

In the Name of Allah

Brochure

**GREEN PRODUCTIVITY DEMONSTRATION PROJECT
(GPDP)
IRAN KHODRO “PAINT SHOP”
ISLAMIC REPUBLIC OF IRAN**

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ABOUT THE COMPANY

Iran Khodro Co. (IKCo) is one of the largest automobile manufacturing companies in I.R.Iran. The general information of the company is given in Table 1.

TABLE 1- GENERAL INFORMATION ABOUT COPMPANY

Name of the Company	Iran Khodro Company (IKCo)
Location	12 Km west of Tehran
Type of Company	Public joint stock company
Date of establishment	1962
Number of Employees	14000
Products	Passenger cars, Minibuses, Buses
Total Products	1'697'582 (End of June 2000)
Registered Capital	342'000'000'000 Rls. (\$1= 8000 Rls.)
Shares Quantity	342 million shares (each 1000 Rls.)
Site Area	2'950'000 square kilometer

The paint shop of IKCo has been selected as a case study in which the Green Productivity Demonstration Project (GPDP) by Asian Productivity Organization (APO) and National Iranian Productivity Organization (NIPO) to be implemented. (Figure 1)



FIGURE 1- THE PAINT SHOP OF IKCo

WHY GP?

Green Productivity (GP) is the application of appropriate productivity and environmental management tools, techniques and technologies that together reduce the environmental impact on an organization's activities. In order to implement a successful GP program in a company, the best approach is to set up a demonstration project in related section. This matter helps the company not only to improve both environmental conditions productivity, but also to disseminate the findings to other similar domestic and foreign factories. GP implementing in industries has many benefits such as reduction of fuel and raw material, improvement of health and safety and environmental protection promotion.

IMPORTANCE OF GP PROJECT

Implementation of the GP project in the paint shop of IKCo, as the first experience of APO in I.R.Iran was highly important. More efficiency along with positive environmental effects, less pollutants, and improved sanitary situation of the employees is a suitable pattern for domestic and foreign industries.

Many Volatile Organic Compounds (VOCs) were produced in different processes such as electro coating, paint spray, and ovens. A large amount of water and chemicals were consumed, too. So, the important challenge was to integrate environmental and health protection with productivity enhancement, in VOC and paint application, waste usage and wastewater, energy, material handling, and with implementing of EMS under ISO 14000. Therefore, it was important to investigate the major environmental problems in the paint shop to identify sets of objectives for implementing a comprehensive GP study and suggesting implementation of GP work in the other automobile manufacturing companies.

MAIN ISSUES AND PROBLEMS

Seven original units of IKCo paint shop consist of degreasing and phosphating, electro coating units, primer coating, metal finishing, wet sanding, preparation, and top coating. Each of these original units consists of several steps. For example, in degreasing and phosphating unit, there are first and second degreasing, water rinsing, zinc phosphating, water rinsing, DI-water rinsing and oven, respectively (Figure 2).

VOC and Paint Applications

From 600 to 650 car bodies were daily painted in three shifts either by manual or automatic spray, some body parts such as under hoods, surfaces between doors and body were painted manually. Majority of VOCs were emitted from curing ovens and spray booth exhaust.

Waste Usages and Wastewater

In the process, because of large amount of water used, a large volume of wastewater was produced. More than 70 percent of total wastewater was coming from the paint shop. The reduction of this water in the paint shop not only had an important effect on the wastewater production, but also reduced the amount of chemicals used for treatment. In another hand, IKCo used to discharge polluted water to the environment, but after installing Dissolved Air Flotation (DAF) and sand filter, treated wastewater can be used for green places watering in the company. This matter is also play an important role due to water shortage problem in the great city of Tehran.

Energy Use and Conservation

Some of the problems of energy use and its conservation in the paint shop, which is important to mention, were the combination of the electric power lines of the shop with other halls. The energy bills in the shop were also not clearly recorded. In addition, most of the lights were on without any benefits.

