Benchmarking of Waste Management Software Based on a Process and Requirements Analysis – Case Study Volkswagen AG

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Abstract
In the context of the diploma thesis, updated benchmarking is required to compare the software that is available for waste management, in order to install the best one in the 10 German production sites of Volkswagen AG. Depending on the result, it will be the concept for an integrated waste management system. The recommended software is a basis of decision-making for a future implementation. The conception process will take place in a global view, the integration with other VW systems (UIS, etc.) should be considered.

1. Introduction
The Volkswagen Group is a large group of companies formed by Volkswagen AG, Audi AG, Seat SA, Skoda Auto and Bentley, among others. That group develops, manufactures and sells cars worldwide in order to assure the individual mobility and autonomy. The companies of VW group work together for the continuous improvement of the ecologic acception of their products, centers of productive activity and in the complete lifecycle, and for that they are committed to rationalize the operation of the natural resources under the consideration of environmental aspects. The environmental management involves all the employees of the group and the collaboration of the suppliers in order to assure the correct fulfillment of the environmental policy and the correct operation of the system for environmental management.

All the brands of the VW group use an environmental management system to apply the environmental policy, their objectives and programs in the activity centers of the company so, e.g. the norm ISO-EN-UNE 14.001 of the 21st August 96. The environmental management of the company covers all the lifecycle of its products and directs the measures for the protection of the environment from its creation, manufacturing and commercialization until the recycling.

Recycling is one of the objectives that the VW group has marked in terms of environment. Recycle means to separate the elements that compose the waste in order to be reused. With that measure several things are obtained: saving resources, decreasing pollution, enlarging the life of the materials although that could be with other uses, saving energy, avoiding the deforestation, saving a huge quantity of the space that waste occupies before it becomes garbage, etc.

Inside the VW group, every company uses its own environmental management system; even so the quantities of waste that it should manage are enormous. A good computerized system helps the administration of wastes in an efficient way and makes possible to use an electronic system for registering and managing the wastes.

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2. Objective of this work

Currently those companies use a program called PRODOK-A to realize the waste management. That software has achieved its objectives, but it is clearly behind the times, technologically as well as with its respects to the current regulations. PRODOK-A is a slow program which produces lots of bugs, and also it is also not prepared for the new changes that are waited for in environmental law. It’s necessary to analyze the market and to find out a new software which replaces PRODOK-A in all the 10 VW group production sites of Germany and VW Transport. PRODOK-A will be a reference for us in our research.

2.1 Prodok-A

According to Oekoradar.de⁵ “Prodok-A software is a system for the completion, documentation and controlling of the refuse economy”.

Prodok-A is a waste management system with integrated cost management. From the refuse economy and the coming legal requirements, the software developed further towards in-plant material flow and costs controlling. Contrary to balance programs the input is based on measured quantities or vouchers, less on the computation of individual flows. The single quantities and direct costs are taken over e.g. from the disposal vouchers, from the bookkeeping and/or PPS systems and classified by cost center allocation.

Apart from complete refuse economy functionality above all the cost calculation is interesting for the material flow management (cost centers, cost objective, plan calculation of actual costs) as well as the illustration of internal material flow. The software has its own module for waste water. The most important points of Prodok-A are:

1. Objective: Compliance, documentation and controlling of the refuse economy, expansion on plant material flow, causer-oriented quantity and cost allocation.

2. Data input: Amounts of material, which can be extended internally, subdivided by waste key.

3. Output: Individually adaptable report, existing quantity/cost data per cost center or cost objective. Entire documentation according to KrW/AbfG⁶.

2.2 Process Description

The process of finding new software began with a survey to the users of PRODOK-A. This survey has helped to understand the problems that users have with PRODOK-A, and to know which characteristics the new software system should have and should be implemented in the future in the VW group.

Parallel, we have also simulated the waste management main process with ARIS. Starting from a model of the Braunschweig production site, we have designed a model for all the waste management processes of the 10 production sites of the Volkswagen group and VW Transport.

Once we had all that information, the next step was to conduct a market research. These results were put under consideration of a validation criterion. That criterion evaluates which software has the main characteristics (Database type, updating possibilities, etc) and which not. We have examined all the 30 software systems rigorously, and after hard filters there remained less than 10 systems in the final stage of our study.

