Designing of Goat's Food Processing Tools Using Quality Function Deployment Method

1) Industrial Engineering, Universitas Ahmad Dahlan, Jl Ringroad Selatan Kragilan Tamanan, Yogyakarta, Indonesia

Correponding email *) :
hapsoro.jatmiko@ie.uad.ac.id

Isana Arum Primasari [1], Hapsoro Agung Jatmiko [1]*, Edo Rizki Drianbodo [1], Oldy Riswan [1]

Abstract. Goat, is one of the most consume meat in Indonesia, it provides much nutrition to the eater and highly recommended by several nutritionist. One of the most critical part in breeding goats, is feeding them, this process is one of the most time consuming and takes a lot of effort, as the food preparation requires a lot of item to mix. Breeder, nowadays mostly feed their goat with "dry food" which are mostly consist of concentrate, this process unfortunately still done manually which, not only takes time but also some chances of potential hazard because most of the concentrate are heavy and huge. This research takes place in Rejodani District in Sleman Regency thus the sample and population of the research are goat breeder around the area. Using Quality Function Deployment method, authors intended to create a new food processing tools for food preparation of the goats. Using the concept screening and selection, out of 3 proposed design, the best design is chosen, followed by validation process to the respondents of the research. The final design of the food processor is the one that could increase productivity of the breeder and less chance of hazard.

Keywords: goat, food processing, design, quality function deployment.

1. INTRODUCTION

Goat has become one of the most prominent livestock in Indonesia, it is estimated that goat breeding in Indonesia has reached 19,3 Million in 2021 [1], this number is even slightly higher compared to the population of cows in Indonesia by 2021 that is estimated by 18.05 million [2]. Yogyakarta, as one of the largest province in Yogyakarta, also contributing in national number for goat breeding. By 2021, it is estimated that there are 421.287 goat population in Yogyakarta [3], by that number, Yogyakarta itself getting a lot of benefit from it, ranging from *sate* stall all around Yogya to handicraft made by goat's leather. The rise of goat's meat consumption is none other by people's awareness to health, in every 100gram of goat meat, roughly contains 23 grams of protein, slightly lower compared to other livestock such as cow [4], but on the other hand, goat meat also has the lowest saturated fat, which is bad for human's body, compared to other animals such as sheep, lamb and even cow. To be able to gain such a good nutrition for each grams of food, one of the main and important thing that should be considered by breeder, is the food given to the goat that could affect the percentage of unsaturated fat and any other substance [5]. Unfortunately, most of the feeding process in most farm in Indonesia, even in Yogyakarta, done manually which could affect several things such as : the potential of getting injured, the quality of the feed which are poor, and time consuming. Each adult goat, needed about 350 grams of concentrate mixture per feeding session and 1500 grams of greens [6], the number seems small for one goat, but if it is a big farm, then the number needed to prepare one session for feeding process would be enormous, high effort and also time consuming, it is also possible to happened for both minor and major injuries.

Designing a new tools or product, basically needs to know what customer's really wanted, as it could affect how good a product to their like. Identifying customer's needs has become a main role in any product design process [7], by doing so, it is more likely the product that being designed will be accepted by customers. One of

the mostly used method in product design is Quality Function Deployment (QFD). QFD is defined as a tool to maximizing customer needs toward product designing [8], and connecting what customer's want with several technical requirements in order to assess and prioritizing which area should be and could be improved [9] while designing a new product. QFD was founded in Japan on the late 1960's as the result of Japan's blooming industry post world war [10], it was a huge success and could elevate Japan's industry into another level. As it emphasize on customer's point of view, there are a lot of research that using QFD, or even integrating it with another method, both in services or product designing. It has been used in redesigning process of a shoes [11], food packaging [12][13][14] or even a tool or machine [15]. Not only product, QFD has also been used a lot in order to increase one services such as in business [16], railway services [17], Small Medium Enterprise [18], and bus service [19]. The previous research showed that QFD has been a cornerstone in both product design and service quality by emphasizing on customer's needs.

