INTEGRATED APPROACH OF KANO, LEAN AND FMEA IN FEED PRODUCTS

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ABSTRACT
Applications of various quality assurance models play a important role in developing a quality product with less cost and reduced time. In particular, Kano, Lean and FMEA model plays a crucial role in increasing the productivity of any product. This paper outlines the integrated approach and application of KANO, Lean and Process FMEA to feed products industry and the integration of these models is the need of the hour. Integrated approach and application of Kano, Lean and FMEA model was carried out for feed products.

Key words: KANO, Lean, FMEA, Feed Quality, Quality Control, Pelleting, waste, Risk Priority Number and Quality Assurance.

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1. INTRODUCTION
Feed quality represents the major item in the quailty of animal production. Without doubt, efforts will continue to refine feed processing techniques to reduce the cost of feed and to increase the quality of feed for a target animal. The possibilities for improvements in feed processing are never-ending; In some cases, changes in feed processing technology will be dictated, not by animal response, but by other motivations such as regulatory guidelines or human health concerns. A case in points the use of hydro-thermal processes, such as pelleting, extrusion, or roasting to reduce the micro biological load in the feed. These processes have been demonstrated to reduce microbial population to near zero, but may have little or no impact on human health risk. Quality of food of animal origin is nowadays a predominant keyword for everyone in society, basically the consumer and the policymaker, but also the producer and the specialist of animal production. Because of an increasing diversity in the number of species involved and of products marketed fresh or processed, quality of animal products has received many definitions and understandings.

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2. LITERATURE REVIEW

M. Thomas D. J. Van Suijilchem Af. B. Van der Poel. has outlined the effects of changes in process parameters and their effect on pellet quality in terms of hardness and durability. The pelleting process in this respect is the combination of conditioning, pelleting and cooling. The parameters discussed with respect to the conditioning process are process variables such as steam and water and system parameters such as residence time and pressure. Parameters during the pelleting process that can be adjusted or influence pelleting properties of a feed mash include layout (e.g. flat-bed vs. ring-die pellet press) and dimensions, roller and die assembly and die velocity of the pellet press. The effect of the changes in one or more parameters and its effect on pellet quality (durability and hardness) is however often a matter of the judgment and experience of the operator. The feed quality as defined as “any of the features that makes something what it is” and “the degree of excellence which a thing possesses”. A quality feed would supply all nutrients in adequate quantity and in high digestibility and ingestibility Anon (1991). Since actual quality assurance, control policies and procedures must be adapted to the needs of each facility. All the above literature indicates that there requires consistency quality in operational level and service level. So the need of the hour is to look into details of quality assurance tools in agro industries to enhance the feed quality. In particular Kano, Lean and FMEA models are explored for feed quality. The goal of Kano is to increase customer satisfaction and build long-term trust with customers. By means of classified surveys the products and services can be adapted to the wishes of the customers. A high-quality product creates customer satisfaction. In the 1980s Professor Noriaki Kano developed a model to describe the satisfaction of customers with products or services and to make them measurable. The basic principle of the Kano model is the classification of product characteristics with the three categories Alena Dressen et al.(1994),

(i) Basic (must be)
(ii) Performance (one dimensional) (iii) Excitement (delighters)

This model also classifies customer preferences into five categories: attractive, one-dimensional, must-be, indifferent and reverse. The Kano model defines various product attributes that are considered important to the customers. Most traditional techniques identify the importance of the performance of attributes and customer satisfaction as non-linear. It suggests attributes as “must-be”, “one-dimensional” or attractive Kano et al.(1984),Berger.C et al.(1993), Matzler et al.(1998), Nilsson-Witell et al.(2005).

i) "Must-be" attributes refer to the basic features of the product or service. These are requirements that the customers expect and which are considered self-evident. When done well, customers are just neutral, but when done poorly, customers are very dissatisfied Alena Dressen.

ii) One-dimensional attributes lead to satisfaction when these are met. And dissatisfaction, if these is not fulfilled. Higher performance brings higher satisfaction and vice versa.

iii) Attractive attributes bring superior satisfaction, if present, but they do not bring dissatisfaction when they are not present or inadequate. These are attributes that are not normally expected.

Two further attributes can be identified in the Kano model: "Neutral" and "Reverse" attributes.

i) Neutral attributes do not bring satisfaction or dissatisfaction.

ii) "Reverse" attributes are the most remote attributes. These are the requirements that cause dissatisfaction.
The most important statement of the Kano model is that a product does not have to have all the functions, but only those that contribute to customer satisfaction. Therefore, customer surveys are the most important data source for working with the Kano model.

The Contribution of Kano model to various industries and in special feed quality was presented.

In 1984, Kano presented his theory of "attractive quality and must-be quality" in the Western world. Through the conceptual elaboration of the Kano methodology, which includes a specific questionnaire for the classification of quality attributes, a new research field was born. Kano, N. (1995).

