The important level of washing machine quality dimensions in 4.0 industrial era based on the perception of a laundry business: A preliminary investigation

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Abstract. The development of technology has created various type of innovative washing machine on the market. Numerous options influenced consumers’ quality expectations. Consumers’ expects more from the ever-growing number of washing machines. This research aims to identify washing machines’ quality dimensions in 4.0 industrial era and their level of importance based on the perception of a laundry business. This study used one subject, a medium-sized drop-off laundry business “X” in Bogor, Indonesia. The identification of indicators and quality dimensions was done through ad scouring process, discussion with the research team, and interviews with Laundry X. The importance level of washing machine quality dimensions was assessed using the Kano model. The results show that washing machines in the 4.0 industrial era have several superiorities in terms of customization, easiness, smartness, safety, performance, aesthetics, durability, information and service support, and environmental orientation and energy efficiency. For Laundry X, easiness, safety, performance, durability, and information & service support are the most important dimensions.

1. Introduction
The world has entered the 4.0 industrial era which can be said to be the fourth industrial revolution. In this era, various devices can be interconnected [1][2] and communicate with each other [2], have intelligence and can work autonomously [2]. Utilization of data and machine learning make this possible [2].

In the 4.0 industrial era, the household appliance industry sector launched many new products and embedded new technology into their products so that their products became more customer-centric. A washing machine is one of the household appliances that is always evolving by bringing new and smart technology. At this point, innovative washing machines with various models, designs, and features are readily available on the market. For example, there are currently washing machines equipped with smart features that allow users to diagnose problems with the washing machine and control washing machines via smartphone.

The success of a new product on the market is determined by consumer acceptance [3]. One factor that determines consumer acceptance is the consumer perception of product quality (perceived quality) [4][5]. Nowadays, the numerous product choices on the market with their unique superiorities
stimulated consumers’ expectations. According to Schwartz, Ward, Monterosso, Lyubomirsky, White, and Lehman [6] and Schwartz [7], if consumers have a lot of product choices, their expectation would rise [8]. For example, if decades ago consumers only expected the main function of a product, with technology advancement, their expectations have arisen. They did not only think about the product’s functionality, but also its economic aspects. In other words, consumers used to consider ‘function’ as the only quality dimension, but now, the quality dimension has widened. Therefore, studies regarding quality dimensions in the 4.0 industrial era and their level of importance from consumers’ perspective are important to be conducted.

Aside from common households, another party that has been affected by the development of washing machines is the laundry industry. As a major washing machine user, the laundry industry also has a high expectation that washing machines offered on the market can fulfill their operational needs and financially favorable. Thus, this research aims to identify washing machines’ quality dimensions in 4.0 industrial era and determine their levels of importance from the perspective of a medium-sized laundry business. Understanding quality from consumers’ perspective is important because consumers have an essential role in molding a product’s success on the market which is characterized by high consumers’ intention to purchase or use the product [9][10][11] and high consumers’ loyalty [12][13].

2. Literature Review

2.1. Perceived product quality
Perceived quality is consumers’ assessment on the superiority of an entity [14]. Perceived product quality is consumers’ assessment on the superiority of a certain product. According to Holm and Kildevang [15], this assessment is subjective and situational [16]. For companies, perceived product quality is important because it has been proven to influence consumers’ acceptance, both in the form of consumer willingness to purchase or use the product [9][10][11] and consumer loyalty [12][13].

Perceived quality is a multidimensional concept [16] [17] [18]. Many researchers have offered several quality dimensions to represent product quality. Garvin [19] [20] described product quality using eight quality dimensions, which are performance, feature, conformance, reliability, durability, serviceability, aesthetics, and perceived quality. Stone-Romero and Stone [21] proposed four product quality dimensions, namely flawlessness, durability, appearance, and distinctiveness. Lifespan, features, performance, and serviceability are perceived quality dimensions of remanufactured products, according to Hazen, Boone, Wang, and Khor [22].

