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DETERMINATION OF EFFICIENCY OF TPM SYSTEM IN IMAM KHOMEINI REFINERY OF SHAZAND BY DEA METHOD

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ABSTRACT

Total Productive Maintenance (TPM) is a new management technique that considers either physical and economic assets or man power of an organization and provides background for victory of an organization in the competitive market. This research tries to describe TPM by relative efficiency method and indices such as OEE, MTBF, MTTR, breakdown ratio, quality, performance, and reliability, and tries to measure the effect of implementation of TPM system in Imam Khomeini Refinery. Then it analyzes the logical results to provide new strategies for future researches. This research uses Data Envelope Analysis (DEA) method to compare the efficiency of this system with other units in three phases of Isomax, distillation, and hydrogen.

Keywords: Total Productive Maintenance, Data Envelope Analysis method, relative efficiency.

INTRODUCTION

In today's competitive environment, those economic agencies are successful that have plans for future. Today's concerns of economic agencies are maximum usage of available sources for their short and long term planning. Success in production and provision of products depends on various factors. One of these factors is a suitable maintenance and repairing system and strategy. The importance of this subject and its accomplishment in industry and production emphasizes it.

RESEARCH LITERATURE

In today's societies, the number of factories is increasing along growth of industries; thus a considerable share of capital is devoted to raw materials, consumable materials, and spare parts. Therefore, the importance of maintenance and providing a suitable ordering, inventory control, and maintenance system is evident. TPM is an important concept that survives different production lines and decreases costs. TPM is a new management technique that considers either physical and economic assets or man power of an organization and

provides background for victory of an organization in the competitive market (Rohani, 2005). Introduction of TPM in 1970 by Japanese industries was the latest outcome of the second period of maintenance developments. TPM in fact is the same US maintenance system that was improved by Japanese industries. The main innovation in TPM system is that operators maintain their machines themselves. In fact, TPM is a major view towards improvement of efficacy and life of machinery. TPM is a unique key that aims production operations. Now, TPM is globally used to increase equipment efficiency. TPM includes aims to decrease faults of devices, including maintenance of equipment in their standard conditions. TPM also improves production, design, and maintenance methods to prevent future problems (American Productivity Development Organization, 1999). In fact, the goals of TPM are preventing waste, good production without quality drop, cost decrement, rapid production, and good delivery (Shirmohammadi, 2003). Maintenance and repairing and production technical support in a production unit is very important and affects changes of products,

quality, etc. Fortes and foibles of this sector directly affects to productivity and profitability.

Therefore, a definite strategy for this sector is very important. The main goal of TPM is optimizing abilities of machinery to maximize production and minimize breakdown, which follows decrement of energy and production costs and increment of production quality.

By TPM, efficacy is improved by increment of accessibility, improvement of productivity in a

certain interval by decrement of faulty products and improvement of quality.

RESEARCH QUESTION

Regarding to TPM in company and with different production lines, the main questions are:

- How is ranking of Shazand Oil Company than other companies?
- How are the resources and production in different units of oil companies?

Table: 1. Types of strategies in TPM (Javadian et al., 2010)

Maintenance strategy	Approach	Specifications	Motto
After-breakdown Maintenance (BM/EM/CM)	Repair during breakdown	High maintenance cost	Repair after breakdown
Preventive Maintenance (PM)	Scheduled maintenance	Periodical services	Repair before breakdown
Predictive Maintenance (PDM)	Control by device situation	Decision for maintenance type	Repair before breakdown
Pre-action Maintenance (PAM)	Identification of breakdown roots	Basic identification and correction of breakdown factors	Remove breakdown root
Reliability Capability maintenance (RCM)	Prioritization by duties and breakdown factors	Identification of functions, standards, breakdown signs and outcomes, prevention and repairing	Repair proportional to breakdown outcome
Total Productive Maintenance (TPM)	Participation of all organizations and production factors	Fulfillment of primary maintenance activities by operators	Using all persons, organization, potential, and motivation

DATA ANALYSIS

Table: 2. Under-study decision units

Under-study decision units	D.M.U.
Shazand Refinery	DM 01
Tehran Refinery	DM 02
Isfahan Refinery	DM 03
Shiraz Refinery	DM 04
Kermanshah Refinery	DM 05
Lavan Refinery	DM 06
Bandar Abbas Refinery	DM 07
Abadan Refinery	DM 08

