DETERMINATION OF THE TECHNOLOGY PLACE IN THE METAL COMPANY ON THE BASIS OF THE TOYOTA’S MANAGEMENT PRINCIPLES

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Abstract
The research questionnaire was conducted in a company, which produces products for the construction – wire, nails. Respondents were asked to rank the factors that describe Toyota’s management principles resulting from the BOST questionnaire. From the analysis of factors set it results that issue of technology is content of Principle 1 (technology development), Principle 2 (technology reliability) and Principle 14 (technology portfolio). So, technology is an issue which occurs at the strategic and operational level. It also contributes to the improvement and development. The results show a high position of factor concerning technology in obtained importance series for any of the analyzed Toyota’s principles. The influence of the respondents characteristics (gender, education, age, work experience, mobility, mode of employment) on the evaluations structure was presented.

Keywords: Technology, wire, nails, BOST questionnaire, Toyota’s management principles

1. INTRODUCTION
Technology as a method [7] for the preparation and process of manufacture or processing of raw materials, semi-finished products and products respectively used in the production is the main factor that affects the competitive position of the company. For these reasons, the operation of every business to improve health and technology are an important part of the overall strategy of the company. The most important projects in this area include acquiring the necessary technology from the outside by purchases of machinery and technological equipment, purchases of licenses for products and related technologies, procurement, development and purchase of specialized manufacturers, needed technology (science and research and development, design, universities and others.), to develop on our own new technology needed, or together with other units.

2. THE CHARACTERISTICS OF THE FOCUS OF THE STUDY
The focus of the study is on the company that operates in steel sector, with its headquarters in Łódź Voivodeship. The company manufactures wire and wire products. The facilities has been extended for forty years and increased its range of products while building new departments e.g. acid processing department, wire department and nail department. A barbed wire department and construction department were also created. The main mission of the plant is to manufacture high-quality nails and wire products according to current Polish standards and international standards, which helps the enterprise attract regular customers. High-scale manufacturing is ensured by extension and modernization of production halls. The facilities have been also equipped in modern machines and equipment manufactured by the renowned international companies.

The basic product manufactured by the plant is wire. There are several groups of wire. These include: bare wire, galvanized wire, copper-coated wire, welding wire, PVC-coated wire and wire for mechanical hammering. Each of the group listed is divided into the groups with higher level of detail, depending on the wire dimensions and the type of the material used. The plant also offers oval, square, square-and-twisted
and ribbed wire. Each wire must meet particular strength recommendations according to the current national and international standards, i.e. PN, DIN, BS, ASTM, FF. The packaging methods are also specified. The product can be wound into reels or circles. Another product manufactured by the plant is nails. The metallurgy department offers a wide range of nails. Nails are manufactured according to particular standards, which define the diameter within the range from 0.8 mm to 9.5 mm and length from 10 mm to 300 mm. It is also required that they meet the following standards: PN, DIN, BS, ASTM and FF. The nails are packed into boxes. They vary in their weight. The division into 0.5 kg, 1 kg, 2.5 kg, 5 kg, 10 kg, 20 kg, 25kg is used in the enterprise. The packaged product is stored in a dry place and far from the corrosion-generating materials.

3. RESEARCH METHODOLOGY

BOST questionnaire [1,2,3] was created by Prof. Stanislaw Borkowski, director in the Institute for Production Engineering in the Faculty of Management in the Częstochowa University of Technology and is based on the principles of Toyota manufacturing system [4]. It can be used both in the production and service-providing companies. The questionnaire is dedicated to both managers and employees and the questions correspond to the Toyota's principles and the Toyota house roof. The BOST questionnaire also contains the evaluation of the managers according to the Toyota's principles and the respondent's profile and specification of the enterprise's/institution's activities.

The BOST questionnaire is comprised of 12 sets of factors. The version for the employees contains a set of factors which determine the elements of the Toyota house roof and the principles 1, 2, 3, 4, 6, 7 and 14, whereas the version for the employers includes a set of factors that describe all the principles of management in Toyota and the elements of the Toyota house roof. The questionnaire contains a ranking of importance and the respondents evaluate the importance of each factor on a particular scale.

The BOST questionnaire was carried out in the company studied among the employees. The detailed analysis concerned 3 sets of factors. The first of them was denoted as the area E2, relates to the principle 1 of Toyota's management ("Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals") and the respondent evaluated, on a scale of 1 to 7, which of the factors (customer's good - DK, independence and responsibility of employees - SP, innovativeness of product - IP, technology development - RT, cooperation with partners -WK, care for the enterprise's culture - PR, trust in relationships with employees - ZP) they regarded as decisive in the concept of development in the enterprise studied.

