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Full Length Research Paper

5S activities and its application at a sample company

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Total Productive Maintenance (TPM) targets enabling the machine operators to undertake the maintenance activities and therefore to increase the efficiency of the equipments. It struggles with six great losses decreasing the efficiency of the equipment. 5S, which is the pre-step of TPM, is a systematic approach providing the contribution of all personnel in the cleaning regime of the company. The clean and steady environment targeted by 5S has positive impacts on the work safety, quality, efficiency and morale. In this study, 5S system, used for ensuring order and discipline in the companies and ensuring the supervision of both simple and even the smallest details, has been reviewed in full details and they have been taken under the content of the research through selecting the assembly department as pilot department for 5S activities applied at a yacht manufacturing company. It has been targeted to set this as a guide for the directors of the company and the researches working in this field by assessing the results of this study.

Key words: 5S, TPM, activity, company.

INTRODUCTION

Total Productive Maintenance (TPM) is a protective maintenance system requiring the participation of all departments in order to obtain maximum equipment efficiency in an organization, which involves all human resources. It is defined as the integrity of effective maintenance and autonomous maintenance activities conducted by all personnel as in small group activities (Jeong and Philips, 2001; Brah and Chong, 2004). TPM is a management system and includes “Total” term, total economic efficiency and profitability as well as total planned maintenance and participation.

The main target of TPM; is to drop six great equipment losses (equipment defect losses, equipment preparation and adjustment losses, small stops and idle operation losses, speed losses, quality defects and reprocessing losses, product losses and initial losses) to zero or to the lowest level and to provide the increase of product quality and equipment efficiency. The business target; can be listed as worldwide success, customer satisfaction, competition power and increasing market share (Nakajima, 1988).

In order to provide the machine equipment efficiency, initially the application of 5S should be encouraged. At the companies applying 5S, the presence of unnecessary equipment around the company is avoided and more effective utilization of the operation area is provided. More productivity is obtained from the old workbenches, better maintenance is done and as a result, the performance of the company improves.

TPM is a system revealing itself as of the beginning of the application. The most important reason of this is the 5S applications. Through the proper application of 5S activities, a visible change occurs within the factory. Since it is executed in order to use the factory’s area and the equipments in a more efficient manner, it improves the efficiency of the company (Sevim, 2005).

Through the first three principles,5S approach prepares the environment conditions minimizing the work flow and through the last two principles, it targets the protection and development of the revealed improvement.

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According to this purpose, the foundations of the company policy oriented to avoiding the ineffective time are taken through the applications of 5S approach. 5S approach forms the basis of the other improvement activities conducted at the company and leaves positive impact on the motivation of the personnel (Sarıcoban, 2006). Furthermore, when 5S is applied; it has important impact on the work safety, quality, efficiency and decreasing the stops. The success of the system requires the recognition of all these operations by everyone and its continuous observation. Another important factor required for its successful application is that everyone has "teamwork soul".

5S Term

5S is a system applied for providing 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 (Erdal, 2007). The 5S philosophy focuses on effective work place organization, simplification of the work environment, and reduction of waste while improving quality and safety.

While 5S system improves the quality and safety, it provides effective company organization and focuses on the simplification of work environment and the minimization of wastes principles. It is expressed by five Japanese words that express cleaning and order at the company and accepting this as work discipline. These words are (Patra et al., 2005; Mora, 2007);

i.) Seiri: Sort
ii.) Seiton: Set in Order/Straighten
iii.) Seiso: Shine/Sweep
iv.) Seiketsu: Standardize
v.) Shitsuke: Sustain/Self-discipline

The greatest feature of 5S approach is that it is simple; for that reason it easily finds area of application. Forming a ground for the other improvement activities, 5S is an important term that carries priority in improvement at a company (Celebi, 1997). The liability and failure, if available, in this kind of a change belongs to the administration, not to the personnel. In order to let the administration wait for this kind of a change from its personnel, it should initially realize this change by itself. In other words, it should value the potentials of the personnel and orient this potential according to the interests of the company. Furthermore, it should have reached to a total quality culture developed as to not cause any problem regarding the success of the recommendation and opinions coming from sub-departments and workers (Karabulut, 1999). In case if 5S awareness is combined with the work, then the targeted objectives are achieved in a faster manner.