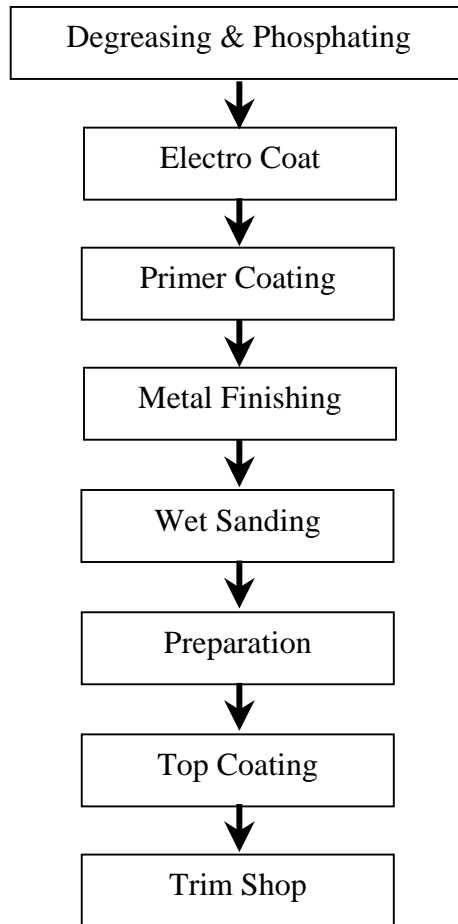


FIGURE 2 – IKCo PAINT SHOP PROCESS FLOWCHART

Materials Handling and Housekeeping

Based on the investigation of the production conditions, the charge of materials and transportation in pre-treatment and Electro Deposition (ED) lines was done manually, which in turn could cause ergonomic problems for workers and increased the possibility of overcharging or spillage of materials dramatically. In addition, PVC spraying was done manually, which got the drawbacks of uneven isolation thickness that did not comply with existing standards, air and environmental pollution and ergonomic problems for workers.

Extra reworking in the production system that was mainly caused by lack of care among workforces and repainting them resulted in waste of time, money, and energy.

Spraying metallic top coating paint was done manually. Having an even paint thickness, continuous spraying and consequently reducing rewordings have had disadvantages of slow production rate, waste of materials and quality-related problems. Other problems were lack of an appropriate procedure for cleaning the shop and epoxy coating, which consequently caused some problems.

Health and Safety

The main problem in ED booth section of the paint shop was ammonia emission to the air and bacteriological problems. The workers' complain of VOCs, ammonia etc. To review

workers complains, a questionnaire was provided, and then the workers of day, afternoon and night shifts were interviewed personally to complete the questionnaire.

GP SOLUTIONS

VOC and Paint Applications (7 options)

1. Recovery of cleaning solvent
2. Automation on paint application on metallic lines
3. Filtration of paint booth exhausts
4. Elimination of bacteria in ED booth by using micro-filters and proper biocides
5. Isolation of PVC and primer coating
6. Installation of ventilation for ED charging section
7. Reduce consumption of air drying paint in polishing and repairing sections

Waste Usages and Wastewater (8 options)

8. Use of photocells to regulate water flows
9. Use of thermostatic valves to regulate water quality and reduce chemical consumption
10. Change of fresh water connection to reduce waste usage
11. Modification of rinsing zones after ED booth
12. Use of solenoid valves for rinsing
13. Use of DAF units
14. Use of sand filter to improve effluent prior to irrigation
15. Eliminate wet sanding process by improving paint quality, paint shop ventilation, and worker training

Energy Use and Conservation (4 options)

16. Substitute proper equipment
17. Use local light systems to reduce general light system
18. Automatic on – off light system
19. Improve insulation on ovens

Materials Handling and Housekeeping (3 options)

20. Reduce materials (solvent, paint etc)
21. Reduce spillage of materials (solvents and pints, etc) by training and waste segregation
22. Reduce spillage of materials (solvents and paints, etc) by use of automatic system at material discharging

Certification of Environmental Management System under ISO 1400

To obtain certification of an Environmental Management System (EMS) that involves all employees to achieve GP in a continual improvement manner

GP IMPLIMENTATION

For GP implementation, each group was assigned to do the following steps in the teamwork:

- Recognition of process
- Information and data collection
- Identification of problems
- Feasibility study
- Purchase demand of required equipments, proposal, purchase and installation
- Implementation
- Monitoring and review
- Sustaining GP

VOC and Paint Application

Recovery of Cleaning Solvent

This option has been done in three steps consist of the reclaimed solvents, recovery of nozzle rinse solvent, and substitution of solvent with detergent.