Based on previous research, this paper will mostly cover and emphasize on designing process of goat's food processor using QFD method. The designing process will focusing on increasing breeder productivity in preparing goat's food and also reducing the chance of hazard while mixing and preparing the food

2. METHODS

This research is conducted in Rejodani District, Sleman Regency, Yogyakarta, for this research there will be several steps conducted.

The first part of the research will be interview with breeder around Rejodani. There are 3 breeders around Rejodani district, that will be the sample and also the population for this research.The interviewing process most likely to find out what the breeders actually needed in feeding process. This part of research will be used as a way to find out the customers needs, thus it will be used in the next step of the research.

Following the interviewing process, the newly found out customer's needs will be used to create the house of quality (HoQ) where customer needs meet with technical requirements. In this part of the research, there will be several concepts and ideas regarding the newly design tools. The final design of the tool, then will be validated to the respondents of the research which are the breeders, to find out whether the newly design has already meet out the needs.

3. RESULTS AND DISCUSSION
3.1 Making an Interview Form

As it is aforementioned, this research will be using interview as a way to find out what the customer needs, a good interview will be crucial in any research steps, as it is one of the way for both researchers and research subject to interact [20], thus an interview form is needed as it is shown in Figure 1 below

Figure 1. Interview Form

Using the interview form in Figure 1, authors then proceed to interview 3 breeder around Rejodani to find out what they needed most in designing a new tools.

3.2 Interviewing Process

The interviewing process is held to 3 respondents, which are goat breeders around rejodani. Using the result on this interview, it will be used to find out the needs statement and then being used to create the appropriate design. The result of the interview is shown in Table 1, 2 and 3 as followed

Table 1. Interview Result 1

Question Number	Answer
1	*"Selama ini, pada saat aku mau nyiapin pakan atau pas nyampur pakan kambingku Pak, itu selalu takes time alias suwe banget. Kadang iso satu jam atau 2 jam sendiri, itu cuman nyampur thok lho Pak"*
2	*"sehari nek aku makani kambingku 3-4 kali Pak, itu tak split 2 jenis, 3 kali pakan kering, 1 kali pakan basah"*
3.	*"Pakan kering? Kui saiki emang banyak yang geser kesitu Pak para pemilik peternakan, kenapa, soale weduse luwih lemu dan lemak nya sedikit. Pakan kering itu biasane pake konsentrat, terus ada beberapa item lain, nilai gizi lebih baik dibanding cuman pake suket thok Pak*
4.	*"Ya memang dadi luwih abot yah soale kan itu biasanya dilebokke karung, sehingga nek misal aku arepe makani kambing ya harus tak junjung Pak, baru dituang dan setelah itu baru diaduk. Sejauh ini nek ngaduk pakan itu masih manual setauku. Nek pakan basah kan luwih penak Pak, cukup modal ngarit thok beres"*
5	*"Ya harapannya kalo dirimu rancang mesin, sampai memikirkan distribusi pakannya juga Pak, karena itu lumayan PR juga"*

The first interviewing process is being held to the owner of *Waringi Farm* shown in Figure 2 below. As it shown in Table 1, the first respondent expressing several concern based on what have been asked by authors. It could be inferred from the first interviewing process that time or efficiency is the main factor as it is found that in one process of feeding preparation took couple of hours.

Figure 2 Interviewing Process of Waringi Farm's Owner

The second interview is done to another goat breeder in Rejodani, the second respondents have been a goat breeder for approximately 4 years. The interviewing process is done both in the house and in the farm as it shown in Figure 3 and 4 below

Figure 3 Interview Process 2 (at Farm)

Figure 4 Interview Process 2 (at Home)