If the personnel recognize the importance of the innovation and developments to be realized, then the established system will be operated in a healthier manner. In case of its application, it has important advantages in terms of both the company and the personnel (Sarıcoban, 2006) it is possible to group the main items of this as following (Anon, 2007):

i.) It becomes the reason of exulting and the company's adaptation by the personnel.
ii.) Unity soul develops among the teammates.
iii.) A system that can be applied jointly by everyone.
iv.) Provides work safety.
v.) Efficiency and quality improves.
vi.) Accident and injuries are removed.
vii.) More joyful working at a clean and regular company.
viii.) Time losses are removed.
ix.) Problems are early diagnosed and rate of fault is minimized.
x.) Machine defects are minimized, machine performance is improved.
xi.) 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 (Mora, 2007). The defective or rarely used material and equipments in the company cause the demolishment of the workplace's order and decrease in the work efficiency (Sarıcoban, 2006). 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 (Celebi, 1997; Kocalan, 1999).

For this reason, when this first basic principle is well applied, the problems and complaints through the work flow will decrease and the communication between the personnel will be simplified. In addition to this, since serious savings will be obtained in the size of the required working environment, important drops will be observed in the operation cost (Sarıcoban, 2006).

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, a localization order is designed for easily accessing to the necessary materials at required times and the materials are put their own places again after utilization (Patra et al., 2005). 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 (Kocalan, 1999). 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.

The regulation process is initially commenced through conducting the current status analysis. Following the analysis of the current status, the place of storage and the method of storage are decided and so time is saved. Some points that can be controlled during regulation can be summarized as following (Celebi, 1997):

i.) 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.
ii.) In cases where “First in first out” principle is used, it should be avoided that stocking is deep.
iii.) The stock areas, shelf and drawers as well as materials should be labeled.
iv.) 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 (Patra et al., 2005). This is because dust, dirt and wastes are the source of untidiness, indiscipline, inefficiency, faulty production and work accidents (Anonymous, 2007). 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 (Celebi, 1997). In case of detailed cleaning, some advantages can be obtained. These can be summarized as following (Karabulut, 1999):

i.) Dirt and dust causes bad operation, corrosion and early demolishment of machine and its components. Therefore, dirt and dust sources are removed.
ii.) As a result of making the workplace more proper to the working conditions, the morale of the personnel improves.
iii.) The abnormal cases such as lubricant leakage, wastes, etc. are recognized immediately.
iv.) As a result of psychological impact, the reactions and performances of the personnel get better.
v.) Through providing a safer working environment, the danger contained works decrease.

In order to realize shining through an effective system, the names of the personnel who are responsible from the cleaning of each zone, each department and each point of the factory should be clearly determined and written at the proper places. The shining time should be very short in order to obtain effective utilization. The best times for cleaning are the beginning of shift, end of shift or after meal. All personnel should be well trained about cleaning and participate in cleaning.

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 (Celebi, 1997; Kocaalan, 1999):

i.) Allocation of workplace in terms of area or machine based regions.
ii.) Determination of representatives for each region.
iii.) Identification of points required to be controlled in each region (formation of cleaning-order lists).
iv.) Removal of negativities recognized as a result of controls.

For full application and development of the standards, the participation of all personnel is required. 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 up-

dated through the 5S boards to be formed at the workplace. Through various campaigns with easy participation, the dissemination of 5S should be targeted (Celebi, 1997). The objectives of these studies can be summarized as following (Karabulut, 1999):

i.) Formation of a disciplined company.
ii.) Removing small faults through the aid of cleaning.
iii.) Providing the execution of visual control.
iv.) Granting the responsibility of the machine to the worker.
v.) Providing the performance of protective activities.
vi.) And granting the responsibility of the workplace to the personnel.

Reception of innovations, which are revealed at each phase of production activities, by the personnel with lowest resistance and enabling the adaptation of the new case at the shortest time can only be possible through a training program to be established. A regular and effective training program shall provide the contribution of the personnel in each phase of the work and so the addition of the innovation to the agenda through a demand sometimes coming from the base, not from the management (Sarıcoban, 2006).

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.

