

Conference Paper

Systems Approach When Substantiating Design Multifunctional Machine for the Maintenance of the Streets and Roads

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Abstract

The article describes a systematic approach to justifying the creation of civilian products at the enterprise of the military-industrial complex (MIC). The direction of development and possible problems in the creation of products are considered. The topic of maintaining the objects of the road network using specialized equipment is disclosed. The portrait of the consumer and his problems are determined. A general description of the created multi-functional small-sized power-armed machine for the maintenance of the road network is given. Created architecture - stakeholders, challenges and issues using systems engineering. The article is the basis for drawing up requirements for creating a system - a multifunctional small-sized power-armed machine.

Keywords: civilian products, systematic approach, consumer problems, multifunctional machine, stakeholder, maintenance of the road network

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1. Introduction

The solution of the strategic task set by the President - to increase to 2025 year to share of civil production up to 30 percent of total production volume, and to the 2030 year - up to 50 percent is facing many enterprises MIC [1]. A systematic approach to the development of promising areas and the creation of new products has an important role in achieving the goals.

To solve the strategic task, it is necessary to increase sales, which in turn leads to the expansion of the existing product line or the search and creation of new directions.

One of the directions in the development of civilian products is the production of machines for maintaining a streets and roads (hereinafter referred to as machines). This direction is promising in terms of increasing the market size and expanding the product line (the company's own research). An important factor is that the company has competencies in the design and manufacture of vacuum cleaning machines with a hopper volume of 1.5 to 2.0 m³.

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2. Results and Discussions

Market analysis shows that the machines manufactured in European countries are high-tech, as they have internal combustion engines, hydraulic and electric drives of motion systems and drive attachments, controlled by software.

Development of the domestic machinery is accompanied by the fact that the partially missing component base and part of the nodes will build themselves again by the enterprises themselves, or for technical task outside organizations. Also, the decrease in the share of imported components during development is explained by the need, subsequently, to obtain a certificate of Russian origin in the supply of machines.

The increase in the volume of the car market from year to year is ensured by the adoption of regulations, rules for landscaping and resolutions of the Heads of maintaining roads, sidewalks, courtyards, parks, sports facilities, etc. in good sanitary and technical condition.

The content of the road network facilities means the year-round implementation of the regulated work package [2-4]:

- sweeping the carriageway and sidewalks with vacuum garbage collection;
- cleaning of the carriageway along the tray with mechanized garbage collection;
- sweeping intersections;
- washing of the carriageway and sidewalks;
- mechanized loading and removal of dirt and garbage;
- ballot box cleaning;
- manual loading and garbage collection;
- sediment removal;
- sweeping and raking snow;
- processing of roads and sidewalks with deicing materials;
- snow throwing by snow blowers;
- removal of snow and ice.

The main consumers of vehicles for maintaining the road network are municipalities, road construction and cleaning companies.

When maintaining the objects of the road network, the consumer has the following problems:

- 1) Reduction of suspensions of harmful substances and dust in the air.



- 2) The permissible amount of pollution generated between the cycles of sweeping machines should not exceed an average of 50 g per 1 sq. m of coating area (depending on accepted standards).
- 3) Maintenance of objects of the road network during the off-season (transitional periods “autumn-winter”, “winter-spring”) by removing sediment, washing and sweeping the roadway, trays and sidewalks, as well as vacuum cleaning at temperatures below 3⁰ C.
- 4) Dust-free removal of residues of anti-icing materials from sidewalks and roads at an ambient temperature of -15⁰ C in the absence of snow.
- 5) Cleaning bins from garbage and washing them. Hand loading and garbage collection.
- 6) The work of sweepers with vacuum and mechanized waste collection without prior wetting.
- 7) Mileage sweepers to the place of unloading estimates and back.
- 8) Mileage sweepers to the place of refueling with water and back.
- 9) Cleaning of trays should be linked to the work schedule of sweepers. Sidewalks must first be removed to prevent re-contamination of the trays.
- 10) When cleaning sidewalks, manual cleaning is performed in the amount of 30% of the total area of sidewalks.
- 11) Removal of unauthorized advertising from lighting poles, traffic lights, pedestals, retaining walls, fences, etc. in hard to reach places.
- 12) When washing coatings, knocking out with a water jet an estimate of garbage on sidewalks and lawns.
- 13) Purification of garbage from the grids of the receiving wells of storm sewers.
- 14) The deadlines for the elimination of winter slippage and the end of snow removal for roads, as well as streets and roads of cities and other settlements, taking into account their transport and operational characteristics, should not exceed 4-6 hours from the moment of detection (depending on accepted standards).
- 15) Cleaning of sidewalks and footpaths from snow should be carried out after the snowfall or blizzard is completed within 1 to 3 hours depending on the traffic intensity of pedestrians (for 1 hour with a traffic intensity of over 250 people / h; for 3 hours with a traffic intensity of 100 people / h).
- 16) Throwing snow with auger blades in dense buildings.
- 17) Loading snow on board a truck.