Table: 3. Under-study indices of TPM, Isomax Unit

Unit:	D.M.U.	R.T.	Time to Repair			Num. Repair	MTBF	MTTR	A	P	Q	OEE*
Isomax Unit	DM 01	2190	24	27	27	3	730	26.00	0.9644	0.7	1	0.6751
	DM 02	2190	29	30	28	3	730	29.00	0.9603	0.7	1	0.6722
	DM 03	2190	25	25	25	3	730	25.00	0.9658	0.7	1	0.6760
	DM 04	2190	28	28	26	3	730	27.33	0.9626	0.7	1	0.6738
	DM 05	2190	28	26	25	3	730	26.33	0.9639	0.7	1	0.6747
	DM 06	2190	28	25	26	3	730	26.33	0.9639	0.7	1	0.6747
	DM 07	2190	28	29	25	3	730	27.33	0.9626	0.7	1	0.6738
	DM 08	2190	22	30	31	3	730	27.67	0.9621	0.7	1	0.6735

* OEE is used for TMP system

Real study time (R.T.): Total study period for TPM indices is six months (from 2005 to 2014; of course,

one day is added for leap year of 2012, which is not considered for equal indices).

Time to Repair: Time for each repair.

Number of Repairs: The number of repairs during study period.

Mean Time Between Repairs (MTBR): The average time interval between repairs.

Mean Time of Total Repairs (MTTR): The average time for all repairs.

Total Equipment Efficiency (OEE): The product of A, P, and Q indices are used.

Efficiency index (P): Considering 10% drop for each repair in a year.

Q: Quality ratio of products

Table: 4. Under-study indices of TPM, Distillation Unit

Unit:	D.M.U.	R.T.	Time to Repair			Num. Repair	MTBF	MTTR	A	P	Q	OEE*
Distillation unit	DM 01	2190	21	23	22	3	730	22.00	0.9699	0.7	1	0.6789
	DM 02	2190	28	26	25	3	730	26.33	0.9639	0.7	1	0.6747
	DM 03	2190	20	20	21	3	730	20.33	0.9721	0.7	1	0.6805
	DM 04	2190	22	23	21	3	730	22.00	0.9699	0.7	1	0.6789
	DM 05	2190	26	25	23	3	730	24.67	0.9662	0.7	1	0.6763
	DM 06	2190	27	26	25	3	730	26.00	0.9644	0.7	1	0.6751
	DM 07	2190	25	23	23	3	730	23.67	0.9676	0.7	1	0.6773
	DM 08	2190	25	35	37	3	730	32.33	0.9557	0.7	1	0.6690

Table: 5. Under-study indices of TPM, Hydrogen Unit

Unit:	D.M.U.	R.T.	Time to Repair				No. Repair	MTBF	MTTR	A	P	Q	OEE*
Hydrogen unit	DM 01	2190	15	17	16	15	4	547.5	15.75	0.9712	0.6	1	0.5827
	DM 02	2190	18	16	17	16	4	547.5	16.75	0.9694	0.6	1	0.5816
	DM 03	2190	15	15	16	15	4	547.5	15.25	0.9721	0.6	1	0.5833
	DM 04	2190	20	21	20	19	4	547.5	20.00	0.9635	0.6	1	0.5781
	DM 05	2190	19	20	17	18	4	547.5	18.50	0.9662	0.6	1	0.5797
	DM 06	2190	18	17	15	17	4	547.5	16.75	0.9694	0.6	1	0.5816
	DM 07	2190	18	18	17	18	4	547.5	17.75	0.9676	0.6	1	0.5805
	DM 08	2190	20	20	19	21	4	547.5	20.00	0.9635	0.6	1	0.5781

Ranking efficiencies of under-study units

Table: 6. DEA model's inputs and outputs, Isomax Unit

Unit:	D.M.U.	Mean of Staff (I)	OEE (O)
Isomax Unit	DM 01	490.67	0.6751
	DM 02	504.00	0.6722
	DM 03	453.33	0.6760
	DM 04	271.67	0.6738
	DM 05	370.00	0.6747
	DM 06	390.00	0.6747
	DM 07	425.00	0.6738
	DM 08	523.33	0.6735

Total Equipment Efficiency (OEE): The product of A, P, and Q indices are used.

Mean of Staff: The average of maintenance project staff.

