Application of FEMA and RPN techniques for man-machine analysis in Tobacco Company

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Abstract: With the rapid growth of the industries and commercial space being more competitive attention to quality control and most importantly to produce zero defect products has become more important than ever. Retaining customers, attracting new customers, and making them loyal require many efforts among which producing competitive, high quality, and zero defects products enjoys the highest weight. Recognition of errors and defects in production lines which cause reduction in product quality is an effective lever to eliminate errors and improve the existing situation. In this paper, failure modes and effects analysis (FMEA) technique has been utilized to find errors and their causes in the production line of the Iranian Tobacco Company. With the completion of FMEA table and calculating Risk Priority Number (RPN) values, all errors were zoned and prioritized. The prioritization of the discovered errors based on FMEA

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PUBLIC INTEREST STATEMENT

This paper is a Case Study in Iranian Tobacco company production line. Using failure modes and effects analysis (FMEA) and Risk Priority Number (RPN) technique and forming FMEA team which consists of three quality control experts, three technicians, three operators, and the researcher, discovering existing errors and their causes in three human, technology and process have been considered. By identifying errors and prioritizing them through FMEA, three following goals are sought:

- Identifying various types of human, technology, and processes errors in Tobacco Company.
- Identifying and prioritizing the most important failures to meet.
- Identifying the most important factor in error occurrence.
technique indicated human error as the most important factor in the emergence of errors.

**Subjects:** Production Engineering; Control Engineering; Production, Operations & Information Management

**Keywords:** Error analysis; production line; quality control; FMEA technique

1. **Introduction**

Competition and struggle to survive in today’s industrialized world in which many factories around the world produce a wide range of different market-requiring goods has become a unique goal. Retaining existing customers, attracting new customers, and making them loyal to your products need intellectual and continual efforts. Quality control in production lines is an appropriate way for achieving this important goal. Before World War II, Japan was known as the producer of cheap and poor goods. After World War II, it tried to enter international markets with the help of quality control methods. Since 1970, Japan has been able to gain the trust of world markets due to its high quality and desirable commodities and has gained the world market in many different fields.

Fault mode and effect analysis (FMEA) is a way that helps significantly to identify different types of errors. FMEA is an experienced and very useful technique to detect, classify, analyze errors, and evaluate the risks arising from them to prioritize the errors in desirable and appropriate manner to prevent them from reoccurring (Dinarvand & Hashemian, 2015).

By identifying the potential causes of errors in production lines and achieving the critical ones with high priority, beneficial ways and concepts such as POKA-YOKE can be used to remove them. POKA-YOKE is based on the belief that few defective products should not even be produced. To become a global competitor, a company must not only pursue products with zero defects, but also apply it (Kouchakzadeh & Ganji, 2014).

In general, errors present in production lines can be caused by human, technology, and process factors which are focused on in this paper:

**Human error:** Human factor is directly causing the errors such as slip (workplace environment such as noisy environment or dark places causes these errors) or carelessness.

**Technology error:** All errors that occur in the production lines are not related to human factor. Errors caused by machines or technology used in production are categorized under technology errors. Equipment amortizations or lack of a precise sensor to detect errors are assumed as technological errors.

**Process error:** Although over 90% of accidents are directly or indirectly related to human factors, and human error is considered the most important cause of accidents, process errors are of high degree to cause accidents (Jafari, 2012). Incorrect operation method, incorporating inappropriate materials in production lines, incorrect design of work procedures and, generally, any error resulting from the incorrect definition of the processes is categorized under the process errors.

In the present paper, investigating Iranian Tobacco Company as a top company in Guilan, identification and evaluation of various errors in the company production line, and fixing the errors using FMEA method will be explored.

Because of eliminating the monopoly of tobacco company via privatization, increasing trend of competition in tobacco market, and also having free space of smuggling different tobacco products, identifying and removing existing errors in Iranian Tobacco Company production line,
increasing efficiency and production quality, and, therefore, increasing the rate of competitive and qualified products in this unfair market atmosphere are important factors in maintaining and promoting the place of this vital industry which is covering a wide range of people as well as government organizations under its supportive umbrella.

