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CYCLE TIME REDUCTION IN ECONOMIZER MANUFACTURING USING 5S TECHNOLOGY: A CASE STUDY

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ABSTRACT

5S is a systematic technique used by organizations comes from five Japanese words. This system helps to organize a workplace for efficiency and decrease wasting and optimize quality and productivity via monitoring an organized environment. It also provides useful visual evidences to obtain more firm results. There is a real need for empirical studies in field of new management systems and their impact on company's performance. A case study has been carried out at Veesons Energy Systems Pvt. Ltd in Trichy, pioneer in boiler parts manufacturing. The company faces lot of problems in cycle time and process delay, intern the profit also getting reduced. As importance role of continuous improvement in today's organizations, and lack of sufficient evidence to show the positive impact of 5S on organizational performance, this paper aims to determine performance factors and characteristics in industrial organizations and identifying the effectiveness of 5S implementation on organizational performance as well. Surveying method is used and data collection is done by distributing questionnaire among five target organizations which have implemented 5S techniques. The target organizations are chosen from different industries and diverse field of work. The results of this research obtained from a comparative measurement of organizational performance before and after 5S implementation. The cycle time has been declined to 3 hours from 10 hours.

***Key words**: 5S, cycle time, boiler parts manufacturing.*

1. Introduction

A systematic method to organize the workplace to keep it neat and clean, to maintain standardized conditions and to sustain the discipline that is needed for high performance. The 5's principles system should come first as a basis for other improvements. 5's identifies where the problems are. It is a great way to eliminate waste. It's sometimes referred to as a housekeeping methodology.

5S is a way to improve the performance and organize the whole system which has been used first time by Japanese. It comes from five Japanese words start with S which is translated into English words to give the best explanation for them.

1.1 Objectives

To find out the various factors that influences the workplace organizations and housekeeping activity in production area.

To identify the impact of workplace organization towards the productivity.

To improve safety, customer satisfaction, personal satisfaction and standardization.

To reduce waste, downtime, defects and delays.

1.2 Problem

Poor systematic method is determined as major problem in small and medium scale industries.

These problems affect the productivity and it causes "Back order" as well.

Throughout the study, the aim is to be proposed new systematic method to the related company to increase the productivity and to meet the customer demand (takt time).

1.3 Limitation of study

Housekeeping activities are required to improve efficiency and quality in an industry without disturbing or changing the operation sequence and production cycle.

There is no better concept of housekeeping activity than 5S principles. There is no concept that can be implemented in industries to improve the efficiency and quality without changing the operation cycle. But 5S principles can be implemented without changing the operation method to improve the quality and efficiency

1.4 Definition of 5S

5S represents 5 disciplines for maintaining a visual workplace. 5S is a system applied for providing

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order and discipline at companies, provides the supervision of both simple and even the smallest details of the company and forms the basis of the other improvement activities.

The 5S philosophy focuses on effective work place organization, simplification of the work environment, and reduction of waste while improving quality and safety.

5S system improves the quality and safety, it is expressed by five Japanese words that express cleaning and order at the company and accepting this as work discipline. These words are ….

- *Seiri: Sort*
- *Seiton: Set in Order/Straighten*
- *Seiso: Shine/Sweep*
- *Seiketsu: Standardize*
- *Shitsuke: Sustain/Self-discipline*

In case of its application, it has important advantages in terms of both the company and the personnel , it is possible to group the main items of this as following…

- It becomes the reason of exulting and the company's adaptation by the personnel.
- Unity soul develops among the teammates.
- A system that can be applied jointly by everyone.
- Provides work safety.
- Efficiency and quality improves.
- Accident and injuries are removed.
- More joyful working at a clean and regular company.
- Time losses are removed.
- Problems are early diagnosed and rate of fault is minimized.
- Machine defects are minimized, machine performance is improved.
- Effective utilization of all areas is provided.

Sort (Seiri)

Sorting necessary and unnecessary materials is sort. The arrangement used for keeping each material in the company at correct place is named as sort The defective or rarely used material and equipment in the company cause the demolishment of the workplace's order and decrease in the work efficiency. Therefore the necessary and unnecessary materials available in the workplace should be sorted and classified. In order to improve the availability of the working machine and hardware some work stations such as the machines, tools, hand machines, materials to be used, etc. should be kept available in an order and at places where can be easily accessed .