The next set of factors (area E3) was connected with the principle 2 of Toyota management ("Create a continuous process flow to bring problems to the surface") and concerns the factors which, according to the respondents, are the most important to the production process. The employees chose from the following factors: continuous system of detecting problems - CP, stopping production after detection of the quality problem - PE, standard tasks, processes and documents -SZ, delegating authority - EU, using only reliable technologies - ST, using visual control - SW (on a scale of 1 to 6).

The last set of factors (area E8) which was analysed in detail was a set of factors which related to the Toyota's principle 14 ("Become a learning organization through relentless reflection (hansei) and continuous improvement (Kaizen).") and it included such factors as: the employment of workers - ZT, relations between employees and bosses - RE, motivation system - SM, documentation - DA, technology portfolio - PT, information flow - PN, quality - JK, cooperation with customers - WS, maintenance - UM, cooperation with suppliers and partners - WD. The employees in the enterprise studied focused on the above factors and responded using a scale of 1 to 10 to the question: Which area will produce best effects after its improvement?

An important element in BOST questionnaire is characterization of the respondents, denoted as area E12. Six personal data were recorded in the questionnaire (gender - MK, education level -WK, age - WI, working
experience - SC, mobility - MR, type of employment - TR) in order to determine the structure of human resources in the organizations studied.

4. **ANALYSIS OF THE RESULTS**

**Table 1** presents the respondents in the company studied (area E12 in the BOST questionnaire), which manufactures wire and nails, divided into:

- gender (MK) - 1 - Man, 2 - Woman,
- education level (WE) - 1 - primary, 2 - vocational, 3 - secondary, 4 - higher,
- age (WI) - 1 - to 30 years, 2 - 30 to 40 years, 3 - 40 to 50 years, 4 - 50 to 55 years, 5 - 55 to 60 years, 6 - 60 to 65 years, 7 - more than 65 years,
- working experience (SC) - 1 - to 5 years, 2 - 5 to 10 years, 3 - 10 to 15 years, 4 - 15 to 20 years, 5 - 20 to 25 years, 6 - 25 to 30 years, 7 - 30 - 35 years, 8 - 35 - 40 years,
- mobility (MZ) - current employment is: 1 - the first, 2 - second, 3 - third, 4 - fourth, 5 - fifth, 6 - further place of work,
- type of employment (TR) - 1 - in the standard mode, 2 - on the basis of the transfer, 3 - due to better financial conditions.

**Tab. 1** Features of respondents. Number characteristic. It concerns company that operates in steel sector

<table>
<thead>
<tr>
<th>Symbol</th>
<th>MK</th>
<th>WE</th>
<th>WI</th>
<th>SC</th>
<th>MR</th>
<th>TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21</td>
<td>6</td>
<td>6</td>
<td>9</td>
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<tr>
<td>2</td>
<td>9</td>
<td>14</td>
<td>10</td>
<td>8</td>
<td>10</td>
<td>12</td>
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<td>3</td>
<td>8</td>
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<td>4</td>
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<td>0</td>
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<td>7</td>
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<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
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</tr>
</tbody>
</table>

As results from **Table 1** (column MK - gender), the men dominate the company studied. They represent 70% of the respondents (21 people). The most of the employees among the respondents are those with vocational education (14 people), which is 47% of the respondents and those with secondary education (8 people). Considering the age (WI) of the employees, the respondents are mostly those at the age under 50 years (24 people), of whom the biggest group are employees aged from 30 to 40 (10 people). Working experience (SC) of the respondents was from 5 to 15 years and for as many as 24 employees this was the first or the second job (MR) in their careers. The most of the employees studied were given employment in the standard mode (14 people) or they were transferred (12 people).

The common element that connected the 3 areas listed was the problem of technology. It is the element of the set of factors in the area E2 (technology development - RT), area E3 (using reliable technologies only - ST) and a set of factors from area E8 (technology portfolio - PT).

**Figure 1** presents histograms with the structure of importance of the factors in the area E2.
Figure 1 shows that the factor which was evaluated as the highest in importance is the factor concerning the development of technology (RT). This factor was evaluated by 50% of the respondents with the scores 6 and 7, of which 30% are scores 7. The factor of the customer's good (DK) was also evaluated very high since it was given 36.7% of the scores 6 and 7. The factors of the area E2 which were given the lowest scores included the care for the enterprise's culture (PR). 60% of the respondents assigned the score 1 to this factor.

Figure 2 presents pie charts with the structure of evaluation of the importance of the factors in the area E3 [6].

Figure 1 Principle 1. Histograms - evaluation structure of the factors' importance for E2 area: a) DK, b) IP, c) WK, d) ZP, e) SP, f) RT, g) PR. It concerns company that operates in steel sector.

