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FAILURE PREVENTION IN MAINTENANCE SERVICES AND LOGISTICS

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Abstract: Influenced by the requirements of global markets, the competition in high technology branches necessitates permanent operational readiness of technical machinery and equipment. Materials of high quality and reliability-oriented engineering philosophies work against system abrasion, but cannot avoid it completely. Decreasing reliability and abrasion of heavy stressed parts are indicative for increasing age of technical equipment. It is up to maintenance to constitute and reconstitute absolute operability. According to DIN EN 13306 : 2010 maintenance is a “combination of all technical administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function”.

Keywords: Management systems, product quality, logistics, maintance

1. INTRODUCTION

Fundamentals of quality management systems are according to ISO 9000 family. This is, essentially, a set of static rules to constitute the basic requirements of quality. But a complete quality management system cannot be reduced to a simple set of rules; it is rather the implementation of thinking quality. Only a certification according to valid norms does not guarantee a positive quality development. The key aspect of improvement is to integrate all quality actors – the system must be lived and experienced. In a first step quality will be defined and the classical quality management systems will be introduced. Based on this fundamental knowledge a new comprehensive quality management system for aircraft maintenance organizations will be presented. [1]

Managed by an inspection plan the activities take place. In addition, to identifying the actual item condition the analysis of generated data is important to initiate future failure prevention. The following tasks are derived from inspection:

- ✓ Determining the actual state
- ✓ Evaluating the actual state
- ✓ Assessing the actual state
- ✓ Initiation of further measures

The assessment of the actual state allows monitoring the wear-out of an unit and provides an insight into its reasons. Planning necessary maintenance activities becomes possible this way.

2. QUALITY

A general definition of quality is given by EN ISO 9000:2005 as a “degree to which a set of inherent characteristics fulfills requirements”. The degree to which these requirements are fulfilled is transferable to products and processes; so quality must be distinguished into process quality and product/service quality. Broader definitions of quality consider five aspects: transcendent,

customer-related, value-related, production-related and product-related. The transcendent aspect will not be considered here; it is more a philosophic approach which takes individual experiences during the whole life of product into account.[3.]**Error! Reference source not found.**

Figure 1 gives an overview of product flows and processes in airline business; the most important interface is given by airport, airline and passenger (1). Regarding to aircraft maintenance organization procedures the quality interfaces between aircraft manufacturer/OEM and maintenance services (2) as well as between airline and maintenance services (3) are of particular importance.

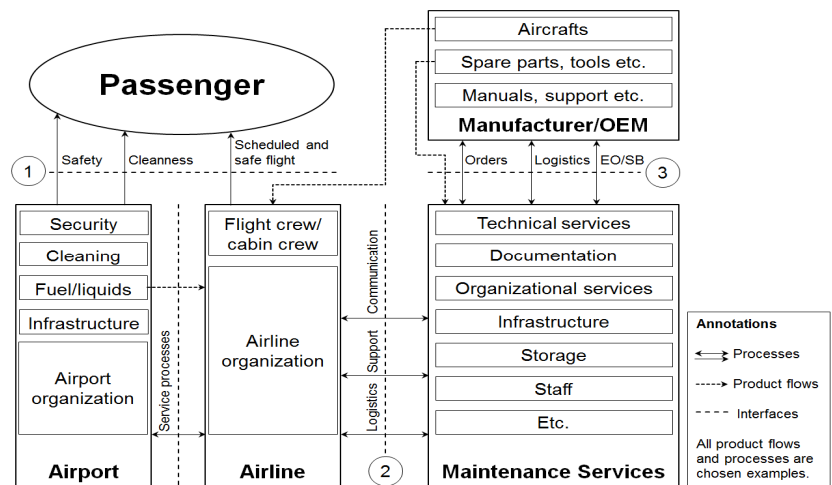


Fig.1 Processes, products and main quality interfaces of airline business

The processes of interface (1) can be summarized to a service for passengers; the service product is a pleasant and safe flight as scheduled. Processes of interface (2) are reducible to the products: serviceable and safe aircraft anytime and anywhere. Products generated at interface (3) are serviceable spare parts, documentations and support on request and as soon as possible.

As presented in figure 1 the smallest units of interest which create consumable service products are processes and product flows (processes with a material flow). According to EN ISO 9000:2005 products resulting from processes and efforts for improving the general service quality should focus these units particularly.

