Possible expanding of the metrology object on the example of industrial enterprises management assessment

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Abstract. Metrology has given the necessary driving force to the second industrial revolution. However, the widespread use of business solutions based on information technologies allows to talk about reducing mass production in favor of individual production. Accordingly, the consequences for metrology are the need to expand the object. The definition and subject of metrology do not contradict this transformation. The axioms of fundamental metrology can be slightly changed on the example of the assessment of industrial enterprises management for the possibility of expanding the metrology object.

One cannot but agree that the current economic situation in our country dictates the search for ways to increasing the competitiveness of products [1]. In the framework of this idea, the authors of believe that the problem of high product quality is the most important [2, 3]. High product quality is achieved, among other things, due to metrological aspects of industrial production management. On the other hand, there is a point of view on the new paradigm of metrological support that the idea of universal and permanent coverage of all the employed population, all types of people’s activities, all organizational, managerial structures, up to the individual level, should be formulated [4].

In our opinion, the difference in views on metrology processes is related to the difference in views on social processes in society. To understand these two points of view, let's look at the history of metrology development. The rise of metrology as a science is associated with the industrial revolution, at the beginning of which measures and weights were standardized. An example is one of the first acts of the French revolution which attempted to replace a diverse set of dimensional units with a metric system and a new calendar [5].

Indeed, before the industrial revolution, time could be measured and compared with the phrase “while you read “Our Father”. Naturally, for different people reading Our Father, the time intervals between the beginning and the end of the prayer will be different. Such units of time, if used in production, could not but affect the quality of products and other aspects of production. To measure space, even more vague concepts were used: “day of riding”, “hour of walking”, “half an hour of a gallop” [5].

The industrial revolution, changing the nature of labor activity, was accompanied by an increase in the size of the market, the volume of trade increased many times, it was necessary to transport more cargo faster than before. The most important thing for producers of goods and for the growing social class that engaged in trade was the accuracy of navigation. Governments offered huge rewards to anyone who could come up with new ways to route merchant ships. Special attention was paid to the development of an accurate standard measurement system and the creation of a new calendar by figures of the French revolution. They considered this task so important that it was considered among the first issues by the National Convention, the highest body of the First French Republic.
So, the industrial revolution led to the creation of mass production. In turn, the industrial revolution was made possible by the discovery and widespread use of new types of energy in industry, such as steam energy and/or electricity. With the opening and beginning of the use of information technologies in business, individual production became profitable [6].

The consumer chooses the cheapest product in terms of mass production (within the framework of price competition), so the manufacturer tries to reduce production costs, which is not possible without metrology. However, the use of information technologies allows you to individualize products or services through the widespread introduction of self-service and other ingenious and non-standard ways of applying new technologies. Even now, it can be argued that the number of employees performing the same operations is not growing, instead, new professions are emerging, which cannot but lead to a greater stratification of workers in terms of wages, and therefore the market for goods is also changing.

It would seem that people's needs are the same, but consumers' requirements for a product or service may be radically different. The times when the choice of the required product was made only due to its specific material or psychological function are now a thing of the past. Now the lifestyle of consumers begins to dominate the choice of products or services [7]. It is clear that the lifestyle can change more often than the basic needs of consumers. In these conditions, production requires very different standards. Consumer preferences, for example, may dictate the environmental friendliness of the products they are going to buy. Similar questions are considered in many publications [8,9,10].

The question remains whether there is an appropriate industry standard. We believe that these are the problems that modern Metrology will face in the near future, namely the need to standardize what was not even possible to standardize before. Although there is still time to prepare, mass production has not surrendered to individual production and most likely it will not completely disappear, but there are two ways for metrology. The first way is to stay in the past with mass production and be present only in a limited segment of production. The second way is to adapt to new conditions and take all possible measures to develop standards from various areas of human activity. The first way is the way of extinction, the second way is the way of the heyday of the science of metrology. The choice is obvious.

We highlight the methodological changes in metrology so that it can meet the challenges of future changes. According to the definition of the science of metrology this is the science of measurements, methods and means of ensuring their unity and ways to achieve accuracy commensurate with the accuracy of reproducing and storing physical quantities by measures [11]. We believe that this definition will be appropriate when expanding the object from physical quantities to the results of management of industrial enterprises. The subject of the methodology on closer examination also corresponds to the proposed extension. Indeed, the subject of metrology is the extraction of quantitative information about the features and properties of objects and processes with a given measurement quality (accuracy, correctness, convergence, reproducibility, stability and efficiency)" [11]. It is obvious that the management process of an industrial enterprise may well be the subject of metrology. In metrology, there are a number of axioms that impose certain restrictions on the process of making measurements and interpreting its results. We present in table 1 the existing and proposed by the author definitions of the axiom of fundamental metrology.

| №  | Classic definition                                      | Definition expanding the object (proposed by the authors)                                      |
|----|--------------------------------------------------------|---------------------------------------------------------------------------------------------|
| 1  | Any measurement without a priori information is impossible | Any measurement without a priori information related to the relevant type of work is impossible |
| 2  | Any measurement is a comparison                         | Any measurement is a comparison in accordance with the developed methodology for the corresponding type of work |
| 3  | Any measurement result without approximating (completing) the value is a random value | Any measurement result without approximating (completing) the value is a random value |

