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Bakery Bread Production System Analysis with Failure Mode and Effect Analysis Method: Case Study of the Armina Food Bread Business

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Abstract

Bread was first developed during the Mesopotamian culture in the Egyptian region 10,000-12,000 years ago. Bread is a food product processed from fermenting wheat flour with yeast or other rising agents, then baking. The development of bread in Egypt then spread to Greece until it finally spread throughout Europe. Armina Food Bread Business in Gresik is a business that operates in the field of bread production. However, Armina Food's bread business experienced problems in bread production which was not optimal and stable, especially in terms of bread sales which experienced a decline due to bread production defects. Research regarding the risks of bread production was carried out at Armina Food Bakery Business using the Failure Mode and Effects Analysis (FMEA) method. FMEA is an analysis technique that identifies production process failures and plans to prevent them from happening again. Bread production risk analysis is carried out by identifying and measuring the risks of fresh bread production. The FMEA method aims to identify risks by considering the criteria of Severity (S), Occurrence (O), and Determination (D). The research results show that the highest risk lies in raw materials (differences in the quality of raw materials from each supplier), production costs (damage to machinery and equipment), and products (competition with other products). Based on risk analysis of bread production using the FMEA method, it was found that the highest risks lie in raw materials, production costs and product.

Introduction

Bread first developed during the Mesopotamian culture in the Egyptian region 10,00-12,000 years ago. This region had wheat plantations as one of the main food ingredients at that time. It was during this time that wheat flour was first discovered and encouraged further processing of this flour into bread as it is known today. The development of bread in Egypt then spread to Greece until it finally spread throughout mainland Europe. From the time of Egyptian culture until now, bread has experienced very rapid development along with discoveries in the field of technology that help process bread. This development is also adapted to the geographical conditions in each region so that the whole world has its own unique bread such as Roti Canai in India, Pita Bread in the Middle East and Tortillas in Mexico (Arwini, 2021).

Bread is a processed food product made from fermenting wheat flour with yeast or other raising agents, then baking. Initially, bread was made from simple ingredients and preparation (Mudjajanto & Yuliati, 2019). Bread is included in one of the conventional biotechnology products because of the fermentation process that utilizes microorganisms (Mudjajanto & Yuliati, 2019; Fan et al., 2024). Bread is a food made from wheat flour which is fermented

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with yeast Saccharomyces cerevicae. Based on the cooking process, bread is divided into three types, namely steamed bread, fried bread and baked bread. Bread has a hollow structure and a soft and elastic texture. Based on the type of dough, bread is divided into three types, namely sweet bread, white bread and soft rolls. This is in accordance with Pratiwi, 2013 which states that bread is a food made from wheat flour which is leavened with bread yeast (Saccharomyces cerevisiae) and baked (Mudjajanto & Yuliati, 2019; Lahue et al., 2020).

The Armina Food Bread Business, which is located in the Gresik area, is one of the businesses engaged in bread production. The workforce at the Armina food business is 8 people, consisting of 8 direct workers. The working hours applied to this business start from 06.00 WIB to 17.30 WIB. The type of bread produced by the Armina food business is sweet bread, each type of bread is divided into several flavor variants. There are 7 types of sweet bread variants. Armina Food's bread marketing areas include Gresik, Lamongan and Surabaya. The average bread sales volume in one day is 300 to 600 slices of bread.

In its production activities, bread cannot be separated from the risk of product failure (Koespratiwi et al., 2021). Risk is a variation in things that may occur naturally or the possibility of an event beyond what is expected which constitutes a threat to property and financial gain due to the danger that occurs (Arifin, 2017). Risk is uncertainty about future events resulting from actions or actions that are dangerous or detrimental (Kusvianti et al., 2023). Risk can be associated with the possibility of unexpected losses. This possibility can indicate the existence of uncertainty. This uncertainty can affect the achievement of the goals of any organization dealing with risk. Therefore, it is necessary to carry out risk analysis to identify, measure, and then develop a strategy as a basis for building a complete risk management system (Smith & Merritt, 2020). Good quality bread is highly expected considering that consumers are users who are increasingly critical in making their choices. This situation makes the quality of bread very important in the competition to reach consumers between similar producers and the survival of the company (Lontar et al., 2022).