Set in order/straighten (Seiton)

Forming a regular workplace, avoiding time loss while searching for material and so improving the efficiency are the main objectives. According to this purpose, alocalization order is designed for easily accessing to the necessary materials at required times and the materials are put their own places again after utilization. As a result of the arrangement performed at the work stations (machines, tools, hand tools, materials to be used, etc.), these should be kept at a place where can be accessed easily due to the case of requirement. The place where the operation is actually realized, material transition paths and the material storage method are the points that should be considered in this step.

- Stock areas should be used at top level. Solutions such as a shelf order in proportion to the height of the classified material and drawers instead of big sized
- Cupboards and boxes can gain efficiency in terms of stocking.
- In cases where "First in first out" principle is used, it should be avoided that stocking is deep.
- The stock areas, shelf and drawers as well as materials should be labeled.
- In case if the dimension and kind of the product change, then special vehicles may be used in machine adjustments.

Since the regulation will avoid time loss that may occur during searching and returning the necessary thing, it carries great importance in terms of work efficiency. Furthermore, it is also important since it forms the basis of standardization and in terms of its effective application.

Shine/Sweep (Seiso)

In order to realize effective tasks, it is essential to create a clean and regular working and living environment. This is because dust, dirt and wastes are the source of untidiness, indiscipline, inefficiency, faulty production and work accidents. We can handle cleaning practices as a two stepped approach; "general cleaning of workplace and availability of dirtiness sources" and "machine, hardware, tool cleanliness" referred as detailed cleaning. In case of detailed cleaning, some advantages can be obtained. These can be summarized as following.

- Dirt and dust causes bad operation, corrosion and early demolishment of machine and its components. Therefore, dirt and dust sources are removed.

- As a result of making the workplace more proper to the working conditions, the morale of the personnel improves.
- The abnormal cases such as lubricant leakage, wastes, etc. are recognized immediately.
- As a result of psychological impact, the reactions and performances of the personnel get better.
- Through providing a safer working environment, the danger contained works decrease.

Standardize (Seiketsu)

Following the application of first 3S principles, the necessary systems are formed in order to maintain the continuance of these good practices at the workplace. In order to do this, these activities should be written according to the procedures and the memorization of these procedures by the personnel as well as the functionality of the rules should be obtained.

Providing the visual control that will enable the revealing of the problems that may negatively affect the conducted cleaning and the order is very important here. The methods which can be recognized by anyone at the workplace, not only by the relevant person, should be developed.

It will be appropriate to write down performance monitoring labels, control lists, tables and some procedure for visual understanding on TPM board that will be formed in order to control the activities. Following the visual control, the following activities are realized in standardize.

- Allocation of workplace in terms of area or machine based regions.
- Determination of representatives for each region.
- Identification of points required to be controlled in each region (formation of cleaning-order lists).
- Removal of negativities recognized as a result of controls.
- Therefore, standardization means to make correct attitude and behaviors

As daily habits and assure their full application in order to get over the handicaps in the first three basic principles.

Sustain/self-discipline (Shitsuke)

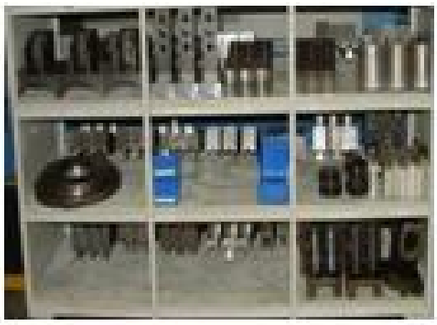
The last step of 5S program covers the improvement of the methods directed to the adaptation of 5S as habit by all personnel. The task here is undertaken by the leader directors. The directors should explain the importance of 5S to the personnel through various trainings and the knowledge of the personnel about 5S should be kept updated through the 5S boards to be formed at the workplace. Through various campaigns with easy participation, the dissemination of 5S should be targeted. The objectives of these studies can be summarized as following.

- Formation of a disciplined company.
- Removing small faults through the aid of cleaning.
- Providing the execution of visual control.
- Granting the responsibility of the machine to the worker.
- Providing the performance of protective activities.
- And granting the responsibility of the workplace to the personnel.