At this point we created a criteria-based check-list and sent it to the finalist software providers. Afterwards the checklists were sent to the companies for processing, those with "OK" are evaluated. After all answers

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⁵ Source: www.oekoradar.de
were sent back, additional information was inquired by telephone. Thereupon a big table was completely filled out with all answers of the companies. Here all lower and secondary criteria were evaluated.

3. Decision Theory

The substantial operational sequence of the decision support procedure PROMETHEE can be described in six steps [Geld99].

1. Find a generalized preference function \( p_k(d) \) for each criterion \( k \).
2. Determine a criterion weighting vector \( w^T = [w_1, \ldots, w_k] \).
3. Specify the following Outranking relation \( \pi \) for all alternatives \( a_i, a_j \in A \):

\[
\pi: \quad \pi(a_i, a_j) = \sum_{k=1}^{K} w_k \cdot p_k\left( f_k(a_i) - f_k(a_j) \right)
\]

The preference index thereby represents a measure for the strength of the preference of an alternative \( a_i \) in relation to an alternative \( a_j \), with simultaneous attention of all criteria (see fig.1)

![Outranking graph](Geld99, p.105).

4. As a measure for the strength of an alternative the output flow (Phi plus) is computed for all \( a_i \in A \):

\[
\phi^+(a_i) = \frac{1}{T-1} \sum_{j=1}^{T} \pi(a_i, a_j).
\]

5. As measure for the weakness of an alternative \( a_i \) the entrance flow (Phi minus) is computed for all \( a_i \in A \)

\[
\phi^-(a_i) = \frac{1}{T-1} \sum_{j'=1}^{T} \pi(a_j', a_i).
\]

6. Evaluation of the outranking relation: The procedure PROMETHEE I, based on the comparison of the initially and output flows, generates a partial pre-order and illustrates thus apart from preference and indifference, and in particular also incomparability between alternatives.
4. Representation and interpretation of the final result

4.1 Preparation to Promethee Algorithm

In the preparations of the PROMETHEE algorithm the weightings for each criterion were determined together with the experts of the VW System Department and the VW Environmental Department. In the following graphic the analysis criteria and their associated weightings are represented.

![Weightings of the criteria]

Fig. 3: Weightings of the criteria.

4.2 Interpretation of the results

The difference between Phi Plus and Phi minus is what really tells us the order in the ranking between all software. The best goals of each software are calculated in the Phi Plus result, the negative ones in the Phi Minus. The difference between them tells us how good that software is. The best Phi Net is obviously the first placed in our Final Ranking.

Followingly, after applying the PROMETHEE algorithm, the results are presented of the results using a result table and the bar diagram which is useful for understanding the meaning of Phi Plus, Phi Minus and Phi Net.
<table>
<thead>
<tr>
<th>System</th>
<th>Phi Plus</th>
<th>Phi Minus</th>
<th>Phi Net</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRIAS</td>
<td>0.423</td>
<td>-0.207</td>
<td>0.217</td>
</tr>
<tr>
<td>Ramses</td>
<td>0.364</td>
<td>-0.214</td>
<td>0.150</td>
</tr>
<tr>
<td>SAP EH&amp;S</td>
<td>0.379</td>
<td>-0.229</td>
<td>0.150</td>
</tr>
<tr>
<td>WIM</td>
<td>0.379</td>
<td>-0.264</td>
<td>0.115</td>
</tr>
<tr>
<td>UMSYS</td>
<td>0.304</td>
<td>-0.345</td>
<td>-0.041</td>
</tr>
<tr>
<td>WAUplus</td>
<td>0.281</td>
<td>-0.325</td>
<td>-0.045</td>
</tr>
<tr>
<td>Prodk-A</td>
<td>0.307</td>
<td>-0.378</td>
<td>-0.071</td>
</tr>
<tr>
<td>AWIPRO</td>
<td>0.149</td>
<td>-0.624</td>
<td>-0.475</td>
</tr>
</tbody>
</table>

Fig. 4: Promethee result table

In the next graphic we will easily see the meaning of the Phi Plus, Phi Minus and Phi Net:

Fig. 5: Result benchmarking between waste management software.

TRIAS, SAP EH&S, Ramses and WIM have the PHI net value > 0. The difference between the PHI net values of the systems shows itself by the result table (P. 5).