MATERIALS AND METHODS

Material

The company where the application is conducted is a company been established in 2002 in order to manufacture yacht. The company has totally 29,000 m^2 area formed of 14,000 m^2 closed and 15,000 m^2 open area. The total number of the personnel working at the company is 360 and 80 of them are employed under white-collar personnel team and 280 of them are employed in production department as blue-collar personnel. There are 5 blue-collar personnel working in the maintenance workshop. The company itself realizes the production and assembly operations of all parts, except the engine of yacht, of 55, 78, and 102 feet luxurious yachts through Vacuum Infusion technique. CMS-Poseidon model is manufactured through the CNC machine at 12.5 x 8 x 4 m operation dimension and other advanced technology machines. Its total production load is 12 yachts per year and the necessary studies are continued for increasing this number.

Method

Reports have been issued through the observations made in the production site in order to identify and remove the negativities affecting the quality and they have been presented to the top management. In these reports, following have been identified;

i.) Definitions have not been made in the production line and throughout the factory.
ii.) Material, semi-finished product and improper product areas have not been determined according to the procedure.
iii.) The utilization areas at the assembly line shelves have not been determined.
iv.) The material warehouses (temporary material stocking areas) have not been defined at the production area (assembly department).
v.) Fiber cutting area is irregular, inadequate and definitions have not been made.
vi.) The machines used throughout the factory are not the originals of the user's instructions.
vii.) There is a chaotic process throughout the factory.

It has been decided on to initiate improvement activities in all departments of the company according to these findings. However, since the work volume is high and has direct connection with the other departments, it has been agreed on that all processes within the company will be positively affected through the performance of a systematic improvement study at the assembly department and this department has been selected as the pilot application area. Within this frame, for each of 5S activities to be executed in the assembly department, 5 assessment questions have been prepared and 5S assessment form has been prepared (Table 1). For answers to be given to these questions in each week, assessment scores as 0 = Very bad, 1 = Bad, 2 = Average, 3 = Good and 4 = Very good have been determined.

For better execution of 5S activities under the company and the performance of controls in a regular manner, the quality management department's engineers have been commissioned. 5S activities applied in the assembly department of the surveyed company have been reviewed for 28 weeks and the forms have been filled as a result of the weekly routine controls. Scores of each week are summed up, so weekly total assessment scores are obtained and the assessments are made through reflecting the weekly scores on the graphics. In order to provide well understanding of 5S weekly score calculations, 5S control list of week 6 has been given in Table 1 and scoring section has been given in Table 2 as examples.

In the study, the data on these forms have been used and the analyses are tried to be performed through observing the applications within the company. Regarding this issue, cooperation has been made with the applicators of the company and the opinions of the people authorized in application throughout the survey have been taken.

RESULTS AND DISCUSSION

The variation of the scores, which belong to the assessment of the activities conducted under 5S content in the assembly department of the survey subject company, between the weeks 1 to 28 has been given in Table 3.

In Figure 1, the compliance of the personnel to the activity of recovery at the departments formed through the regular and continuous marking and sort of the unnecessary machine, equipment and parts for weeks 1 to 12 has been assessed. The curve showing the classification score has shown a very vertical curve till the week 7. When compared to the initial status, the improvement recorded in each week shows that the classification activities as of the week 7 are been accepted as work discipline by the personnel of the company. The fluctuation observed in the graphic between weeks 11 to 17 can be assessed as the delay of the sort activities following the increase of the work load within the company during the same dates. During the same weeks,

Table 1. 5S Assessment Form (Of Week 6).