Table 1. The axiom of fundamental metrology
Some researchers [11] believe that it is necessary to establish an axiom about the physical nature of the compared quantities, but we believe that this proposal excludes further qualitative development of metrology as a science and do not agree with this approach. The first axiom in Table 1 has been changed due to the need to define a priori information for the proposed extension of the metrology object. It should be noted that classifying and accurately determining the type of management of industrial enterprises is a difficult task. At the moment, there are four approaches to management: functional, process, system, and situational [12]. In practice, a management model with a functional approach is widely used, which is characterized by the presence of an organizational structure, the subordination of employees to the chief within certain job responsibilities [13]. The example of the Morning Star Company refutes such a model and a need of any organizational structure and bosses. The company's occupation is tomato processing, which accounts for 25-30% of all tomatoes processed in the United States. Now this company owns three large plants for processing agricultural products. This is a large-scale production organization with no managers and no organizational structure. It works using two basic principles: "A person cannot be violent towards another person" and "People should be involved in the work". Each of the employees offers how they can help in achieving the strategic goal of the organization and what resources they need for this. So, all the employees of this company are not only administrative managers, but they are also production managers. It's just that there are no managers in this company. Thus, employees of such a company must have several specialties (Management as major qualification is required). It is a difficult task to employ such specialists in the labor market, however, the example of the Morning Star Company indicates a solution to the problem. So, there are classic management organizations, there is an organization without managers and management in the usual sense, so there are organizations with clear instructions on what and how functions should be performed by managers [14]. From our point of view, it is the latter type of organization that should be included in the range of tasks solved by metrology in the future.

Traditionally, the assessment of the efficiency and performance of industrial enterprises management corresponds with the assessment of management system and is measured in the amount of profit. In such conditions, there are no problems with measuring the profit amount, but this criterion does not characterize the efforts of the manager, his qualifications, competence, professional level, etc. This criterion does not also take into account the features of management approach. That is, one can measure the profit of an industrial enterprise, but one can't measure how well managers have worked. But it's not important with this approach. Accordingly, then there were key performance indicators (KPI) as a measure of achieving the goals set for an industrial enterprise. And since the amount of profit can be one of the goals set, the approach with key performance indicators includes the approach with determining the amount of profit. As well known, Peter Drucker proposed the "goal management" approach and R. Kaplan and D. Norton developed it into a system of balanced scorecard. In practice, the system of balanced scorecard is widely used. But along with the positive aspects of using the system of balanced scorecard, there are also negative ones. For example, the system is difficult to implement and requires the involvement of consultants and experts. This is an unnecessary expenditure of time, resources, and finances [15]. The market situation is currently changing quite quickly and, in the event of such a change, the system of balanced scorecard will require adaptation to the changed external or internal environment of the industrial enterprise. Thus, a simpler operating system is required to measure management results.

It should be noted that in addition to general management, we can talk about the management of production functions, which also does not simplify the problem we have highlighted. For example, management in the field of human recourse. The first to standardize activities in this field of professional activity were specialists from the United States. All the HR officers were united into the Society for Human Resources Management (SHRM). Based on their combined opinion, the Certification Human Resources Institute (SHRI) was established, which has developed an appropriate standard. Based on this standard, in a special test center, the HR officers who want to pass a certification test are examined and can be assigned one of three certificate stages:
• Professional in Human Resources (PHR);
• Senior Professional in Human Resources (SPHR);
• Global Professional in Human Resources (GPHR).

But such an institution and a professional standard is not the only one. But the mentioned society is one of the largest, it includes about 300 thousand HR officers of the world. In our country, there is a National Union of HR specialists, which developed a standard of professional activity in 2007 and since then up to 2014, about 500 persons were certified. These standards refer to requirements for staff, but there is a standard with requirements for the institution. In the UK, the "Investors in People" standard was adopted. The purpose of its development was the problem of increasing labor productivity. It includes actions for training staff, creating and developing a business strategy, developing and applying a human resource management strategy, leadership and management strategy. The contribution of employees to the achievement of the organization's strategic goals is evaluated and key performance indicators of the organization are monitored. In 2014, more than 200 organizations used the "Investors in People" standard, often achieving impressive effectiveness. For example, the Russian branch of “TNT Express” increased the company's turnover by 40%, and the turnover rate decreased by half after the introduction of the standard [16].

Increasing labor productivity is possible when applying the appropriate standards to the activities of organizations, rather than to individual specialists. But the "Investors in People" standard does not allow to accurately measure a manager: it does not have a well-developed methodology for measuring the manager’s effectiveness, it is “blurred” and subjective, and requires improvement if it comes to using metrological measurements. Thus, the information given in this article as a priori shows that certain studies are required in order for the first axiom of fundamental metrology to be performed for measurements in the field of management evaluation of industrial enterprises.

The second axiom in table 1 has also been transformed taking into account the proposed by authors’ extension of the metrology object. As follows from the description of approaches to the definition of a priori information, the problem is to offer a way of measuring the managers’ efforts to achieve the strategic goals of the organization. So, the essence of the authors’ proposal is that to identify the functions that are associated with the achievement of the company's strategy and to set criteria for their evaluation. We believe that some separate (or elementary) functions are usually not related to strategic goals, but the result of combining such functions may well influence strategic goals. We called this combination of functions as a complex function and apply three criteria for measuring functional performance: performance, economic and social efficiency [17]. An algorithm for forming a complex function of HR management was developed and the procedure for working with them by managers was determined [18]. So, to work with the complex functions there is a need of providing organizational change associated with various order processing functions. To work with the supporting functions, we propose a service center [19]. To work with the strategic functions, we propose a matrix organizational structure of the specialists of the enterprises at different levels of corporate management. This research could be applied as a basis for developing a measurement methodology for industrial enterprises management assessment.

The authors considered and justified the necessity and inevitability of expanding the object of metrology, clarified the basic concepts of the axioms of fundamental metrology, and presented the research of the main approaches for expanding the object of metrology on the example of assessing the industrial enterprises management.

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