As a result of 5S activities applied before TPM, a clean work environment will be formed, the work efficiency will be improved and therefore a substructure for TPM will be established.

2. Project Examples

2.1 Before 5S



3. Key to Success of Implementation of 5S

Do all the way – When establishing proper arrangement, make sure to carry out all the tag campaigns and use correct red tagging formats and procedures. When establishing orderliness, use signboards.

Make sure that signboards have proper format, descriptions and locations. Proper your company's own 5S manual. Complete with all the necessary details.

The president should inspect the shop floor personally. The president should personally inspect offices and point out their various positive and negative conditions.

Don't stop halfway in establishing 5S. Don't do things halfway. Once the 5S promotional organization and methods have been established, get started and stick with it.

When developing red tagging and signboards throughout the company, make sure gets everyone involved. Ones you have laid the foundation by establishing proper arrangement and orderliness, start developing discipline habit to keep the foundation strong.

5S is a half way towards other improvements – don't stop with 5S; follow through with zero defects, cost reduction and other productivity and quality improvements.

Once the office has been cleaned up, start putting casters on drawer cases to make them easily movable.

Eliminate defects as close to their source as possible and implement flow process. By implementing 5S eventually productivity, efficiency and working spirit will be promoted. It is not only useful to manage workplace physically but also useful to develop employee's attitude and discipline.

4. Implementation of 5S

4.1 Step By Step Internal Audit

Preparation of 5S auditing
Formation of 5S audit team
Representative from all departments
Internal 5S audit training
Defining territorial areas
Setting up 5S grouping in each department
Develop audit criteria
Based on working area
Preparation of audit material
Stickers
Report writing format
Auditor tag
Distribution of audit criteria for each of 5S working areas
Grouping of auditor and area for auditing.

5. Auditing Committee

5.1 Function

Developing 5S evaluation criteria, guidelines and stickers.

Developing schemes on measuring impact of audit; scoring point and achievement level.

Developing guidelines to aid in effective standardization of improvement projects.

Submitting audit summary every month to the top management.

5.2 Internal training

Weekly training
Encouraging workers
Generating the interest

5.3 Territorial areas

Administrative group – getting complete daily report Production group – keeping watch on production. Store group – providing all the necessary materials and tool at workplace, proper storing of finished work piece.

5.4 Audit criteria

Proper sorting
Proper usage of stickers and labels
Quality check
Safety of workers

5.5 Implementing

Step 1

- Setting up audit checklist criteria according to area of 5S team.
- Setting up audit summary report.

Step 2

- Audit schedule
- Area to be audited
- Audit date

Step 3

5.6 Audit implementation performing audit

- All 5S auditors gather at the meeting room half an hour before audit.
- Briefing by 5S audit to chairman
- Activities of the day.
- Highlighting any new area criteria to be checked.
- Action date on sticker (two weeks from audit date)
- Time to report back.
- Wearing 5S auditor tag.
- Every auditor is only allowed to use up to three stickers of each kind for each 5S team.

6. Advantages of 5S

1S

- Process improvement by cost's reduction
- Stock decreasing
- Better usage of the working area
- Prevention of losing tools

2S

- Process improvement (increasing of effectiveness and efficiency)
- Shortening of the time of seeking necessary things
- Safety improvement

3S

- Increasing of efficiency of machines.
- Maintenance of the cleanness of devices
- Maintenance and improvement of the machines, efficiency
- Maintenance of the clean workplace, easy to check
- Quick informing about damage (potential sources of damages)
- Elimination of the accident's reasons.

4S

- Safety increasing and reduction of the industry pollution.
- Working out the procedures defining the course of processes

5S

- Increasing of the awareness and morale
- Decreasing of mistakes quality resulting from the inattention
- Proceedings according to decisions
- Improvement of the internal communication processes
- Improvement of the workers relation.

7. Company Profile

M/s.Veesons Energy Systems Pvt.Ltd., is a leading manufacturer of Boilers, Boiler Components and Allied Systems from Tiruchirapalli, tamilnadu. We have got more than 30 years of experience as a vendor for M/s. Bharat Heavy Electricals Ltd., tiruchirapalli for their 100,200&500 MW boiler. The annual turnover at present is around Rs.100 Crores. The employees strength is around 800.