5S	No.	Control point	Assessment criteria	Score				
				0	1	2	3	4
Seiri - Sort	1	Part and materials	There is no unnecessary material at stocks or been processed.		X			
	2	Machine and equipments	All machines and equipments are operated in a regular manner.			X		
	3	Connection apparatus, sets and molds	Connection sets, tools, molds, cutters are used in order.			X		
	4	Visual control	Unnecessary materials can be easily distinguished.		X			
	5	Disposal standards	There are clear standards to dispose unnecessary things.		X			
Seiton - Set in Order	6	Warehousing labels	There are labels for determining the region and places.			X		
	7	Labeled shelves and parts	Each shelf at the storage areas and each part on it are marked.	X				
	8	Quantity determinants	Clear marks showing min. and max. stock.	X				
	9	Separation lines	Separation lines are certain and clear.	X				
	10	Connection apparatus and sets	Connection apparatus and sets are well arranged and their receipt and return is ergonomically easy.			X		
-Seiso - Shine	11	Grounds	Grounds are always clean and shining.				X	
	12	Machines	Machines are clean and painted.		X			
	13	Cleaning and control	Same importance paid on both cleaning and control.		X			
	14	Cleaning responsibility	There is a rotation claim for cleaning and the place of cleaning-person to clean relation is certain.	X				
	15	Setting cleaning as a habit	Cleaning is a habit.			X		
Seiketsu Standardize	16	Ventilation	Air is fresh and odorless.	X				
	17	Lightening	There is adequate lightening.		X			
	18	Working clothes	Clothes of personnel are clean and free of lubricant.			X		
	19	Protecting from dirt	Importance paid on avoiding dirtiness.			X		
	20	First three steps	There is a system for protecting the first three S.				X	
Shitsuke – Sustain	21	Wearing rules	Organization and cleaning are appropriate to all rules.				X	
	22	Utilization of appropriate equipment	Work safety equipments obligatory for the work performed are adequate and used.		X			
	23	Interaction between people	5S proper for application and there is satisfactory environment.			X		
	24	Rule and procedures	All rules and procedures are known and applied.			X		
	25	Observation of rules	All rules have been adapted and well applied.			X		

*0: Very bad, 1: Bad, 2: Average, 3: Good, 4: Very good.

Table 2. 5S Scoring Section of week 6.

5S Activities	Sort	Set in order	Shine	Standardize	Sustain	Total score
General column total	7	4	7	8	10	**36**

Table 3. 5S Weekly assessment scores.

5S Activities (weeks)	Sort score	Set in order score	Shine score	Standardize score	Sustain score	Total score
1	0	0	0	3	4	7
2	0	0	1	2	6	9
3	1	2	2	3	7	15
4	4	2	6	7	9	28
5	6	2	7	7	10	32
6	7	4	7	8	10	36
7	11	11	6	9	10	47
8	12	10	7	8	11	48
9	12	9	7	8	11	47
10	12	9	7	8	11	47
11	12	9	7	8	11	47
12	11	8	6	8	11	44
13	10	8	6	8	11	43
14	6	7	3	6	11	33
15	6	7	3	6	11	33
16	6	7	3	6	11	33
17	6	9	4	7	11	37
18	7	11	5	9	11	43
19	9	11	6	10	11	47
20	11	11	8	11	11	52
21	12	11	9	13	12	57
22	12	11	8	13	12	56
23	12	11	8	12	12	55
24	11	10	8	11	12	52
25	10	9	8	9	12	48
26	9	9	7	9	12	46
27	7	9	7	9	11	43
28	8	9	7	9	11	44

