Purchasing management by using a hybrid multiple criteria approach based on PROMETHEE method

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Presentation

1. Introduction

2. Objectives and methodology

3. Criticality and strategic indices of products

4. Criticality and strategic indices of suppliers

6. Conclusions and future work
The most recent literature review (Ho, Xu and Dey, 2010):

- **Individual and integrated approaches:**
  - Data Envelopment Analysis
  - Mathematical programming: Linear and integer programming, Goal programming and multiobjective programming
  - Analytic Hierarchy Process and Analytic Network Process
  - Fuzzy set theory
  - Simple multi-attribute rating technique
  - Genetic algorithms

- **The supplier selection problem**
Introduction

The company:

Raw materials:

More than 700 Products:

Applications:
- Human nutrition
- Pharmacy-cosmetology
- Paper/board
- Chemistry-bioindustry
- Animal nutrition

the leader in the production, technology and application of polyols (sugar alcohols)
The Company: Roquette group

Valencia (Spain)
The problem: purchasing management

- Roquette Spain has implemented purchasing and warehouse management module of the SAP ERP software.
- This system does not provide techniques to analyse and evaluate the high number of products and suppliers.
- **Previous system was only based on acquired products**
  - The products were analysed according to their risks without taking into account their suppliers.
  - Assessments are carried out quarterly and data from last three years are used.
The problem: purchasing management

- The previous methodology has some **drawbacks**:
  - Criteria measured in different units are aggregated.
  - The weights of criteria were assigned after trial and error tests.
  - Very different products were able to obtain the same number for criticality.

- The company was interested in developing a new system of purchasing management:
  - Products
  - Suppliers
Objectives

- To develop a multiple criteria methodology to evaluate suppliers of Roquette Laisa Spain in order to establish the best relationship with each of them:
  - Partners
  - Long term contracts
  - Market policies
  - Elimination

This objective has been achieved in close collaboration with the personnel in the purchasing department of the company.
Multiple Criteria based Methodology

- Chemical products
- Packaging products
- Technical products
Multiple Criteria based Methodology

SUPPLIERS

\[ S_1, S_2, S_3, \ldots, S_N \]

PRODUCTS

\[ P_1, P_2, P_3, \ldots, P_N \]
Multiple Criteria based Methodology

AHP: to weight the criteria (group decision making)

PROMETHEE: to obtain the Global Index of Products and Suppliers
First-step: Criticality and strategic indices of products

- Criticality Index
  - Safety and environmental regulations
  - Number of suppliers
  - Delivery time
  - Provisioning factor

- Strategic Index
  - Contact with the final product
    - Stopping production of the factory
    - Affect the image of the company
    - Purchase volume

- Global Index of Products
### Criticality and strategic indices of products

#### AHP: critical criteria weights

#### Pairwise comparison matrix of critical criteria

<table>
<thead>
<tr>
<th>Criticality Index</th>
<th>Safety and environmental regulations</th>
<th>Number of suppliers</th>
<th>Delivery time</th>
<th>Provisioning factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety and environmental regulations</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Number of suppliers</td>
<td>0.33</td>
<td>1</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Delivery time</td>
<td>0.14</td>
<td>0.17</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Provisioning factor</td>
<td>0.13</td>
<td>0.11</td>
<td>0.50</td>
<td>1</td>
</tr>
</tbody>
</table>
Criticality index of products: weights of criteria
Strategic index of products: weights of criteria
**Criticality and strategic indices of products**

**PROMETHEE II: Evaluation Table**

<table>
<thead>
<tr>
<th>PRODUCTS</th>
<th>Purchase volume</th>
<th>Provisioning factor</th>
<th>Safety and environment regulations</th>
<th>Product affects the image</th>
<th>Contact with the final product</th>
<th>Stopping production</th>
<th>Delivery time</th>
<th>Number of suppliers</th>
</tr>
</thead>
<tbody>
<tr>
<td>18670066</td>
<td>386,823,97</td>
<td>42</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>45</td>
<td>5</td>
</tr>
<tr>
<td>20020340</td>
<td>551,293,73</td>
<td>93</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>45</td>
<td>4</td>
</tr>
<tr>
<td>20030395</td>
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<td>11</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>18670015</td>
<td>6,670,28</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>20042800</td>
<td>116,265,63</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>30</td>
<td>3</td>
</tr>
</tbody>
</table>
Criticality and strategic indices of products

