ERP System for Food and Beverage Industry

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Abstract

Past research has recognised the need for enterprise - wide integration. This is now possible because of the recent advancements in information technology. The integration can be achieved by the customisation of an Enterprise Resource Planning (ERP) system for a food & beverage industry, which should contribute to the design, planning, production, packaging and marketing of healthy and safe foods. We propose a set of information requirements which should be incorporated into the ERP system and the adaptation of a pattern recognition mechanism which can help in the discrimination process of the quality category of food products, which is of high importance for the enterprise. This paper is based on literature study and provides insights into the need for the connection of an ERP system with specialized chemical applications in the food and beverage industry. In addition, future research issues are discussed.

***Keywords**: ERP system, food quality, pattern recognition, traceability, HACCP*

1. Introduction

Enterprises in the food and beverage industry struggle to provide the market with high quality products. On the one hand, enterprises perform chemical analysis to both raw ingredients and to final produced products, in order to achieve that high level of quality. On the other hand, enterprises invest into information technology and expect to have an information system which can support all the processes in their business. The information system should manage all the resources and processes of the business which will lead it to attain the goal of the production of high quality products. Therefore, an enterprise in this industry could use an Enterprise Resource Planning (ERP) system.

An ERP system assists organisations to identify and manage properly enterprise-wide resources across all the business processes such as Accounts Payable, Accounts Receivable, Costing, Sales and Distribution, Materials Management, Production Planning, Human Resources. It can provide the

organisation with competitive advantage through improved business performance (Hitt et al., 2002) by integrating all the business processes. Any kind of data which is being produced in any step of any process should be stored in a real-time environment such as an ERP system. Such a system comprises of a commercial software package that promises the seamless integration of all the information flowing through the company – financial, accounting, human resources, supply chain and customer information (Davenport T.J. 1998). Particularly, in the food and beverage Industry, there is a need for gathering chemical (Bassompiere et al. 2004), nutritional, and quality information which is relevant to food composition.

It is true that there is no single ERP software which can meet all the functionality and all special requirements of an enterprise. Companies in the software industry try to persuade their perspective customers that their system can be seamlessly integrated to their environment. ERP sellers present customisability as the strongest feature of their ERP solution. They promise that their system can be adapted properly and incorporate the most critical processes of the specific business environment.

The purpose of this study is to motivate the ERP vendors to take into serious consideration the specific requirements of the enterprises involved in the food processing environment. We propose them to adapt their systems so they can manage the vast amount of valuable data which come out of chemical analysis which is being performed to food products. They have to investigate thoroughly the technical aspects of the transformation of chemical data from chemical devices into the ERP repository.

In section 2 we review relevant literature and approach our research question. In section 3 we present the specific information requirements of the industry under investigation and describe the production process in terms of integration of an ERP system with chemical applications. In section 4 we draw conclusions and provide future research directions.

2. Research

This study presents a proposal for both the ERP vendors, food scientists and managers of enterprises in the food and beverage industry, to cooperate in order to implement a system which will meet all the information requirements of this industry. Which specific information elements are necessary for such an industry and which technique is necessary to be integrated into the ERP system? Our aim is to provide a relevant answer to these questions.

Previous studies have presented the need for the ERP systems to be customised and manage all the sources of information that flows across the enterprise. The ERP should be aligned with all the business processes of an enterprise (Hammer M. et al., 1999). Davenport (Davenport T.H., 1998), attributed many failures of ERP implementation to the lack of alignment with business needs. In a study focused on the need to link ERP systems with both external and internal data, Li (Li C., 1999), identifies the need for "generating business intelligence that matters" as a primary key to the next generation ERP systems. The strong

competition among enterprises drives them to investigate the aspects of data centralisation, information sharing and integration (Yen H.R. et al., 2004). Bowersox (Bowersox et al. 1998) called for more effort toward integration of supply chain systems using ERP systems. Any misalignment between the ERP system and the processes of an enterprise must be resolved (Soh C., et al. 2004). Moreover, a major problem which is also referred in literature is that existing ERP systems can only partially resolve the problem with the planning process in food processing industries (Wout V.W., et al. 2005). This is another indication that more research is necessary in order to extend the capabilities of existing ERP systems and meet the specific information requirements of the food and beverage industry. Our research is focused on the determination of the specific information elements which should be incorporated into an ERP system and we present them in the next section.