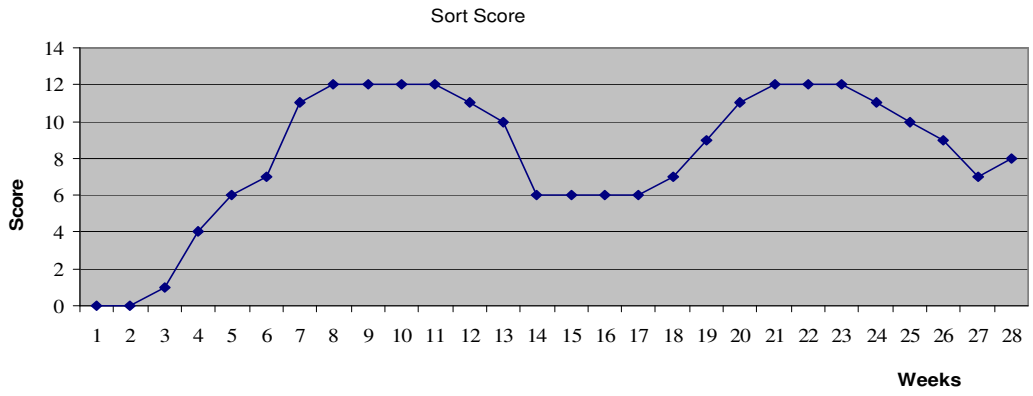

Figure 1. Sort score variation graphic

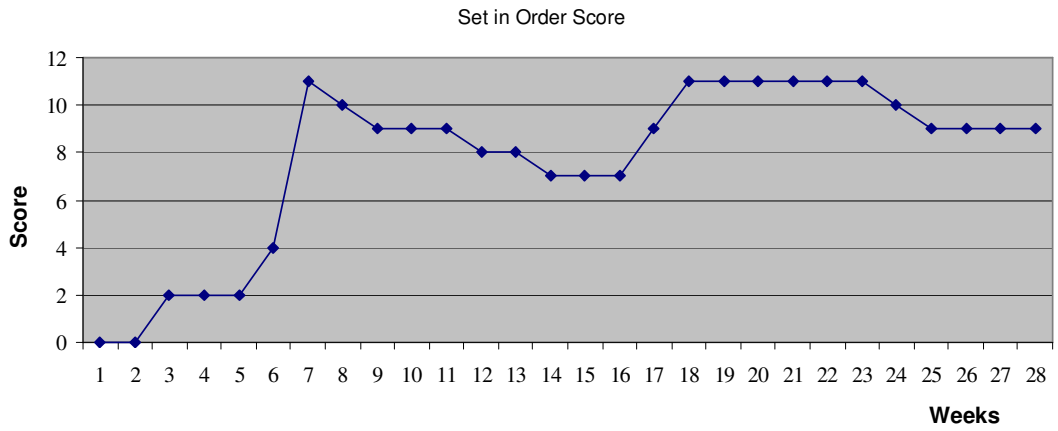

Figure 2. Set in Order score variation graphic

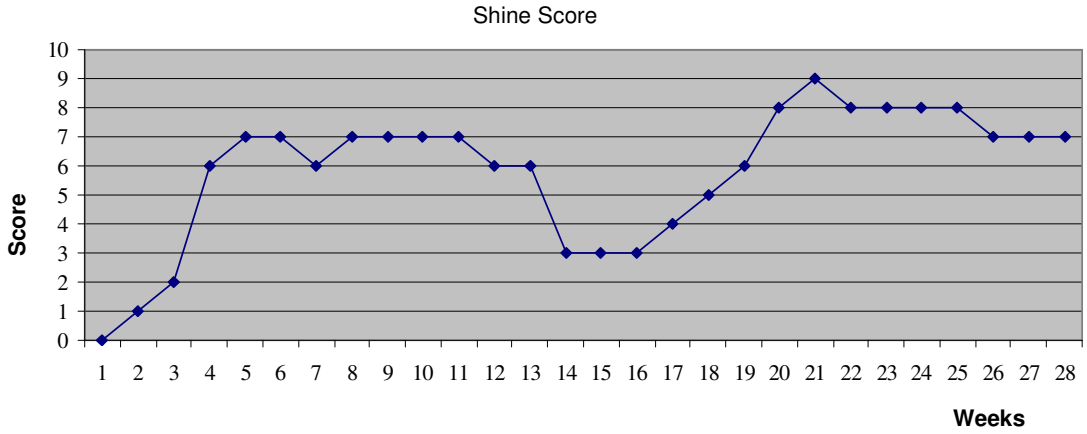

Figure 3. Shine score variation graphic

a parallel action has been observed in the graphics belonging to the other criterion.

In Figure 2, it is seen that an order has been tried to be established till the week 7 regarding the performance of the activities for the determination of the inner-production stocks' quantities and places and the preparation of the material and stock quantity cards. Following the week 18, the acceptance of the activities as a rule continuously applied within the company has been provided and it has been observed that due diligence has been spent on the compliance to these rules. In particular, following the week 18, it has been determined that a successful process has been experienced in providing the continuous of the established regime and that the regulation criterion have been adapted as habit by the personnel.