Figure 2 Principle 2. Pie charts - evaluation structure of the factors' importance for E3 area: a) CP, b) PE, c) SZ, d) EU, e) ST, f) SW. It concerns company that operates in steel sector.
As results from the charts presented in Figure 2 the factor which was evaluated the highest in the set of factors in the area E3 was the factor concerning using reliable technologies only (ST). To 46.7% of the respondents, this factor is very important and the most important (scores 6 and 7) in the manufacturing process. The factor of stopping production after detection of a quality problem (PE), connected with Jidoka concept, was also evaluated very high. 43.4% of the respondents gave this factor the scores 5 and 6. The respondents regarded the factor connected with delegating authority (EU) as the least important factor to the manufacturing process - over 50% of the respondents evaluated it as 1.

The places recorded for the last of the analysed areas (E8) [5] in the ranking of importance in the company studied are presented in Table 2.

**Tab. 2 Principle 14. The places of factor in E8 area in the importance series for individual evaluations.**

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>The factor’s place in the importance series</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DA RE WD ZT PN UM WS PT JK SM</td>
</tr>
<tr>
<td>2</td>
<td>PN WD DA PT RE WS SM ZT JK UM</td>
</tr>
<tr>
<td>3</td>
<td>WS PN DA WD RE ZT JK PT SM UM</td>
</tr>
<tr>
<td>4</td>
<td>RE WS DA SM UM ZT PN PT WD JK</td>
</tr>
<tr>
<td>5</td>
<td>SM WD WS DA PT RE JK UM PN ZT</td>
</tr>
<tr>
<td>6</td>
<td>UM PT PN RE SM DA JK WD ZT WS</td>
</tr>
<tr>
<td>7</td>
<td>ZT JK SM PT UM WS PN WD DA RE</td>
</tr>
<tr>
<td>8</td>
<td>JK ZT PT SM UM DA RE WD WS PN</td>
</tr>
<tr>
<td>9</td>
<td>PT UM JK SM RE PN WS ZT DA WD</td>
</tr>
<tr>
<td>10</td>
<td>UM SM JK RE DA WD PT WS PN ZT</td>
</tr>
</tbody>
</table>

The data in Table 2 show that the factor of maintenance of machines (UM) was on the first place in the ranking of importance for the score 10, on the second for the score 9; The factor of the quality (JK): on the first place in the ranking of importance for the score 8, the second for the score 7 and the third place for the scores 9 and 10. This means that this factor was evaluated very high and it might generate the biggest effects after its improvement. The factor of technology portfolio (PT) was also evaluated very high. Table 2 shows that this factor took the first place in the ranking of importance for the score 9 and the third for the score 8, which demonstrates that it is a very important area which might result in biggest effects after its improvement. The factors which were evaluated by the respondents as those which might the smallest effects after their improvement are the factors connected with documentation (DA) - first place in the ranking of importance for the score 1 and the third place in the ranking of importance for the scores 2, 3 and 4; factor of the information flow (PN) - the first place in the ranking of the importance for the score 2 and the second place in the ranking for the score 3; and the factor of cooperation with suppliers and partners (WD) - 3rd place in the ranking for the score 1 and the second place for the score 2.

5. **SUMMARY**

The most of the respondents who filled in the BOST questionnaire in the enterprise studied were men with vocational and secondary education level, aged below 50, with working experience from 5 to 15 years, employed in normal mode or transferred, for whom the enterprise is the first or the second job in their careers. While answering to the questions contained in the BOST questionnaire, they pointed to the problem of technology as a very important issue, both in terms of development/reliability of technology and the area that is likely to produce the highest effects after its improvement. In the areas E2 and E3 it was technology...
which was given the most of the high scores (being assigned also the lower scores), whereas in the area E8 it was similarly high evaluated as the factor connected with maintenance of the machines (UM) and quality (JK). Figures 3a, 3b and 3c, presented in the form of a radar chart, pie chart and histogram show the mean (numerical) data for evaluation of the importance of the factors analysed in the areas E2, E3 and E8.

**Fig. 3** Averages (numerical) of importance evaluation for factors in: a) E2, b) E3, c) E8 area.

It concerns company that operates in steel sector

The figures confirm high evaluation of the factors connected with technology. These factors (technology development - RT, and using reliable technologies only - ST) took the second place (in the areas E2 and E3) as a result of the analysis of the mean values of evaluation of the importance. In the case of the area E8, the factor of technology portfolio (PT) was also evaluated very high, with the mean score of 6.5.

The analysis of the selected questions in the BOST questionnaire reveals that the employees in the company that manufactures steel products view the problem of technology as very important. They consider development of technology as an opportunity. The process of development of technology might considerably determine the concept of the development in the enterprise studied. Using reliable technologies only is for the respondents a very important factor to the manufacturing process and a suitable technology portfolio might produce great effects after its improvement.

**LITERATURE**