The result of the second interview is shown Table 2 below

Table 2 Interview Result 2

Questions No	Answer
1	*"Nek saya sudah pakan kering mas, hasile wedusku memang lebih bagus. Bakul-bakul sate kambing sekarang mlayu ne ke tempat saya nek pada cari kambing. Kadang sebulan saya kesusahan untuk menyediakan kambing untuk para pemilik warung sate ini, yo maklum mas, ternak saya masih belum terlalu besar. Berapa? Sekitaran 150-200 ekor Mas punya saya"*
2	*"Sehari? Sehari biasane 4 kali mas le ku makani, kui wae isih do dokoh wedhus wedhus ku, hahahaha"*
3	*"Cukup lama mas untuk sekali proses penyiapan pakan kambing, kurang lebih 2 jam an cuman untuk ngudak dan nyampure. Itu karena murni pake tenaga manusia saya Mas, ngingu wedhus sekaligus makaryani tonggo teparo iki"*
4	*"Yang saya pakai bahannya? Macem macem Mas, mulai dari polar, ppgs, CGF, premix, itu? Kebanyakan kui impor mas bahannya, iyo lumayan kacek regane, hahaha. Kalau bahan lokal ada katul, kadang ya kopra, sawit juga tapi yo arang-arang mas. Kadang saya tambahi juga tetes tebu, buat perasa, iya bentuknya cairan gitu kemudian saya semprotkan ke pakan yang sudah saya campur*
5	*" Sebenarnya problem terbesarnya kalau dikerjakan dengan manual adalah kadang tidak rata dan belum tercampur mas. Iya, betul sekali, kadang beberapa bahan baku pakan tidak tercampur rata mas, kadang isih sok di ublek-ublek meneh ben nyampur, jadinya penjadwalan pemberian pakan agak mundur. Kambing termasuk kewan sek rodo sensitif terkait pakan, ketika jadwal bergeser ada potensi mengubah jadwal mereka selanjutnya mas."*

The second respondent have changed the feeding process for the goat using only dry food and concentrate, although there are several times that the goat still being fed with grass and greenery. The concentrate being used by the second respondent is shown in Figure 5 below.

Figure 5 Concentrated Food

The last interview is also done to one of the breeder around rejodani district, the result of this interview is shown in Table 3 below

Table 3 Interview Process 3

Question No	Answers
1	"Nggih Mas, betul, saya sudah melihara semenjak tahun 2000 awal dulu, awalnya iseng coba coba, alhamdulillah malah laris wedhus wedhus e kula. Sehari biasanya untuk pakan 3 kali Mas, pagi-siang-sore ditengah tengahnya saya kasih tambahan pakan 2 kali, kalau di total? Berarti kurang lebih 5 kali sehari
2	"Menawi pakan, saya sudah tidak pakai suket melih mas, tetapi kadang-kadang memang masih pakai, banyak belajar dari teman teman sesama peternak kambing juga pakai pakan jenis baru ini"
3	"Kalau masalah, sebenarnya tidak ada, cuman memang agak kerepotan saya ketika harus nyampur semua pakan tersebut, karena saya garap dewean ini mas"
4	"Ngapunten saya belum ada bayangannya, mungkin intinya yang bisa memudahkan saya untuk memberi pakan mendha ne saya"

The third respondents of this research, is also using dry and concentrated food for feeding process, although some grasses and greenery still being fed to the goat. Another key point on the third interview is that there are some difficulties occurred while mixing the food, because the weight of the concentrated food and the size of it while the breeder is an elderly person. Based on the interviewing process, authors could conclude the customers needs needed to create a new design.

3.3 Determining Need Statement and House of Quality

As the result of the three interview, it could be inferred and concluded that there are at least 5 main point that become a concern in the feeding process, the need statement determination is shown in Table 4 below.

Table 4 Need Statement Concept Design

Interview Recapitulation	Need Statement	Simplified Needs Statement
Breeder, usually feed their goats more than 3 times a day, and goats are time sensitive animals if their feeding time keep changing everyday whether it is because the food is not ready or anything else	**The Food provided should be sufficient enough for the daily need of the goats**	*Sufficiency Factor*
The food that being prepared, mostly dry and concentrated food. Each bag of dry food weighted minimum 50 kilos, and it need to be poured up and stirred up before being given to the goats	**The feeding process preparation should be considering the safety of the workers**	*Health and Safety System/tool | Safety Factor*
The mixing process still done manually, and it took a long time before the food finished	**Effectiveness is the key for every feeding process in every single day**	*Effectiveness Factor*
The mixing process, most of the time is not fully mixed, it could affect the nutritional value for the goats	**The consistency of the output (feeding item) is important**	*Consistency Factor*

