Australian Journal of Science and Technology

ISSN Number (2208-6404)
Volume 6; Issue 1; March 2022

Original Article

The main indicators of the operational manufacturability of mining and transport equipment of open pits

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ABSTRACT

The efficiency of mining and transportation equipment is determined by the amount of work performed by the machine and the cost of its operation, which, in turn, is determined by the quality of the machine – a set of properties provided by standards and regulations that determine the degree of its suitability for use for its intended purpose under certain conditions. Schemes of systematization of the main factors affecting the technological characteristics of mining machines and the main indicators of the quality of the workplace of equipment in open pits, as well as directions for improving the operational technological characteristics of mining machines.

Keywords: Appointments, conditions, economics and safety, indicators, manufacturability, mining equipment, operation, performance, systematization, transport machines

Submitted: 04-12-2021**, Accepted:** 10-01-2022**, Published:** 30-03-2022

INTRODUCTION

The development strategy of large mining enterprises in Uzbekistan is aimed at further improving the quality and competitiveness of products and a gradual increase in production, in this regard, enterprises are actively updating and modernizing the fleet of mining transport equipment, the purchase of new mining transport equipment of high unit capacity.[1] With the help of the chosen technology of open-cut mining provides a combination in time and space: The processes of opening the pit field and working horizons, mining excavations, overburden and mining operations; processes of preparing rocks for excavation; excavation and loading; transportation of rock mass; product quality management; processes of organization; and planning of mining operations.[2]

PURPOSE OF WORK

The purpose of the study was establishing the main indicators of the quality of the workplace of the quarries, which involve substantiating the choice of means of mechanization.

DISCUSSION OF THE ISSUE

The main indicators of quality, characterizing the mining, and transport equipment pits can be divided into the following main groups: Performance indicators and purpose, reliability indicators, ergonomic indicators, aesthetic indicators, indicators of operational manufacturability, transportability indicators, indicators of standardization and unification, patent indicators, environmental indicators, and safety indicators.

The essence of one of the classifications of technological equipment proposed by Professor R. Yu. Poderni consists in the following, that the equipment used in quarries is divided into seven classes according to their functional purpose (i.e., according to the technological characteristics): Equipment for preparing rocks for excavation, mining-loading, mining-transport, transport, dump-forming, sorting and processing, and equipment for auxiliary works.[3] The equipment of each class is divided into groups, each of which includes types that differ in design. Each type of equipment has several standard sizes that coincide mainly in design, differing in productivity, size of working equipment, weight, etc.[4]

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The classification proposed by Professor Anistratov and Anistratov, laid signs that reflect the nature of the operation of the main equipment, the composition of the mining, and transport equipment. The advantage of the classification of Anistratov and Anistratov[5] is that it takes into account the continuous, discrete and mixed nature of the equipment, which reflects the relationship between functional machines.

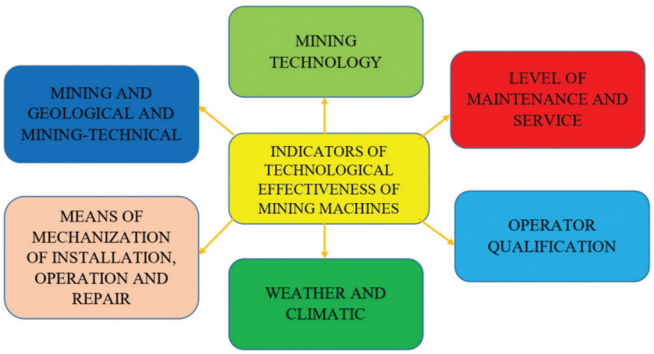

Figure 1: Scheme of systematization of the main factors affecting the technological performance of mining machines

SOLUTION OF THE PROBLEM

As a result of analysis of the works of leading scientists in the mining industry identified and systematized, the main factors affecting the indicators of manufacturability of mining machines [Figure 1].

