example, if the weight is less than 4.2 sorter moves left. if the weight is more than 4.8 sorter goes right.

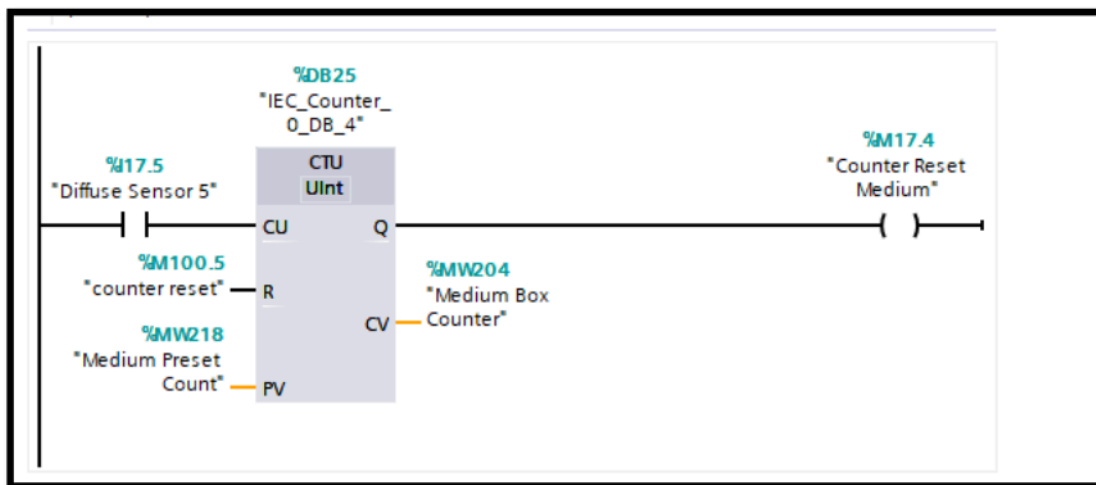


This network uses a CTU (Count Up) function block with a UInt data type to count operations triggered by a pusher. The count provides a means to track the number of packages being sorted by the pusher. The CTU operand also has a counter reset button set up in the HMI.

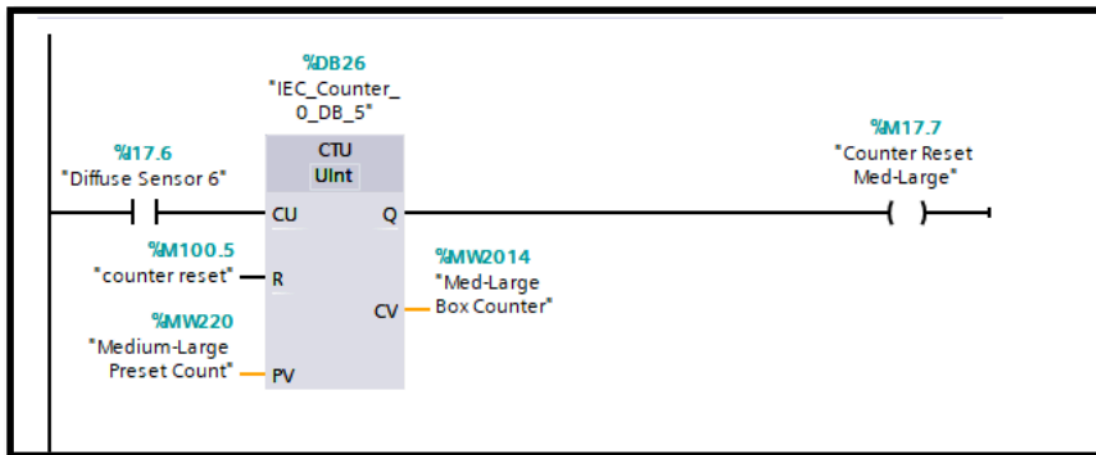
This network is also linked to the Package error screen. where the user can enter a preset value for the number of packages that pass before the warning light activates.