Automation of Paint Application on Metallic Lines

Because of technical problems such as painting table, and non-uniformity the metallic line had been readjusted. By implementing the automation system the following objectives have been achieved:

- Reducing manpower by at least nine persons.
- Improvement of paint quality on finished vehicles due to uniform of paint and consequently obtaining better results in audit.
- Smooth and increase in production process due to faster operation and fewer reworking.
- Reducing paint consumption (in manual spraying operation the paint consumption was approximately 4-5 Kg/body while by installation of automatic system this figure reduced to 1.5-2 Kg/ body. Since around 200 vehicles were painted with metallic paints, about 400 Kg paint has been saved daily.
- Reducing the rejects from 15% to 1.5%.

Filtration of Paint Booth Exhaust

Solvents and extra paint particles released from spray guns were discharged into venturi water. Water was collected in 150 cubic meters under the paint shop and circulated back to the venturi. Venturi water curtain underneath of the booth was not operating in optimal condition. Disconnection between water curtain in venturi and positive pressure in spray booth let the aerosols of solvent and paint particles escape into the air through exhaust.

Isolation of PVC and Primer Coating

Consultation among IKCo management for the isolation of primer coating resulted in proposing a layout, installing Air Conditioner (AC) system, installing vacuum to remove

paint particles, improving walls and installing glasses and separating the stations by leather curtains.

Reduce Consumption of Air-Drying Paint in Polishing and Repairing Sections

The painting repair booth was divided into two sections of installing portable heating equipment and air conditioner, water basin and lights

The outcome of this option were; smooth and continuous production, reduction in paint consumption, reduction in energy use, reduction in labor work, reduction in equipment parts replacement, paint quality improvement, and VOC emission reduction.

Waste Usages and Wastewater

Use of Photocells, Thermostatic and Solenoid Valves

Before implementing the GP project, a large amount of industrial water was wasted during the time of breakfast, lunch, dinner, and distance between two bodies in the conveyor and when the production stopped in the paint shop. By installing photocells, thermostatic and solenoid valves, water consumption stops automatically, when there is no body in the conveyors. By implementing these options, 13 percent of water consumption has been saved, that is about 55000 cubic meters annually. In addition, use of chemicals has been saved about 40 Kg/day.

Change of Fresh Water Connection to Reduce Wastewater Usage

Previously, the daily discharge of used water in passivation unit after phosphating process was about 80 cubic meters in the rinsing part. It has been shown that the quality of this water was suitable (conductivity was 20-30 μs) and could be used in other units that required DI water. By implementing this option, 21000 cubic meters of water and 25 Kg/day of chemicals were saved, annually.

Modification of Rinsing Zones after ED Booth

For modifying DI water consumption after ED booth for being reused, an 8 cubic meters storage tank and its related apparatus were installed. By implementation this option, not only the quality of water has been improved, but also about 100 cubic meter of DI water consumption has been saved.

Use of Dissolve Air Floatation Unit

Implementation of the option improved quality of treated wastewater that is also important from the economical and technical point of view.

Use of Sand Filter to Improve Effluent Prior to Irrigation

Installation of sand filters has improved the quality of treated wastewater. This can be used for irrigation of green places in the company. After implementing GP project, all treated wastewater parameters have improved

Eliminate Wet Sanding Process by Improving Paint Quality, Paint Shop Ventilation

In this process, more than 200 cubic meters industrial water and 50 cubic meters DI water was used. By improving the quality of used paint and automation of paint spraying, wet sanding process was eliminated. By implementing this option, 70000 cubic meters of used water has been saved per annum.

Energy Use and Conservation

Substitute Proper Equipment

For decreasing the mechanical depreciation and friction, promoting efficiency, and minimizing idle times, the existing conveyors (inside the cabins and in the hall) were changed from shoes system to the roller one.

Use Local Light System to Reduce Energy Consumption

Because of the importance of this stage of the project, it was considered in two parts:

- General Lighting by emphasizing on the industrial lamps of ceiling
 - Changing the type of the lamps because of unreasonable height
 - Deleting the lamps for being unnecessary
 - Deleting the lamps over the canals
 - Deleting the necessity of more light
- Local Lighting. This part mainly consists of fluorescent lamps. All lines were studied in respect of the number and types of lamps, feeding panel, and method of lighting control.

