VALUE ANALYSIS OF THE CHASSIS TECHNOLOGY OF THE ROAD ROLLER

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INTRODUCTION

Manufacturers of machinery parts have been getting into a difficult predicament. They must produce parts and sub-units of excellent quality at a competitive price. Due to the increased competition, the customer can easily find another manufacturer if their expectations are not met. It seems that the application of traditional methods only partially assists in the realization of these goals. At the same time, road-building, road maintenance, and road works became important tasks that all countries must face. Road transportation plays an important role in the domestic and international logistical systems. The management of the company we have examined decided to try out the method of Value Analysis. According to the domestic and foreign literature sources, the company learned, that the application of this method facilitates the achievement of significant economic results. The company management chose the Value Analysis of the chassis technology of the road roller.

(Nádasdi, Ferenc – Ladi, Ákos(2014); Nádasdi, F. – Keszi – Szeremlei, A. – Vámosi, K. (2018):

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The main features of the chassis technology of the road roller

The chassis of the road roller is manufactured by a machinery engineering company. The customer is the market leader of this particular product. The distributor guarantees excellent quality, high performance, economic operation and longevity of the end-product (road roller). The customer has been delegating these qualities to the spare parts, and sub-unit manufacturer companies as well. The company examined by us considers this customer company as one of their most important partners. In order to keep their supplier status, the company management has decided to apply Value Analysis.

Goal of the project

Due to stricter expectations towards the product, product development based on consumer demands, the increased competitiveness and the ever-accelerating changes in the technology, the constant analysis of the technical and economic parameters of the technological processes gained importance.

Main goal: To increase the market position of the product
Sub-goals:

- more sufficient response to the customer and manufacturer demands
- elimination of quality issues deriving from the manufacturing process
- reducing operational costs
- reducing operational time
- reducing the material and energy consumption of the technology
- increasing the utilization of the capacities of the main manufacturing process and of the equipment
- Reducing the amount of heavy physical work
- compliance with health, accident and environmental protection requirements.

Subject of the project

The subject of our project is the optimization of the chassis technology of the road roller. The analysis of the technological process extends from the semi-finished raw material to the painted, ready for assembly state. The product takes its final form after applying both manual labor and modern technologies.

The technology chain is divided into the following phases:

- Parts preparation phase:
  - Sheet cutting subsection
  - Edge bending subsection
  - Cutting subsection
- Assembly phase
- Welding phase
- Surface finishing phase
- Packaging phase

The drawings of the parts consisting of 8, 20 and 25-mm thick plates are designed with the help of a computer program in accordance with the overall dimensions of the plate. The high-performance CNC laser cutting machine and the flame cutting machine cut the orthographic projections of the parts. The cut parts enter the surface treatment equipment. During this process, the rust, the metal residue and the burrs, which are left over after rolling and thermal cutting, are removed from the surface of the parts by using a special device that shoots out tiny metallic particles and buffs the surface. Following the surface treatment process, the parts manufacturing department receives the product and based on the drawings given by the customer, the parts are being further processed. The following steps include universal manufacturing technologies such as cutting, which consists of drilling and surfacing, computer controlled edge bending and cutting, forming. Following this phase, the assemblers receive the parts. Utilizing special equipment, the the product is assembled. After finishing the welding, the product gets to the painting preparation line, where welding spatter is removed by hand tools and deformations are corrected. In the painting machine, first, a primer coating is sprayed on by a solvent dyeing process, which on average must be 60µm. Thereafter, the product receives its final color, which on average, together with the primer must be 120 µm. Once the product is finished, the Quality Control Department inspects whether the manufacturer had carried out and completed all steps in accordance with the original documentation. At the end of the technological chain are the packaging and truck loading of the product. Storage and assembly following transportation are being conducted by the customer company. (Nádasdi, Ferenc – Ladi, Ákos (2014), (Nádasdi, F. – Keszi – Szeremlei, A. – Vámosi, K. (2018); (Stewart, R. B. 2005).

Information about the technological process

Table 1 shows the main operations and equipment of the road roller chassis.