PROMETHEE II: Preference functions

- Safety and environmental regulations
- Contact with the final product
- Stopping production of the factory
- Affect the image of the company
Criticality and strategic indices of products

PROMETHEE II: Preference functions

- Number of suppliers
- Delivery time
  - $q = 80$ days
- Provisioning factor
- Purchase volume
  - $p = 50000$ euros
  - $q = 1000000$ euros
## Criticality and strategic indices of products (D-Sight)

<table>
<thead>
<tr>
<th>Products</th>
<th>Criticality index</th>
<th>Strategic index</th>
<th>Billing (euros)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18670015</td>
<td>46.37</td>
<td>37.57</td>
<td>4,656.98</td>
</tr>
<tr>
<td>20042800</td>
<td>52.29</td>
<td>60.62</td>
<td>96,307.10</td>
</tr>
<tr>
<td>18670066</td>
<td>52.44</td>
<td>36.10</td>
<td>297,134.91</td>
</tr>
<tr>
<td>20020340</td>
<td>51.28</td>
<td>35.78</td>
<td>465,748.47</td>
</tr>
<tr>
<td>20030395</td>
<td>53.42</td>
<td>59.32</td>
<td>1,370,447.75</td>
</tr>
</tbody>
</table>
The PROMETHEE II Complete Ranking of products

Criticality and strategic indices of products
Second-step: criticality and strategic indices of suppliers

- Global Index of Suppliers
  - Criticality Index
    - Criticality Index of Products
    - Delays
    - Commercial Risk
    - Risk of the supplier country
    - Risk of the supplier billing
  - Strategic Index
    - Strategic Index of Products
      - Purchase volume
      - Claims
Second-step: criticality and strategic indices of suppliers

AHP: critical criteria weights

An example of pairwise comparison matrix

<table>
<thead>
<tr>
<th>Criticality Index</th>
<th>Criticality Index of Products</th>
<th>Delays</th>
<th>Commercial Risk</th>
<th>Risk of the supplier country</th>
<th>Risk of the supplier billing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criticality Index of Products</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Delays</td>
<td>0,20</td>
<td>1</td>
<td>0,33</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Commercial Risk</td>
<td>0,33</td>
<td>3,00</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Risk of the supplier country</td>
<td>0,14</td>
<td>0,20</td>
<td>0,33</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Risk of the supplier billing</td>
<td>0,14</td>
<td>0,20</td>
<td>0,33</td>
<td>1,00</td>
<td>1</td>
</tr>
</tbody>
</table>
Second-step: criticality and strategic indices of suppliers

Results of criteria weights for criticality index of suppliers
Second-step: criticality and strategic indices of suppliers

Global results of criteria weights for strategic index of suppliers
Second-step: criticality and strategic indices of suppliers

