Performance Improvement Methodologies for Ground Support Equipments

Prof. Dr. Mohamed Naguib, Prof. Dr. Abd-Elhakim Elmenhawy, Eng. Seif Elrefaey

Abstract - Ground Support Equipments cause a lot of aviation accidents which cause direct costs and indirect costs, so it is very important to improve their performance to be sure that all ground aviation processes are done correctly from the first time without any failures or wrong actions. Improving the performance is done by increasing efficiency, effectiveness and safety. There are many performance improvement methodologies that can be applied to Ground Support Equipments like Toyota Production System (TPS), Total Quality Management (TQM), Six Sigma (6σ), Lean Manufacturing and ISO standards.

Index Terms - Ground Support Equipments (GSE), Performance Improvements, Toyota Production System (TPS), Total Quality Management (TQM), Six Sigma (6σ), Lean Manufacturing, ISO standards, ISO 6966

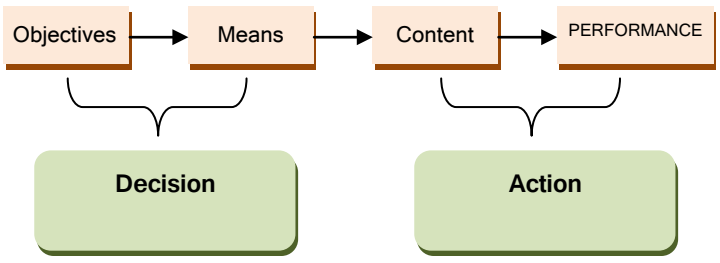
1 Introduction

Before improving the performance, it is important to define the meaning of "performance". According to Business Dictionary "performance" is defined as the accomplishment of a given task measured against preset known standards of accuracy, completeness, cost, and speed. In a contract, performance is deemed to be the fulfillment of an obligation, in a manner that releases the performer from all liabilities under the contract. (Business dictionary, 2017)

To perform is to take a complex series of actions that integrate skills and knowledge to produce a valuable result. In some instances, the performer is an individual, in another; the performer is a collection of people who are collaborating such as a research team, committee and student team. Performance, as the adage goes, is a "journey not a destination." The location in the journey is labeled as "level of performance." Each level characterizes the effectiveness or quality of a performance. (Elger, 2011)

To study the performance of the organization is to analyze the organizational behavior and performance improvement can come only from an improvement in the behavior. These considerations make clear reference to the organizational strategy. Bourgeois proposes in this respect the following model Figure (1) (Octavian et al, 2012)

FIG.1: BOURGEOIS MODEL



1.1 Dimensions of performance

TABLE 1: DIMENSIONS OF PERFORMANCE (ARCHER ET AL, 2015)

Term	Definition
Goals (objectives, aims)	What you want to achieve
Targets	What you want to achieve in measurable terms
Inputs (money, people, material)	What you use in trying to achieve your goals
Processes (activities)	What you do to achieve your goals
Outputs (products, services)	What you provide in order to achieve your goals
Outcomes (results, effects)	What you achieve through your outputs

2 Performance Improvement

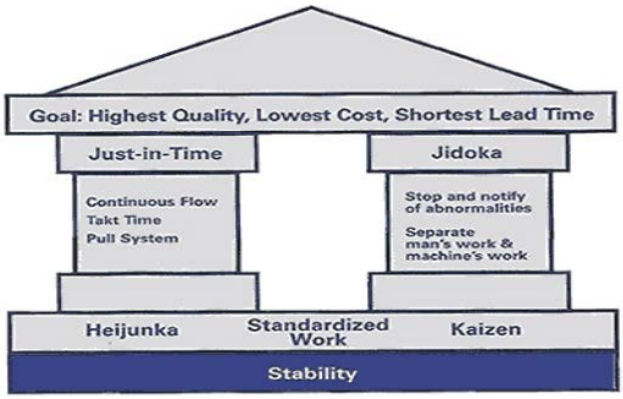
Performance improvement is modifying certain procedure to increase the output, increase efficiency, or increase the effectiveness of the processes; there are a lot of methodologies for performance improvements:

2.1 Toyota Production System (TPS)

To implement the Toyota Production System (TPS), it is important to understand what is known as the "Toyota House" as shown in figure (2). It starts with the goal of best quality, lowest cost and shortest lead time, representing the roof. The outer pillars are Just-in-Time (JIT), which is probably the most famous aspect of the TPS, and Jidoka. Jidoka emphasizes the visibility of a problem. In the center of the house are people. Finally there is the foundation that is stable and stan-

dardized processes, Visual management, Toyota Way Philosophy, and heijunka, which means smoothing the production flow in terms of both volume and mix, (Marksberry, 2013).