Table: 7. DEA model's inputs and outputs, Distillation Unit

Unit:	D.M.U.	Mean of Staff (I)	OEE (O)
Distillation Unit	DM 01	466.00	0.6789
	DM 02	550.00	0.6747
	DM 03	497.33	0.6805
	DM 04	433.33	0.6789
	DM 05	403.33	0.6763
	DM 06	487.67	0.6751
	DM 07	453.33	0.6773
	DM 08	625.00	0.6690

Table: 8. DEA model's inputs and outputs, Hydrogen Unit

Unit:	D.M.U.	Mean of Staff (I)	OEE (O)
Distillation Unit	DM 01	155.25	0.5827
	DM 02	176.50	0.5816
	DM 03	110.25	0.5833
	DM 04	130.00	0.5781
	DM 05	107.75	0.5797
	DM 06	104.75	0.5816
	DM 07	115.25	0.5805
	DM 08	131.25	0.5781

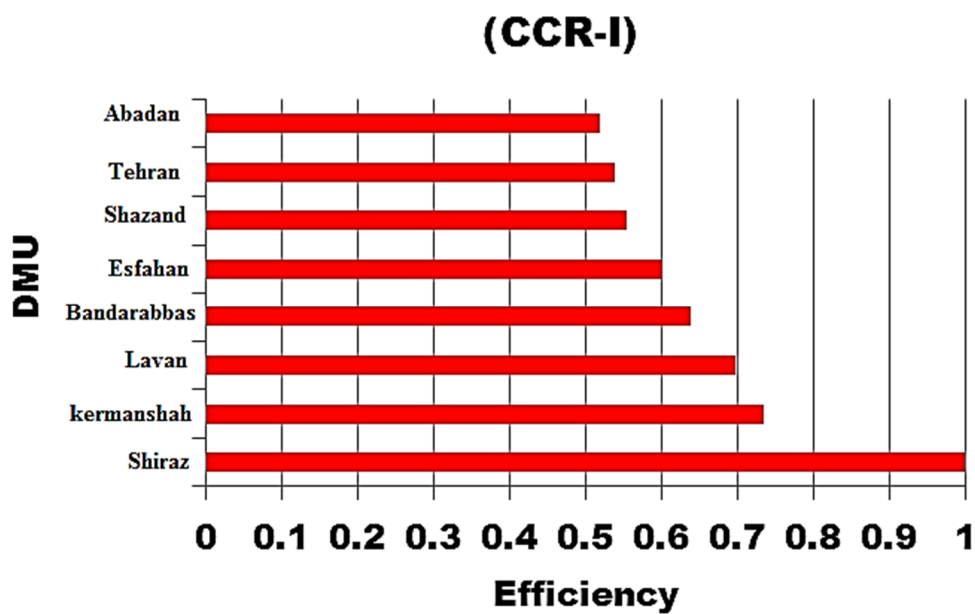


Fig. 1. DEA model, Isomax Unit

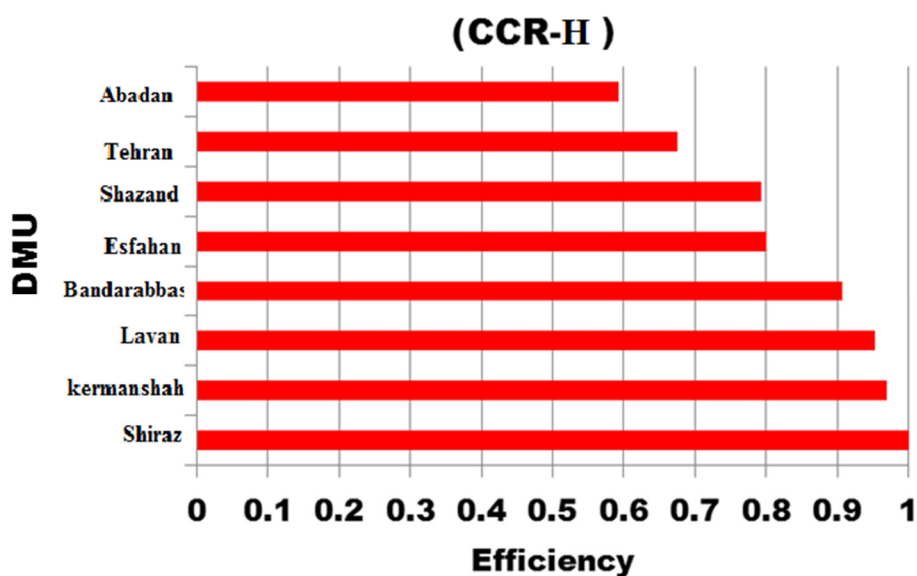


Fig. 2. DEA model, Hydrogen Unit

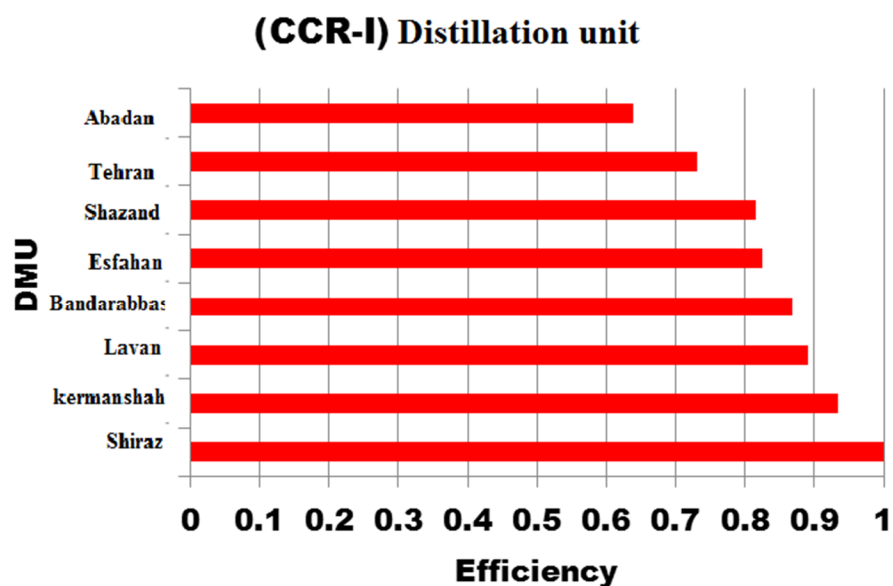


Fig. 3. DEA model, Distillation Unit

Table: 9. Ranks of decision-making units

NO.	DMU	Isomax Unit	Distillation Unit	Hydrogen Unit
		SCORE	SCORE	SCORE
1	Shazand Refinery	0.5547191	0.8687945	0.6759895
2	Tehran Refinery	0.5377427	0.7316005	0.5934844
3	Isfahan Refinery	0.6012547	0.8159744	0.9527986
4	Shiraz Refinery	1	0.9342882	0.8008352
5	Kermanshah Refinery	0.7352792	1	0.9689524
6	Lavan Refinery	0.6975725	0.8255042	1
7	Bandar Abbas Refienry	0.6392157	0.8909673	0.9071812
8	Abadan Refinery	0.518862	0.6383188	0.7932082

Table: 10. Ranks of decision-making units

No.	DMU	Isomax Unit	Distillation Unit	Hydrogen Unit	SAW	Final Rank	
		Score	Score	Score			
1	Shazand Refinery	0.5547191	0.868795	0.67599	0.325784	8.478229	6
2	Tehran Refinery	0.5377427	0.731601	0.593484	0.233484	6.076210	8
3	Isfahan Refinery	0.6012547	0.815974	0.952799	0.467451	12.16497	5
4	Shiraz Refinery	1	0.934288	0.800835	0.748211	19.4714	1
5	Kermanshah Refinery	0.7352792	1	0.968952	0.712451	18.54085	2
6	Lavan Refinery	0.6975725	0.825504	1	0.575849	14.98592	3
7	Bandar Abbas Refinery	0.6392157	0.890967	0.907181	0.516658	13.44554	4
8	Abadan Refinery	0.518862	0.638319	0.793208	0.26271	6.836781	7
Sum:					3.842598	100	

DISCUSSION AND CONCLUSION