As a result of the analysis of works of a number of researchers, we made systematization of the main indicators of quality, characterizing the working places of opencast mining and

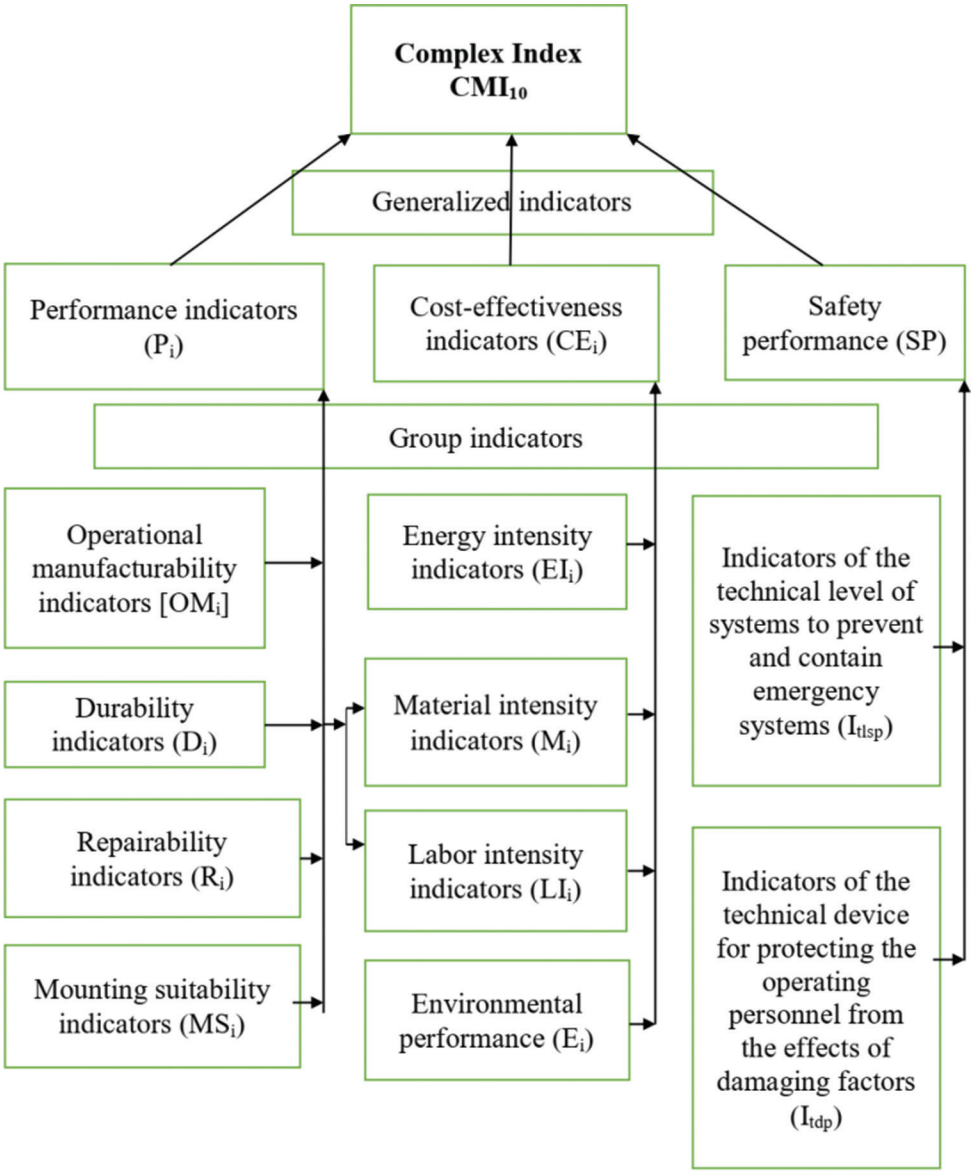

Figure 2: The main indicators of the quality of the workplace of the equipment in the quarries

Table 1: The main group indicators of the operational manufacturability of mining and transport equipment of open pits and parameters for assessing their