2.2. Kano model
Kano model is a tool proposed by Kano, Seraku, Takahashi, and Tsuji in 1984 [23]. This tool is useful for understanding consumers’ need and their impacts on satisfaction [23]. This model divides product attributes into several categories based on their ability to satisfy the consumers. The categories are must-be attributes, one-dimensional attributes, attractive attributes, indifferent attributes, reverse attributes, and questionable attributes [23].

- Must-be attributes are attributes that are considered as a must for a product [24]. If this attribute does not exist, consumers would be dissatisfied, but the existence of this attribute would not improve consumers’ satisfaction [23] [24] [25].
- One-dimensional attributes are attributes which existence would produce linear satisfaction [24]. Better performance would lead to higher satisfaction and vice versa [23] [24]. The existence of this attribute would create consumers’ satisfaction and the absence of this attribute would create dissatisfaction [23] [24] [25].
- Attractive attributes are attributes whose presence are not expected by consumers, but its existence would considerably improve consumers’ satisfaction [24][25][26]. The absence of this type of attribute would not spark dissatisfaction [23] [24] [25].
- Indifferent attributes are attributes which presence or absence does not affect consumers’ satisfaction level [25]
• Reverse attributes are attributes which presence would initiate dissatisfaction and their absence would create satisfaction [25]

• Questionable attributes are attributes which presence or absence sometimes would initiate consumers’ satisfaction or dissatisfaction [26]

Figure 1 shows the Kano model. The level of attributes fulfillment is indicated by the horizontal axis and the level of customer satisfaction with the level of those attributes fulfillment is indicated by the vertical axis.

In the Kano model, data gathering was conducted using a questionnaire with functional and dysfunctional questions [25]. Functional questions explore consumers’ responses if a product has a certain attribute. Dysfunctional questions explore consumers’ responses if a product does not a particular attribute.

![Figure 1. Kano model (Source: [27] cited in [23])](image)

3. Methodology
This research is a case study of a medium-sized laundry business (Laundry X) in Bogor, Indonesia. Laundry X has 15 washing machines that are used to complete customer orders. Its customers consist of corporate and individual customers. The company’s organizational structure consists of four levels. It has around sixty employees. The research stages are illustrated in figure 2.

3.1. Identifying washing machine quality indicators
The indicators were identified through advertisement materials of three washing machine brands on their manufacturer's website. The brands were chosen because according to Laundry X, these three brands were superior compared to their other counterparts. The quality indicators gathered were then being recapped, synthesized, and validated through team discussions and interviews with the director of Laundry X.
Determined the superior washing machine brand based on Laundry X's recommendations

Opened the website of selected washing machine brands

Determined the popular washing machine series

Made a list of features of the washing machines. These features were then used as quality indicators of washing machines

Synthesized the collected quality indicators

Validated the quality indicators

Classified quality indicators based on their “superiority topic” These topics were called washing machine quality dimensions

Created Kano questionnaire

Collected data: Laundry X's feeling if certain quality dimension exists (functional question) or does not exist (dysfunctional question) in Laundry X’s washing machines

Analyzed data

Determined the importance level of each dimension

Figure 2. The research stages
3.2. Identifying washing machine quality dimensions
Quality indicators gathered at the first stage were categorized based on their “superiority topic”. These topics were called washing machine quality dimensions. The categorization was conducted using a thematic analysis on all indicators.

3.3. Determining the importance level of each dimension
The importance level was determined using the Kano model. For data gathering process, a Kano model questionnaire was created. This instrument was used to explore the response of Laundry X’s director as a washing machine user. The questionnaire gauged the director’s feeling if certain quality dimension exists (functional question) or does not exist (dysfunctional question) in Laundry X’s washing machines. Answers options for all questions were ‘like’ (S), ‘expect’ (H), ‘neutral’ (N), ‘live-with’ (T), and ‘dislike’ (TS).