The goal of this research was studying the effects of TPM policies on Shazand Oil Company's production equipment as follows:

For Isomax Unit, maintenance indices and related staff for Shiraz Refinery are the most efficient ones, and the ones for Abadan, Tehran, and Shazand refineries are the least efficient. For OEE, the more the OEE, the better the TPM. Therefore, for Isomax Unit, Isfahan and Shazand refineries are more efficient in their maintenance systems. In contrast, Tehran Refinery has the lowest efficiency. So, it is proposed to decrease its maintenance time to improve this index.

For Distillation Unit, maintenance indices and related staff for Lavan Refinery are the most efficient ones, and the ones for Abadan, Tehran, and Shazand refineries are the least efficient. For OEE, the more the OEE, the better the TPM. Therefore, for Distillation Unit, Isfahan Refinery is more efficient in its maintenance system. In contrast, Abadan Refinery has the lowest efficiency. So, it is proposed to decrease its maintenance time to improve this index.

For Hydrogen Unit, maintenance indices and related staff for Kermanshah Refinery are the most efficient ones, and the ones for Abadan, Tehran, and Isfahan refineries are the least efficient. For OEE, the more the OEE, the better the TPM. Therefore, for Hydrogen Unit, Isfahan and Shazand refineries are more efficient in their maintenance systems. In contrast, Shiraz and Abadan refineries have the lowest efficiencies. So, it is proposed to decrease its maintenance time to improve this index.

For usage of resources and outputs to the elapsed time in production units, we concluded that Shiraz Refinery could achieve its efficiency limit regarding to its staff, OEE, and TPM. On the other hand,

Abadan and Tehran refineries couldn't achieve this efficiency limit. However, it should be noted that the efficiencies of all studies units are higher than half, which indicate efficiencies of decision-making units are close together.

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