Branches and service center are available at Bangalore, Chennai, Erode, Hyderabad, Kolkata, Madurai, Raipur, and Sambalpur&Tirupur. Boiler installed in 16 states in India and in Srilanka, Nepal, Madagascar and Thailand

7.1 Product profile

VSPL do in-house design, Manufacture, Supply, Erection and commission of following boiler ranges, Shell Type Boilers, Fixed Grate Boilers, Hybrid Boilers, Travelling Grate Boilers.

7.2 Applications

Boilers play a very important role in chemical industries, power plants, rice mills, in cold countries hot water producing boilers are used for heating the buildings, sugar mills.

8. 5S Audit Checklist

1S	N0	Check item	Description	Score			
				CS	BS	JS	EP
SORT	1	Material or parts	Does the inventory or in-process inventory include and unneeded materials or parts?	1	1.5	1.5	1
	2	Machines or equipment	Are there any unused machines or other equipment around?	1	1	1	1.5
	3	Power equipment	Tripping dangers such as electrical cables, etc. are removed from standing/walking areas?	1.5	1.5	1	1
	4	Jigs ,tools ,or dies	Are there any unused jigs, tools, dies or similar item around?	0.5	1	1.5	1
	5	Paper works	Only there required paper work is present at the workstation. Out-dated or otherwise unnecessary posters, announcement, reports etc..are removed from the work place.?	1	1	1.5	1
	6	Visual control	Is it obvious which items have been marked as unnecessary?	1.5	1.5	1.5	1.5
	7	Work in process documents	Are all WIP location necessary or in use?	1	1	0.5	1
	8	Written standards	Has establishing 5s's left behind any useless standard?	0.5	0.5	1	2
			Sub total	8	9	9.5	9

2S	N0	Check item	Description	Score			
				CS	BS	JS	EP
SET IN ORDER	1	Location indicators	Are shelves and others storage areas marked with location indicators and addresses?	1	1	1	1.5
	2	Item indicators	Do the shelves have signboards showing which items go where?	0.5	1	1	1.5
	3	Locker cabin	Are the interior content of all lockers, cabinets and drawers labeled and neatly arranged?	0.5	0.5	0.5	1
	4	Quantity	Are the maximum and minimum allowable quantities indicated?	1	1	0.5	1.5
	5	Emergency indicator	Stop switches and breakers are highly visible and located for easy access in case of emergency	1	1	1	1
	6	Demarcation of walkways and in-process inventory areas	Are white lines or other markers used to clearly indicated walkways and strong areas?	0.5	0.5	0.5	1.5
	7	Emergency exit	The workplace layout accommodates easy exit in case of emergency?	1	1	1	1
	8	Jig and tools	Are jigs and tools arranged more rationally to facilitate picking them up and returning them?	1	1	1	1.5
			Sub total	6.5	7	6.5	10.5

3S	N0	Check item	Description	Score			
				CS	BS	JS	EP
SHINE	1	Floors	Are floors kept shiny clean and free of waste, water and oil?	1.5	1.5	1	1.5
	2	Machines	Are the machine wiped clean often and kept free of shavings, chips and oil?	1.5	1	1.5	1.5
	3	Cleaning equipment's	All cleaning equipment's are neatly stored and is readily available when needed	1	1.5	1.5	1.5
	4	Cleaning and checking	Is equipment inspection combined with equipment maintenance?	1	1.5	1	1
	5	Cleaning responsibilities	Is there a person responsible for overseeing cleaning operation .?	1	1.5	1.5	1

	6	Habitual cleanliness	Do operators habitually sweep floors and wipe equipment without being told.?	1.5	1	1.5	1
	7	Equipment safety concerns	Equipment safety concerns are clearly identified ,safety guards are painted, in good working condition and provide adequate protection	1	1.5	1.5	1.5
			Sub total	8.5	9.5	11.5	9