The problem in the Armina Food Bread Business is that the conditions for making bread are still not optimal and stable. This can be seen from the fluctuation in the volume of bread sales at the Armina Food Bread Business from year to year. There was a decline in sales in February, April, May, June, July, October and December 2020, an average of 11.4%. This decline was due to the large number of bread defects during production, such as inappropriate bread shapes, unequal pieces of bread, bread color that tended to be too brown, damaged shapes that were stacked with other bread, packaging errors. The most dominant damage that occurs is damage to an inappropriate shape. This error resulted in the selling price of bread decreasing from the actual price. This failed bread can be sold for up to IDR 3,000 per package, resulting in a very drastic decline in sales. The improvement efforts that have been carried out by Armina Food are only in selecting raw materials from different brands. The Armina Food Bread Business has never carried out an analysis of the form of production quality activities in its company.

Based on the problems above, a research analysis of the risk of bread production was carried out in the Armina Food bakery business. The method used is Failure Mode and Effects Analysis (FMEA). FMEA is an analysis technique that combines technology and experience in identifying production process failures and planning to prevent them from recurring (Khoiriah, 2017). A failure mode is anything included in the design, conditions outside the specified specification limits or product changes that cause disruption to the product's function (Cabanes et al., 2021).

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Methods

Place and time of research

In this final assignment, the research was carried out at the Armiina Food Roti Business which is located at Jalan Raya Balongpangang Greisiik. The research is planned for June 2024 until the data required for this research is sufficient.

Data Analysis Using the Failure Mode Effect Analysis (FMEA) Method

In this research, analysis is carried out in two stages, the first stage is to analyze the risks of plain bread products by using the FMEiA method. The FMEiA method is used to identify and measure the risks of fresh bread production. The FMEiA method aims to identify risks by using the consideration of Seiveriity (S), Occurreincei (O) and Determination (D) criteria. Seiveriness (S) is a condition that will result in or predict the occurrence of a failure. The seiveriness rating scale is used starting from a scale of 1 to 10. For more clarity, the seiveriness scale can be seen in Table 1. Occurrence (O) is a scale that indicates the probability of occurrence of a failure mode. Occurrence (events) can be indicated in 10 levels starting from level 1 (events that have never happened) to level 10 (events that are most likely to happen or difficult to avoid). The Occurrence Scale can be seen in Table 1.

Table 1. Seiveriness Scale and Occurrence Scale

Information		
Score	Severity Scale	Occurrence Scale
1	Can be ignored	It's impossible for that to happen
2-3	Ringing	Rarely happens
4-6	Within the limits of tolerance	It's quite possible it could happen
7-8	Beyond the limits of tolerance	It's very possible for it to happen
9	Dangerous	It is certain that this will happen
10	Very Dangerous	It's bound to happen

Source: Hariastuti (2018)

Deiction (peindeiteiksiian) is an assessment that indicates the magnitude of the likelihood of the cause of failure to escape from the control stage or damage detection. The level of level of deiteictiion starts from level 1 (indicating the possibility of escaping from control is very small (definitely teirdeiteiksii) to 10 (indicating the possibility of escaping from control (not experiencing deiteictiion). The Deiteictiion scale can be seen in Table 2.

Table 2. Deiction Scale

Score	**Information**
1	Can be detailed
2	It could almost be explained
3	High
4-6	In session
7-8	Reindah
9	It's hard to explain
10	It cannot be explained

Data Collection Methods

This data collection method means the data used by the researcher to identify the problem, namely:

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Data Type

There are two types of data in this division, namely primary data and secondary data. Primary data is data that is obtained directly in the field. Primary data can be obtained from interviews, observations and questionnaires. Secondary data is data that is not obtained directly in the field. Secondary data can be obtained from books, journals, or research related to improving product quality.

Data Collection Techniques

Observation is a data collection technique where the observation process is carried out by carrying out direct research to see the conditions/problems that exist in the Roti Armiina food business. Interviews are a data collection technique where the interview process is carried out by means of questions and answers to stakeholders related to the production and sale of fresh bread in the Armiina Food Bread Business. It is a method for collecting data by providing written questions or statements with the hope that the research will provide a response to the statements or questions provided. Reispondein in this division are stakeholders, namely UKM owners and employees of Rotii Armiina food businesses.