The traditional approach to the classification of attributes and Witell et. al., (2013) draws the conclusion that more exploration of other approaches is required. For this reason, we are advised to use the traditional five-level Kano-questionnaire. Matzler and Hinterhubers (1998) has described the deal with the link between the Kano methodology and other methods such as QFD, SERVQUAL and FMEA. The most common is a combination of the Kano methodology and QFD Lars Wiell, Martin Lofgren (2007). Instead, researchers published papers that introduced new fields of application for empirical studies and modified versions of the Kano model.

The Lean service applications, tools and techniques in service industries researchers and main contributions to the Lean service sector was highlighted by Higor Dos Reis Leite and Guilherme Ermai Vieira (2015). According to Womack et al., 1990, the principles of lean manufacturing are five, namely: Value Specification, Value stream mapping, flow optimization, pull production system and perfection or continuous improvement. The use of Lean Manufacturing Tools and the corresponding shift in philosophy, in to food and

Beverage industries, the application of Lean Manufacturing tools in the production system of these companies was discussed Rui Borges Lopes et al (2015). Dimitrious Folinas et al., (2013) has described the three-step approach for measuring the environmental performance of specific supply chains in agro food sector based on the VSM techniques was proposed and analysed: mainly on production costs, higher risks and competition for resources by the producers. The classification of seven wastes was proposed by M. L. Emiliani, D. J. Stee, (2005) of a business process and included the following: Overproduction, waiting, Transportation, processing, Inventories (raw material, work- in-process and finished goods moving (movement) both operator and machine and defects: Defective products or process outputs and some of the techniques used are Take time, Kaizen, Statistical process control, Poke -yoke, 5S, Value stream Mapping (VSM), TQM, Kanban and Jidoka,

Higor dos Reis Leite and Guilherme Ermai Vieira (2015) has described the Lean service applications, tools and techniques in services industries researchers and main contributions to the Lean service sector. According to Womack & Jones (2003), has suggested the uses of the principles of lean manufacturing are five, namely: Value Specification, Value stream mapping, flow optimization, pull production system and perfection or continuous improvement. Rui Borges Lopes et al (2015) has highlighted the use of Lean Manufacturing Tools and the corresponding shift in philosophy, in two food and Beverage industries, the application of Lean Manufacturing tools in the production system of these companies. The development of supply-chain management in a food chain with a special reference to the Lean production concept was discussed Ulla Lantinan and Margit Torkko (2005).
The FMEA being a risk assessment tool that mitigates potential failure in system, design, process or service. It was widely used to define, identify and eliminate known and potential failures, problems, and errors. In recent years, there has been more research about FMEA application in the healthcare system Hu-Chen Liu, et al (2014). FMEA has extensively used as a powerful tool for safety and reliability of products, industries particulary, nuclear, aerospace, automotive, chemical, mechanical, medical technologies and electronics Sharma, R. K., Kumar, D., Kumar, P. (2005). FMEA is a widely used by reliability practitioners in America, European and Japan manufacturing companies Chen J. K. (2007).

In general, the risk priorities of failure modes through the Risk Priority Number (RPN), are calculated as a product between the probabilities of the severity (S), occurrence (O) and detection (D) of failure. That is $RPN = S \times O \times D$ The three risk factors (S, O, D) are evaluated using the 10-point scale described in Table 1 – 3

Chang, K. H et al. (2010), Z. Yang nad J. Wang et al.(2015). Those failure modes and causes that have the highest scores should then be addressed through product redesign.

The criticality assessment approach based on qualitative rules which provides a ranking of the risks of potential causes of failure. The structure of the qualitative rules was of the if-then rule in the FMEA were shown in the form of a three-dimensional Puente et al., (2002). A general FMEA framework for capturing the failures due to system/component interactions at the product architecture (PA) level Nepal, B. P. et al.,(2008). The application of fuzzy FMEA to an auxiliary feed-water system of a two-loop Pressurized Water Reactor (PWR) has been stated by these authors Guimaraes, A. C. F., et al., (2004a) (2004b) (2006) (2007). The application of FMEA to risk management in the construction industry using combined fuzzy FMEA and fuzzy AHP. FMEA innovation can become a more powerful tool for safety and reliability analysis of systems, processes, designs and services in the organization when know the risk factor and risk priority method are appropriate and suitable to the specific risk evaluation problems Abdelgawad, M., & Fayek, A. R. (2010).

Sibel Ozilgen (2013), conducted a Failure mode and effect analysis for dairy product manufacturing and Implementation of the recommended actions appeared to have reduced the RPN values below the acceptable limit. It has been widely used by manufacturing companies for quality and safety assurance. Near the beginning and steady use of FMEAs in the design process let to the engineer to drawing out failures and manufacture dependable, protected, and customer satisfying goods. FMEAs also carry chronological information for use in upcoming product development Bo Bergman & Bengt Klefsjo (2010).