FIG.2: TOYOTA HOUSE DIAGRAM



The fourteen principles of Toyota Production System are divided into four different categories: (Liker, 2004)

1) Long term philosophy,
   - Make basic management decisions according to the long term philosophy.

2) The right process will produce the right result,
   - Creating a continuous process flow will bring problems to the surface.
   - Using the "pull" system will avoid over production.
   - The work load has to be leveled out. (heijunka)
   - To get quality right the first time, a culture of stopping to fix problems should be built.
   - The foundation for continuous improvement and employee empowerment is standardized tasks.
   - Visual control will surface hidden problems.
   - Only reliable, thoroughly tested technology that serves people and process should be used.

3) Add value to your organization by developing your people
   - Leaders should be grown in a way such that they understand the work, live the philosophy, and teach it to others.
   - Exceptional people and teams who follow the company's philosophy have to be developed.
   - It is important to respect the extended network of partners and suppliers by challenging them and helping them improve.

4) Continuously solving root problems drives organizational learning.
   - To thoroughly understand the situation, leaders need to go and see for themselves.
   - It is important to make decisions slowly and thoughtfully, and implement them rapidly.
   - To become a learning organization.

2.2 Total Quality Management (TQM)

Total Quality Management is a management approach that originated in the 1950's and has steadily become more popular since the early 1980's. Total Quality is a description of the culture, attitude and organization of a company that strives to provide customers with products and services that satisfy their needs. The culture requires quality in all aspects of the company's operations, with processes being done right the first time and defects and waste eradicated from operations, (Bagad, 2008).

The ultimate goal of a TQM effort is to satisfy not only the shareholders but also the customers, staff, business partners, and suppliers (Stakeholders). An effective total quality effort will require the participation of everybody in the company or organization and good communication with other departments is important to get richer information. Communication clarifies expectations and is supported by continuous improvement effort from all in the organization to meet those expectations. In a TQM effort, all members of an organization participate in improving the processes, products, services and the culture in which they work. Every employee has valuable and valid knowledge of how their particular job could be done better, and when these ideas are appreciated in a supportive environment then, and only then, can there be a total organization awareness of the employee's effect on the product or service. This helps prevent resistance to change, as employees feel empowered to improve their condition instead of feeling trapped in a situation where their suggestions are not valued. However, the entire total quality effort must be planned and managed by the company's management team. Most quality management leaders agree that the biggest ingredient and most critical issue in quality is management commitment to support employees who in turn will support the customer, (Naagarazan and Arivalagar, 2005). The methods for implementing TQM approach are found in the teachings of such quality leaders as W. Edwards Deming, Kaoru Ishikawa, Joseph M. Juran, and Feigenbaum.

2.3 Six Sigma (6σ)

A methodology that provides businesses with the tools to improve the capability of their business processes. For Six Sigma, a process is the basic unit for improvement. A process could be a product or a service process that a company provides to outside customers, or it could be an internal process within the company, such as a billing or production process. In Six Sigma, the purpose of process improvement is to increase performance and decrease performance variation. This increase in performance and decrease in performance variation will lead to defect reduction and improvement in profits, to employee morale, and quality of product, and eventually to business excellence. In any process, the Six Sigma standard means that the defective rate of the process will be 3.4 defects per million units, (Shanker, 2009).

The most important methodology in Six Sigma management is perhaps the formalized improvement methodology characterized by DMAIC (Define-Measure-Analyses-Improve-Control) methodology.

Phase 1: (Definition) this phase is concerned with identification of the process or product that needs improvement. It is also concerned with benchmarking of key product or process characteristics of other world-class companies.

Phase 2: (Measurement) This phase entails selecting product characteristics; i.e., dependent variables, mapping the respective processes, making the necessary measurement, recording the results and estimating the short- and long term

process capabilities

Phase 3: (Analysis) this phase is concerned with analyzing and benchmarking the key product/process performance metrics. Following this, a gap analysis is often undertaken to identify the common factors of successful performance;

Phase 4: (Improvement) this phase is related to selecting those product performance characteristics which must be improved to achieve the goal. Once this is done, the characteristics are diagnosed to reveal the major sources of variation. Next, the key process variables are identified usually by way of statistically designed experiments including Taguchi methods and other robust design of experiments (DOE).

