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The conception of selected Technology Assessment method and the possibilities of TS application

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GENERAL REQUIREMENTS

An important current civilization problem is the aging of societies in which the role of older people is growing. Such persons as well as younger people are users and maintainers of various technical means present in various spheres of their lives. They have their specific needs related to their operation or maintenance, have their own capabilities and limitations in contact with these means. Therefore, the problem that engineers have is shaping the technical means in the process of meeting needs (in the cycle of his life), to ensure the quality of life of such people at the appropriate level, while at the same time bearing the lowest possible costs.

Opposite to this challenge, the scheme of the discussed process was proposed. It includes the stage of describing the need, design, construction, manufacture and exploitation. Operation presupposes the rational use of technical means in accordance with the intended use and taking actions to maintain or restore technical means to operate. It provides very valuable data and information on the functioning of the technical means. These include subjective data from people of different ages, constituting a personal opinion of users/maintainers, including older people and complementing objective data – actual values of exploitation measures characterizing reliability, reparability/serviceability, failure rate, operating costs, quality operation, ergonomics, etc. The use of such data on the one hand will improve the exploitation itself, on the other hand it will contribute to meeting the needs of improving the quality of life of users and maintainers of technical means, as well as design and construction that will satisfy this need. An opportunity for receiving such data may be the Technology Assessment philosophy, which assumes assessment of the technical means and events, processes and exploitation systems that accompany its operation. Data on these phenomena, acquired for the purposes of improving the design/construction/technical means, in the process of its operation can be processed using specific mathematical relationships. With their use, you can calculate the values of the measure of the assessment of technologies supporting its functioning.

A very important factor in this process is also taking into account the impact of a given process on the environment. This is particularly important in the area of Upper Silesia where the economy has been based on mining and metallurgy for many decades. In this case, mining in particular, through the occurrence of a number of natural hazards

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(Brodny & Tutak, 2019, Tutak & Brodny, 2018, Tutak & Brodny, 2019) and technical ones has a significant impact on the technical and ecological awareness of the region's society (Palka et al., 2017, Palka et al., 2017). This is due to the high impact of this industry on the natural environment and work (Brodny & Tutak, 2016, Brodny & Tutak, 2016, Brodny & Tutak, 2018. Similar tendencies are also observed in the European Union countries (Brodny & Tutak, 2019).

The article presents the concept of a mathematical formula allowing to calculate the value of measures supporting the improvement of exploitation, as well as improving the design/construction of a technical mean, based on the opinions of people of different ages about its functioning. The areas of human activity are also indicated – those in the production/service organization and those outside the activity in which this indicator can be applied.

THE CONCEPTION OF ELABORATED TECHNOLOGY ASSESSMENT METHOD

The method that represents the following relationship comes opposite the problem of human impact assessment on objects, systems and operation process:

$$W_i = \sum_{i=0}^{n} (P_i \cdot K_i) \tag{1}$$

where:

W – value of measure of reliability, maintainability/reparability, quality etc.

P – probability of occurrence of measure value

K – assessment (1 – 5, where 1 – the lowest value of phenomenon, 5 – the highest value of phenomenon)

The essence of the method consists in developing W_i characteristics as a function of the age of a person. This characteristic complements the characteristics obtained on the basis of empirical data about the behavior of a technical mean. An example of such a characteristics is shown in Figure 1.