Based on the result of Table 4, it could be found that there are at least 4 main points and needs statement that should be a concern for authors to create a newly designed, namely : a)sufficiency factors b)health and safety system c)effectiveness factor d)consistency factor. Using the 4 needs, it could be used in the next step of this research which is creating the House of Quality (HoQ) where needs will meet the technical requirements. The HoQ is shown in Figure 6 Below
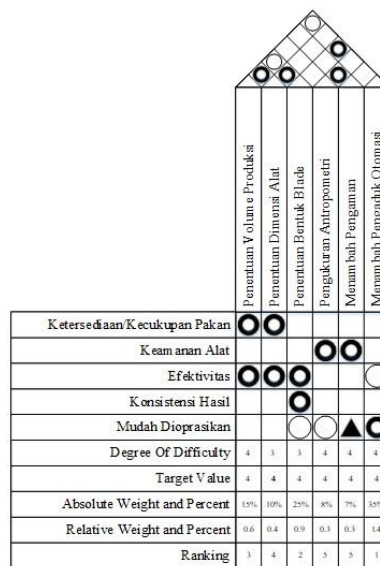
Figure 6 House of Quality

Based on Figure 6, it could be inferred that there are several technical requirements for the newly designed tools such as :

1. Adding automatic mixer
2. Blade design
3. Production Volume
4. Product dimensions
5. Anthropometric factors
6. Secure lock and extra safety features

3.4 Generating Concept, Screening and Selection

The house of Quality has provided guidance for the designing process, the aforementioned technical requirements of the product, can be used to generate several concept for the upcoming design. Another key point that should be considered, is the benchmark product. Benchmark could be used as a reference by inventors to identify the best product or service in order to create the same level of product or service based on the referenced product [21][22]. The referenced or benchmark product/tools in this research as it follows

Molen Machine : as one of the main problem stated in the need statement, breeder's problem is the effectiveness of the mixing process, mixing process' output and the effort of doing one. Thus *Molen* could be one of the tool that could help on this. *Molen* machine would be the benchmark product in the selection and screening process.

3.4.1 Concept Generation

Based on the technical requirements, the following step is to generate concept. Generating concept would be a crucial point in QFD method, as it would be a decision whether one design could help to answer the customer's needs or not. In this research, there are 2 Design Concept that have been generated, as it is shown in Figure 7 and 8 Below

Figure 7 Concept Design 1

The first concept design, provide several points that have become the concern by the breeder. The newly proposed design tool is provided with several improvement compared to the current process such as an enclosed process, stirrer and sufficient volume to feed the goats.

Figure 8 Concept Design II

The second concept is also providing convenience for breeder yet still answering the customer's needs in the previous segment. The difference between the first and the later design is in the shape of the design and the blade revolving inside the compartment that being used to mix and stir the concentrated food.

3.4.2 Concept Screening

Following the generated concept, the next step of the research, will be the selection concept between the two and the benchmark product. The selection process is shown in Table 5 below.

Table 5 Concept Screening

Criteria	Benchmark (*Molen machine*)	Concept I	Concept II
Automatic Mixer	0	+	+
Blade Design	0	-	+
Production Volume	0	+	-
Dimensions	0	0	0
Anthropometric Factors	0	+	+
Secure Lock & Extra Safety Feature	0	+	+
Σ +	0	4	4
Σ -	0	1	1
Σ 0	6	1	1
Total	**0**	**3**	**3**
Continue	no	**yes**	**yes**

Based on the result shown in Table 5, both concept I and II have the advantages over the benchmark product, security and safety has become the main concern in this research along with effectiveness and product output. Using the score in Table 5, the next step in this research is the concept scoring.

3.4.3 Concept Scoring

Following the previous result, the next step in this research is the concept scoring, to finally rate which concept should be brought into final design. The scoring result of both concept is shown in Table 6 below.