18) Sprinkling of anti-icing materials on sidewalks, landing sites of stops of urban passenger transport, in parks, squares, yards and other pedestrian and landscaped areas.

19) Cleaning fallen leaves. Harvesting leaf clusters and dirt.

20) Downtime of vacuum cleaning machines in the off-season and in the winter at an ambient temperature below $+3^{\circ}\text{C}$.

21) Overall dimensions and maneuverability of cleaning equipment - large machines do not perform high-quality cleaning and interfere with pedestrians and vehicles. For example: A high-pressure apparatus with a water tank based on a Gazelle or Kamaz for washing fences creates obstacles to road traffic, the process of washing fences is performed by the operator supplying high-pressure water.

22) Unification of equipment fleet. It is necessary to maintain a fleet of various equipment (a vacuum sweeper based on Kamaz, a Kamaz dump truck, an MTZ tractor, a high-pressure apparatus with a water tank based on a Gazelle or Kamaz, an UAZ with a distributor of anti-icing materials) that performs highly specialized tasks. Accordingly, questions arise about downtime, cost of ownership and the payback of such equipment. For example: the MTZ-82 tractor performs snow removal well in winter using a blade or a roller brush, but it does not sprinkle roads and sidewalks with ice-resistant materials, and in summer it is not used at all as a sweeper.

To satisfy the consumer and solve all his problems, it is necessary to create a target system — multifunctional small-sized power-armed machine for maintaining a road network using the following interchangeable attachments:

- brush assembly with two tray brushes and dust suppression system;
- manipulator brush;
- vacuum equipment with a hopper for estimates of 1 m^3 complete with a manual garbage collector;
- a tank, with a volume of 1.3 m^3 , for irrigation with a frontal ramp and a pressure washer;
- distributor of anti-icing materials;
- plow jointed blade 1.5 m wide;
- roll brush 1.5m wide;
- auger rotor snow thrower with adjustable force, direction and distance of snow throwing;
- cleaver of compacted snow and ice;

- multifunctional boom.

Also as a result of analysis of the problems identified needs awn Development and centralized system for monitoring cleaning and any adaptation of existing systems to ensure efficient use of machinery park.

At the end of this stage of work, the architecture was compiled - stakeholders, challenges and issues. A fragment of architecture is shown in (Fig. 1).

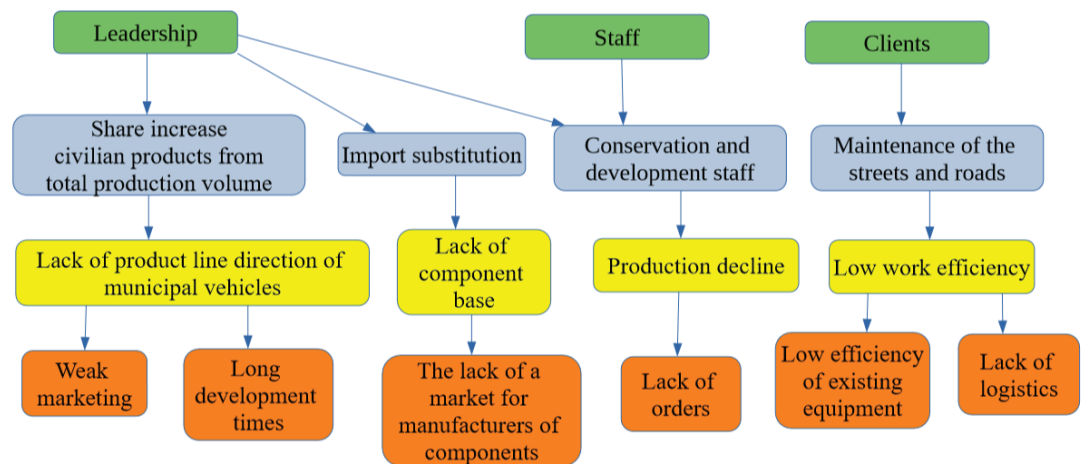


Figure 1: Fragment of architecture - stakeholders, challenges and issues

3. Conclusions

Currently, there are prerequisites for the creation of domestic technology in connection with the current political situation and sanctions. Consumers are obliged to purchase domestic products, and mechanisms for the return of the recycling fee after the sale of equipment have been developed for domestic manufacturers. The product in question is created at the defense industry enterprise in the framework of the program of diversification and development of civilian production.

The work carried out allows us to understand consumers problems, possible solutions, and serves as the basis for drawing up requirements for creating a system.

References

[1] The list of instructions of the President of Russia dated December 5, 2016 No. Pr-2346.



- [2] GOST R 50597-93 «Roads and streets. Requirements for the operational state acceptable under the conditions of ensuring road safety».
- [3] «Regulations for the maintenance of the road network in the winter and summer periods of 2019» Appendix No. 1 to Order No. 21/41/0139 of 04.10.2018. from the deputy head of the Administration of the city of Yekaterinburg.
- [4] «Technological regulations for the implementation of work on the cleaning of intra-quarter territories of St. Petersburg that are part of the common land» Appendix to the order of the Housing Committee of July 18, 2016 N 897-p.