Properties and indicators	Evaluation of indicators
Operational performance	Dynamics of volumes (extracted, excavated, transported, and processed) of rock mass under specific mining, geological, climatic, and technological conditions for the periods under consideration: Month, year, before the first overhaul (m3, tons)
Operational manufacturability Bottomhole	Volume (withdrawn, excavated, transported, and recycled) in specific technological schemes of use per hour of productive work (m3/h, t/h)
Services	Time consumption for maintenance work to the extent specified in the manufacturer's operational documentation (h/m3, h/t)
Energy capacity	Specific (per unit volume of rock mass) power consumption by periods of performance assessment (kWh/m3, kWh/t)
Material capacity	Specific (per unit volume of rock mass) consumption of materials and spare parts, spent on maintenance and repair, by the term of operation evaluation of productivity ($/m3, $/t)
Labor intensity	Specific (per unit of rock mass volume) labor costs for management, maintenance and repair by the service life of the performance evaluation (man-hours/m3, man-hours/t)
Cost-effectiveness	Cost of (extracted, excavated, transported, and processed) rock mass under specific mining, geological, climatic, and technological conditions for the periods of productivity assessment ($/m3, $/t)
Longevity	Working time by volume (extracted, excavated, transported, and processed) of rock mass during productive work before the first overhaul (m3, tons)
Repairability	Total length of critical routes of network diagrams and total labor intensity of repair work for the period of the first repair cycle (current, medium, and first overhaul) (h, man-h)
Installability	The duration of the critical path of the network schedule, as well as the total labor intensity of the installation of equipment under operating conditions according to the technologies established by the factory installation documentation
Eco-friendliness	Specific (per unit of rock mass) costs to eliminate the consequences of environmentally harmful impact on the environment, including the disposal of our own environmentally harmful waste by periods of productivity assessment ($/m3, $/t)
Safety	Indicators of technical level of systems of prevention and localization of emergency situations Indicators of technical level of devices for protection of operating personnel from electric current, noise, vibration, mechanical factors, and other harmful effects

transport equipment and they can be divided into the following main groups: Generalized-indicators of efficiency and purpose, indicators of efficiency and safety indicators; group-indicators of reliability and durability, ergonomic indicators, aesthetic indicators, manufacturability and maintainability indicators in operation, and indicators of transportability [Figure 2].

In the field of manifestation of manufacturability of equipment design distinguish manufacturing and operational manufacturability. Production manufacturability is determined by the amount of time and money spent on design and technological preparation of production, technological processes, control, and testing.

Operational manufacturability of design of mining and transport equipment is determined by the amount of time and money spent on a reasonable choice and equipment processes, quality installation, use of the machine for its intended purpose, maintenance. and repair of the machine. Generalization of the results of research in the field of manufacturability of mining and transport equipment allows us to conclude that for mining and transport machines at all stages of their life cycle in open pits, the main indicators of manufacturability of their designs are productivity, utilization factor, availability factor, and total labor intensity, as well as the cost of installation, operation, and repair.

The established systematization[6] of the main group indicators of operational processability of mining and transport equipment of open pits and parameters for assessing them are given in Table 1.

Thus parameters of labor input and levels of manufacturability of structure on labor input are determinants of technological effectiveness of mining machine, and parameters of operational cost of work and levels of manufacturability of structure on cost-parameters of optimization, that is, parameters defining the most effective level of their