In Figure 3, it is shown that the cleaning activities initiated through the removal of lubricants, water and dust, etc. from the environment and workplaces have been continued by the personnel of the company in a regular and systematic manner during 28 weeks. The increase in the work load following the week 11 has been effective on the increase of the pollution observed in the environment. As a result of the sensitivity of the personnel on cleaning after the week 17, a positive improvement has been observed in this area. During the whole process, particularly during the controls performed in week 22, it has been determined that the requested success has been obtained and the shine activities have been started to be taken as habit by the personnel.

In Figure 4, it is observed that the standardize scores had a stabile process between weeks 4 to 18 and from week 18 to 22, the success level increased in a rapid manner. It is thought that the increase here reflects the constancy in the application of the accepted rules and conducted arrangements. Since the scores do not show great differences between the weeks, this reflects that the first three criterion activities conducted under 5S activities are applied in a well manner.

As it can be seen from Figure 5, the graphic curve of the sustain scores progresses almost as a plain line following the first weeks. In the graphics of the other criterion, the fluctuation observed during the weeks 11 to

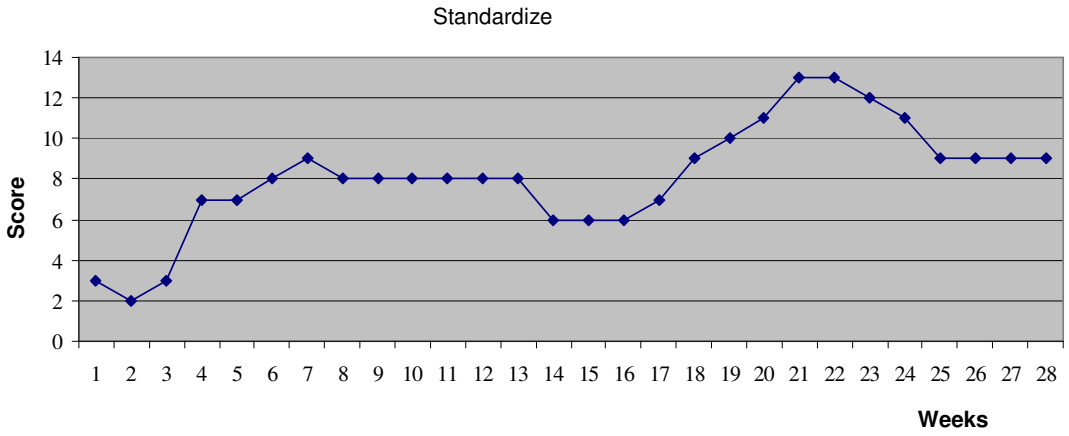

Figure 4. Standardize score variation graphic.

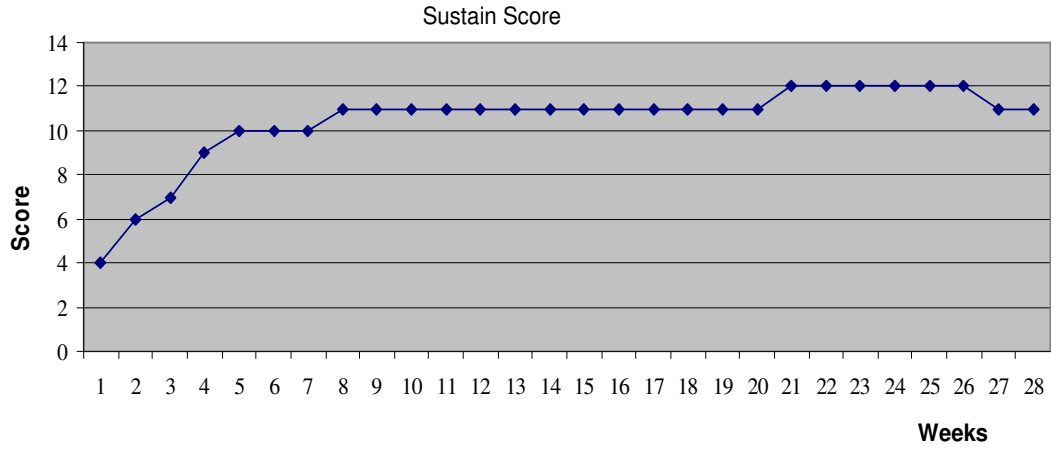

Figure 5. Sustain score variation graphic.