Problem Solving Steps (Flowchart)

The steps used to identify problems that can be taken in this final task are to obtain results or solutions from this work which will be carried out from the beginning to the end of the work.

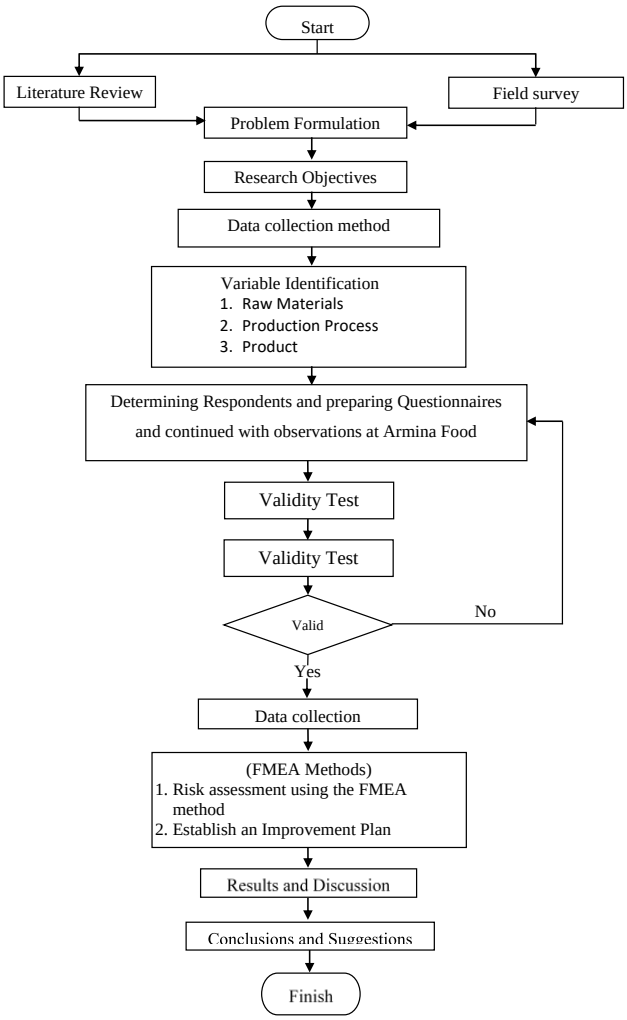

Figure 1. Problem Solving Flowchart

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Starting from being an activity that includes creating a proposal, writing a problem title to developing research. A literature review means collecting some information related to the theories of some of the concepts that are relevant to the problem being discussed.

Means preliminary research carried out at the beginning of the research to better understand the problem conditions regarding the field conditions that will be used as the research, so as to make it easier for the research to be carried out and in line with the objectives of the project. In carrying out production activities, Armiina Food is required to be skilled in carrying out production processes.

Analyzing the risks of defective bakery products at Armiina Food will then require improvement recommendations in order to minimize product defects in the next production process.

Carrying out an initial identification of variations based on the problems obtained when carrying out literature studies and field studies, so that independent and dependent variations can be identified from the research carried out.

After identifying the problem, the next step is to start conducting interviews and questionnaires with related parties to obtain data that needs to be processed to facilitate research activities. Previously, we had to know first what data would be taken and where the data was obtained from. (1) Once discussions are carried out, it is necessary to provide conclusions and suggestions; (2) Done.

Results and Discussion

Data Collection

The data collected is data on variables and attributes related to the types of defects in the production of the selected baked goods. Data on product defects is obtained from the division of the production head, while the production process of the bakery is carried out directly, through the distribution of questionnaires as well as brainstorming with field supervisors and employees of the production department.

Total Production Results

In the Arminian food bakery business, the type of bread produced is baked bread. The production results data is divided into several categories. This is data on the production results of the Armiina Food bakery business.