4S	N0	Check item	Description	Score			
				CS	BS	JS	EP
STANDARDIZE	1	Improvement memos	Are improvement memos regularly being generated	1	1.5	1.5	1.5
	2	Tools	Are the standard responses for missing tools, lower than min. quantities or cleaning activities not followed?	1.5	1.5	1.5	1.5
	3	Improvement Ideas	Are improvement ideas being acted on?	1.5	1	1.5	1
	4	Missing equipment	Are the standard responses for missing tools, lower than minimum quantities or cleaning activities not followed?	1	1.5	1	1
	5	Key procedures	Are standard procedures clear, documented and Actively used?	1.5	1.5	1	1
	6	Audit result	The result of the previous audit are posted and clearly visible to the entire team	2	1.5	1	1
	7	Work environment	The work environment satisfies the requirements of the work being performed, lighting(brightness & color), air quality, temperature, etc.	1.5	1	1	1
	8	Improvement plan	Are the future standards being considered with a clear improvement plan for the area?	1	1	1	1
	9	The first 3 Ss	Are the first 3 Ss' (sort, set locations and shine) being maintained?	2	1.5	1.5	1.5
			Sub total	13	11	11	10.5

5S	N0	Check item	Description	Score			
				CS	BS	JS	EP
SUSTAIN	1	Training	Is everyone adequately trained in standard procedure?	1	1.5	1.5	1.5
	2	Tools and parts	Are tools and parts being stored correctly?	1.5	1.5	1.5	1.5
	3	Involvement	Recognition is given to teams who get involved in 5S activities	1.5	1	1	1
	4	Stock controls	Are stock controls being adhered to?	1	1	1	1
	5	Time allocation	Time and resources are allocated to 5S activities (e.g. designated daily/weekly clean-up time, 5S team leader, etc.)	1.5	1	1	1
	6	Procedures	Are procedures up-to-date and regularly reviewed?	1	1.5	1	1.5
	7	Operation involvement	All operators, team leaders ,supervisors, etc. are assigned 5S activities to be completed at least once/week	1	1.5	1.5	1.5
	8	Activity boards	Are activity boards up-to-date and regularly Reviewed?	1.5	1	1.5	1.5
			Sub total	10	10	10	10.5

9. 5S Activity Descriptions- Week: 1

9.1 Section:cutting section

5S	1S	2S	3S	4S	5S
No.of Question	8	8	7	9	8
Maximum score	40	40	35	45	40
Score obtained	9	7	9.5	11	10
Average score	0.225	0.175	0.271	0.244	0.25

9.2 Section: bending section

5S	1S	2S	3S	4S	5S
No. of Question	8	8	7	9	8
Maximum score	40	40	35	45	40
Score obtained	8	6.5	8.5	13	10
Average score	0.2	0.163	0.243	0.29	0.25

9.3 Section: joining section

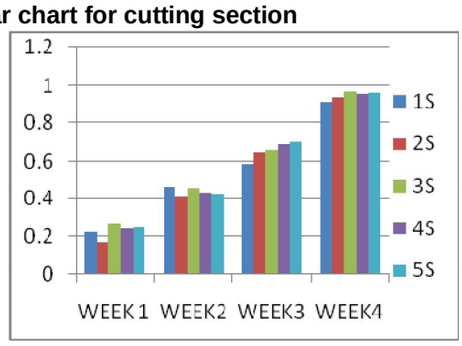
5S	1S	2S	3S	4S	5S
No.of Question	8	8	7	9	8
Maximum score	40	40	35	45	40
Score obtained	9.5	6.5	11.5	11	10
Average score	0.237	0.163	0.329	0.244	0.25

9.4 Section: end process

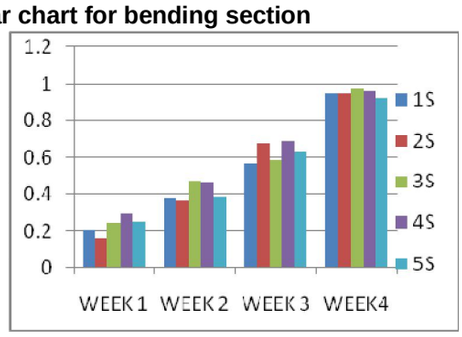
5S	1S	2S	3S	4S	5S
No.of Question	8	8	7	9	8
Maximum score	40	40	35	45	40
Score obtained	9	10.5	9	10.5	10.5
Average score	0.225	0.263	0.257	0.233	0.25