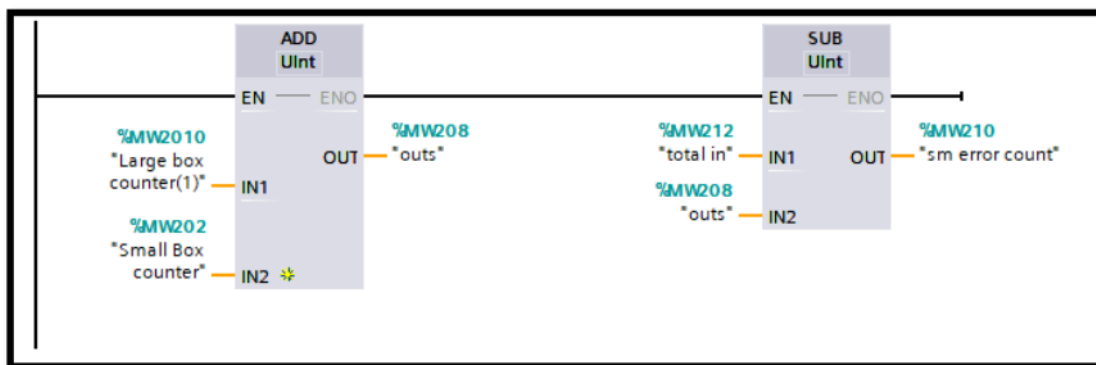
This network shows the count of the small boxes as they pass through the emitter set to detect small boxes. You can also see the count is set to the reset button in the HMI screen. and also is set up to the preset counter value in the hmi screen



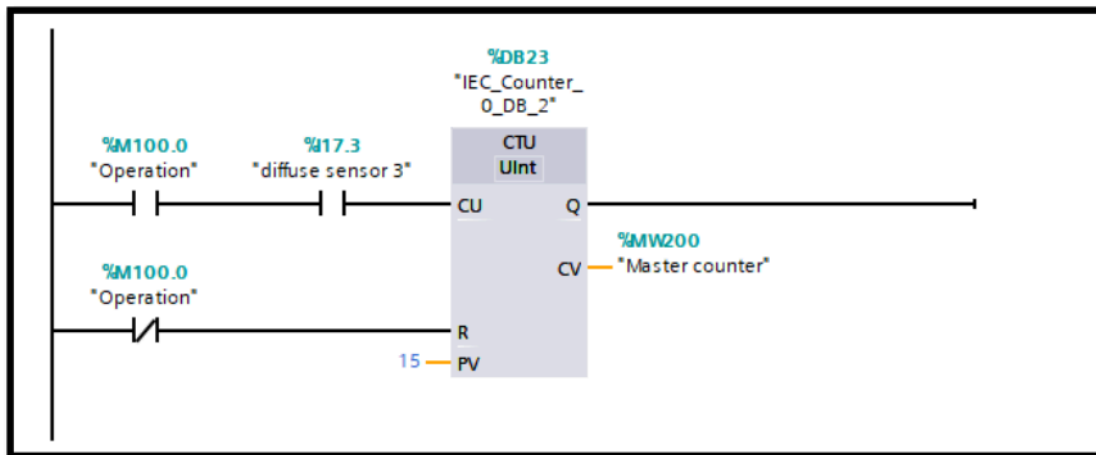
This network shows the count of the medium boxes as they pass through the emitter set to detect Medium boxes. You can also see the count is set to the reset button in the HMI screen. and also, is set up to the preset counter value in the hmi screen



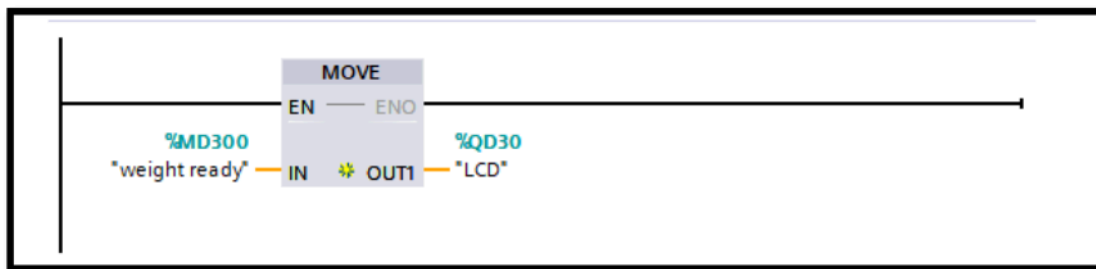
This network shows the count of the Medium-large boxes as they pass through the emitter set to detect Medium large boxes. You can also see the count is set to the reset button in the HMI screen. and also is set up to the preset counter value in the hmi screen