3. Information requirements

Overall, an ERP system in the food & beverage industry should be able to fulfil the following critical requirements:

- **Management of food quality**: Nowadays, food quality has been a major concern for any consumer. More and more organisations in the food industry have adopted a quality assurance scheme. In order to manage to identify a product which does not comply with the standards of the quality scheme, the organisations have the challenge to get benefit from computer-driven pattern recognition techniques. Such techniques are based on multivariate statistical methods such as principal component analysis (PCA), linear discriminant analysis (LDA), and artificial neural networks (ANN). Clustering and classification are the major subdivisions of pattern recognition techniques. By using these techniques samples can be classified according to a classification rule which can be developed from a set of samples for which the property of interest and the measurements are known. The rule can then be used to classify other samples which are not part of the original set. Each sample is represented as a data vector $x = (x_1, x_2, ...x_i, ..., x_n)$, where x_i present a specific measurement of a food product. These techniques use as a source, data which come out of NMR (Nuclear Magnetic Reasonce Spectrometry), MS (Mass Spectrometry), HPLC (High Performance Liquid Chromatography), multisensor arrays and other devices and help the analysts to distinguish a diseased state in a product. In such a case, the product which will not reach the necessary quality level has to be rejected instead of reaching the consumer.

  We propose that these techniques should be applied at the beginning of the food production process, where raw ingredients get into the production line. As chemical analysis is being performed to raw ingredients, it is necessary to verify that the quality of the raw ingredients is the appropriate. For example, when an organisation buys from a supplier olive oil from Crete for example, it has to make sure that its origin is really Crete. Many studies have been conducted in this area for oil, (Ramos L.S., 2002), for wine (Beltran N.H. et al., 2005), for potatoes (Anderson K.A. et al., 1999), (Padin P.M., et al., 2001) and for the identification of dioxins (Bassompiere M. et al., 2004).

Research on the determination of the geographic origin or the quality brand of food products is a suitable area for the application of classification procedures (Lees M., 2003). Pattern recognition techniques are also used to applications which give as an outcome the identification and classification of flavour and other measurements of quality using the electronic noses and tongues (Deisingh K. et al., 2004).

Chemical analysis is also performed to intermediate products in various stages of the supply chain. The need for storing and managing the results of these analyses is of vital importance. At the end of the food production process, samples of the final food product are being analysed in order to be verified that meet certain quality criteria. The final product has to be verified that is totally safe for human's health. A Pattern Recognition (PR) application should get the results of the chemical analysis, performed at the end of the production process and classify the food product to categories such as "product of quality A", "product of quality B" and even to more categories. The classification result which is the outcome of the pattern recognition algorithm is based on a set of classification rules. These rules indicate a set of measurements which are useful in determining group identity. The PR application should then, seamlessly provide the ERP system with the information concerning the specific attributes of the food product which is being analysed. Overall, we can say that the PR application acts as an interface between the chemical analysis application and the ERP system.

Summarizing, an ERP system can receive as an input the results of the classification analysis which is coupled with pattern recognition techniques which in its turn is based on the results of the chemical analysis to a food product. These results give a level of quality of the product. The ERP system should be the kernel of all these procedures. It should store and manage all the necessary information which is needed by a food chemist in a food industry (Jouravleva D., 2003).

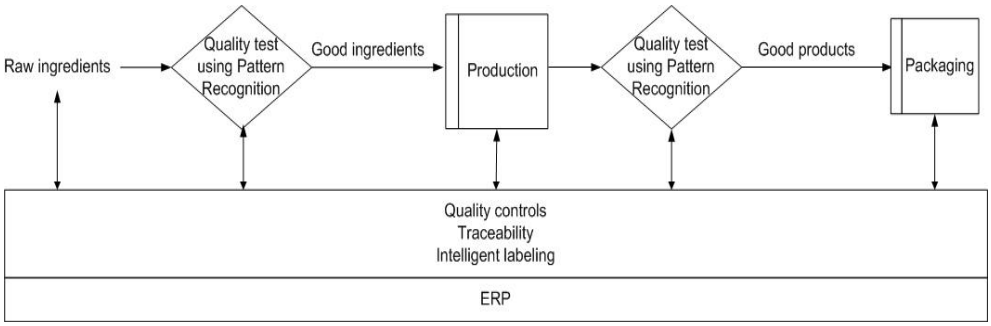

Figure 1. The ERP system as a base for the production of high quality food.

Management and control of recipes. The ERP system should be able to manage the creation and the modification of certain recipes which form the rules for the mixtures of specific ingredients and give as an outcome

the final food product. The whole production line is based on the recipes. It is critical to connect the recipes with the production planning within the ERP system. Ingredients which participate into a recipe have to be defined on a weight or quantity basis and in relevant proportions. Other features which accompany the recipe are: cooking temperature and time, cooling temperatures and other specific conditions. The outcome of the production line, the food product, must be defined with at least the specific dates, conservative information and the nutritional values.