As mentioned earlier, this paper is a case study in Iranian Tobacco Company production line. Using FMEA technique and forming FMEA team which consists of three QC experts, three technicians, three operators, and the researcher, discovering existing errors and their causes in three human, technology and process based on literature review and reviewed articles have been considered. By identifying errors and prioritizing them through FMEA, three following goals are sought:

1. Identifying various types of human, technology, and processes errors through case study in the Tobacco Company.
2. Identifying and prioritizing the most important errors to analysis their effects.
3. Identifying the most important factors of errors that to be the occurrence.

2. Literature review
Several studies have been done on production to detect existing errors in production lines along with the ways dealing with them. The focus of many such studies has been on the performance of technical variables, and the importance of non-technical variables such as human errors and customers are ignored in spite of the fact that the role of human error, especially in these days is much bolder. Nan and Sansavini (2016) proposed a hierarchically based modeling approach aiming to show the explicit effect of human performance on the infrastructure systems. In this approach, the recognition components play an effective role. So, an analytical method based on the Cognitive Reliability Error Analysis Method (CREAM) using a knowledge-based approach has been presented (Nan & Sansavini, 2016).

One of the fundamental problems in manual assembly workshops is human error during operation. To overcome this problem, different approaches such as focused staff training, POKA-YOKE tools or invasive measuring systems for monitoring the process and identifying inaccurate procedures or errors in connecting components are now being used. In a case study, Dalle Mura, Dini, and Failli (2016) suggested an innovative system, based on the interaction between a force sensor and an augmented reality (AR) equipment. This system was used to give the required information to the operator on the correct assembly sequence and alerted him when an error occurred. This system caused a dramatic reduction in human error in the case study mentioned.

In addition to the human error, there are other errors that lead to reduced quality or problems in the production process and reduced efficiency. These errors, which in turn can have a big role in reducing competitiveness, can result from certain sources such as raw materials, technology used, manufacturing process, and so on. In recent years some interesting researches have been done in this regard. Guo and Yang (2015) developed a method for detecting heat loss error at workshop level. In this context, the dynamic and hierarchical energy consumption model (DHECM) of the thermodynamics theory in the existing process was offered. Eventually, they could estimate the heat loss by better performance and could help to find errors in lower levels.

To improve the preciseness of the cutting, Engin, Guiassa, Mayer, and St-Jacques (2015) proposed an approach to compensate cutting process errors. Loss compensation is the modification of the tool dimension and path using information on the machine. Accordingly, they developed a depth cutting distribution-based approach to calibrate cutting process according to the on-machine error discovery model. The results showed that the approach was effective and had resulted in significant error counts.
These days a lot of attention is paid to quality control of machine processes to ensure the product quality. Since the quality change consists of composite errors, error control is the key point in product quality approval. Despite the critical importance of this issue, unfortunately, we see that the prediction error methods are not used to prevent it. Gao, Ran, Wang, and Zhong (2015) proposed a new method comprising error prediction based on error change mechanism in order to control the error sources in multi-stage machine processes for the purpose of improving product quality.

Factories and companies are frequently trying to employ methods and tools to improve efficiency and quality for long-term success so as to enhance their competitive advantages. From this perspective, one of the most successful concepts to eliminate waste and worthless activities taking place in many companies is the essence of lean manufacturing principle. Choomlucksana, Ongsaranakorn, and Suksabaia (2015) conducted a case study using the application of lean manufacturing principles in producing metal stamping sheets to identify the chances of reducing wastes and improve efficiency.

Most manufacturing industries, especially small and medium industries are unwilling to automate their production lines using robots. This is due to the fact that the majority of industrial robots are not suitably equipped to recognize their surroundings and make intelligent decisions based on production. In a case study, Ahmad and Plapper (2016) introduced a ToF sensor based on intelligent data collection and decision-making methodology to have the unknown and un-programmed obstacles concentrate and suggested a secure process of peg-in-hole automated assembly so that the importance of using robots in small industries can be clearly known.

In another case study, Gijo and Scaria (2014) showed a successful implementation of Six Sigma methodology along with Beta correction technique in an automotive part manufacturing company. They could thereby reduce capabilities problems and make a considerable improvement in their production process.