Improve Insulation on Ovens

- Making, installing, and exchanging the cabins and insulating of the stacks
- Creating air seal system: The door and walls of the panel were not insulated and this not only was wasting the fuel and less thermal efficiency of the furnaces but also was increasing the temperature of the hall. With designing and implementing the air seal system for furnaces, the following results were achieved:
 - High efficiency of the furnaces
 - Saving in fuel consumption
 - Energy consumption
 - Decrease of the environment temperature

Materials Handling and Housekeeping

Changing the Manual Transportation of Paint Tanks into an Automatic One

In order to fulfill this objective, the second paint circulation system including mixers, heat exchanger, control room, dulution tanks and surrent reclaim tank have been designed and installed. The obtained results are as follows:

- Elimination of manual transportation of paint tanks
- Reduction in personnel to eight persons

- Possibility of using different paints
- Reduction in paint wasting due to a closed-circuit circulation system

Epoxy Coating of Paint Shop Floor

Approximately 10000 square meters of the paint shop floor has been coated with monolithic epoxy layer. This option had the following benefits:

- Reduction of thinner consumption for cleaning from 200 to 140 liter per day
- Improvement of hygienic condition in the workplace
- Quality improvement due to dust absorption by epoxy layer
- Appearance enhancement

Design and Setting up of Some Boards

This option was done in order to increase the cultural awareness among personnel and to familiarize them with GP concepts.

Optimization of Degreasing Materials Consumption

In the degreasing process, a plan has been designed and installed in which fresh degreasing solution from the second degreasing stage was fed into the first degreasing stage, which can reduce material consumption by 10%.

Reduction in the Number of Rejected Vehicles and Replaced Parts

Installation of the portable paint stoving system, air washers, water tank, and related parts had the following results:

- Smoothness of production
- Reduction of rejected vehicles by 25%
- Reduction in paint consumption
- Reduction in work force and energy consumption

Training

In order to increase practical skills of the personnel and improve the quality, training courses were held at different times and on an average, every individual received one hour training.

A ten-percent reduction in negative mark in the paint production shop has been observed during the first six months as a result of implementation of training course.

Health and Safety

Elimination of Bacteria in ED Booth by Using Micro-Filters and Proper Biocide

Installation of micro-filters and its equipments including Ultra Filters (UF) and membranes have omitted related bodies bacteria.

Installation of Ventilation for ED Charging Section

By transferring the filter rinsing operation to the refinery, the main source of ammonia has been omitted.

Hygienic Complaints

From completed questionnaire in implementation of GP project, considering the extension of halls in this factory and doing of different activities in a hall, the number of complain related to the workers health has been reduced.

Certification of Environmental Management System under ISO 1400

By using matrix method for EIA six items of dust, exhaust emission and hazardous gases, VOCs, industrial waste water, hazardous materials in soil, and waste disposal were more significant among other environmental aspects that should be considered as priority cases and objective in EMS.

Two identified training in ISO14001 standard have been applied:

- Training to aware all the personnel generally
- Training to improve the specific tasks

CONCLUSION

Generally, Implementation of GP project can be summarized as:

- Promotion of quality and efficiency of production (reduction in the number of rejected bodies from 60-65 bodies a day to 30-35 bodies a day)
- Efficiency of the personnel promotion
- VOC reduction resulted in air quality improvement, employees environmental quality improvement and paint consumption reduction
- Water conservation
- Material saving such as paint, coagulant, thinner
- Process improvement
- Energy efficiency by improving local lightening, elimination of extra lights
- Improved housekeeping
- Improvement of effluent wastewater quality for irrigation
- Destructive effects on environment
- Elimination of manual transportation of paint tanks
- Reduction in personnel
- Improvement of hygienic condition in the workplace
- Reduction in ammonium concentration to the below level of TLV
- Reduction in the number of complain related to the workers health
- Elimination of present bacteria in ED booth and its related problems
- Economic savings are as follows:
 - Total annual social benefits of about \$ 217468.5
 - Considerably high NPV even at interest rate of 25%

- The internal rate of return of 35% without considering the social benefits
- The short payback period within 2.5 years
- The ratio of benefit to costs of about 1.38
- Six items of dust, exhaust emission and hazardous gases, VOCs, industrial wastewater, hazardous materials in soil, and waste disposal have been considered as priority cases and objective in EMS.