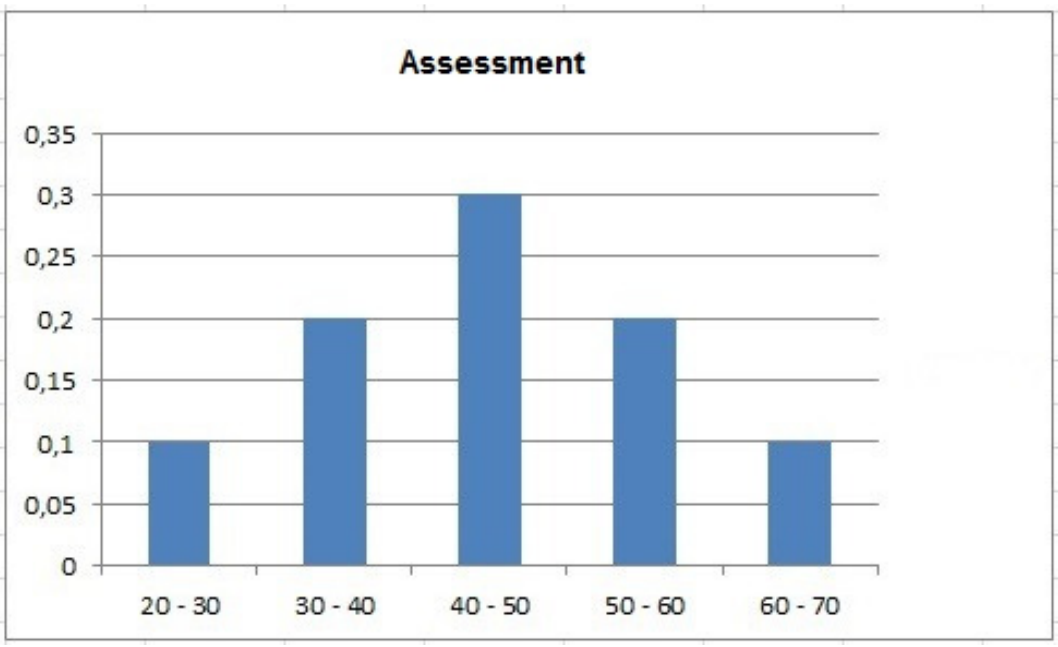

Fig. 1 W_i characteristics in the function of human age

THE POSSIBILITIES OF APPLICATION OF THE DEVELOPED TECHNOLOGY ASSESSMENT METHOD

The method presented in point 2 of the article can be applied in the following areas of human activity:

- improving the quality of life of users of technical means at various ages through rational management of company resources;
- improving the quality of life of users through user-centered design;
- exclusion from exploitation by the elderly technical means/their components based on technology assessment;
- analysis and optimization of needs people of different ages;
- modeling the movement of older people;
- elimination of social exclusion of older people;
- improving the quality of life of people of all ages through appropriate knowledge management.

These areas will be of interest to the author and will be described later in the article.

Improving the quality of life of users of technical means at various ages through rational management of company resources

The quality of life of people of all ages can be improved by improving the efficiency of the exploitation processes of technical means operated and maintained by such persons. This efficiency can be improved by extending the times of effective operation at the expense of maintenance/repair times of technical means. The timing of service/repairs is influenced by the time needed to organize the material and human resources needed to perform them. Therefore, in order to improve the quality of life of people – users of technical means, this time should be minimized.

The answer to this problem is the use of various quantitative and qualitative methods. The BOST method, which is the answer to Toyota's philosophy described in (Borkowski, 2012, Borkowski, 2016, Borkowski, 2017) can be considered the first in the area of social assessment of technology.

This method allows obtaining data on the functioning of the company or its parts that are opinions of the company's employees. It includes a number of characteristics on the basis of which a decision can be made to improve the company's operations.

In order to improve the company's performance, you can also use the indicator described in point 2 of the article. Based on the phenomenon and the scale of its occurrence, knowing the probability of the appearance of an opinion on a particular assessment, it can be stated what are irregularities in the functioning of resource management.

Improving the quality of life of users through user-centered design

The concept of user-centric design can include assumptions of the concept of universal design (design for all) and empathetic design. Universal design is the design of products and the environment so that they are available to all people, to the greatest extent possible, without the need for adaptation or specialized design (this definition was created by Ron Mace and was developed by the Universal Design Center at North Carolina State University). Design for all ('design for all') focuses on the broadly understood human diversity and in this sense is universal: no one is subject to exclusion, and every user of public space benefits (Błaszak & Przybylski, 2015). One

of the main objectives of the universal design strategy is to promote equality and ensure full participation in the social life of people with reduced functionality by removing existing barriers and preventing the emergence of new ones (The Norvegian Ministry of the Environment, 2007)
Whereas empathetic design according to (Ćwiklicki et al., 2019) consists in observing people using current products or services in their own environment. It includes the following stages:

- observation;
- collecting data;
- reflection and analysis;
- brainstorming;
- development of prototypes.

