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PROVIDING RELIABILITY OF HUMAN RESOURCES IN PRODUCTION MANAGEMENT PROCESS

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Abstract:
People are the most valuable asset of an organization and the results of a company mostly depends on them. The human factor can also be a weak link in the company and cause of the high risk for many of the processes. Reliability of the human factor in the process of the manufacturing process will depend on many factors. The authors include aspects of human error, safety culture, knowledge, communication skills, teamwork and leadership role in the developed model of reliability of human resources in the management of the production process. Based on the case study and the results of research and observation of the author present risk areas defined in a specific manufacturing process and the results of evaluation of the reliability of human resources in the process.

Key words: *human factor, reliability of human factor, HRA*

INTRODUCTION

The goal of every manufacturing company is to provide product that meets customer requirements. It is therefore important that the manufacturing process was carried out in under controlled conditions which should be developed and established as the best response to the problem scenarios associated with the production process. Production process and its exploitation characteristics require specific approach to the issue. Necessity to maintain high efficiency of technical systems results in necessity to obtain full information on technical system condition, as making correct decisions requires taking numerous and various factors occurring during analysis and in the future into consideration [10]. The conducted observations and interviews suggest, however, that the most systematic approach to identifying hazards and their ratings is applied mostly in companies in the automotive, pharmaceutical and food industries. However, this was not a voluntary approach to the issue of owners and top management, but existing and applied in the industries of management standards such as ISO/TS 16494 and ISO 22000. In many industries (eg. in the oil industry), the problem of reliability is so important, that international standards related to the production assurance and more reliable management are developed [11]. The problem of the reliability of the manufacturing process can be seen in many aspects. One of them is human resources and their impact on the quality, performance and reliability of the processes. Production company is a system of social engineering in which employees can use in their technical resources available on daily basis for carrying out their duties [5] and analysis of the results cannot be done without taking the human factor into consideration. The goal of the paper is to present a different approach to production process management, a human-centric approach in which a human being is an element of a production process and his reliability influences results of the process. The reliability of human factor in production process is to be analyzed, with respect to human errors, knowledge, safety culture and leadership, as well as communication skills and team-work capabilities. The next goal of the paper is proving that assessment of reliability of humans, known as HRA methodology (Human Reliability Assessment) does not require any financial assets nor complicated realization procedure.

ELEMENTS OF HUMAN RELIABILITY

Reliability is the characteristics of an object analyzed providing information on its work – whether its functioning is correct and functions and actions completed in a given time and in given conditions [19]. The relation introduced above refers to probability that an object which started its work in time $t = 0$ will not break down before the moment defined as $t < T$, where T is durability of the object mentioned [12]. Within reliability theory, there are numerous measures for quantitative assessment of importance of a given element of a system and its influence on correct functioning of an object. The issue of importance assessment is connected with necessity of searching for "weak links" of the system [2]. Production system reliability analysis may take numerous technical factors into consideration, however it will not be comprehensive without considering human factor. Human reliability is defined as the probability that a person correctly performs activities required by a system in a required time period (for example if time is a limiting factor) [15].

The reliability of human resources is influenced by:

- human error,
- safety culture,
- knowledge,

- communication skills,
- teamwork,
- leadership.

The human factor plays an important role in the secure execution of each process. The role of human error in the assessment of the reliability of the manufacturing process is extensive. Assessment of the impact of human error on the reliability of the processes involves the systematic application of information about human characteristics and behaviour to increase the safety of a process and of a system. The moment when a person is in relation to the production process is important, as well as the fact that an error can be made in the pre-production phase (eg. during maintenance of machinery and equipment) and in post-production (for example, when switching devices for traffic) [8, 16]. Human error can also be committed in the implementation of strict manufacturing process and is often linked to the ergonomics of the process, because the ergonomic quality of hand tools increases the efficiency of work performed [1]. Safety culture which is defined as a set of psychological, sociological and organisational factors initiating and maintaining all the actions undertaken to preserve life and health at work as well as in non-professional activities is another very important factor of reliability of the manufacturing process analyzed in terms of the human factor. Safety culture is the foundation of a well-functioning system of occupational health and safety, which is a system in which an occupational hazard and fatigue of workers is minimized [13], which directly affects the provision of high quality business services, manufacturing and production [6] and thus the reliability of the man in the manufacturing process. Knowledge is another issue that affects the reliability of human resources in the management of the production process and should be understood in terms of information and intellectual capital of the organization. Information provides a new point of view in the interpretation of events, and discover previously unknown matter that is shaping knowledge [3]. The important aspect is identification of sources of technological knowledge, which is the knowledge of employees taking part in production process. The sources to be considered include technical documentation, information coming from direct supervisors, information coming from production managers, self-acquired and coming from inter-generational communication [18]. Intellectual capital (i.e., human capital, along with his powers, and structural capital in the form of databases, procedures, information systems, etc.) includes not only the knowledge resources of the company, but the entire property, which stems from the knowledge base, which is a kind of know-haw, which should be interpreted broadly, as illustrated in Figure 1.