Table 3. Number of bread Bakery Production Results

Period	Month	Production Results (pcs)
1	January	4.500 pcs
2	February	5.000 pcs
3	March	5.000 pcs
4	April	4.000 pcs
5	May	4.500 pcs
6	June	5.000 pcs

Source: Internal data on bakery production results in 2024

This research table carries out data collection using secondary data collection methods, namely interviews and direct observation.

Number and Type of Disabilities

The number of defects and types of defects that occur during the bakery production process at the Armiina Food Rotii Business can be seen in table 4.2.

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Table 4. Number and Types of Defects in bread Bakery Production

Period		
January	Color Defects (burnt)	150
	Shape Defects	200
February	Color Defects (burnt)	110
	Shape Defects	190
March	Color Defects (burnt)	95
	Shape Defects	150
April	Color Defects (burnt)	100
	Shape Defects	150
May	Color Defects (burnt)	110
	Shape Defects	130
June	Color Defects (burnt)	98
	Shape Defects	110

Source: Internal Production Data at Armina Food's Bread Business

This research table carries out data collection using secondary data collection methods, namely interviews and direct observation.

Production Process in the Armina Food Bread Business

The production process in the Armina Food bakery business applies a discontinuous production process, this can be seen from the varied types of products and production is carried out according to consumer orders, a business uses a system that is not continuous, intermittent due to several conditions such as seasonal consumer demand, characteristics nature of production tools, characteristics of production tools that are influenced by climate, and seasonally available raw materials.

The intermittent production process in the Armina Food bakery business is also based on the products being worked on so that the production equipment used is arranged and arranged flexibly, so that it will also indirectly influence the production layout.

Data Processing

Data processing in this research uses the FMEA method after obtaining data at the Armina Food Bread Business through the method of distributing questionnaires and direct observation of the production process. The data obtained includes Raw Materials, Production Process and Product Marketing.

Production Risk Calculation Results Using the Failure Mode and Effect Analysis (FMEA) Method

The production risk assessment in the Armina Food Bread Business consists of 3 variables, namely raw materials, production processes and products. This variable has several risk indicators which are then given an assessment. The assessment aims to find out the RPN value based on the S, O and D criteria.

RPN = Severity weight × Occurance weight × Detection weight

Table 5. Severity, Occurance, Detection and RPN Value Calculation

Risk Factors	Risk Indicator	S	O	D	RPN
Raw Materials	Delays in raw material supply	4	6	5	120
	Fluctuating raw material prices	10	6	5	300
	Differences in the quality of raw materials from each supplier	10	10	6	600

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Production Process	Contamination from dust, hair and foreign objects	8	8	5	320
	Damage to machinery and equipment during the process	8	7	7	392
	Damage to bakery products	4	6	8	192
Product Marketing	Fluctuating demand for bread	8	5	9	360
	Delay in bread delivery	3	4	8	96
	Similar competitors	8	8	9	576

Strategy Formulation

The strategy formulation stage is the stage of seeking improvements in overcoming problems in order to minimize the impact that will occur. At this stage, we also provide input to SMEs about alternative improvements that can be made. The highest risks found in raw material variables, production processes and products have a high chance of giving rise to other risks, so it is necessary to formulate strategies to minimize these risks. The strategies that SMEs can implement to minimize the impact of risks that will occur can be seen in Table 6.

Table 6. Risk Minimization Strategy for Bakery Bread Production Systems

Information		
Objective	Minimize risks in bread production	Minimize the risk of bakery bread production on raw material variables, production processes and products.
Variable	Raw material	Minimize the risk of differences in the quality of raw materials from each supplier.
	Production process	Minimize the risk of damage to machines and equipment during the production process.
	Product	Minimize the risk of similar competitors.
Strategy Alternatives	Establish Partnerships	Collaboration with several business actors to assist in supplying additional ingredients for the bread production process and expanding the marketing network for bread products.
	Equip production facilities	Improving technology that supports the smooth running of bread production activities.
	Machine and equipment maintenance	Provide regular maintenance on machines and equipment to prevent damage during production.
	Workforce training	Providing knowledge to workers to increase their ability to support success in bread production.