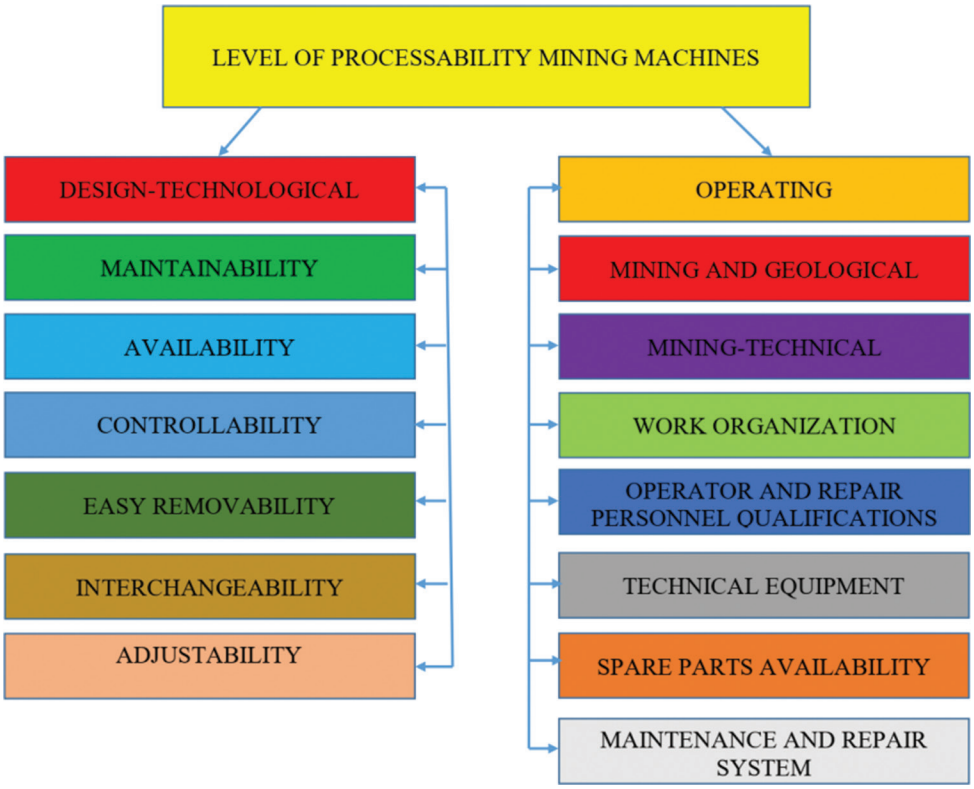

Figure 3: The main directions of increasing the level of operational manufacturability of mining machines

functional purpose. Under the change of conditions affecting the individual indicators of manufacturability, we should understand the change in technology and means of mechanization of installation, operation and repair of the machine, maintenance conditions, qualification of workers, changes in mining-geological, mining-technical, weather-climatic conditions, etc.

Machine performance depends on a number of factors that determine the operating conditions of mining and transport machines, which must be taken into account when creating them. In general, it is determined that the level of manufacturability of mining and transport equipment is influenced by two groups of interrelated structural and operational factors. The first group of factors includes availability, controllability, capacity, interchangeability, and controllability. The second group of factors includes organization of work and repair; qualification and number of maintenance and repair personnel; system of supplying spare parts and materials; mining and geological and climatic conditions; maintenance and repair of systems; technical equipment of works performed during maintenance and repair; and observance of rules and regimes of machines operation. All the above group indicators are defined by us, as the main directions of increasing the level of operational manufacturability of mining machines, which can be grouped into two large classes: Design-technological and operational [Figure 3].

GENERALIZATION AND DISCUSSION

The problem of manufacturability of structures can be solved only in combination with the problem of operation and reliability. Moreover, the solution of the latter is carried out in connection with the need to estimate the parameters of maintainability and reliability, as to determine the number of unscheduled repairs, it is necessary to have information about the number of failures. This approach allows to solve the following main tasks: Determine the composition of requirements for manufacturability; carry out a full assessment of manufacturability and operational efficiency; substantiate the need to improve manufacturability and operational efficiency; and develop measures to improve manufacturability and operational efficiency.

CONCLUSION

Thus, the operational manufacturability should correspond not only to the qualitative characteristics of the system structure and recovery strategy, but also ensure the efficiency and quality of operation of mining and transport equipment of the open pit.

Technical and economic decisions made in open development are considered as interrelated elements of a complex system and quality elements of the structure of production, will allow to establish rational parameters and modes of operation of jobs under given conditions.

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