The use of the company's capital to increase the reliability of human resources is conducive to proper communication which is the result of a well-structured decision-making process, as well as the smooth flow of information. Man is the most important element in the company. The man creates, develops and improves the company by making all kinds of activities. However, any decision made or action taken may contribute to the materialization of the risk or error. Minimization such situations with a high risk of failure in terms of human resources is also teamwork. Therefore, an important aspect of management is to provide staff with the skills, knowledge and abilities. Leadership is another issue that affects the reliability of human resources. Managers of charisma, trustworthy, with friendly attitude to colleagues, advising instead of showing errors are the basis of the process with high reliability characteristics of human resources [14]. Motivating, which is the integral role of leadership is directly translated into the results achieved in the by people in the activities they are involved in. Motivating in this case may take both forms, informative and directive. The informative form is based on explaining, presenting and discussing to provide employees with confidence on understanding their tasks, on the other hand directive form is based on definition of requirements presented as orders, prohibitions, regulations to provide employees with confidence on their safety and minimize stress -generating situations [17], that directly influence human reliability in production process.

Summarizing the considerations above, identification of hazards in the area of "human resources", to be taken into account and analysed, includes:

- competences,
- responsibility (financial, business),
- training,
- incentive system,
- authority to take decisions,
- access to information,
- planned changes in the staff.

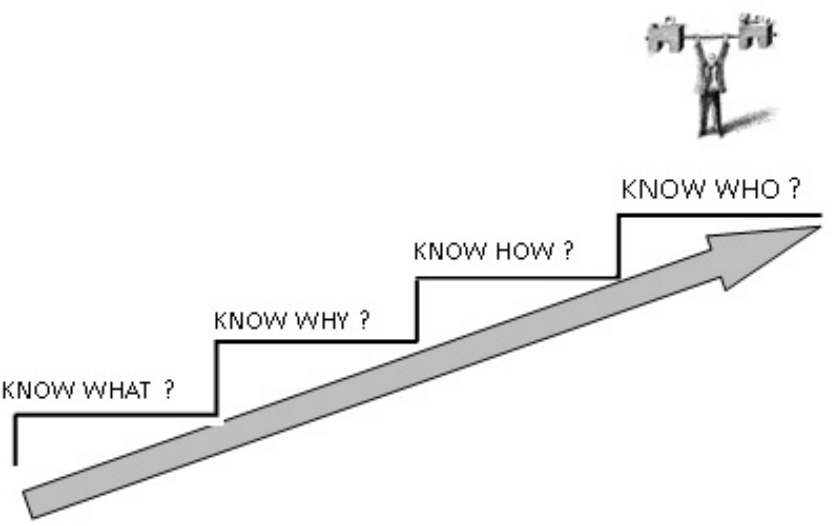

Fig. 1 Know – how of organization in the aspect of reliability of human resources

The model of personnel reliability process management is shown in Figure 2.