3. PROCESS QUALITY

Process quality definitions reflect a value- and production-related approach with explicitly measurable elements and properties. The result of this measurement provides a degree of meeting the requirements for the considered elements and properties of products and processes. Each negative deviation is equivalent to a quality reduction. [2]

The definition of a process is given by EN ISO 9000:2005 as a “set of interrelated or interacting activities which transforms inputs into outputs” in order to add a value. Process orientation has a high relevance for industrial practice; quality monitoring for processes is the basis of reliability. [3]

Improving the quality of processes is synonymous to improve product/service quality and means to focus on customer needs. As an additional benefit economic efficiency and profits usually increase.

4. SERVICE PRODUCT QUALITY

As a result of processes there is a product with an added value; in case of figure 1 the products of the interfaces are services. Each service is a customer-oriented product and the priority of implementing quality improvements measures depends on the connected value. Service/product quality always has a (quasi-)transcendent aspect; next to safety and reliability sustainability also influences the level of customer satisfaction. From customers point of view the number of incidents as a consequence of the service/product has a high impact on service product quality. Figure 2 illustrates influencing aspects of service product quality and

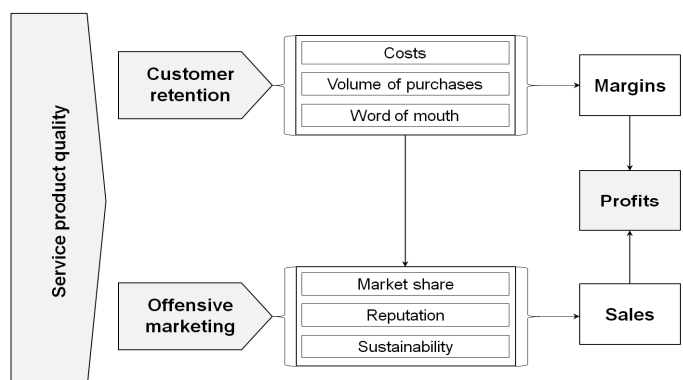


Fig.1 Service/product quality spells profits; reflecting
Kossmann, M. (2006), p. 3

Figure 2 illustrates influencing aspects of service product quality and

their impact on profits. Especially for new customers and customer acquisition the benefits result from service and product quality. [2,3]

All presented aspects and figure 28 refer to internal as well as to external service/product quality. In case of exclusive internal services marketing offensives do not relate to the whole market; they are adapted for internal use. Aspects of customer retention need to be considered anyway to improve quality.

5. MANAGEMENT SYSTEMS

Quality needs rules; without a strict set of standards quality in aircraft maintenance and logistics is not possible. These standards define requirements which are absolutely necessary to enable quality. Furthermore, these standards must be able to evaluate and to improve themselves. The aim is to provide a comprehensive quality management system for all products and services in aircraft maintenance environment. Following, the properties of the two most important quality approaches EN ISO 9000 family and EFQM (European Foundation of Quality Management) are introduced.

ISO 9000 Family of Standards: The ISO 9000 family is a set of standards designed for any type of organization. It helps to manage, control and improve the quality. A static system of rules is given to establish an organization which is enabled to provide quality. Thereby the regulatory framework covers the following eight areas:

- ✓ Customer focus
- ✓ Responsibility of leadership
- ✓ Involvement of people
- ✓ Process-oriented approach
- ✓ System approach to management
- ✓ Continuous improvement
- ✓ Factual approach to decision-making
- ✓ Mutual beneficial supplier relations.

A general concept for each type of organization is provided; the family has industry-specific interpretations of the guidelines:

- ✓ ISO/TS 16949 –Quality management system requirements for automotive-related product suppliers
- ✓ TL 9000 – Quality excellence for suppliers of telecommunications
- ✓ ISO EN 9100, AS 9100 –Aerospace industry implementation of ISO 9001
- ✓ ISO EN 134485 – Medical industry implementation of ISO 9001

The ISO 9000 family standards are provided as a process-based TQM system (Total Quality Management); a complete quality management with a continual improvement. Figure 3 displays the functioning of an ISO 9000 quality management.

An ISO 9000 certification provides a harmonized concept of common certification standards which is a key factor for international business. If all related business partners and suppliers in national, international and global markets have a common certification standard, an essential precondition of cross-industry quality is fulfilled.