Source: Processed data (2024)

Fishbone Diagram Bread Production Minimization Strategy

Based on the production risk analysis in the Armina Food bakery business, several problems were found, namely in materials, people, machines and methods. Then the data is processed so that strategies for minimizing problems during production are found so that defects do not occur in the future/minimise defects in bakery bread products, which can be seen in Figure 1 below:

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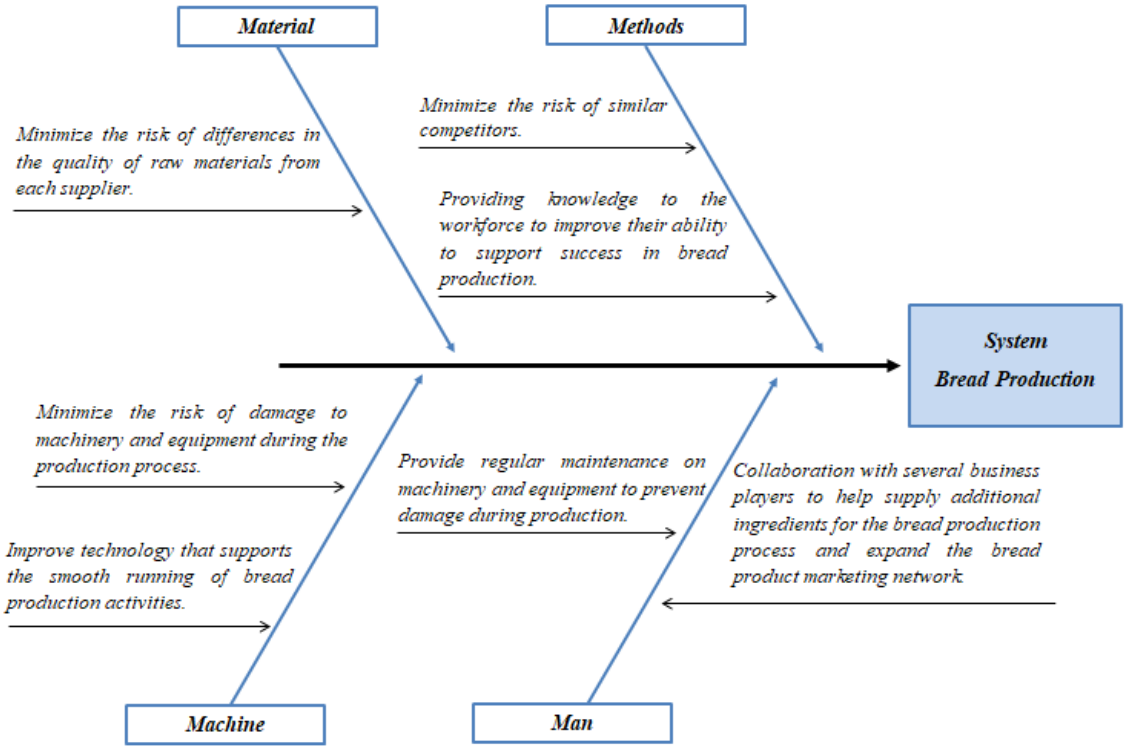

Figure 1. Fishbone Diagram Strategy for Minimizing Bakery Bread Production at Armina Food

Based on the results of this fishbone diagram analysis, a strategy for minimizing bread production can be seen so that production errors do not occur in the future in order to maintain the quality of bakery bread. The following is a description of the minimization strategy: *Materials:* Minimize the risk of differences in the quality of raw materials from each supplier. *Machine:* Minimize the risk of damage to machines and equipment during the production process and improve technology that supports the smooth running of bread production activities. *Method:* Minimizing the risk of similar competitors and providing knowledge to the workforce to increase their ability to support success in bread production. *Human:* Regular maintenance of machines and equipment to prevent poor production and aimed at greater production results

From this research it can be concluded that from the cause and effect diagram it has been determined which ones must be improved in terms of material, machine, method, and human minimization.

The first is in terms of material minimization, minimizing the risk of differences in the quality of raw materials from each supplier, the second is in terms of machine minimization, minimizing the risk of damage to machinery and equipment during the production process and improving technology that supports the smooth running of bread production activities, the third is in terms of minimizing methods, minimizing the risk of similar competitors and providing knowledge to the workforce to improve their ability to support success in bread production, and the fourth is human minimization, regular maintenance of machinery and equipment to prevent damage during production and cooperation of several business people to assist in supplying additional ingredients for the bread production process and expanding the bread product marketing network.