Table 1. The main operations and equipment of the road roller chassis (exception)

Manufacture of road roller chassis				
Parts preparation phase	Assembly phase	Welding phase	Surface finishing phase	Packaging phase
Equipment	**Equipment**	**Equipment**	**Equipment**	**Equipment**
5 ton electric forklift truck	5 ton electric forklift truck	5 ton electric forklift truck	5 ton electric forklift truck	5 ton electric forklift truck
10 ton electric wire rope hoist	6.3 ton jib crane	6.3 ton electric wire rope hoist	6.3 ton electric wire rope hoist	10 ton electric wire rope hoist
Laser cutter	Assembly machine	Welding machine	Conveyor	Impact wrench
Flame cutter	Welding machine	Pre-springing machine	Grinder	8 ton diesel forklift
300 ton bending machine	Impact wrench	Release agent	Spray gun	
Universal turn/mill machine	Grinder	Rotary device	Flashlight	
Radial drill machine	Certified tape measure		Certified tape measure	
Machining center				
Operations	**Operations**	**Operations**	**Operations**	**Operations**
M1 Delivery to machine	M9 Delivery to machine	M16 Delivery to machine	M22 Delivery to machine	M29 Delivery to machine
M2 Loading the machine	M10 Loading the device	M17 Loading the turning machine	M23 Movement	M30 Loading crate pallets
M3 Plate cutting	M11 Assembly	M18 Welding	M24 Suspension	M31 Scew tightening
M4 Plate cutting	M12 Welding	M19 Pre-setting and pre-springing	M25 Surface grinding	M32 Loading truck
M5 Cold shaping	M13 Screw tightening	M20 Correcting welding errors	M26 Spraying paint	
M6 Dimensioning	M14 Surface grinding	M21 Positioning	M27 Checking the operation	
M7 Separating material	M15 Checking dimensions and sizes		M28 Checking dimensions and sizes	
M8 Dimensioning				

Source: (Nádasdi, Ferenc – Ladi, Ákos (2014); (Nádasdi, F. – Keszi – Szeremlei, Andrea – Vámosi, Kornélia (2018)

DEMAND ANALYSIS

The team members decided that as the first step of the process, the product itself should be analyzed. This process can ensure that the product does not have unnecessary functions and expenses. According to our experience, it is necessary to coordinate technological changes with product development and product design.

Customer demands towards the chassis of the road roller are the following:

I1 It should be usable in the compacting technique
I2 It should be able to be built in during assembly
I3 It should agree with engineering tolerances
I4 Surface treatment quality should comply with regulations
I5 Thickness of sprayed paint must comply with regulations
I6 Penetration depth and size of welded seams must comply with regulations
I7 Corrosion protection of raw surfaces after painting must comply with regulations
I8 Surfaces must remain scratch-free and undamaged after transportation
I9 Painting must be weather-proof
I10 The price should contain the target profit
I11 It must aesthetically comply with the appearance of the final product

The second step of the demand analysis is the analysis of the expectations and demands towards manufacturing itself. How does manufacturing have to be improved in order for the expectations towards the product to be fully met? The main element of manufacturing is the technology; therefore, our analysis covers this area.

Demands towards the technological process are the following:

I1 It must minimize raw material use
I2 Precision of parts production must comply with regulations
I3 It must secure assembly precision and accuracy
I4 It must secure parts supply
I5 It should eliminate any welding deformities
I6 Quality must be ascertainable
I7 Use of minor materials must be ascertainable
I8 Amounts of time spent must be ascertainable
I9 Manufacturing must be finished by a specified time
I10 The readiness stage of the product must be traceable
I11 It must comply with environmental protection regulations
(Bolton, James D. - Nayak, Bijay K. (2004), (Bytheway, Charles W. (2007); (Nádasdi, F. – Keszi – Szeremlei, A. – Vámosi, K. (2018)

Function analysis

As a first step, we would like to define the functions of the product. Secondly, we will define the functions of the technology.

Functions of the road roller chassis

F0 Enables further utilization

F1 Secures assembly
    F11 Secures precision of engineering dimensions

F12 Complies with drawing specifications

F2 Secures supply of the function

F21 Secures precision of engineering dimensions

F22 Should be resistant to loads

F3 Enables posterior repairment

F31 Enables assembly

F4 Complies with durability requirements

F41 Resists mechanical impacts

F42 Resists corrosive effects

F43 Resists atmospheric stresses

F5 Complies with life protection requirements

F51 Resists bigger collisions

F6 Enables cleaning

F7 Complies with aesthetic requirements

(Clancy, D. F. - Dennis L. M. (2004), (Kaufman, J. J. - Woodhead, R. (2006); (Nádasdi, F. – Keszi – Szeremlei, A. – Vámosi, K. (2018)