Currently, most studies about identification and classification of human errors and factors related to accidents are focused on organized accidents in high-risk systems, and the occupational accidents of manufacturing have been ignored. Maldonado, Reyes, Riva, Rodolfo de la, and Woocay (2015) produced an article to evaluate the relationship between occupational accidents including hand injuries in the automotive manufacturing industry that offered a quantitative study with a cross-correlation design. They determined human error as the main cause in creating occupational accidents. Having reviewed the studies and a variety of errors discovered by the researchers with the tools to remove or correct them, the researcher proceeds the present research.

3. Research methodology

To achieve the objectives of the present study, we need to explain some steps which can contribute to better understanding of the issue. In order to identify and evaluate various human, technological, and process-based errors, studies in the field of zero defect processes were explored, and with the help of POKA-YOKE concepts in categorizing error and reviewed studies, the researcher is to organize the discovered errors in Iranian tobacco production line in three categories of human, technology and process. Having the errors identified, completing the FMEA table were attempted to specify the three main FMEA factors such as severity, occurrence, and detection for error prioritization and exploring the most important factor in the emergence of errors detected. After explaining FMEA to the people engaged with the project, the related table was completed. Calculating RPN which is made of multiplying the three main factors of severity, occurrence, and detection lets us prioritize errors using FMEA rating chart so that it was easy for us to find the most prioritized and, consequently, the most critical errors and consequently the most important factor in creating these errors in the company product line and remove them in order of preference. POKA-YOKE principles can play a significant role in achieving the ideal state of zero defect quality control.
4. Case study: cigarette production process

Tobacco is the main material of cigarette. Tobaccos processed in processing section are transferred from silo to the cigarette factory through sucking pipes. Figure 1 illustrates the process of cigarette production.

Upon the arrival of tobacco in Protose, cigarette filters enter the machine through shooting to complete the process of cigarette production. Produced cigarettes are transferred to packaging machines. In GD machine, combined with foil, paper, and pack stamp, packs of 20 cigarettes are produced. These packs will be moved to CT to be covered with cellophane. Then, CT packs them in a 10-pack box. The boxes are covered by CH machine with cellophane to protect cigarettes from moisture. Finally, the process ends up with packaging 50 ten-pack boxes in cartons by worker to transfer them to the stock house.

5. Fill the FMEA worksheet

With the help of a 10-member team consisting of three QC experts, two technical experts in mechanics, two technical experts in electricity, two operators and the researcher, monitoring the production line begun. Having the team members justified about the concepts of POKA-YOKE and FMEA method, the reason of error occurrence, the effects of errors, and the three main factors of FMEA in a 1–10 range consistent with the characteristics of each error, Table 1 was made.

The frequency of discovered errors was achieved over a period of 3 months via observation and referring to QC record sheets for errors. The frequency helped us in filling in the FMEA table that will be discussed later.

To calculate the amount of RPN for each error and prioritize them, the researcher used Excel software.

It should be noted that the English letters of Pr, W, H, T, and P in Table 1 stand for Protose, Worker, Human, Technology and Process factor, respectively.

6. Discussion and the research findings

6.1. Plotting FMEA area chart

This chart is used at times when the RPN is equal, but the factors are different. For instance, suppose two errors with the same 12 RPN. The main factors in the first error factors of severity, occurrence, and detection are 2, 2 and 3 and in the second one are 3, 4 and 1, respectively. It can be observed that these two errors are different with regard to the three major factors since severity and occurrence are two important factors in zero defect for producing activities. Plotting FMEA chart based on these factors, the researcher tried to prioritize and discover the results achieved.
Table 1. FMEA worksheet and errors