Conclusion

The conclusion of the risk analysis for the production of baked goods at Armina Food is as follows: (1) The results of identifying risks in bread production at Armina Food show that there are 9 risks in bread production. In the raw material aspect, there are 3 risks, such as

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delays in the supply of raw materials with RPN 120, fluctuations in raw material prices with RPN 300, and differences in the quality of materials from each supplier with RPN 600. On the production process side, there are 3 risks such as contamination, machine damage and equipment with RPN 392, and product damage with RPN 192. Meanwhile, in the product aspect, there is a risk of fluctuating demand for bread with RPN 360, delays in delivery of bread with RPN 96, and competition with similar products with RPN 576; (2) From the risk evaluation of bread production using FMEA, the highest risk was found for each variable. These risks include raw materials (differences in the quality of raw materials from each supplier), production processes (damage to machinery and equipment), and products (competition with other products).

References

Arifin, M. S. (2017). Risk management on NPP/Nuclear installation construction and regulatory applicable in Indonesia.

Arwini, N. P. D. (2021). Roti, Pemilihan Bahan Dan Proses Pembuatan. *Jurnal Ilmiah Vastuwidya*, *4*(1), 33-40. https://doi.org/10.47532/jiv.v4i1.249

Arwini, N. P. D. (2021). Roti, Pemilihan Bahan Dan Proses Pembuatan. *Jurnal Ilmiah Vastuwidya*, *4*(1), 33-40.

Cabanes, B., Hubac, S., Le Masson, P., & Weil, B. (2021). Improving reliability engineering in product development based on design theory: the case of FMEA in the semiconductor industry. *Research in Engineering Design*, *32*, 309-329.

Fan, L., Ma, S., Li, L., & Huang, J. (2024). Fermentation biotechnology applied to wheat bran for the degradation of cell wall fiber and its potential health benefits: A review. *International Journal of Biological Macromolecules*, 133529. https://doi.org/10.1016/j.ijbiomac.2024.133529

Khoiriah, S. (2017). Pengaruh keragaman produk dan pelayanan terhadap loyalitas konsumen pada 'Barokah Mini Market Gunung Terang Di Kabupaten OKU Timur.'. *Jurnal Aktual STIE Trisna Negara*, *15*(1), 10-18. https://doi.org/10.47232/aktual.v15i1.9

Koespratiwi, A. F., Rahayu, D. K., & Widada, H. D. (2021). Analisis Strategi Mitigasi Risiko Pada Usaha Pembuatan Roti. *Matrik: Jurnal Manajemen dan Teknik Industri Produksi*, *21*(2), 111-126. http://dx.doi.org/10.30587/matrik.v21i2.1483

Kusvianti, P., Ashari, A. P. R., & Izzah, A. N. (2023). Pandangan Ulrich Beck Tentang Risiko dan Ketidakpastian yang Dialami Oleh Masyarakat Modern. *Jurnal Ilmiah Ecosystem*, *23*(1), 149-163.

Lahue, C., Madden, A. A., Dunn, R. R., & Smukowski Heil, C. (2020). History and domestication of Saccharomyces cerevisiae in bread baking. *Frontiers in genetics*, *11*, 584718. https://doi.org/10.3389/fgene.2020.584718

Lontar, B., Qadri, A., Melati, V., Ryan, M. A., & Dinsar, A. (2022). Revitalisasi Penjualan: Strategi Pemasaran Digital untuk Meraih Sukses Bisnis Roti dan Kue bersama Holand Bakery. *Jurnal Ilmiah Multidisiplin Amsir*, *1*(1), 137-147. https://doi.org/10.62861/jimat%20amsir.v1i1.453

Mudjajanto, E. S., & Yuliati, L. N. (2019). Bisnis Roti. Penebar Swadaya Grup

Smith, P. G., & Merritt, G. M. (2020). *Proactive risk management: Controlling uncertainty in product development*. productivity press.

ISSN: 2716-3865 (Print), 2721-1290 (Online)