Figure 1 shows the functions of the technology

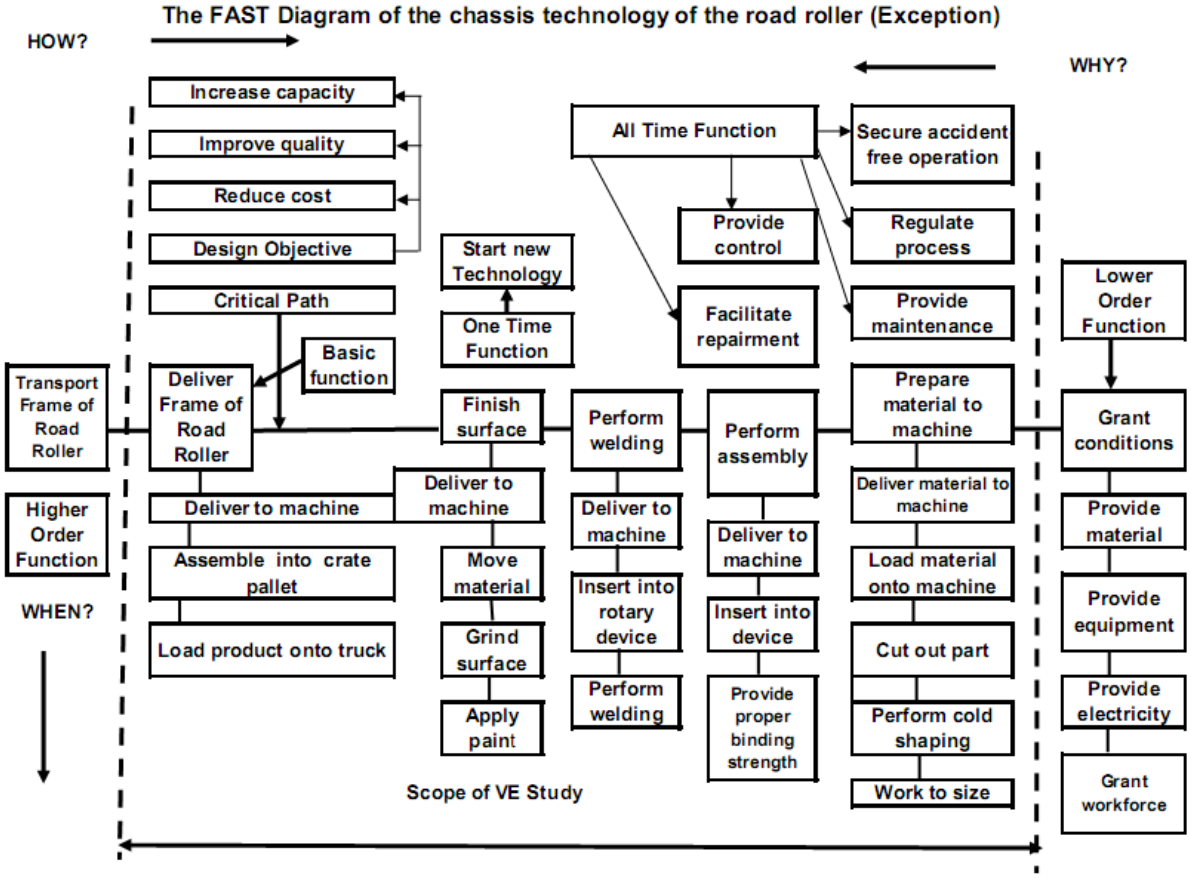

Figure 1 shows the functions of the technology.
Source: (Nádasdi, F. – Keszi – Szeremlei, Andrea – Vámosi, Kornélia (2018)

During the review of the technology, the method of Value Analysis has been utilized. Defining the functions and the function costs made the development of the technology possible. One of the important results of the Value Analysis performed was that the team had explored opportunities which the management had not thought of previously.

The parameter-depth analysis of the technology functions can be seen in Table 2.