- **Traceability**. The ERP system should monitor and keep trace of any combination of incoming and outgoing resources such as raw ingredients, co-products and by-products, recycles, equipment, people, processing time, waste etc. Peculiar conditions may apply according to the variation of the raw materials which depends on, among others, the season, the climate and the supplier. Moreover, co-products and by-products come because of decompositions (cutting, separation, ultra filtration, etc.) or transformations (reactions, pasteurisation, cooking, etc.) (Marcam, 2004). These peculiarities impact the traceability requirements of core processes such as: production management, planning management, inventory management and quality management. According to the European Community's General Food Law (EC 178-2002) which states that the implementation of a traceability system has become a mandatory requirement for any organisation in the food and beverage industry. EC believes that traceability is an instrument of risk management and health protection of the consumer. EC defines traceability as the capability to trace food products through all steps of production, transformation and distribution. It is a fact that organisations which put strong emphasis on food quality and security are less prone to loose market share when food-related health problems, such as mad cow disease and dioxins, arise. The ERP system should :
  - keep track of each step of the production process from production forward to selling and shipment of finished products
  - find, based on tracking information, backward all requested details of each product at each stage between selling/shipment and production
  - keep all the relevant information for each stage in the production line

- **Intelligent labelling.** The ERP system should provide a relevant identity for each product. Such an identity can be visible using a label which should provide information about the recommended temperature, the cooking or the freezing time, best-before date, nutrition values etc. The label should be accurate and consistent with any other label which is used in any packaging material.

- **Hazard Analysis Critical Control Points (HACCP) principles**. The ERP system should adhere to HACCP principles. These have been incorporated into the Food Safety Legislation in many countries (David W.K., Acheson M.D., 2001). HACCP information can easily be associated with any item in the production process: Raw Ingredients, Recipes, Finished Products, Production Batches, Customer Invoices, and Vendor Purchase Orders. All aspects of HACCP should be monitored with respect to safety, quality and security of

food. The ERP system should establish an effective mechanism for keeping record of all HACC Points as it :

- focuses on identifying where hazards are likely to occur and preventing from contaminating food,
- collects data in real time,
- instantly alerts the technician to Critical Control Points (CCP) violations,
- produces statistical process control (SPC) charts for analyzing CCP compliance in order to prove that the process is under control (Morris E. C., 2001),
- allows internal and external auditing by inspectors who need to investigate how well an organisation comply with food safety law over a period rather than how well it is doing on any given day,
- assists organisations to compete more effectively in the world market,
- reduces barriers to international trade.

In case of an invoice printing the inventory level must automatically be updated with assigned lot numbers for HACCP tracking.

All the above elements have to be seamlessly integrated. All the processes and the supporting technologies are essential to provide visibility and consistency across the enterprise. An enterprise which looks for the implementation of an ERP system which fulfils the pre-mentioned elements must ensure the integration of database, pattern recognition techniques and chemical analysis applications. Moreover, the benefit will come when these technologies are used properly in order to handle the following:

- data from popular weighing and metering devices including scales and silos, protein analysers, HPLC analysers, GC-MS analysers, NMR, sensors etc,
- data from special data capture and display devices which provide streamline in the production line,
- data relevant to the production process. In the food industry, the process model should allow the user to define inputs and outputs including catalysts, energy, machine set points, recycled materials, products,
- data concerning the dispatch procedures, including van load scheduling. Logistics should take into account the perishable food products which are delivered under specific conditions,
- inventory data, which is a very critical area for manufacturers. Especially in the food industry where raw ingredients must often be reserved long in advance. Suppliers, customers and product capacity must be balanced in long term (Wout V.W. et al. 2005). Superior inventory tracking is necessary which gives the ability to monitor raw ingredients, providing with an accurate view of the inventory status and cost at any given time,
- data which have to be exchanged between all the participants in a supply chain such as the suppliers, the distributors and the resellers.

4. Conclusion

The intense competition among organisations in the food and beverage industry and the international economic conditions, require the provision of high quality food products. In order to achieve such a high quality level, organisations tend to adopt an ERP system to their particular needs, which will guide and support them to reach that quality level. In this paper we proposed a set of requirements which has to be fulfilled in a new enterprise-wide system for the food and beverage industry. When an enterprise adapts such a system can achieve its business goal, which is the production of high quality products. The new enterprise-wide system must have all the necessary functionality and should offer valuable advantages to the top management. The centralized repository with all the information which flow across the enterprise will help the managers and food scientists in the process of the production planning.

Overall, this study raises several issues that should be considered in future ERP implementations in the food and beverage industry. More intensive research, however, is needed in the area of transferring the valuable data from the chemical analysis devises to a pattern recognition application and the results of it to the enterprise-wide system. In addition, this study intends to extend the research in the direction of the technical and managerial aspects of the integration between ERP system, quality system using pattern recognition techniques, traceability system and chemical analysis applications.

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