Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 96 (2014) 143 – 147

Procedia Engineering

www.elsevier.com/locate/procedia

Modelling of Mechanical and Mechatronic Systems MMaMS 2014

The proposal of stock items reconfiguration on the basis of cluster analysis results

Jana Halčinová[a]*, Peter Trebuňa[b], Iveta Janeková[c], Jozef Živčák[d], Jozef Janek[e]

[a, b, c, d]*Faculty of Mechanical Engineering, Technical University of Košice, Letná 9, 042 00 Košice, Slovakia.*
[e]*SCA Hygiene Products Slovakia, 049 12 Gemerská Hôrka, Slovakia.*

Abstract

The submitted article is focused on the field of distribution logistics with the aim of cluster analysis application as a tool for creation of groups of similar stock items (clusters) leading to speed up the company's reactions on customers' requirements. When creating the groups (clusters) of stock items by using cluster analysis it is necessary to have information about the process which directly follows. It means that in case of analysis of distribution centre stock items, the input information are the data of product distribution of the previous period or distribution plan for the future period. Changes in distribution play an essential role in clustering that is why it is appropriate to use distribution data from several periods not just one. The output of the process of finished goods stock clustering by using hierarchical methods of cluster analysis is dendrogram. Consequently based on problem solver's subjective opinion the optimal numbers of clusters are selected and are incorporated into the proposal of finished goods warehouse layout reconfiguration. The result of cluster analysis in the form of finished products clusters is possibly applicable in other business processes, for instance production cells creation, raw materials warehouse layout reconfiguration and many others because the criterion of cluster creation are customers' requirements which is determining criterion in the entire process of customer oriented companies.

Peer-review under responsibility of organizing committee of the Modelling of Mechanical and Mechatronic Systems MMaMS 2014

Keywords: cluster analysis, dendrogram, finished goods warehouse, reconfiguration.

* Corresponding author. Tel.: 00421556022358;.
E-mail address: jana.halcinova@tuke.sk

Peer-review under responsibility of organizing committee of the Modelling of Mechanical and Mechatronic Systems MMaMS 2014
doi:10.1016/j.proeng.2014.12.133

1. Introduction

Cluster analysis belongs to multivariate statistical methods. It is defined as general logical technique, procedure which allows clustering various objects into groups – clusters on the basis of similarity or dissimilarity. Cluster analysis involves computational procedures, which purpose is to reduce a set of data on several relatively homogeny groups – clusters, while the condition of reduction is maximal and simultaneously minimal similarity of clusters. Similarity of objects is determined by the degree of similarity (correlation coefficient and association coefficient) or the degree of dissimilarity – degree of distance (distance coefficient). On the basis of clustering, methods of cluster analysis are classified as hierarchical or non-hierarchical methods. Hierarchical methods of cluster analysis are based on the hierarchical systematization of objects and its clusters. The procedures, methods begin from the separate objects which represents clusters. Progressively, the amount of clusters is getting down and in the end all objects, clusters are reduced into the whole. Hierarchical methods lead to hierarchical (tree) structure which is graphically figured as dendrogram (tree diagram). Non-hierarchical methods do not create hierarchical (tree) structure and the objects are categorized into the number of disjunctive clusters specified in advance [1].

Cluster analysis, which idea is to create groups (clusters) on the basis of dissimilarity (distance) of the objects indicated by various variables, was used when designing stocks reconfiguration within the warehouse of existing industrial concern. Stocks stored in finished goods warehouse illustrated in Fig. 1 are considered to be the interest objective.

Fig. 1. Finished goods warehouse in analyzed industrial concern.

2. Analyzed industrial concern

Analyzed industrial enterprise is an international manufacturing concern distributing products to countries depicted in Fig.2 included with their percentage share.

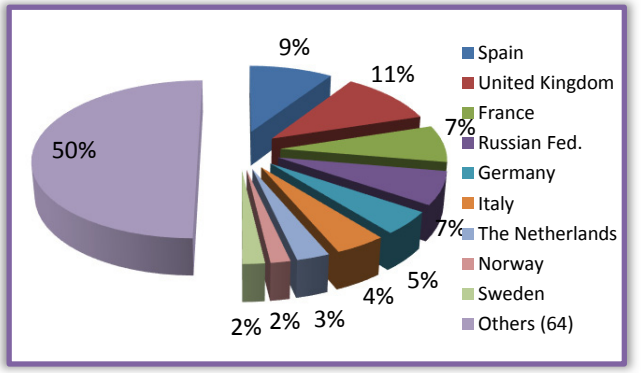


Fig. 2. Percentage of products distribution to particular countries.