This network is set up to detect error counts on the small and large boxes



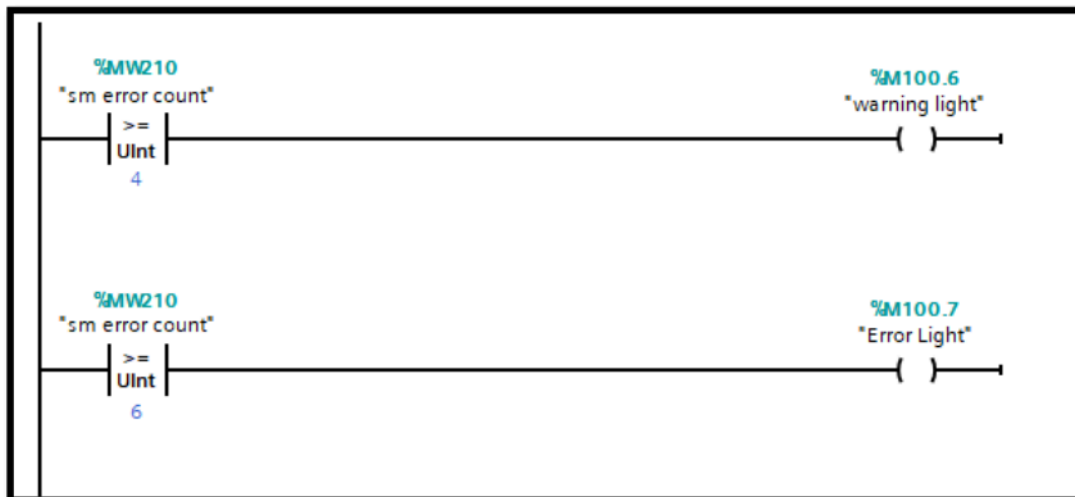
This network shows the master count being counted off of the diffuse sensor. You can also see a CTU operation set to UInt to count in whole integers.



This network shows how the weight measured by the scale, is displayed onto the LCD for the user to read and log.



This network is used to calculate whether there is a difference between the master count and the number of parcels that have reached their destination. By working out the difference in numbers the system can detect how many errors there have been and signal to the user if there has been an error



This Network shows the operation of a warning and error count light and what numbers are needed to be exceeded for this light to operate.

For example, the first line shows a greater than Uint with the number 4 below, this means if the error count exceeds 4 the warning light will come on

The second line shows that if the error count exceeds 6 then the error light will operate.

Discussion

The analysis of a (PLC) system in the context of a factory I/O sequencing system demonstrates the versatility and reliability of PLCs. With through background research, the literature review and through firsthand experience with virtual plcs. I can conclude that PLC's are groundbreaking pieces of equipment that can be used to achieve new levels of automation.