Regarding one of the evaluations differences (PHI net) of the alternative software solutions, thus groups of systems can be formed, which possess a similarly high suitability for the employment in the Volkswagen company.

Finally, the system TRIAS was clearly best evaluated. The difference for the group of the three systems directly following in the Ranking (SAP EH&S, Ramses as well as WIM) amounts to 0.067 evaluation units, due to the advantages of TRIAS in the following system properties: Efficiency, Future security (Functional), Degree of automated reports mode well as date administration.

Within the group of the three following systems SAP EH&S and Ramses possess a equivalent high evaluation. However the sum of the strengths (PHI plus) is as well as the weaknesses (PHI minus) of SAP EH&S higher than Ramses. The system Ramses possesses altogether more balanced system properties.

The strengths of SAP EH&S are in the fields of date administration, future security (functional) and degree of automated reports mode. The system Ramses is likewise outstanding in the areas future security
(functional) and date administration. SAP EH&S is favorably with this system, with the range interfaces (internal + external) as well as with the processing degree of specialized tasks.

With 0.035 as the difference to these two systems, WIM software has some positive aspects in the evaluation. This is on the characteristics future security (functional), date administration, future security (technology) as well as initial costs to lead back, which represent the strengths of WIM.

With all remaining systems it has some weaknesses and/or disadvantages. Among these systems also the reference system Prodok-A is ranked. Thus this aspect clearly speaks for a separation of the so far assigned waste management system. It is remarkable that the strengths of Prodok-A (PHIplus) are higher than the better-evaluated software WAUplus.

The systems UMSYS and WAUplus received a higher evaluation than Prodok-A by the procedure. The difference between the PHI values of these two software solutions is marginal with 0.004 evaluation units. WAUplus offers a reduced function range within the range waste management. From these aspects result low evaluations in the criteria of efficiency and processing degree of specialized tasks. To use UMSYS in the Volkswagen company, additional modules have to be created via customizing, which can be provided again extensively (high customizing expenditure). Besides the initial costs are on a very high level.

The system AWIPRO was evaluated lowest in the total evaluation with clear distance (0.404 evaluation units difference to the reference Prodok-A). It is not completely configurable for the Volkswagen-specific requirements and shows this by a majority of the weakness analysis criteria.

4.3 Results for the ten criteria in Net Diagram

![Diagram showing results of benchmarking between waste management software](image)

Fig. 6: Result for the ten most important criteria in the net diagram

The applications were evaluated best in each case in the following fields:

- **TRIAS**: Efficiency, future security (Functional), degree of automated reports mode, date administration.
5. Conclusions and Outlook

The objective was to find up to date software for the Volkswagen Group. The process to find new software was started with a survey to the 10 production sites of the Volkswagen group and VW Transport. This survey has helped us to understand the problems that PRODOK-A gives to the user, the employees, and to know which characteristics the new software system should have and should be implemented in the future in the VW group.

After the survey to the employees that use this software in the production sites of Volkswagen AG in Germany, we did a market research to find software that could be implemented in VW. Parallel, we have also simulated the waste management process with ARIS. Starting from the Braunschweig production site model, we have implemented a model for all the waste management processes of the 10 production sites of the Volkswagen group and VW Transport.

The market research gives us 30 software systems that were initially what we have looked for. But most of them use MS Access as database and Volkswagen needs a consistent and strong database for a client-server system basis with multi-user transactions. Finally, we keep 8 software systems for the final Benchmarking.

In order to know the final result we use PROMETHEE Algorithm. This algorithm, with the correct weightings given, gives a recommendation that the best option for Volkswagen AG is TRIAS. TRIAS was better than the other software systems in the following fields: Efficiency, future security (functional), degree of automated reports mode, date administration. And those fields make it the best option for the Volkswagen group.

The next step after the results, that this thesis presents, depends on Volkswagen AG. The result of the thesis says that TRIAS is the best option for VW. Ramses and SAP EH&S, the software that are in second and third position in the ranking, are also good, but TRIAS is better valued. With that diploma thesis, VW has the arguments to decide which software should finally be implemented. After Volkswagen’s decision, the implementation of that software has to be done quickly. PRODOK-A should not be used any more. The new environmental laws come soon and PRODOK-A is not prepared to them.

To conclude, the orientation of this thesis was to give more detailed information and the best arguments in order to allow Volkswagen group to decide the best option to be implemented for its waste management.
Bibliography