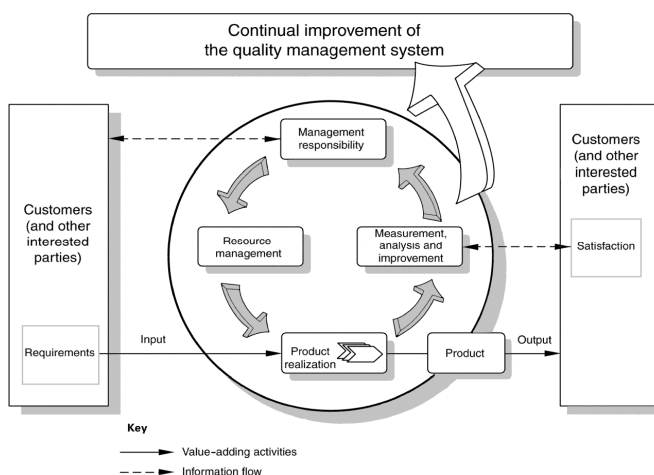


Fig.3 Model of a process-based quality management system, DIN EN ISO 9000:2005 (2005), p. 11

The regulatory framework of the ISO 9000 family is binding for all certified participants. Although there is implemented a continuous improvement the set of rules is static; the certification process bases on standardized checklists. A Benchmarking system with much more flexibility and a much higher level of up-to-dateness is not provided.

6. EUROPEAN FOUNDATION OF QUALITY MANAGEMENT (EFQM) SYSTEMS

EFQM is a structured concept that provides an opportunity to any kind of business for evaluation of the own quality management system. This concept supports the development of such systems and serves as a progress monitoring system. It bases on clear management responsibility as well as on an employee and a resource responsibility. All requirements of ISO 9000 family standards are fulfilled; they are fundamental for establishing EFQM systems and in result for a TQM system. Self-evaluation in combination with Benchmarking aspects facilitates continuous improvement.

A holistic view on the business organization becomes possible through implementation of an EFQM model. Therefore, the system is distinguished in nine criteria (see figure 4) with five enablers (leadership, partnerships and resources, strategy, people and processes) and four results (people results, customer results, society results and key results). Each criterion of the EFQM systems is weighted with a level of importance; customer results have the most impact with about twenty percent. [4, 5]

Continuous improvement is a key aspect of EFQM and has significantly more importance in contrast to the ISO 9000 family; customer results have a much higher impact. The system fulfills all general ISO 9000 requirements and it is applicable for nearly every business. However, aircraft maintenance business is subjected to a much more complex regulatory framework. And yet, the level of continuous improvement and the consideration of customer needs are trendsetters for new quality management systems in aircraft maintenance business.

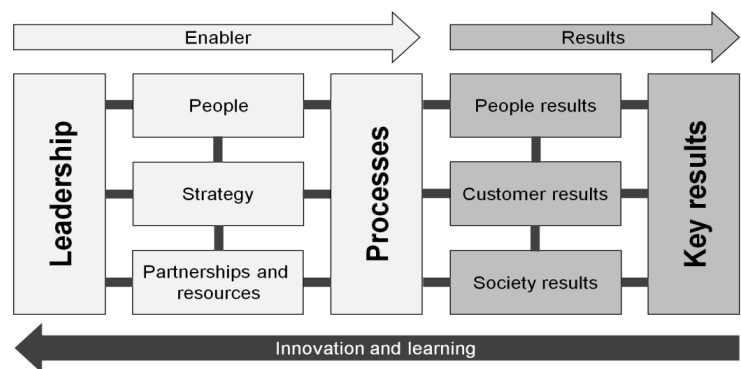


Fig.4 EFQM model (quality management); cf. Amelung, E.