17 have been revealed although the continuous performance of the discipline and training activities. It is thought that the continuation of the training activities is the most important motivation and incentive activity in terms of the internalization and acceptance of 5S system by the personnel of the company. Furthermore, the continuance of the graphic curve at the peak point is important since it shows that the personnel exhibit behaviors in compliance with 5S rules and that they exhibit attitudes according to the discipline related issues.

The assembly line 5S weekly assessment scores have been collectively given in Figure 6.

As it can be seen from Figure 6, an output has been obtained in all applications starting from the first week to the week 8 and a success has been obtained. This success provided between weeks 8 to 13 has been protected and no regression has occurred. The reason of the drops been experienced in the first four S between the weeks 13 to 18 is that the load of the personnel increased and the personnel thought that they have successfully applied 5S, therefore the required due diligence has not been exhibited when compared to the first weeks. However, through the aid of the trainings continued after the week 18, they have been informed about the continuance of the success in 5S activities. Following this, an improvement has been observed in the practice. This output has been sustained till the week 25 and the applications started to be a habit in the personnel. Even though the actions of the decreases and increases in all areas change proportionally, they have not exhibited any difference in terms of their directions and success has been achieved in terms of providing sustainability of 5S application process during 28 weeks.

Conclusion

5S is an approach that can be easily applied in all organizations. Its simplicity and easy recognition is the superior side of 5S. Whilst the results of the application

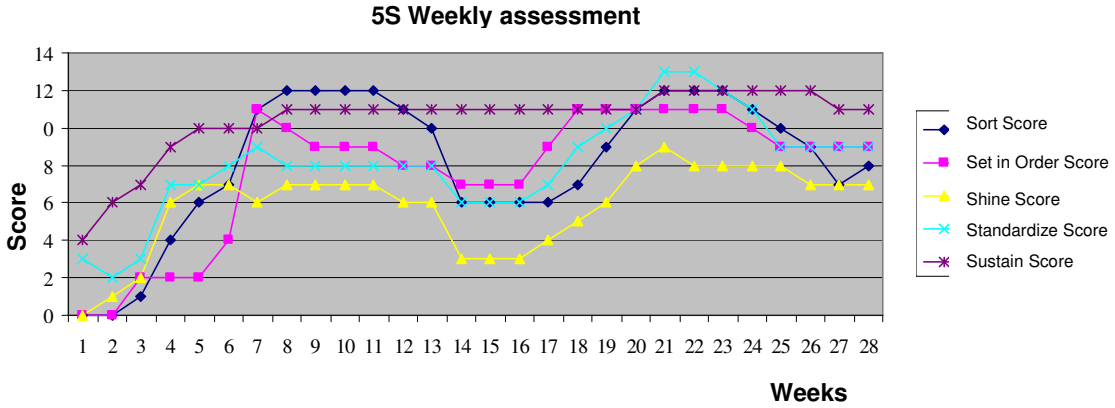

Figure 6. 5S weekly assessment score variation graphic.

are obtained rapidly, its most challenging side is to provide the permanency of the approach. 5S activities have been conducted during 28 weeks in the assembly department of the survey subject company. When the obtained results were evaluated, it has been observed that the company came to a point better than the initial status. The clearly seen of the weekly results hang on 5S acknowledgment boards within the company by all personnel played an efficient role in the involvement of them to the process. Upon this, the notification boards have been updated and therefore the importance given to the process has been perceptibly shown to the personnel.

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. The personnel gained collective work skill following the team activities and they became more sensitive in term of improvement. With the aid of the successful practices in training and discipline issues, many factors causing work accidents have been removed. Through the positive results obtained as a result of the application, the motivation of the personnel in joint targets has been positively affected and the permanency of the process has been provided.

5S approach is not a study covering a certain period of time, rather it is a method defending the requirement of the standardization and continuation of all improvements been performed. 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 achievement of expected results. These kinds of studies should be continuously supported by the planned training programs (Sevim Korkut and Erdinler, 2003).

Finally, the competition may be formed between the teams, departments, companies, etc. groups in order to increase the efficiency of 5S system at the companies and granting award (salary, bonus, promotion, etc.) to the team became successful at the end of the process by the directors may facilitate the supply of high success in 5S application in a short time.

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