| Factor       | Number | Error                          | Errors’ reason                                                                 | Errors’ effects                                                                 | Severity | Occurrence | Detection | RPN   | Morning shift | Afternoon shift | Night shift | Total |
|--------------|--------|-------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------|----------|------------|-----------|-------|---------------|----------------|-------------|-------|
| H.Human      | 1      | Pr                            | Non-tobacco materials in cigarette                                           | Inappropriate separation of non-tobacco materials, especially when Burak       | 2        | 2          | 9         | 36    | 10            | 11             | 9            | 30    |
|              | 2      | GD                            | Labels in wrong position                                                     | Slip                                                                            | 7        | 2          | 2         | 28    | 11            | 9              | 12           | 32    |
|              | 3      | W                             | Missed carton in case                                                        | Carelessness                                                                    | 8        | 2          | 2         | 32    | 8             | 5              | 12           | 25    |
|              | 4      | W                             | Wrecked carton in case                                                       | Carelessness                                                                    | 8        | 5          | 8         | 320   | 30            | 20             | 50           | 100   |
|              | 5      | W                             | No glue on one/bath sides of case in wrapping                                | Carelessness                                                                    | 8        | 4          | 1         | 32    | 21            | 18             | 28           | 67    |
|              | 6      | GD                            | No coding on packs                                                          | Operator carelessness                                                          | 8        | 3          | 2         | 48    | 18            | 15             | 20           | 53    |
|              | 7      | W                             | Wrong coding on right case                                                   | Carelessness                                                                    | 9        | 6          | 3         | 162   | 43            | 37             | 52           | 132   |
|              | 8      | Pr                            | Tipping paper                                                                | Cutter misalignment and dullness                                              | 10       | 7          | 4         | 280   | 79            | 64             | 83           | 226   |
|              | 9      | Pr                            | Cutting cigarette roads in a bad shape                                        | Cutter misalignment or dullness                                               | 2        | 5          | 4         | 40    | 20            | 15             | 19           | 54    |
|              | 10     | Pr                            | Change in cigarette paper color                                              | High temperature heaters                                                       | 8        | 3          | 3         | 72    | 19            | 21             | 20           | 60    |
|              | 11     | Pr                            | Weight less/more than the standard cigarette                                | Unadjusted machine                                                             | 8        | 6          | 5         | 240   | 79            | 75             | 74           | 228   |