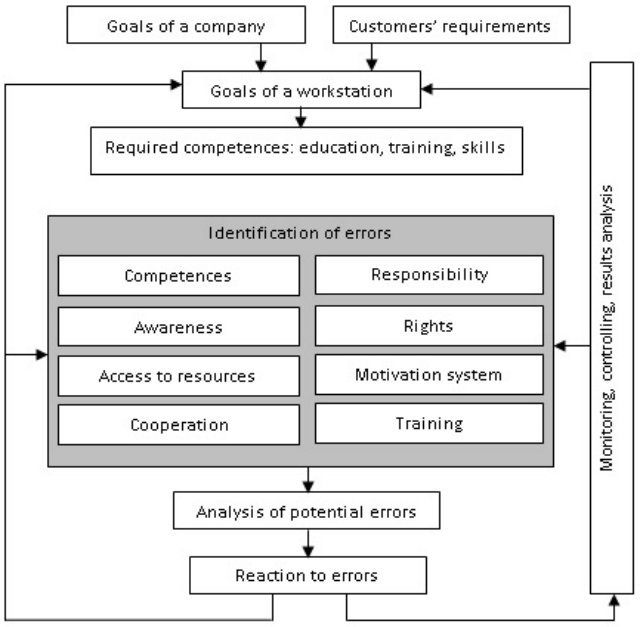

Fig. 2 Model of staff reliability management process

Thus, going from the top it is necessary to translate business objectives and requirements of the client for the purposes of the respective positions and define the required competencies for employees in order to ensure that business objectives are achieved and customer requirements are met. Consequently, the risk analysis may lead to changes in the position of such necessity to divide or a join the workplaces, or the quality of company's staff.

PRODUCTION PROCESS AND RELATED RISKS

Elements of the production process

The production process is a crucial component of functioning of every manufacturing company and may consist of elements such as research and development process, the process of distribution and customer service and the manufacturing process.

As presented in the scheme above, Production process includes three components [9]:

- the manufacturing process which represents the overall processes for fabrication and assembly of production carried out,
- manufacturing support (auxiliary) process, ensuring maintenance of machinery and equipment manufacturing, maintenance planning, to ensure the provision of energy and functioning of so called infrastructure,
- manufacturing service process, for administrative services, occupational safety, security.

Each production system is purposely designed and structured composition of material, energy and information used by humans and used in the manufacturing of certain products to meet the diverse needs of consumers [4].

During the analysis of risks in the production process, the first step is looking for the main risks at the level of the operation, and only after that identification operations are considered most at risk of its constituent elements or treatments, activities and flow of work.

Threats In Production Process

Any activity, including the production process entails the possible risks, which can result in failure to achieve the target. For the production objective is efficiency and effectiveness and thus the risks can cause: delays, cost overruns and failure to comply with the quality. Additional consequences of threats are: loss of goodwill among customers and other stakeholders, the loss of financial liquidity, exposure of workers to the loss of health or even life, not meeting the general goal of enterprise. An analysis of the production process should be considered in the context of the eight areas presented in Figure 3.

System approach and analysis of the following areas makes it impossible to miss any of the factors that can disrupt the production process.

HUMAN RELIABILITY ASSESSMENT

Reliability assessment with HRA methodology

Human Reliability Assessment (HRA) is a method based on the analysis of human behavior. With the HRA it is possible to assess what impact the behavior of the staff has on the process under normal and emergency situations in a hurry when a person is in stress. The basis of this method is to evaluate the impact of human activities on the potential