Table 2. Technological functions, parameters, their values and the matrix of the current equipment. (Exception)

Functions	Parameters	Value	Equipment
Prepare material	Plate weight	Max. 10 tons	Electric wire rope hoist
	Plate's external dimensions	Comply with the regulations	
	Speed	Max. 10 m/min	
Load machine	Plate weight	Max. 10 tons	Electric wire rope hoist
	Plate's external dimensions	Comply with the regulations	
	Speed	Max. 10 m/min	
Secure dimensions	Plate thickness	Max. 20 mm	Laser cutter machine
	Cutting speed	0.9 – 3.3 m/min	
Insert into rotary device	Product weight Product dimensions	Max. 6.3 tons 1.5 m x 1.5 m	Jib crane
Create binding strength	Magnitude of current Down feed rate Magnitude of voltage	100 – 350 Ampere 2 – 28 m/min 18 – 41 Volt	Arc-welding machine (consumable electrode)
Load crate pallets	Air pressure Product weight Product dimensions	8 Bar Max. 10 tons 1.5 m x 1.5 m	Impact wrench Electric wire rope hoist
Load product onto truck	Product weight Product dimensions	Max. 5 tons 1.5 m x 1.5 m	Electric forklift

Source: (Nádasdi, Ferenc – Ladi, Ákos (2014), developed further by the authors. (Nádasdi, F. – Keszi – Szeremlei, A. – Vámosi, K. (2018).

Defining weak points

The "Cut out parts" function belongs to the cost-critical points because of the ineffective use of the hot-rolled raw material generating large amounts of waste during the process. Presently, only a 64% utilization of the material can be achieved.

Another costly operation is the currently limited number of products being loaded onto one truck. The efficiency of the current transportation is low. Existing transportation does not reach 50% of the potential.

The "Perform welding" function also belongs to the cost-critical points. At the present, the road roller chassis are manually welded. Robotic welding is an available technology. According to experience, robotic welding is generally more precise than manual welding.

From the point of view of product quality, the "Apply paint" function has created a critical present situation which only partially satisfies the quality expectations of the customer. Inadequate surface finishing has already wasted millions of HUF for the company.

The "Perform cold shaping" is another function-critical point, because the shaping and design of the available edge bending tools do not allow perfect angular accuracy in case of every single bending process. This results in unnecessary downtime during the following assembly of the parts.

SUGGESTIONS

The team has developed many versions in the field of technology development. The goal is to improve quality and reduce costs as much as possible. The company management considers it a strategic goal to keep its supplier status. Competition has been incredibly strong and company management thinks it is of crucial importance to improve the current situation.

As an example, we would like to present the following suggestions which we believe would improve the company if implemented.

<table>
<tr><td colspan="2">Number of idea # 1</td><td colspan="2">What does the solution pertain to?
Improvement of technological process</td></tr>
<tr><td colspan="2">Which function is involved?
Transport Frame of Road Roller</td><td colspan="2"></td></tr>
<tr><td colspan="4">Description of idea: Optimizing (increasing) the number of products transported in one truck, aligned with the maximum permissible load of the truck.</td></tr>
<tr><td>Advantage:
More products in one transport</td><td>HUF/pair:
31,000 HUF</td><td>Disadvantage:
Usage of specialized crate pallet</td><td>HUF/pair:
8,000 HUF</td></tr>
<tr><td>Total:</td><td>31,000 HUF</td><td>Total:</td><td>8,000 HUF</td></tr>
<tr><td colspan="2">Opinion:
Usable afterward: X
Not usable afterward:</td><td colspan="2">Savings:
31,000 HUF/pair</td></tr>
<tr><td colspan="4">Note:
Annual saving: 3.0 million HUF
Requirement: specially designed and manufactured crate pallets
Note: 1 USD ~ 270 HUF (2018-10-16; OTP Bank)</td></tr>
</table>

Expected results

The following results can be reached by implementing new technology development: the company can achieve the improvement of the product quality, full compliance with customer and manufacturer demands, capacity growth, cost reduction and the increased satisfaction of the manufacturer of the final products.

SUMMARY

The application of Value Analysis in machinery engineering assisted in the formulation of several feasible suggestions, about which the company experts have not thought of before. The implementation of the suggestions may improve the company's market position. In Hungary and in the international market there are several companies that have the ability to displace the company from the market. Therefore, it was important for the company to apply Value Analysis and implement the suggested results. The leaders of the company have chosen several of the suggested technological solutions that the company resources allowed. (Miles, L.D. 1973), (Sato, Y. - Kaufman, J. J. 2005); Nádasdi, F. – Keszi – Szeremlei, A. – Vámosi, K. (2018).

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