Data collected from the questionnaire were analyzed to find out the dimensions of washing machine quality that were liked and expected by Laundry X and the ability of the quality dimensions to influence its satisfaction. The analysis was done by referring to table 1. For example, if a quality dimension of the washing machine is expected (H) by Laundry X and the absence of such dimensions is undesirable and cannot be tolerated by Laundry X (TS), then that dimension is included in the must-be attribute category. The washing machine quality dimensions included in the must-be, one-dimensional, and attractive attributes are quality dimensions that are considered important by Laundry X.

| Quality dimensions | Dysfunctional questions |
|--------------------|------------------------|
|                    | S | H | N | T | TS |
| Functional questions | S | Q | A | A | A | O |
|                     | H | R | I | I | I | M |
|                     | N | R | I | I | I | M |
|                     | T | R | I | I | I | M |
|                     | TS | R | R | R | R | Q |

Q = questionable attribute, A = attractive attribute, R = reverse attribute, I = indifferent attribute, O = one-dimensional attribute, M = must-be attribute

Source: [28] cited in [23]

4. Result and discussion
4.1. Washing machine quality indicators
The potential quality indicators were gathered through the websites of three washing machine brands. This process resulted in 55 potential indicators. The list was synthesized to reduce or add indicators. Forty-four indicators came out of the synthesizing process. A validation process was done with a research team to ensure user’s understandability.

The indicators list was given to Laundry X and interviews were conducted with the directors to ascertain the relevance of each indicator with the context of the washing machine in the 4.0 industrial era. The changes to the list were done based on the director’s input. Forty-three indicators were finalized in this stage (see table 2).

4.2. Washing machine quality dimensions
The indicators were then categorized to quality dimensions based on “superiority topic” represented by each indicator. Categorization was done using a thematic analysis. The results show that there are
nine dimensions from 43 indicators, which are customization, easiness, smartness, safety, performance, aesthetics, durability, information and service support, and environmental orientation and energy efficiency (see table 2).

**Table 2. Washing machine quality indicators and dimensions**

| No. | Indicators                                                                                     | Dimensions | Definition                                                                                                                                  |
|-----|-----------------------------------------------------------------------------------------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | My washing machine has a complete feature option                                              | Customization | The washing machine as a complete feature as needed by the consumers and it has features for all types of fabric                           |
| 2   | The features fulfill my and my family’s needs                                                   |             |                                                                                                                                           |
| 3   | My washing machine has complete features for all types of fabric                               |             |                                                                                                                                           |
| 4   | My washing machine can be operated with minimal touch and all processes can be done automatically from weighing, determining water need, rinsing, and drying. | Easiness    | The washing machine can be operated with minimum effort                                                                               |
| 5   | My washing machine has front control design, so it is easy to read and use                     |             |                                                                                                                                           |
| 6   | My washing machine has dedicated slots for detergent and softener, so they do not mix          |             |                                                                                                                                           |
| 7   | My washing machine has error/trouble notification feature                                       | Smartness   | The washing machine has smart technology, for example, error notification, automatic troubleshooter, washing history storage, remote control, etc. |
| 8   | My washing machine has a troubleshooting feature that can be used without using customers’ service line |             |                                                                                                                                           |
| 9   | My washing machine has a remote control feature, so I can operate it using a smartphone        |             |                                                                                                                                           |
| 10  | I can use a smartphone app to download new washing feature when I need one                      |             |                                                                                                                                           |
| 11  | I can use a smartphone app to identify problems with my washing machine                         |             |                                                                                                                                           |
| 12  | My washing machine has data on my washing history                                              |             |                                                                                                                                           |
| 13  | My washing machine has a feature that informs me the drum-cleaning schedule                     |             |                                                                                                                                           |
| 14  | My washing machine does not shake too much                                                      | Safety      | The washing machine was made with users’ safety and health in mind for short and long-term period.                                       |
| 15  | My washing machine is not noisy                                                                 |             |                                                                                                                                           |
| 16  | My washing machine has a safe design                                                            |             |                                                                                                                                           |
| 17  | My washing machine does not induce skin                                                         |             |                                                                                                                                           |
irritation or allergy