Phase 5: (Control) this last phase is initiated by ensuring that the new process conditions are documented and monitored via statistical process control (SPC) methods.

2.4 Lean Manufacturing

The key focus of lean manufacturing is to identify and eliminate wasteful actions that do not add value to customers in the manufacturing process. Lean manufacturing deals with production system from a pure process point of view, and not a hardware point of view, therefore, lean operation principles can be used to greatly improve the efficiency and speed of all processes, (Carreira, 2005). Principle of lean manufacturing (Wilson, 2010):

1) Value is specifying what creates value from the customer's perspective, any process that the customer would be prepared to pay for that adds value to the product.
2) Value stream is identifying all the steps along the process chain. The value stream is the sequence of processes from raw material to the customer that create value.
3) Flow is making the value process flow, linking of all the activities and processes into the most efficient combinations to maximize value-added content while minimizing waste.
4) Pull is making only what is needed by the customer (short term response to the customer's rate of demand Based on a supply chain view from downstream to upstream activities where nothing is produced by the upstream supplier until the downstream customer signals a need.
5) Perfection is striving for perfection by continually attempting to produce exactly what the customer wants.

Lean production was about creating value for the customers with a minimum amount of waste and with a maximum degree of quality. Waste was defined as any activity that consumes resources and creates no value. Identification and elimination of waste makes it easier to focus on value adding activities and to become more cost efficient. The main sources of waste found in industry as follows: (Autry et al, 2013)

Overproduction, Waiting, Defect waste, Unnecessary inventory, Unnecessary processing, Unnecessary transportation between work sites, Unnecessary motion in the work place,

2.5 ISO standards

ISO has published 21536 International Standards and related documents, covering almost every industry, from technology, to food safety, to agriculture and healthcare.

The benefits of applying ISO International Standards are to ensure that products and services are safe, reliable and of good quality. For business, they are strategic tools that reduce costs by minimizing waste and errors and increasing productivity. They help companies to access new markets, level the playing field for developing countries and facilitate free and fair global trade, (ISO, 2017).

Quality management standards (ISO 9000 Family)

The ISO 9000 family of international quality management standards and guidelines has earned a global reputation as a basis for establishing effective and efficient quality management systems, ISO technical committee (ISO/TC 176) is responsible for the ISO 9000 family of standards for quality management and quality assurance, (ISO, 2017). Current standards from ISO/TC 176 and its subcommittees was mensioned in Appendix A.

ISO 9001:2008 specifies the basic requirements for a quality management system (QMS) that an organization must fulfill to demonstrate its ability to consistently provide products (which include services) that enhance customer satisfaction and meet applicable statutory and regulatory requirements. (ISO 9001/2008)

ISO 9001:2015 (the most recent version of the standard) is made up of a number of different sections, each concentrating on the requirements involved in different aspects of a quality management system. (ISO 9001/2015)

- Clause 0-3 – Introduction and scope of the standard
- Clause 4 – Context of the organization
- Clause 5 – Leadership
- Clause 6 – Planning
- Clause 7 – Support
- Clause 8 – Operation
- Clause 9 – Performance evaluation
- Clause 10 – Improvement

Occupational health and safety management standards

ISO is developing a new standard, ISO 45001, Occupational health and safety management systems - Requirements, that will help organizations reduce this burden by providing a framework to improve employee safety, reduce workplace risks and create better, safer working conditions, all over the world, (ISO, 2017). The standard is currently being developed by a committee of occupational health and safety experts, and will follow other generic management system approaches such as ISO 14001 and ISO 9001. It will take into account other International Standards in this area such as OHSAS 18001, the International Labour Organization's ILO-OSH Guidelines (ILO-OSH 2001), various national standards and the ILO's international labour standards and conventions.