PROMETHEE II: Evaluation Table

<table>
<thead>
<tr>
<th>SUPPLIERS</th>
<th>Claims</th>
<th>Purchase volume of supplier</th>
<th>Risk of the supplier billing</th>
<th>Risk of the supplier country</th>
<th>Commercial Risk</th>
<th>Delays</th>
<th>Strategic index of products</th>
<th>Criticality index of products</th>
</tr>
</thead>
<tbody>
<tr>
<td>302563</td>
<td>1</td>
<td>0.15</td>
<td>3.25</td>
<td>B</td>
<td>0</td>
<td>15</td>
<td>36.17</td>
<td>52.68</td>
</tr>
<tr>
<td>304061</td>
<td>0</td>
<td>4.36</td>
<td>15.48</td>
<td>B</td>
<td>0</td>
<td>0</td>
<td>61.40</td>
<td>53.93</td>
</tr>
<tr>
<td>304422</td>
<td>0</td>
<td>0.06</td>
<td>0.00</td>
<td>B</td>
<td>0</td>
<td>0</td>
<td>36.10</td>
<td>52.44</td>
</tr>
<tr>
<td>304438</td>
<td>1</td>
<td>3.79</td>
<td>24.50</td>
<td>B</td>
<td>0</td>
<td>0</td>
<td>59.32</td>
<td>53.42</td>
</tr>
<tr>
<td>304573</td>
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<td>2.84</td>
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<td>262</td>
<td>37.41</td>
<td>52.38</td>
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<td>304601</td>
<td>1</td>
<td>1.49</td>
<td>1.44</td>
<td>B</td>
<td>0</td>
<td>85</td>
<td>61.11</td>
<td>51.76</td>
</tr>
</tbody>
</table>
Criticality and strategic indices of suppliers

PROMETHEE II: Preference functions

- Criticality Index of Products
- Strategic Index of Products
- Commercial Risk
- Risk of the supplier country
Criticality and strategic indices of suppliers

PROMETHEE II: Preference functions

- Delays
  \( q = 80 \text{ days} \)
- Claims
- Risk of the supplier billing
  \( q = 2.3\% \)
  \( p = 20\% \)
- Purchase volume
### Criticality and strategic indices of suppliers (D-Sight)

<table>
<thead>
<tr>
<th>SUPPLIERS</th>
<th>CRITICALITY INDEX</th>
<th>STRATEGIC INDEX</th>
<th>BILLING</th>
</tr>
</thead>
<tbody>
<tr>
<td>351454</td>
<td>56,95</td>
<td>58,96</td>
<td>337,50</td>
</tr>
<tr>
<td>351121</td>
<td>41,93</td>
<td>39,51</td>
<td>153,440,00</td>
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<tr>
<td>351110</td>
<td>37,12</td>
<td>33,79</td>
<td>19,160,00</td>
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<tr>
<td>349878</td>
<td>44,93</td>
<td>41,72</td>
<td>6,422,76</td>
</tr>
<tr>
<td>346534</td>
<td>59,89</td>
<td>63,16</td>
<td>305,852,00</td>
</tr>
<tr>
<td>346380</td>
<td>39,54</td>
<td>34,50</td>
<td>71,335,70</td>
</tr>
<tr>
<td>345835</td>
<td>62,77</td>
<td>65,94</td>
<td>20,246,60</td>
</tr>
</tbody>
</table>
Second-step: criticality and strategic indices of suppliers
Conclusions

- We have analysed and modified the majority of criteria used in the company to evaluate the products purchasing.

- We have also changed the performance measures of criteria that were being used and are still in use in order to evaluate products.

- The purchasing department has implemented a group decision making by using AHP method in order to weight the criteria in the evaluation of products and suppliers.

- We have designed two indices for suppliers by using the PROMETHEE method in order to evaluate how critical and strategic they are.
Conclusions

- The criticality index are mainly related to the market while the strategic index is due to internal operations and decisions of the factory.

- This methodology has been implemented in the Spanish factory that has overcome drawbacks of the previous one. For example, two different products could have the same criticality value. This is not the case when using PROMETHEE.

- This new methodology has been implemented since the last year for the suppliers of
  - Chemical products
  - Packaging products
Conclusions and future work

Future work

- This methodology can be implemented in other factories of Roquette group and other companies by defining their appropriate criteria.

- We are applying this methodology (ongoing work) for suppliers of technical products that represent a very high number (8,000) and have great diversity of applications.

- Materials for technical products: electrical, electronic, pneumatic, mechanical, hydraulic, etc. For example, in spare parts we have to consider if parts are for critical machines, safety issues, cost of materials, etc.
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