Products distribution development of analyzed manufacturing concern during the period under review was relatively steady with only small deflections in customers' requirements (see Fig. 3). This matter of fact is significant input information for cluster analysis execution. As the distribution development during the period under review was relatively steady it is effective to perform cluster analysis of finished goods stocks leading off from data of particular products distribution in 2013 and 2014. Changes in distribution development will be considered in cluster analysis result.

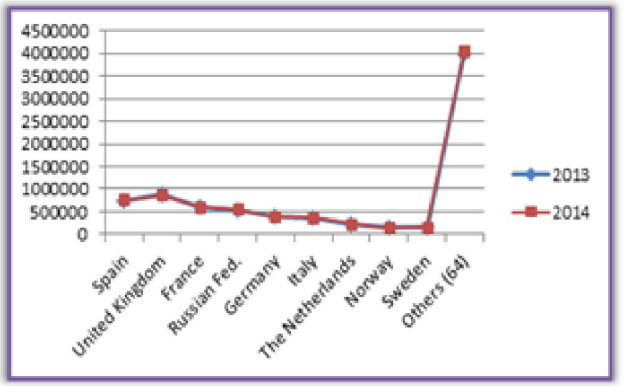


Fig. 3. Distribution development of analyzed manufacturing concern.

3. Cluster analysis of stocks

On the basis of products distribution data in 2013 and 2014, cluster analysis was done and its result intended to be a selection of clusters for the following warehouse layout reconfiguration.

Input information for cluster analysis execution was a set of monthly data about distribution of 35 finished products in 2013 and 2014 (distribution plan). For the representation of similarity relations among the objects (products) squared Euclidean distance and hierarchical cluster analysis method – Ward's method were used. Hierarchical methods of cluster analysis create clusters in a form of tree structure according to distance and the optimal number of clusters is a problem solver subjective decision.

Graphic output of finished products clustering of selected manufacturing concern is a dendrogram (see Fig. 4) illustrating various numbers of clusters depending of distance (dissimilarity).

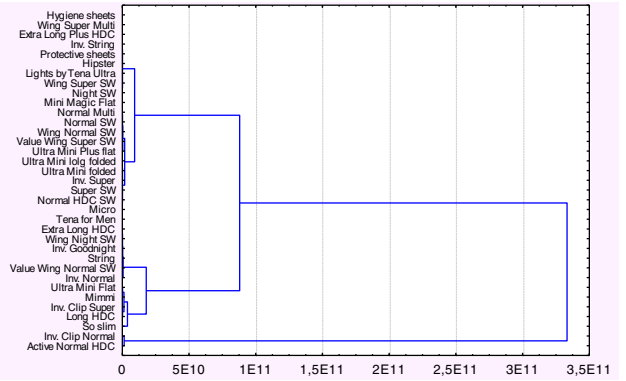
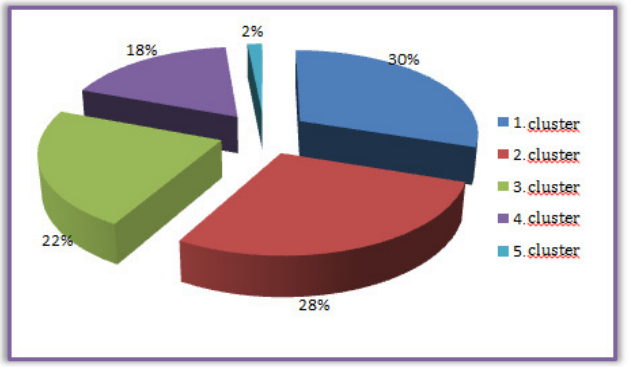


Fig. 4. Dendrogram of products in 2013 and 2014.

4. Cluster analysis results

Based on heuristic approach of determining the quality of decomposition it is possible to consider 5 clusters of finished products to be an optimal number of clusters.

The share of particular products distribution of manufacturing concern is when managing stock Fig.5 the greatest holding is represented by the first and both together majority of total dispatch.



clusters in total above mentioned a determining criterion items. As depicted in in the total distribution and the second cluster represent the absolute

Fig. 5. Share of product clusters in total distribution.

5. Warehouse layout reconfiguration

The above mentioned matter of fact is necessary to take into account when designing finished goods warehouse layout reconfiguration. The basic principle of the optimal layout of particular items within the warehouse is to place the products with the greatest holding in distribution closer to the exit to make the process of manipulation with finished products toward the customers more effective and faster. The draft of stock organization within the finished goods warehouse in consideration of cluster analysis results and available warehouse capacity is illustrated in 3D form (see Fig. 6) and 2D form (see Fig. 7) as well.