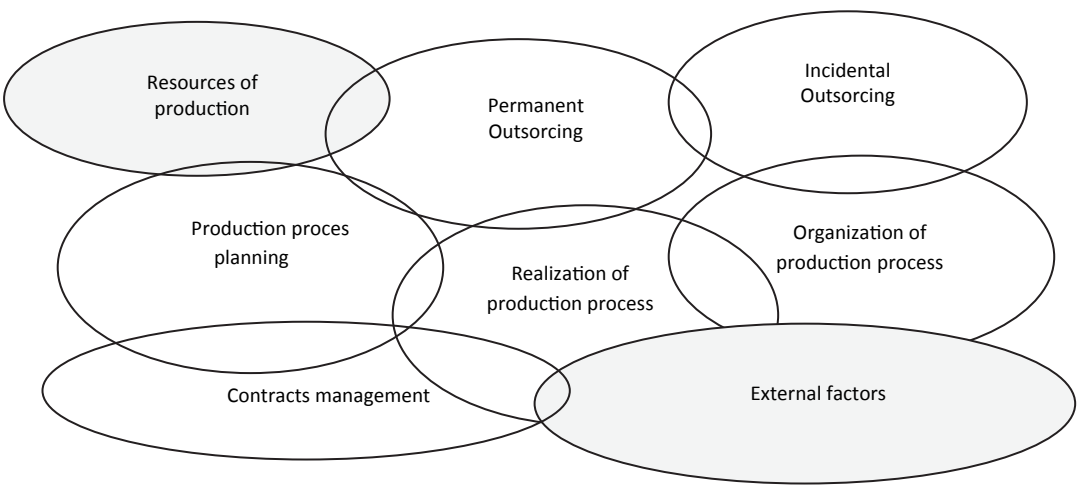

Fig. 3 Areas of analysis of threats to production process
Source: [own work based on 7].

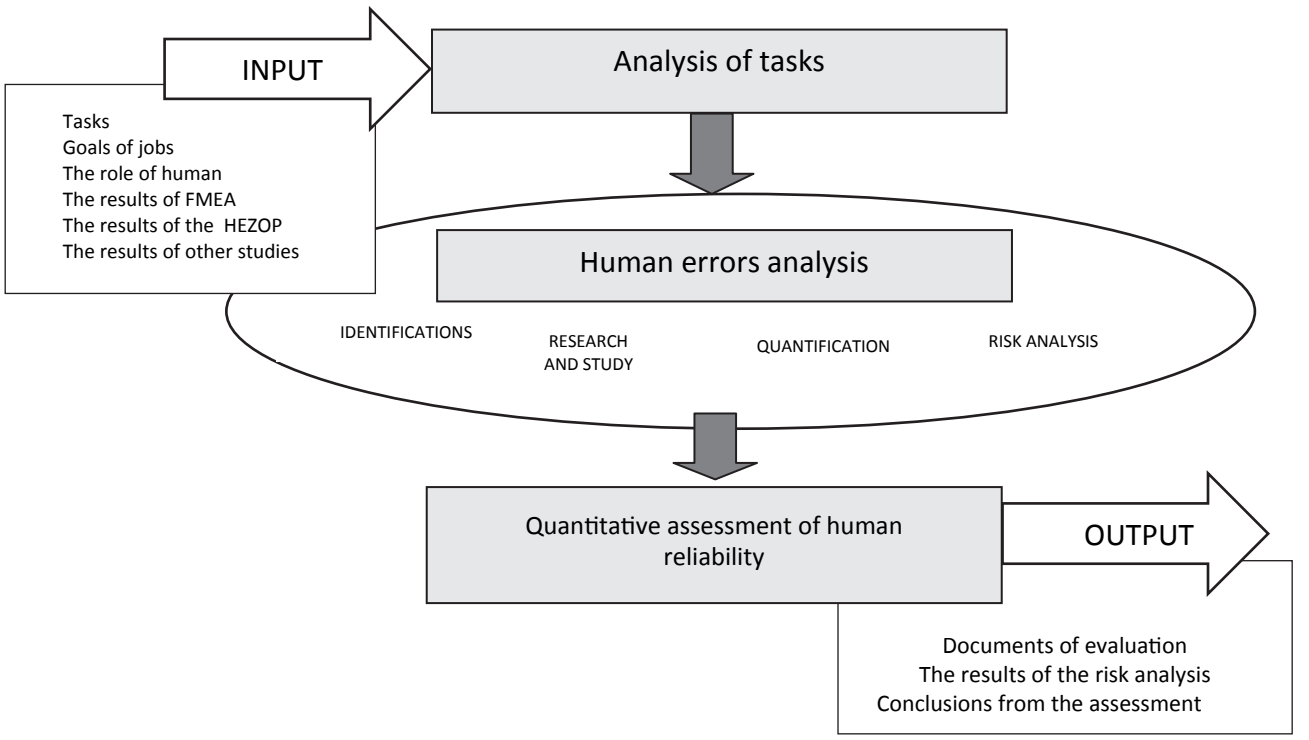

Fig. 4 Areas of analysis of threats to production process
Source: [own work based on 7].