3. INTEGRATED APPROACH OF KANO LEAN AND FMEA [KLF]

The KLF Model has been developed based on two important traditional models, namely, KANO, LEAN and FMEA . The KLF Model has been developed based on two important traditional models, namely, KANO, LEAN and FMEA . The integration of these models was developed in a stage wise manner. The validation process of the model was built in a stage wise fashion. The following are the steps for the development of KLF Model

STEP-1: Requirement Analysis
Categorize the requirements and prioritize them based on the expectation of the customer needs and satisfaction level using Kano model. Get the product requirements from the customers or users with all its functionalities and features of project using Kano model.
STEP-2: Categorize and Prioritize Requirement
Categorize and prioritise the requirements in the KLF model

STEP-3: Identify the Critical-To-Quality (CTQ)
Identify the Critical-To-Quality (CTQ) or defects or new requirements in the software development phases and eliminate the unwanted process and implement the main functionality in the process.

STEP-4: Calculate the Risk Priority Number (RPN)
Calculate the Risk Priority Number (RPN) and check whether if there changes in functionalities in process have their causes and desired effects in current process.

STEP-5: Thought Process Mapping (TPM)
Document the CTQ or defects or new requirements and solve the issues by Thought Process Mapping (TPM) through which we can visualize the actual problem, and we can apply all ideas to solve the problem or issue.

STEP-6: Process Flow Map
Create a Process Map to know how the process works with all existing functionality in the current process.

STEP-7: Pareto Chart and Brain Storming
Perform Pareto Chart analysis and Brain Storming techniques to encourage creativity

STEP-8: Failure Mode Effects Analysis (FMEA)
Identify non-value added process using Failure Mode Effective Analysis (FMEA)

STEP-9: Risk Priority Number (RPN)
Compute the Risk Priority Number (RPN) using the formula

\[ \text{RPN} = \text{Severity} \times \text{Occurrence} \times \text{Detection} \]

STEP-10: Improved New Process Flow
Eliminate time delays in the process using Thought Process Mapping (TPM) and create the new improved process flow.

STEP-11: Calculate The Risk Priority Number (RPN 1 & RPN 2)
Check if the specific changes in the process have desired effects and their causes by calculating the RPN 1 and RPN 2. If new process flow is more effective than the current process continue the process otherwise repeat the step 1 to 10

STEP-12: Control Mechanism
If new process has desired effects and causes then Finalize the Process Improvement Method and standardize the new process flow.

These steps advocates three models namely kano, lean and FMEA in an integrated approach. Any standard agro industry can be taken as case study for further data analysis and validation.
4. RESULTS AND DISCUSSIONS

Cause and Effect Analysis

Cause and effect Analysis was devised by Kaoru Ishikawa, a pioneer of quality management, in the 1960’s. It is a diagram-based technique which combines brainstorming with mind map, helps to identify all of the likely causes for the failure effects with the help of experts. Since there is no historical failure data available for the production line, literatures may suggest that cause and effect analysis would found to be useful. There are five potential causes were identified in the poultry feed production line. They are listed in the below:

i) Material shortage
ii) Process delay
iii) Product will be out of specifications
iv) Product line stoppage
v) Production loss.

Evaluation Criteria

In this section, each potential cause is ranked based on the evaluation criteria settled up. The criteria for severity, occurrence and detection are given below:

An FMEA uses three criteria to assess a failure mode:

i) The severity of the effect on the customer and the consumer. ii) How frequently the problem is likely to occur.

iii) How easily the problem can be detected. Personnel’s must set and agree on a ranking between 1 and 10 (1 = low, 10 = high) for the severity, occurrence and detection level for each of the failure modes. Although FMEA is a qualitative process, it is important to use data (if available) to qualify the decisions the team makes regarding these ratings. To reduce the system risk level, it is decided to intervene in the system when the RPN was equal to or greater than a threshold value of 50, or when the severity of the failure was considered too high to permit the potential occurrence of the failure. The reason of this choice is that with a statistical confidence of 95% and a maximum number possible for RPN of 1000(10 X10 X10), the threshold is 5% of 1000. The intervention was based on the identification of a list of “Recommended Actions” that could prevent the failures, reducing the rate of occurrence and detection. (c) Recommended Actions The criteria used to evaluate these failures were the amount of damage caused to the production in terms of lost production volume, idle time of the plants, waste of raw material and resources, maintenance costs, etc. Observing the threshold RPN, it can classify the risks into corrective and non-corrective risks. Risk that has RPN more than 50 are categorized as corrective risk otherwise categorized as non-corrective risk. The reading of the table reveals the potential RPN failures individuated in the production cycle. There are reasons for this result; high values of occurrence and detection and high value of severity. To reduce that when a problem is discovered, it should be addressed and resolved as soon as possible. These failures can be easily prevented through the execution of the recommended action such as periodic maintenance of the machines, SOPs and training the operators.

5. CONCLUSION

A detailed literature study about the various quality models was discussed ie Kano, Lean and FMEA. Their applicability in the area of Agro Industries (Feed Products) was searched. The Literature study highlights that Kano, Lean and FMEA has only limited work and carried out independently in the area of feed products. The literature study shows that integrated approach of Kano, Lean and FMEA model was not carried out earlier in the feed products.
The integration of these models for Agro Industry (feed products) is an innovative approach. The KLF was developed and applied in a feed mill for feed products and it shows considerable improvement in quality. This is a pioneer work in feed products.

REFERENCES

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Integrated Approach of Kano, Lean and FMEA in Feed Products


BIOGRAPHIES

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