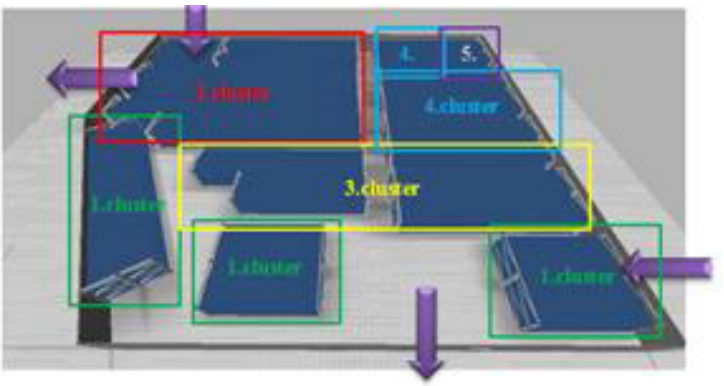


Fig. 6. 3D draft of finished goods warehouse layout with clusters definition.

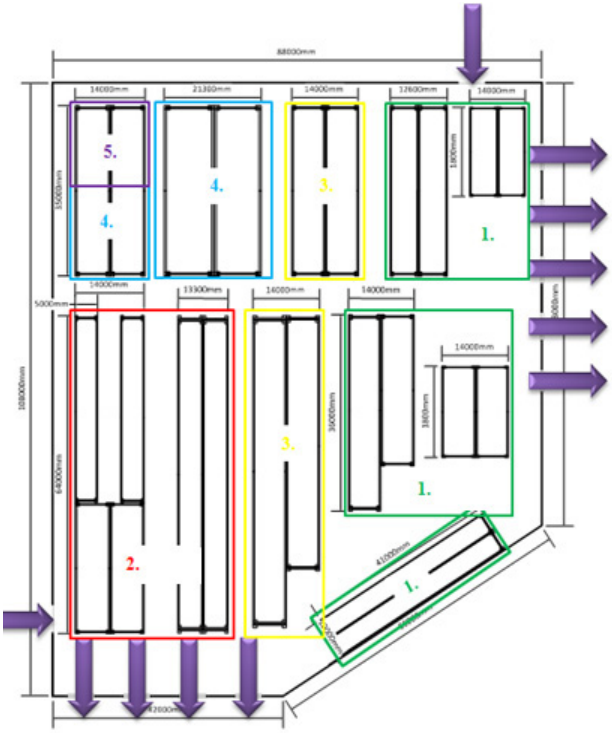


Fig. 7. 2D draft of finished goods warehouse layout with clusters definition.

6. Conclusion

The aim of submitted article was to create clusters of similar products on the basis of cluster analysis according to customers' requirements. Created clusters as a result of the analysis differ from the current way of finished goods warehouse layout in analyzed company that is why they have been incorporated to the proposal of distribution shed reconfiguration. The result presents systematic and logical solution of the way how to manage finished goods stocks. Applied algorithm is usable not only in production and distribution companies but in medical domain as well.

Acknowledgements

The article has been supported by the research grant No. ITMS 26220220185 of the project: University Medical Science and Technology Park in Košice (MediPark).

References

[1] J. Bacher, A. Poge, K. Wenzig: *Clusteranalyse – Anwendungsorientierte Einfuhrung in Klassifikationsverfahren*. Munchen: Oldenbourg. 2010. 432s. ISBN 978-3-486-58457-8.
[2] B.S. Everitt, S. Landau. M. Leese, D. Stahl: *Cluster Analysis*. London: Wiley, 2011. 348s. ISBN 978-0-470-74991-3.
[3] J. Han, M. Kamber*: Data Mining – Concepts and Techniques*. San Francisco: MK Publisher, 2006. 772 s. ISBN 13:978-1-5580-901-3.
[4] L. Kaufmann: *Finding groups in data: an introduction in cluster analysis*. Hoboken: Wiley. 2005. 342 s. ISBN 0-471-73578-7.
[5] P. Trebuňa, J. Halčinová: *Experimental modelling of the cluster analysis processes*. In: Procedia Engineering. Vol. 48. 2012, s. 673–678. ISSN 1877-7058. Fogg, B.J, *Persuasive technology: using computers to change what we think and do*, Morgan Kaufmann Publishers, Boston, 2003, 30-35.
[6] P. Trebuňa, M. Fiľo, M. Pekarčíková: *Supply and distribution logistics*. Ostrava. Amos, 2013. 133 p. ISBN 978-80-87691-02-1.