for threats and errors, and to evaluate the significance of these threats [15]. Errors of personnel may affect the reliability and quality or safety. Intuitive human activity can have positive and negative effects, so studying the behavior and trying to consider the various decisions, can help eliminate bad decisions, and thereby prevent the process from disaster and prevent the emergence of threats. HRA analysis takes into account the characteristics of personnel, work environment, responsibilities and accountability. Assessment is not only man, but also a machine – man system. HRA method shall be determined for certain activities, especially in situations where a specific action mitigates the effects of the failure, and failure or incorrect operation may lead to the development of failure. HRA analysis identifies the various types of erroneous actions that may arise, namely:

- error omission, failure to perform the required action,
- a runtime error, which may include the following,
- failure to carry out the required action,
- operation carried out with too much or too little force, or without the required accuracy,
- action taken at the wrong time,
- action (or actions) taken in the wrong order,
- extra-curricular activity, not the required action taken instead of or in addition to the action required.

The basic steps included in HRA assessment areas are identified in Figure 4.

HRA method is a process defining elements of the input and output stages of the assessment of possible human error. The basic elements of this study are:

- identify errors and their analysis,
- assessment of possible errors and their quantification.

HRA is typically performed after analysis of another type (eg HAZOP, FMEA), by means of which the impact of human error on the existence of serious consequences was shown.

The manufacturing process of lead pins

Production company in which the study was conducted, is a mid-sized businesses, which employs 100 workers. The main product is the pole lead to an industrial battery or traction battery. For this purpose are used in the production of two types of treatments: cutting and casting . Machining is done on a machining center, which is one of the most modern in Europe, made by the Swiss company PFIFFNER Instrument Transformers Ltd. This center provides primarily process stability and dimensions of the product and a very short time to obtain the final product. The metal workpiece at the center are mainly brass. The parameters that are monitored in the dimensions of internal and external threads as agreed with the client. This plant was one of the few companies in Poland and Europe specializing in the casting of lead on gravity. This method requires precision which is guaranteed by a firm and ripped crew. For the purpose of preparing and casting company manufactures molds and permanent molds. The parameters that are monitored include temperature of forms, lead, and details - as agreed with the customer. The production process consists of two stages:

1. Production of bushes,
2. Production a lead cast.

Table 1 shows the operations of manufacturing process.

Table 1
Manufacturing process operations for lead rocker for batteries

Stages of production process	Operations at each stage of process
Production of a bush	download the rod from stock loading bar for machine tools setting of machine parameters, run control the first 5 pieces manufacture bushings, gauges 3 times per shift placing bushes in containers marking containers degreasing bushes provide bushes for tinning workstation tin plating bushes provide for the position of casting
Production of a lead cast	taking lead from a warehouse placing lead in a stove melting lead checking process' parameters placing bushes in forms casting rockers cleaning the cast controlling adherence of a rocker machining packing and issuing to a warehouse

HRA analysis for the casting work station

Since it was found that the skills of an employee, his precision and accuracy in the process of casting by gravity are the key to quality of finished products, HRA methodology was used to identify the threats. The results of this analysis are shown in Table 2.

Table 2
Manufacturing process operations for lead rocker for batteries

Analyzed aspect	Error	Results
Not doing actions	Discordant products	No delivery to customer
Failed actions	Discordant products	Over-production-increase in costs, complaints
Lack of exactness	Discordant products	Over-production-increase in costs, complaints
Wrong time	Lack of products	No delivery to customer
Wrong order of actions	Discordant products	Over-production-increase in costs, complaints
Extra activities	Doing extra activities	Waste of time

The table shows that the next threat company has to be prepared to and needs to eliminate is a waste of time. Every unnecessary action done by the production employee's makes him more tired and less motivated to exercise primary production. A consequence of the analysis was to develop a standard implementation process and individual operations. In addition, a regular internal training of the principles of casting. Training is carried out employee holding the greatest experience.

CONCLUSIONS

The employee is the most important resource of the company but also on the other hand is the weakest link, which can be broken. Even though employees do not know their tasks, goals, and responsibilities, they can affect the quality of customer service, company's image and thus the liquidity. Therefore, implementation of the presented model of process of personnel reliability management is beneficial for each company, to be aware of the risks that can occur and implement error response scenarios wherever we are able to develop a suitable solution. The presented case study demonstrates the fact that the analysis of the reliability of human resources can be used in production without incurring significant expenditures for research.

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