An ISO 45001 based OH&S management system will enable an organization to improve its OH&S performance by:

1) developing and implementing an OH&S policy and OH&S objectives
2) establishing systematic processes which consider its "context" and which take into account its risks and opportunities, and its legal and other requirements
3) determining the hazards and OH&S risks associated with its activities; seeking to eliminate them, or putting in controls to minimize their potential effects
4) establishing operational controls to manage its OH&S risks and its legal and other requirements
5) increasing awareness of its OH&S risks

6) evaluating its OH&S performance and seeking to improve it, through taking appropriate actions
7) ensuring workers take an active role in OH&S matters

In combination these measures will ensure that an organization's reputation as a safe place to work will be promoted, and can have more direct benefits, such as:

1) improving its ability to respond to regulatory compliance issues
2) reducing the overall costs of incidents
3) reducing downtime and the costs of disruption reducing the cost of insurance premiums
4) reducing absenteeism and employee turnover rates
5) recognition for having achieved an international benchmark (which may in turn influence customers who are concerned about their social responsibilities)

The OHSAS Standards covering OH&S management are intended to provide organizations with the elements of an effective OH&S management system that can be integrated with other management requirements and help organizations achieve OH&S and economic objectives. (OHSAS 18001/2007)

This OHSAS Standard specifies requirements for an OH&S management system to enable an organization to develop and implement a policy and objectives which take into account legal requirements and information about OH&S risks, (OHSAS 18001/2007) these requirements are:

1) General requirements
2) OH&S policy
3) Planning
4) Implementation and operation
5) Checking
6) Management review

Environmental management standards

The ISO 14000 family of standards provides practical tools for companies and organizations of all kinds looking to manage their environmental responsibilities. ISO 14001:2015 and its supporting standards focus on environmental systems. The other standards in the family focus on specific approaches such as audits, communications, labeling and life cycle analysis, as well as environmental challenges such as climate change, (ISO, 2017). Current standards from ISO/TC 207 and its subcommittees was mensioned in Appendix B.

There are many reasons why an organization should take a strategic approach to improving its environmental:

1) Demonstrate compliance with current and future statutory and regulatory requirements
2) Increase leadership involvement and engagement of employees
3) Improve company reputation and the confidence of stakeholders through strategic communication
4) Achieve strategic business aims by incorporating environmental issues into business management
5) Provide a competitive and financial advantage through improved efficiencies and reduced costs
6) Encourage better environmental performance of suppliers by integrating them into the organization's business systems

Ground service and maintenance equipment standards

It is all standardization about materials, components and equipment for construction and operation of aircraft and space vehicles as well as equipment used in the servicing and maintenance of these vehicles. (ISO, 2017)

ISO/TC 20 is a technical committee of the International Organization for Standardization (ISO) responsible for developing internationally accepted standards for aircraft and space vehicles. This covers standards for the materials, components and equipment used to both develop and maintain them, including:

1) Design and Construction
2) Test and evaluation
3) Operation
4) Air traffic management
5) Maintenance
6) Disposal/end of life
7) Safety, reliability and environmental considerations

Current standards from ISO/TC 20 and its subcommittees was mensioned in Appendix C.

ISO 6966 was prepared by Technical Committee ISO/TC 20, Aircraft and space vehicles, Subcommittee SC 9, Air cargo and ground equipment. The first edition of ISO 6966-1, together with ISO 6966-2, cancels and replaces ISO 6966:1993, which has been technically revised.

ISO 6966 consists of the following parts, under the general title Aircraft ground equipment — Basic requirements:

Part 1: General design requirements: this part of ISO 6966 specifies the general requirements to be taken into account by manufacturers for the design of aircraft ground support equipment. It identifies the various concerns to be taken into consideration to ensure ground equipment presents the appropriate general design characteristics, (ISO 6966-1, 2005).

Part 2: Safety requirements: this part of ISO 6966 specifies the safety requirements to be taken into account by manufacturers for the design of aircraft ground support equipment. It identifies the various concerns to be taken into consideration to ensure ground equipment safety for operators and aircraft, (ISO 6966-2, 2005).

3 Conclusion

There are alot of improving methodologies can be applied to improve the performance of Ground Support Eqipments, the most of Ground Aviation Services Companies in Egypt apply quality management standards through ISO 9001/2008. Although these companies apply quality management standards, the performance of Ground Support Eqipments is low with low efficiency, low effectiveness and low safety and increase the cost of failure which represented in Aircraft diversions, Flight cancellations, Passenger food and lodging, Management and supervision time, Incident investigations, Purchasing seats on anther airline, costs of workplace injuries.