(Continued)
| Number | Factor | Number | Error | Errors’ reason | Errors’ effects | Severity | Occurrence | Detection | RPN | Shift plenty |
|--------|--------|--------|-------|---------------|----------------|----------|------------|-----------|-----|--------------|
|        |        |        |       |               | Reduction in tobacco moisture |          |            |           |     | Morning shift  |
|        |        |        |       |               |                |          |            |           |     | Afternoon shift|
|        |        |        |       |               |                |          |            |           |     | Night shift   |
|        |        |        |       |               |                |          |            |           |     | Total        |
| 12     | CT     | Cutting poly wrap in a bad shape | Cutter misalignment or dullness | Reduction in tobacco moisture | 4 | 2 | 5 | 40 | 13 | 10 | 14 | 37 |
| 13     | CH     | Improper packed carton | Misalignment in CH | Change in product appearance | 8 | 2 | 2 | 32 | 19 | 22 | 17 | 58 |
| 14     | CV     | Halogram in wrong position | Unadjusted machine | Change in Carton appearance | 3 | 5 | 1 | 15 | 12 | 14 | 15 | 41 |
| 15     | Pr     | Short/long cigarette | Unadjusted Cutter | Tobacco loss or customer dissatisfaction | 9 | 5 | 3 | 135 | 44 | 37 | 42 | 123 |
| 16     | Pr     | Script on cigarette roads | Misalignment in related bent | Change in cigarettes appearance | 1 | 5 | 1 | 5 | 5 | 4 | 4 | 13 |
| 17     | Pr     | Smithereens of cigarettes at the junction of cigarette paper | Road path is not cleared, opening road guard | Cigarette bad shape | 1 | 8 | 2 | 16 | 11 | 10 | 6 | 27 |
| 18     | Pr     | Filter fall off | Related path is not cleared or device misalignment | Jams in GD, the product is not used | 9 | 6 | 5 | 270 | 80 | 73 | 84 | 237 |
| 19     | GD     | Pack stamp wrong position | Related path is not cleared or device misalignment | Customer dissatisfaction due to bad packaging | 9 | 9 | 4 | 324 | 80 | 76 | 91 | 247 |
| 20     | GD & CH | Unclear printing | Printer is not cleaned or has problem | Problem from QC point of view and negative affect on customers | 9 | 8 | 4 | 288 | 78 | 66 | 84 | 228 |
| 21     | GD & CH | No printing | Printer is not cleaned or has problem | Acute problem due to legal requirements | 9 | 7 | 4 | 252 | 74 | 60 | 71 | 205 |
| 22     | CT     | Wrapping poly wrap with open side | Heater is dirty | Reduction in tobacco moisture and cigarette loss end | 8 | 7 | 5 | 280 | 72 | 63 | 91 | 226 |
| Factor | Number | Error | Errors’ reason | Errors’ effects | Severity | Occurrence | Detection | RPN | Shift plenty |
|--------|--------|-------|----------------|----------------|----------|------------|----------|-----|--------------|
|        |        |       |                |                |          |            |          |     | Morning shift | Afternoon shift | Night shift | Total  |
|        |        |       |                |                |          |            |          |     | 23 CT | Wrapping poly wrap with open bottom | Heater is dirty | The moisture content of tobacco and its loss | 8 | 7 | 5 | 280 | 67 | 58 | 88 | 213 |
|        |        |       |                |                |          |            |          |     | 24 CH | Cartons bad shape | The related path is dirty | Improper packaging and customer dissatisfaction | 10 | 3 | 10 | 300 | 65 | 60 | 60 | 185 |
|        |        |       |                |                |          |            |          |     | 25 CT & CV | Unclear printing | Printer is not cleaned or has problem | Problem from QC point of view and negative affect on customers | 8 | 7 | 5 | 280 | 66 | 59 | 83 | 208 |
|        |        |       |                |                |          |            |          |     | 26 GD & CH | Wrong coding | Carelessness | Creating difficulty in tracking goods produced | 9 | 7 | 4 | 252 | 61 | 42 | 44 | 147 |
|        |        |       |                |                |          |            |          |     | 27 Pr | Defects of filter tiny holes | Laser out of date and defect in it | Customers feels cigarettes are not light during smoking | 8 | 5 | 7 | 280 | 54 | 49 | 60 | 163 |
|        |        |       |                |                |          |            |          |     | 28 Pr | Loos end | Technical problem | Customer dissatisfaction | 10 | 6 | 4 | 240 | 73 | 65 | 80 | 218 |
|        |        |       |                |                |          |            |          |     | 29 GD | Gap between filter and tobacco in cigarettes | Technical failures in devices | Low tobacco, GD stop, customer dissatisfaction | 10 | 5 | 3 | 150 | 28 | 35 | 40 | 103 |
|        |        |       |                |                |          |            |          |     | 30 GD | Foil in bad position | Unadjusted rollers | Loos of tobacco and cigarette obviousness | 8 | 4 | 5 | 160 | 42 | 39 | 51 | 132 |
|        |        |       |                |                |          |            |          |     | 31 GD | Script on pack | Dried glue in the path due to extra glue | Change in pack appearance | 7 | 9 | 4 | 252 | 80 | 72 | 83 | 235 |
|        |        |       |                |                |          |            |          |     | 32 CV | No carton tear tap | Tape wrapped around the rollers | Difficulty in opening product and customer dissatisfaction | 10 | 5 | 6 | 300 | 60 | 53 | 82 | 195 |
|        |        |       |                |                |          |            |          |     | 33 GD | Pack side or bottom is open | Drying head of gluer nozzle | Improper packaging and customer dissatisfaction | 8 | 5 | 2 | 80 | 23 | 21 | 26 | 70 |
|        |        |       |                |                |          |            |          |     | 34 GD | Extra gluing | Misalignment and technical problem | Causing quality problems in appearance | 9 | 6 | 3 | 162 | 64 | 50 | 49 | 163 |
| Factor       | Number | Error              | Errors' reason                                      | Errors' effects                                     | Severity | Occurrence | Detection | RPN       | Total       |
|--------------|--------|--------------------|-----------------------------------------------------|-----------------------------------------------------|----------|------------|-----------|-----------|-------------|
|              |        |                    |                                                    |                                                    |          |            |           |           |             |
| P. Process   | 35     | 5                  | Buttery fly in tobacco                              | No on time spraying                                 | 10       | 3          | 10        | 300       | 0           |
|              |        |                    |                                                    | Significant losses for customer health              |          |            |           |           |             |
|              | 36     |                    | Any changes in raw materials                       | Lack of quality in supplier material or material damaging by transportation | 10       | 8          | 4         | 320       | 86          |
|              |        |                    |                                                    | Rising in different types of waste                  |          |            |           |           | 75          |
|              | 37     | GD                 | No pack stamp                                       | Bad pack stamp                                      | 10       | 6          | 4         | 240       | 65          |
|              |        |                    |                                                    | Improper packaging and customer dissatisfaction     |          |            |           |           | 60          |
|              | 38     | GD                 | Pack stamp in wrong position                       | Pack stamp is cut bad                               | 9        | 8          | 4         | 288       | 83          |
|              |        |                    |                                                    | Change in product appearance                        |          |            |           |           | 69          |
|              | 39     | CT & CV            | Any rupture in poly wrap                           | Bad raw materials                                    | 8        | 2          | 3         | 48        | 17          |
|              |        |                    |                                                    | The moisture content of tobacco and its loss        |          |            |           |           | 19          |
|              | 40     | CH                 | Openness one or two sides of carton                | Drying head of glue not able                        | 10       | 8          | 5         | 400       | 85          |
|              |        |                    |                                                    | Improper packaging and customer dissatisfaction     |          |            |           |           | 83          |