Performance Evaluation

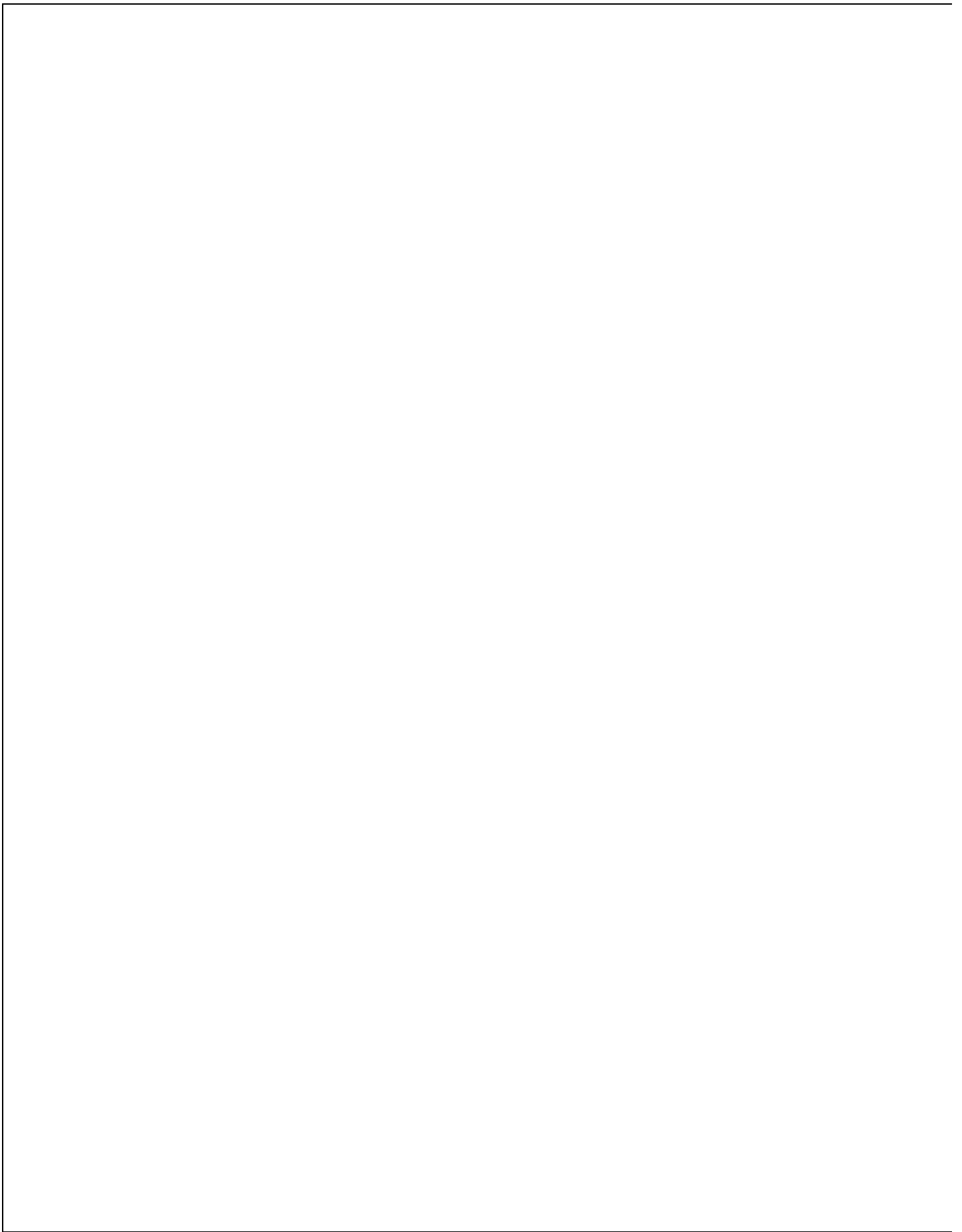
The FactoryIO system successfully sorted the four packages according to predetermined weight and size criteria. This highlights the PLC's ability to handle repeatable and accurate tasks in real time. It also demonstrates the integration of hardware and software in a control process using sensors for input data and actuators for sorting packages.

The Ladder logic programme is also a sign of how well a PLC can be programmed into performing at high levels with top level efficiency. The network consists of 23 networks all labelled with what each individual network does.

The student also achieved functional HMI screen displays full operation in real time environments. Showing total packages counted, box weight measurement, emergency stop button and more.

Challenges Faced

Despite general success there were few challenges faced. PLC's are highly versatile but have a learning curve for them to be fully utilised. Taking the time to learn the fundamentals and building knowledge from the ground up took time.



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PLC word Document A1

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

63/100

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12

PAGE 13

PAGE 14

PAGE 15

PAGE 16

GRADING FORM: SMU GENERIC_GJ

NATHAN EVANS

63

RESEARCH-INFORMED LITERATURE



Good literature review of PLCs on the market, with images 75%

7.5

KNOWLEDGE AND UNDERSTANDING



The factory looks good with all of the required components included plus a few others. Your factory operates well and demos very well. 75%

22.5

ANALYSIS



Your ladder logic program is comprehensive and well documented throughout with an alarm strategy. The uploaded file has a number of problems with the system tags, tags appear in the HMI which have no corresponding tag in the PLC. This problem stopped the program from loading and running. Although the alarm strategy does not appear to function fully 52%

15.6

PRACTICAL APPLICATION AND DEP.



Your root HMI screen is well laid out and informative for the operator but the alarm screen and the engineer screen are not carrying sufficient information 60 also the screen images in the report do not match the screen in the system. 52%

10.4

SKILLS FOR PROFESSIONAL PRAC.



The report is nicely presented with the network operations described.. The illustrations are good and clear. A good selection of references. 70%

7