7. QUALITY MEASUREMENTS

Quality is not just available – quality must be created and improved; a key pre-condition is the measurement of the present quality level. So the status quo is attested and a systematic use of identified potentials is certified. Therefore, it is necessary to provide standard quality data and information as reference for reviewing measured data. As a basis for a subsequent analysis the measurement provides data which have to meet defined requirements. According to figure 5 each quality concept is reducible to a target-performance comparison. [6, 7]



Fig.5 Quality – a target-performance comparison; reflecting Masing, W. (2007)

The degree of compliance is determined through reviewing conformity. Dimensional characteristics of quality are measurable objectively; non-dimensional quality criteria allow only a subjective measurement (especially in case of evaluating sensual impressions). Thus, a measurement is carried out fundamentally for an objective review and a quality determination. [7]

In general, transparency and traceability of inspection results are prerequisite for decision-making and implementing improvements. Figure 6 illustrates a measurement of criteria and the determination of the degree of compliance to the target conditions. Without a measurement (a review and an analysis of the results) there is no support for planning, management or improvement of quality. [8]

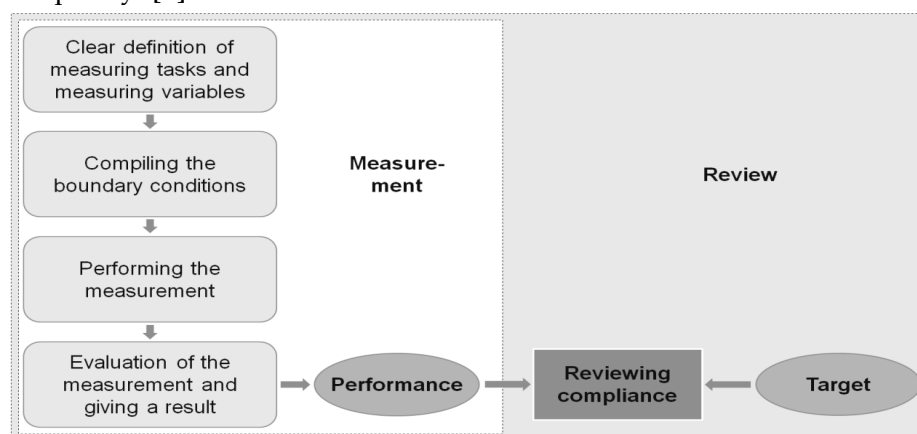


Fig.6 Measurement and review of quality; reflecting Weckenmann, A. and Werner, T.

8. QUALITY MANAGEMENT APPROACH

Safety, reliability and customer satisfaction summarized by the concept of quality are the reason for implementing quality management systems. Designing them is a balancing act between a strict regulatory framework and a flexible construction which is adaptable to each type of business. It should be found an optimum of necessary regulations which considers all requirements of aircraft maintenance business and the provisioning of capabilities for continuous improvement of processes as well as the organization itself.

Requirements of a quality management system often are derived from quality expectations of the stakeholders. Table 1 gives an overview of involved stakeholders selected and their expectations.

Tab.1 Quality expectations of some stakeholders; reflecting Seghezzi, H. D. et al. (2007)

Customer	Public	Provider
Function and equipment	Safety	Failure reduction
Trust	Environmental protection	Flexibility (set-up times)
Safety	Sustainability	Production capabilities
Service life	Trust	Product conformity
Reliability		Economic efficiency
Finishing quality		

As introduced before, conformity to the ISO 9000 family of standards provides a good basis for managing quality; but the requirements need to be extended to provide a more self-evaluating quality management system with a broader focus on improvement. Identified demands are distinguishable into general and aircraft maintenance-specific requirements.

9. CONCLUSIONS

Quality management systems can be viewed as a black box with an input and an output value. The input value consists of customer needs and the requirements of a quality management system as defined previously; the output is the final product or service.

Essential for failure prevention in maintenance and logistics is the type of quality management system. Each product/service consists of several processes; so guaranteeing quality requires a good process quality. For global acting airlines there is also a need for harmonization with a minimum of common standards to ensure a cross-boundary quality. Important quality management systems are given by the European Foundation of Quality Management and the EN ISO 9000 family of standards with adaption for aircraft maintenance EN ISO 9100. Both models have several gaps which are picked up to create a new comprehensive approach. Innovative key aspects of the new quality management system are an open-loop design with the ability to perform branch-specific

Bench markings and a permanent improvement supported by an implemented change management. The system also includes the human factors concept as well as the failure reporting system as described by law. Thus, comprehensive quality can be ensured under consideration of the long-time quality imperative.

An empiric study generates practical-relevant data to verify the propositions of the present thesis. It is an international study with twenty-three participants from three different continents. Particular focus is on the general design of aircraft maintenance organization procedures, applied quality management systems and the chosen spare part supply.

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