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In this method, the graph of high severity and high occurrence is divided into four areas that includes the first area containing errors with high severity and high occurrence, the second area containing errors with high severity and occurrence lower than 5, the third one containing errors with severity lower than 5 and high occurrence, and the fourth one containing errors with both severity and occurrence lower than 5. Having the chart drawn, the errors will be prioritized based on RPN in each area. The priorities areas are from 1 to 4 in order.

Generally, having investigated the errors in the production line and divided them into four areas, their priorities were found. Among the errors in each area, the error with higher PRN was prioritized to others. With this issue in mind, the prioritization of all errors was made.

As shown in Figure 2, the majority of errors in the first area and the critical area are subject to human errors. This implies the high priority of human errors.

For more accuracy, errors in each area were prioritized based on related RPN in Table 2. It should be noted that Table 2 is prepared in accordance with the FMEA area chart in Figure 2.

In each row in Table 2, the errors are specified in error number and three factor types for more clarity. Accordingly, the errors in factor type H, T, and P refer to human factor, technology factor and process factor, respectively. As it is clearly shown, human error with the highest frequency is the most important and prioritized factor.

7. Conclusions
With the ever-increasing advances in technology and the birth of modern industries and the international markets being more competitive, maintaining the existing customers, attracting new customers, and focusing on their loyalty to products and new customers build the foundation of any company’s survival. Producing high-quality products is an appropriate strategy to
| Area  | Priority no. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|-------|--------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| First | Error no.    | 40| 19| 4 | 36| 32| 20| 38| 8 | 22| 23 | 25 | 27| 18 | 21 | 26 | 31 | 11 | 28 | 37 | 7 | 34 | 29 | 15 | 33 |
|       | Factor type  | P | H | P | T | H | P | H | H | H | H | T | H | H | H | H | T | H | T | P | H | T | T | H | T |
| Second| Error no.    | 24| 35| 30| 10| 6 | 39| 3 | 5 | 13| 2  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|       | Factor type  | H | P | T | H | P | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H | H |
| Third | Error no.    | 9 | 17| 14| 16|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|       | Factor type  | H | H | H | H |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Fourth| Error no.    | 1 | 12|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|       | Factor type  | H | H |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
achieve this goal. This would only be reached by focusing on the production line. Identifying the existing errors in production lines and trying to fix and prevent the occurrence of them are extremely helpful to increase the quality of products and save time during manufacturing. Fault mode and effect analysis method is a beneficial way of discovering errors and their causes. Thus, we used FMEA methodology to identify errors in the production line of Iranian Tobacco Company. The value of RPN for each error was calculated, and the errors were prioritized in four areas via FMEA chart. The results showed that human factor is the main factor in making production line errors compared to technology and the process factors. Therefore, it is recommended that a field study be conducted about the factors causing these human errors. Factors such as unequal income with work-related stress, lack of adequate motivation, existing disparities among different levels can affect the occurrence of these problems.

Regarding the other discovered errors and in line with having a production line with no-error, the implementation of POKA-YOKE concepts and zero defect processes employing several tools are recommended to remove the errors. A variety of sensors or even simple methods that workers sometimes design and offer to remove and avoid repeating the errors are such tools. In the end, a model which reduces errors to zero was presented. For explaining the beneficial side of this study, a simple calculation is given. Each pack of cigarette costs one dollar, and the average number of packs in each production line is 300 per minute ending up to 300 dollars in each minute. It means that in a department with three shifts working a day and an average number of 10 production lines, 9000 dollars can be earned for each minute saving.

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