|   |   |
|---|---|
| 18 | The door of my washing machine can be closed gently, safe, comfortable, and does not create too much noise. |

|   |   |
|---|---|
| 19 | My washing machine can dissolve detergent completely |
| 20 | My washing machine can work fast |
| 21 | My washing machine can rinse the detergent completely (no residue on clothes) |
| 22 | My washing machine is strong |
| 23 | The result of my washing machine is optimal |
| 24 | The result of my washing machine is even |
| 25 | My washing machine does not cause wrinkles |
| 26 | My washing machine produces fast-dry clothes |
| 27 | My washing machine does not damage my clothes |
| 28 | My washing machine has a relatively small size with big capacity, so it saves room |

|   |   |
|---|---|
| 29 | My washing machine has a modern design |
| 30 | My washing machine has a good and stylish design |
| 31 | My washing machine has an interesting color |

|   |   |
|---|---|
| 32 | My washing machine has a wide impact- and scratch-resistant glass door |
| 33 | My washing machine is durable and does not break down easily |
| 34 | My washing machine has a long warranty for the motor and other parts |

|   |   |
|---|---|
| 35 | My washing machine has various customers’ support lines (email, phone, and live chat) |
| 36 | I can ask for product support through social media |
| 37 | I can ask for product support whenever I want including on holidays |
| 38 | I can ask for product support whenever I want in the day (24 hours) |
| 39 | My washing machine only requires a minimal amount of water |

|   |   |
|---|---|
|   |   |
| Performance | The washing machine can wash, rinse, and dry clothes without creating damage. |
| Aesthetics | The washing machine was designed with physical aesthetics in mind. |
| Durability | The washing machine is durable, does not break down easily, and has a lifetime warranty. |
| Information and service support | The washing machine has service and product support including repair and maintenance |
| Environmental orientation & | The washing machine is environmentally friendly. |
My washing machine can work with small water pressure. For example, it does not require too much water or consume large electrical power.

My washing machine does not consume large electrical power even though it is always plugged in.

In a power outage, when the power back on, my washing machine can continue the process automatically.

4.3. The importance level of washing machine quality dimensions

The importance level of the quality dimensions was determined based on the analysis of Kano questionnaire. Table 3 shows the data collected from the questionnaire. The criteria in Table 1 were used to analyze the data. Table 4 shows the result. Based on the analysis, it is known that Laundry X deemed easiness, safety, performance, durability, and information and service support as one-dimensional attributes. It means that Laundry X would be satisfied if those attributes exist and dissatisfied if they do not.

Higher quality of those five dimensions would improve laundry X’s satisfaction level. Laundry X would be dissatisfied if the washing machine is hard to operate, unsafe, has a poor performance, short-lived, and does not have adequate information and service support.

The result also shows that ‘customization’ is an attractive attribute for Laundry X. The presence of this dimension would increase Laundry X’s satisfaction, but its absence would not cause dissatisfaction. The result shows that Laundry X considers ‘smartness,’ ‘aesthetics,’ ‘environmental orientation & energy efficiency’ as indifferent attributes. The presence or absence of those dimensions does not affect their satisfaction.

Table 3. Data collected

| No. | Quality dimensions of washing machine | Questions | Answer |
|-----|--------------------------------------|------------|--------|
| 1   | Customization                        | F          | How do you feel if your washing machine can be customized? | v |
|     |                                      | DF         | How do you feel if your washing machine cannot be customized? | v |
| 2   | Easiness                             | F          | How do you feel if your washing machine is easy to operate? | v |
|     |                                      | DF         | How do you feel if your washing machine is not easy to operate? | v |
| 3   | Smartness                            | F          | How would you feel if your washing machine was equipped with smart technology? | v |
|     |                                      | DF         | How would you feel if your washing machine was not equipped with smart technology? | v |
| 4   | Safety                               | F          | How do you feel if the washing machine is made by considering the safety aspects? | v |
|     |                                      | DF         | How would you feel if your washing machine was made without considering the safety aspects? | v |
5 Performance
F How do you feel if your washing machine has good performance? v
DF How would you feel if your washing machine did not perform well? v