10. Overall performance charts

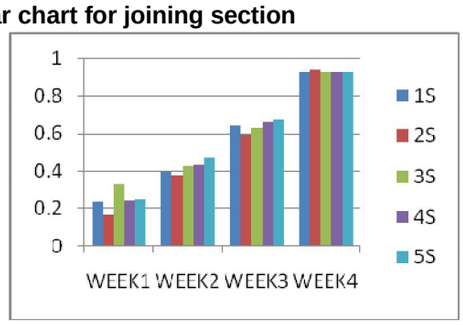
10.1 Bar chart for cutting section



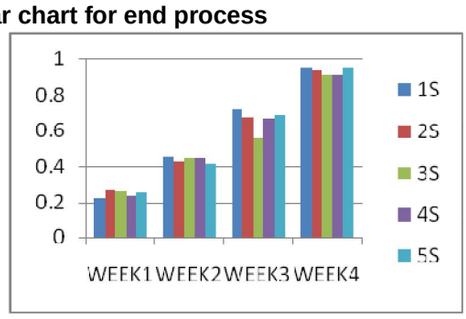
10.2 Bar chart for bending section



10.3 Bar chart for joining section



10.4 Bar chart for end process



11. Performance Study

11.1 Cutting section

Time requirement for cutting process:

Cutting time / tupe = 45 sec
No. of Cuts / tupe= 3 (max)
Total time =3x45 = 135 sec
Cutting time for coil tupes = 27 min

Before 5S

The machine was ported to the job to complete the required process. So time taken to complete the process was more due to overweight of the machine.
Total time required=2293.7 sec = 38 min

After 5S

After implementation of 5S, the job is moved to the machine. Job can be moved easily due to its less weight and it can be processed with less time.
Total time required=2047.5 sec = 34 min

11.2 Bending section

Before 5S

The machine was ported to the job to complete the required process. So time taken to complete the process was more due to overweight of the machine.
Total time required=139.34 min = 140 min

After 5S

Due to the implementation of 5S, searching time of jobs is reduced by providing required tools in a box closer to the machinery. Hence, the searching time can be reduced upto 80%.
Total time required=124.96 min = 125 min

11.3 Joining section

Before 5S

Before 5S implementation, the welding cables were brought to a long distance. Due to this, current density got reduced. Hence, welding wasn't proper and more number of electrodes were consumed.
Total time required=92.76min =98min

After 5S

After 5S implementation, materials to be welded are brought near to the welding source. So, welding is carried out at proper current density. Hence, the welding is in good quality and also consumption of electrodes are less.
Total time required=75.46min =75min

11.4 End process

Before 5S

The machine was ported to the job to complete the required process. So time taken to complete the process was more due to overweight of the machine.
Total time required=202min

After 5S

Due to the implementation of 5S, searching time of jobs is reduced by providing required tools in a box closer to the machinery. Hence, the searching time can be reduced upto 80%.
Total time required=187min

12. Result

12.1 Area reduction

Project area	Space occupied before 5S m^2	Space occupied after 5S m^2	Reduction area m^2	Reduction area In %
Cutting section	290	260	30	10.34
Bending section	312	240	72	23.07
Welding	273	210	63	23.10
End process	364	280	84	23.08

12.2 Cycle time reduction

Time taken to manufacture an economizer coil before the implementation of 5s was 10hours but now the time taken to manufacture a coil is reduced to 7hours due to the implementation of 5s
Time reduction = 3hours/economizer

12.3 Suggestions

- Implement 5S is to reduce workplace waste and optimizes productivity and maintaining an orderly workplace.
- Implement 5S in the production area with top level management and employee involvement.
- Get everyone involved – 5S is not be the responsibility of few members in a concern. It is a concern of everyone to act.
- All levels of management should take part in decision making responsibility and ensure 5S implementation.
- By implementing 5S, the Workflow will be simplified.

- 5S implementation which helps to standardize improvement of production and maintenance of critical process parameters.

13. Conclusion

5S is an approach that can be easily applied in all organizations. Its simplicity and easy recognition is the superior side of 5S. As a result of 5S activities applied before TPM, a clean work environment has been formed, increase has been provided in the work efficiency and therefore a substructure has been established for TPM. With the aid of the successful practices in training and discipline issues, many factors causing work accidents have been removed.

A successful 5S application is dependent on the trainings to be provided by the directors to the personnel. Even a smallest levity that may form during the training challenges the achievements of expected results.

Finally, efficiency is improved due to 23% of area reduction and 30% of cycle time reduction.

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