4 APPENDICES

APPENDIX A:

Current standards from ISO/TC 176 and its subcommittees

Standard/ document	Title
ISO 9000:2005	Quality management systems – Fundamentals and vocabulary
ISO 9001:2008	Quality management systems – Requirements
ISO 9004:2000	Quality management systems – Guidelines for performance improvements
ISO 10001:2007	Quality management – Customer satisfaction – Guidelines for codes of conduct for organizations
ISO 10002:2004	Quality management – Customer satisfaction – Guidelines for complaints handling in organizations
ISO 10003:2007	Quality management – Customer satisfaction – Guidelines for dispute resolution external to the organization
ISO 10005:2005	Quality management – Guidelines for quality plans
ISO 10006:2003	Quality management – Guidelines for quality management in projects
ISO 10007:2003	Quality management – Guidelines for configuration management
ISO 10012:2003	Measurement management systems – Requirements for measurement processes and measuring equipment
ISO/TR 10013:2001	Guidelines for quality management system documentation
ISO 10014:2006	Quality management – Guidelines for realizing financial and economic benefits
ISO 10015:1999	Quality management – Guidelines for training
ISO/TR 10017:2003	Guidance on statistical techniques for ISO 9001:2000
ISO 10019:2005	Guidelines for the selection of quality management system consultants and use of their services
ISO/TS 16949:2002	Quality management systems – Particular requirements for the application of ISO 9001:2000 for automotive production and relevant service part organizations
ISO 19011:2002	Guidelines for quality and/or environmental management systems auditing

APPENDIX B:

Current standards from ISO/TC 207 and its subcommittees

Standard/ document	Title
ISO 14050:2009	Environmental management vocabulary
ISO 14040:2006	Environmental management life cycle assessment principles and framework
ISO 14015:2001	Environmental management - EASO
ISO 14020:2000	Environmental labels and declarations – general principles
ISO 14001:2004	Environmental management systems – requirements with guidance for use
ISO 14031: 1999	Environmental management - environmental performance evaluation - guidance
ISO 14004:2004	Environmental management systems – general guidelines on principal and systems
ISO 14063:2006	Environmental management – Environmental communication – guidelines and examples
ISO 14065:2007	Greenhouse gases – requirements

APPENDIX C:

Current standards from ISO/TC 20 and its subcommittees

Standard/ document	Title
ISO 10254:2016	Air cargo and ground equipment -- Vocabulary
ISO 10842:2006	Aircraft -- Ground service connections -- Locations and types
ISO 11075:2007	Aircraft -- De-icing/anti-icing fluids -- ISO type I
ISO 11076:2012	Aircraft -- De-icing/anti-icing methods on the ground
ISO 11077:2014	Aircraft ground equipment -- De-icers -- Functional requirements
ISO 11078:2007	Aircraft -- De-icing/anti-icing fluids -- ISO types II, III and IV
ISO 11532:2012	Aircraft ground equipment -- Graphical symbols
ISO 14625:2007	Ground support equipment for use at launch, landing or retrieval sites -- General requirements
ISO 15845:2014	Aircraft ground equipment - Boarding vehicle for persons with reduced mobility - Functional and safety requirements
ISO 16004:2017	Aircraft ground equipment -- Passenger boarding bridge or transfer vehicle -- Interface requirements with aircraft doors
ISO 17775:2006	Aircraft -- Ground-service connections -- Potable water, toilet-flush water and toilet drain
ISO 20683:2016	Aircraft ground equipment -- Nose gear towbarless towing vehicle (TLTV), Design, testing and maintenance requirements
ISO 21100:2014	Air cargo unit load devices -- Performance requirements and test parameters
ISO 27470:2011	Aircraft ground equipment -- Upper deck catering vehicle -- Functional requirements
ISO 27471:2012	Aircraft ground equipment -- Upper deck loader -- Functional requirements
ISO 6966-1:2005	Aircraft ground equipment -- Basic requirements -- Part 1: General design requirements
ISO 6966-2:2014	Aircraft ground equipment -- Basic requirements -- Part 2: Safety requirements
ISO 6967:2006	Aircraft ground equipment -- Main deck loader -- Functional requirements
ISO 7718:2016	Aircraft -- Passenger doors interface requirements for connection of passenger boarding bridge or passenger transfer vehicle
ISO 8267:2015	Aircraft -- Tow bar attachment fittings interface requirements
ISO 9667:2016	Aircraft ground support equipment -- Tow bars

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