Table 6 Concept Scoring

Criteria	Weight (%)	Concept I		Concept II	
		Rating	Weighted Score	Rating	Weighted Score
Automatic Mixer	15	4	**60**	4	60
Blade Design	10	3	**30**	4	**40**
Production Volume	25	4	**100**	3	**75**
Dimensions	8	4	**32**	4	**32**
Anthropometric Factors	7	3	**21**	3	**21**
Secure Lock & Extra Safety Feature	35	5	**175**	5	**175**
Total Score		**418**		**403**	
Continue?		**COMBINE**		**COMBINE**	

3.5 Final Design and Validation

Both concept I and II are excel in their own, thus it comes to a decision that both design should be combine in order to find out the best proposed design. Figure 9 below shows the final proposed design of the product.
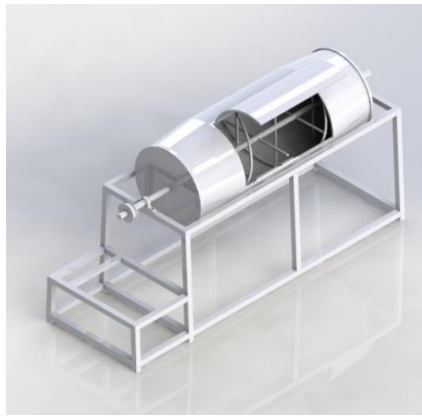
Figure 9 Final Design of the Product

The proposed design, will have to be validated by the three respondents of the research. The validation process is done by showing the proposed design to the respondent. The result of the validation process is shown in Table 7 below

Table 7 Validation Process

Respondent Number	Is the Proposed Design correspond with the one you imagine?	Comments?
1	Yes	"i would like to have the design to be made, even it is just a prototype, i need to make sure the machine good enough for daily use"
2	Yes	-
3	Yes	"It would help me to ease any mixing process. I will spend less effort in preparing my goat's daily food. I wont be burdened with heavy lifting which i have done several years back"

Based on the validation process, the proposed design has meet out what the customers wanted, as the three respondents of the research already agreed the proposed design. Emphasizing on customer's needs has made the designing process becoming easier, as the inventor only needed to create and made the proposed design based on the customer's needs. Current design should be manufactured next, in order to be tested in a real system.

4. CONCLUSION

Goat feeding is a crucial factor in breeding and raising goat, as the nutrition needed by goat will affect its growth and their meat composition. Sadly, most of the goat breeder still done the process manually, thus, affecting several factors such as safety, effectiveness and food output. Based on that, the newly proposed design for the process is imperative, using interview among breeder around Rejodani District, it could be found that there are 4 main concern of the food preparation for the goat. Using QFD, the customer's needs found is then being translated into 6 technical requirements which then be used to made the final design. Automatic mixer and safety factor plays an important role in the design as it appeared in the proposed final design

5. REFERENCES

[1] Karnadi, A. "Populasi Kambing Indonesia Capai 19,23 Juta Ekor pada 2021" https://dataindonesia.id/sektor-riil/detail/populasi-kambing-indonesia-capai-1923-juta-ekor-pada-2021. (Accessed Jan. 20, 2023)

[2] Karnadi, A. "Pasokan Sapi Potong Indonesia Capai 18,05 Juta pada 2021" https://dataindonesia.id/sektor-riil/detail/pasokan-sapi-potong-indonesia-capai-1805-juta-pada-2021. (Accessed Jan. 21, 2023)

[3] Badan Pusat Statistik. (2021). *Populasi Kambing Menurut Provinsi (Ekor)*.Jakarta

[4] Derendra, C. (1988). The Nutritional Value of Goat Meat. 76-86

[5] Correa, J. (2016). Nutritive Value of Goat Meat. 1-3

[6] Cosgrove, N. "How Much and How Often to Feed Goats [Feeding Chart & Guide]" https://petkeen.com/goats feeding-chart-guide/. (Accessed Jan.20, 2023)

[7] Muci-Küchler, K. H., & Weaver, J. M. (2004). Learning How to Identify Customer Requirements: A Key Component of Product Development Courses. Proceeding of American Society for Engineering Education Annual Conference & Exposition, 1–31.