Using the indicator presented in point 2, you can confirm which principles of universal design are used in the design of a technical measure. This will be the case if the value of the indicator is comparable for people of all ages.

Exclusion from exploitation by the elderly technical means / their components based on technology assessment

The developed social technology assessment indicator could be used for decision making in the 6R area (Reduce – Reuse – Recycle – Recover – Redesign – Remanufacture). By reducing, i.e. reduce, reduce, according to (SKANSKA, 2019), there are activities aimed at preventing the occurrence of waste, by eliminating losses in resources through better planning and design. According to this reference, the word reuse (reuse) means increasing creativity in the enterprise in the area of reuse of waste whenever possible; it is profitable and reduces the amount of waste on landfills. Recycle is understood as the processing of waste into usable material. Recover is the recovery of material, energy and is an alternative solution to recycling, if it is impossible. Redesing (design) involves redesigning a useless technical means, while the word remanufacture involves its re-creation. The subject of these philosophies is described in (SKANSKA, 2019, Chen et al., 2015, Hapuwatte & Jawahir, 2019, Go et al., 2011, Huang, 2016, Knowles, 2013).
In order to apply the aforementioned philosophy in an enterprise, it is necessary to develop a decision support system – indicating the best solution for a technical means that is or is not in a state of fit. The best such solutions can be indicated on the basis of technical data that can be obtained as a result of the use of methods and techniques for testing the technical condition (diagnostic ones) of used technical means, as well as by applying methods of assessing their reliability. Diagnostic data can be processed using short-term forecasting methods, allowing the assessment of the technical condition of the technical mean in the future. The analysis carried out with the use of the aforementioned methods will allow to assess the degree of its physical wear.
The technical assessment of a technical mean, allowing decisions to be taken on one of the tasks of the 6R philosophy, should be supplemented with objective results of an economic analysis that justifies the advisability of applying one of the actions resulting from the application of this philosophy. The economic evaluation of individual activities should take into account the criteria: physical and moral wear of the operated facility.

Evaluations aimed at identifying the most appropriate 6R solution, including exclusion from exploitation of a technical mean, should also be carried out taking into account methods and techniques of technology assessment, including the indicator proposed in the article. The developed indicator will complement the 6R methodology with social participation, providing a subjective assessment of the physical and moral wear and tear of technical means, based on which a decision will be made to exclude it or not to use it. It is assumed that people of different ages may have different views on the issue of the moral aging of technical means.
Based on the results of the above-mentioned assessments, using the methods and techniques of knowledge engineering (including decision boards) decisions should be made to exclude or not exclude a technical means from exploitation.

Analysis and optimization of needs people of different ages

Among the human needs according to A. H. Maslow, detailed in (Wilsz, 2009) we can distinguish:

- physiological needs;
- security needs;
- needs of belonging and love;
- the need for respect and recognition;
- cognitive needs;
- aesthetic needs;
- the need for self-realization.

Among the needs of older people, it is possible to distinguish (Lost Spaces, 2017):

- physical needs (nutrition, mobility, social care, personal hygiene, exercise, safety);
- intellectual needs (reading, knowledge about diseases, the ability to learn new activities);
- emotional needs (sense of autonomy, sense of belonging, feeling of being under care);
- social needs (communication, social interaction outside the family, connections with family and friends).

The subject of interest of the author of the article will be the analysis of needs in the use of various technical means, using the indicator presented in point 2, by people of different ages. In particular, the author's interest will be focused on public transport buses. In addition, optimization of needs in the above-mentioned area of people of different ages with the use of various simulation and optimization methods will be considered.