6 Aesthetics
F How would you feel if your washing machine was made by considering the aesthetic aspects? v
DF How do you feel if your washing machine is made without considering the aesthetic aspects? v

7 Durability
F How do you feel if the washing machine is durable? v
DF How do you feel if your washing machine is not durable? v

8 Information and service support
F How do you feel if your washing machine has information & service support? v
DF How would you feel if your washing machine did not have information & service support? v

9 Environmental orientation & energy efficiency
F How do you feel if your washing machine is environmentally friendly & energy efficient? v
DF How do you feel if your washing machine is not friendly to the environment & not energy efficient? v

F = functional question, DF = dysfunctional question

Table 4. The results of Kano analysis

| No. | Quality dimensions of washing machine | Category |
|-----|--------------------------------------|----------|
| 1   | Customization                        | A        |
| 2   | Easiness                             | O        |
| 3   | Smartness                            | I        |
| 4   | Safety                               | O        |
| 5   | Performance                          | O        |
| 6   | Aesthetic                            | I        |
| 7   | Durability                           | O        |
| 8   | Information and service support      | O        |
| 9   | Environmental orientation & energy efficiency | I   |

A = Attractive attribute, I = Indifferent attribute, O = One-dimensional attribute
4.4. Discussion
Each consumer has different needs and expectation. They are influenced by many things. This research revealed that for Laundry X, as a washing machine user in the 4.0 industrial era, easiness, safety, performance, durability, information & service support, and customization were important. Those six dimensions were deemed as important because their existence considerably supports Laundry X’s operation and financially advantageous. If those six dimensions were poor, Laundry X’s operation would be hampered, and they would suffer a loss.

Furthermore, Laundry X was indifferent when it came to ‘smartness’, a unique feature of the 4.0 industrial era. The existence (or absence) of this feature did not affect their satisfaction level. This was probably due to unfamiliarity with the feature or Laundry X felt that they have not needed it yet.

Aside from smartness, ‘aesthetics’ also seemed to be unimportant. Probably this was because Laundry X is a business entity. The function was the most important dimension for them. Laundry X also considered the last dimension, ‘environmental orientation and energy efficiency’, as unimportant. They opted to use another strategy to get around this dimension. For example, to reduce electrical power for a hot cycle washing, Laundry X used pre-heated water from outside the washing machine, so the machine’s heater feature (which required large power) was not used.

This research contributes in the form of washing machine quality dimensions in the 4.0 industrial era based on the perception of a laundry business and their level of importance. It provides initial implications that washing machine manufacturers need to focus on the easiness, safety, performance, durability, information & service support, and customization aspects. In addition, the smartness, environmental orientation and energy efficiency, and aesthetics aspects of washing machine need to be more introduced so consumers know and maximize their use so that their existence is more useful.

5. Conclusion
The development of technology in the 4.0 industrial era has stimulated various innovative products. One of them is washing machine. Nowadays, washing machine brands have launched innovative products. Many options were offered and they affected the users’ expectations.

This research aimed to identify washing machine quality dimensions in the 4.0 industrial era and their importance level for a laundry business. This research was a case study using a middle size laundry business in Bogor, Indonesia as the subject.

The result showed that in the 4.0 industrial era, washing machines have superiority in terms of customization, easiness, smartness, safety, performance, aesthetics, durability, information & service support, and environmental orientation & energy efficiency. In this particular study, the subject deemed easiness, safety, performance, durability, information & service support, and customization as important quality dimensions. Laundry X preferred a washing machine that was easy to operate, safe, had a good performance, durable, offered information and service support, and could be customized.

This study has a limitation. It only used one middle size laundry business. Further research with multiple users is needed to capture the expectation of wider consumers.

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