[8] Hauser, J. R., Griffin, A., Klein, R. L., Katz, G. M., & Gaskin, S. P. (2010). Quality Function Deployment (QFD). In Wiley International Encyclopedia of Marketing. John Wiley & Sons, Ltd. https://doi.org/10.1002/9781444316568.wiem05023

[9] Erdil, N. O., & Arani, O. M. (2019). Quality function deployment: more than a design tool. International Journal of Quality and Service Sciences, 11(2), 142–166. https://doi.org/10.1108/IJQSS-02-2018-0008

[10] Akao, Y. (1997). International Symposium on QFD '97-Linköping QFD: Past, Present, and Future. International Symposium on QFD, 1–12.

[11] Jatmiko, H.A., & Nugroho, D.S. (2022). IMPLEMENTING KANSEI ENGINEERING AND QUALITY FUNCTION DEPLOYMENT METHOD IN DESIGNING SHOES 鈇 : CASE STUDY AT REJOWINANGUN ORIGINAL LEATHER. In Journal of Engineering Design and Technology 70 Journal of Engineering Design and Technology (Vol. 22, Issue 1). http://ojs.pnb.ac.id/index.php/LOGIC

[12] Ardian, A., & Jatmiko, H. A. (2021). Designing food packaging of bitter melon chips using Kano and quality function deployment: case study in KRIPIK Pare Pak IPHE. KKU International Engineering Conference, 82–89.

[13] Wattanutchariya, W., & Royintarat, T. (2012). Implementation of Quality Function Deployment and Kansei Engineering for GABA Rice Snack Development. Environment and Natural Resources, 10(2), 1–10.

[14] Andriani, D. P., Choiri, M., & Priharseno, D. (2017). Aplikasi Quality Function Deployment Untuk Redesign Kontainer Penyimpanan Pada Industri Kemasan Kaleng. Jurnal Teknik Industri, 18(2), 176–190. https://doi.org/10.22219/jtiumm.vol18.no2.176-190

[15] Sukardi, Setyaningrum, R., & Nuswantoro, Izzhari. D. (n.d.). PERANCANGANG SLICER MACHINE CRACKERS DENGAN MENGGUNAKAN METODE KANSEI ENGINEERING DAN QUALITY FUNCTION DEPLOYMENT (QFD) SEBAGAI UPAYA MENINGKATKAN PRODUKTIVITAS UMKM KERUPUK IKAN.

[16] Shrivastava, P. (2013). House of Quality: An Effective Approach to Achieve Customer Satisfaction & Business Growth in Industries. International Journal of Science and Research, 5(9), 1365–1371. www.ijsr.net

[17] Putri, S. I., Sumartini, S., & Sofia, A. (2017). Metode Service Quality (Servqual) dan Quality Function Deployment (QFD) sebagai Usulan Perbaikan Kualitas Pelayanan di PT. Kereta Api Indonesia (Persero). JURNAL ILMU MANAJEMEN DAN BISNIS, 8(1), 11–16. https://doi.org/10.17509/jimb.v8i1.12656

[18] Efendi, Z., Pertanian, J. T., Pertanian, F., & Bengkullu, U. (2007). Penerapan Quality Function Deployment (QFD) untuk Peningkatan Kinerja Industri Kecil Bakso Sapi Berdasarkan Kepuasan Pelanggan. 2(2), 85–91.

[19] Nurkertamanda, D., Husain, F., & Widharto, Y. (2021). Redesign of Bus Services Using Quality Function Deployment (QFD) to Improve Services to Passenger (Case Study: PO XYZ). OPSI, 14(1), 73. https://doi.org/10.31315/opsi.v14i1.4747

[20] All About Interviews. (2014). 1–12. www.aber.ac.uk/en/is/elecinfo/eiaz/

[21] Bhutta, K. S., & Huq, F. (1999). Benchmarking – best practices: An integrated approach. Benchmarking: An International Journal, 6(3), 254–268. https://doi.org/10.1108/14635779910289261

[22] Sammut-Bonnici, T. (2015). Benchmarking. In Wiley Encyclopedia of Management (pp. 1–2). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118785317.weom120043