Modeling the movement of older people

One of the problems associated with the adaptation of technical means to the needs of older people is the adoption of roads on which such people will move, as noted in (Lost Spaces, 2019). Therefore, it is important to recognize the activities that the above-mentioned people undertake in the workplace and on the way to work, as well as in their free time. The consequence of its identification should be the development of road models that are overcome by older people. This subject is described in (Elbayoudi, 2015, Mahmoud, 2011). In (Elbayoudi, 2015) simulation models of the activity of an elderly person were presented. The correctness of the selection of such

models could be verified using the indicator described in point 2 of the article. Designing roads on which older people move can also be supplemented with the use of GIS (Geographic Information System) models, presenting map information with their consideration.

Elimination of social exclusion of older people

The limitations appearing in older people include the feeling of uncertainty and the awareness that you are awkward in modern society. Such persons believe that not keeping up with technical progress, they are not only useless, but also lose their authority. They also believe that modern society perceives them as a burden and an obstacle to progress and prosperity. In their case, an attitude full of bias to everything new is also typical, and breaking the reluctance to change is not easy for them (Kędziora-Kornatowska, 2011).

An example of such attitudes can be digital exclusion, which was highlighted in (Kaźmierczak et al., 2015). Small screens, small fonts and too small keys make it very difficult for older people to use them (Morbitzer, 2013). The Internet can be distinguished to the media exploited by seniors. Often, older people either do not see the need to use websites, or do not have the skills to effectively use websites or do not have the appropriate equipment to use this service (Kaźmierczak et al., 2015).

Another type of exclusion may be the lack of use by older people of means of transport, as noted in (Wieczorek, 2017).

The answer to the presented problems may be the conduct of assessment of technology, consisting in the assessment of the value of the indicator presented in point 2 of the article.

Too much dissatisfaction among older people visible on the characteristics shown in Figure 1 should result in changes in the design/construction of the technical means used by them and/or in the course of its operation.

Improving the quality of life of people of all ages through appropriate knowledge management.

Improving the quality of life of people of all ages, as users/maintainers of technical means, can be done through proper knowledge management. The method of supporting this management can be mentoring, described in (Harvard Business Essential, 2005, Parsloe, 2008). It may consist in the transfer of knowledge by older people to younger and less experienced people, and vice versa. An important element that supplements this method may be the indicator described in point. 2. Thanks to its use in the company, along with the use of the rule method, it is possible to gather relevant knowledge, above all hidden knowledge, which will be made available to employees if necessary.

CONCLUSIONS

So far, the improvement of exploitation has been focused on quantitative data, constituting objective data on the technical means, events that occur in its operation, processes and its operation and maintenance systems. The truth about exploitation can be determined additionally on the basis of subjective data about this exploitation. An opportunity in this respect is the technology assessment, which complements technical, economic and environmental data with data, which allows to determine

whether the user accepts whether or not the technical mean and its operation. The result of research on this issue is the indicator presented in the article. It gives the opportunity to improve the technical mean and processes as well as the systems of its exploitation, through its use at various stages in the process of satisfying the needs, i.e. design, construction, manufacture and exploitation.

Therefore, it is advisable to continue work on the research areas indicated in the article and the possibilities of using the developed indicator. The effect of this work should be the methodology of shaping the technical life cycle, based on the mentioned indicator as a method of social assessment of technology.

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Abstract. The article addresses the problem of population aging and the related problem of using and maintenance of technical means by the older persons. Such persons, as participants of the exploitation process, experience various problems. Therefore, the challenge is to adapt technical means to the needs of older people. The response of engineers to this challenge may be the technology assessment, which assumes the adoption of various achievements in the field of philosophy, sociology, psychology or other social sciences as tools for their work. The proposal for such a solution is presented in the article and it is an indicator that allows you to draw conclusions about the real needs of older people. The effect of calculations with its use is the Wi characterization in the function of the human age. This characteristic complements the characteristics obtained on the basis of empirical data about the behavior of a technical mean. The article also presents the possibilities of using the discussed indicator. These include: improving the quality of life of users of technical means at various ages through rational management of company resources, improving the quality of life of users through user-centered design, exclusion from exploitation by the elderly technical means/their components based on social technology assessment, analysis and optimization of needs people of different ages, modeling the movement of older people, elimination of social exclusion of older people, improving the quality of life of people of all ages through appropriate knowledge management.

Keywords: technology assessment, older persons, exploitation, designing, management