



Market Oriented Industrial Services Innovation Using Hybrid QFD and Kansei Engineering

Nanang Yulian and Tatang Akhmad Taufik

EasyChair preprints are intended for rapid dissemination of research results and are integrated with the rest of EasyChair.

July 27, 2021

MARKET ORIENTED INDUSTRIAL SERVICES INNOVATION USING HYBRID QFD AND KANSEI ENGINEERING

Nanang Yulian

Department of Aircraft Support & Power Services,
Cengkareng 15125 Indonesia, E-mail: n.yulian@gmf-aeroasia.co.id
Department of Technology Management, Institut Teknologi Sepuluh Nopember
Surabaya 60111 Indonesia, E-mail: n.juliant@gmail.com

Tatang Akhmad Taufik

Department of Technology Management, Institut Teknologi Sepuluh Nopember
Surabaya 60111 Indonesia, E-mail: tatang.taufik@gmail.com

ABSTRACT

Industrial Gas Turbine Repair and Motor & Generator Overhaul is one of the business units in PT GMF Aeroasia, Tbk. This business unit is a derivative of aviation. With the large market potential and the decline in the aviation market due to the COVID-19 pandemic, this business is one of the company's hopes. With this, sales of these services need to be increased in order to help the company's business sustainability. Companies currently need to improve the quality of these services to increase sales and customer satisfaction.

This research was conducted at a business unit, namely Industrial Gas Turbine at the largest aircraft MRO company in Southeast Asia, PT GMF Aeroasia. The subject of this research is service design using the Kansei Engineering and Hybrid QFD methods. This approach is applied in order to improve customer service and satisfaction.

The research method begins with determining the performance of service attributes based on service quality elements, then followed by evaluating service gaps between perceived service and expected service, determining the kansei score and evaluating Kano on one dimensional and attractive attributes. After obtaining the importance weight, the design process is continued with HoQ. This study recommends new service innovation the company can apply to increase sales.

Keywords: Kansei Engineering, Hybrid QFD, Service Innovation

1. INTRODUCTION

With large market potential on industrial gas turbine and power generation area, it is tight competitive too. Beside of that, aviation service already disturbed due to COVID-19 pandemic since 2020, so PT GMF AeroAsia Tbk. as aviation service was very depressed. In line with the pandemic, corporation depend on non aviation businesses, one of them is Industrial Gas Turbine Repair dan Motor & Generator Overhaul. Because of that, the sales need to be escalated for supporting corporation existence. Corporation need service quality enhancement in order to escalate sales and customer's satisfaction. On other side, if COVID-19 pandemic is over, this business still needs enhancement in order to maintain service diversification and decrease dependence on PT Garuda Indonesia Tbk.

In this research focus on identify customer priority needs, services quality compared to competitors, priority improvement and appropriate innovation which help service quality improvement. Services scope is power services on motor generator and industrial gas turbine repair.

Hopefully, this research output could help corporation to determine appropriate policy so as improve service quality and get sales escalated well. Moreover, help employees find their service standard based on customer's satisfaction.

Service quality affect customer satisfaction, Ravichandran (2010). The assessment of service quality can be performed by investigating the gap between perceived quality and customer expectation . through a research tool known as SERVQUAL SERVQUAL as model with some items that determine service quality as degree and direction between perception and customer expectation (Berry,1985). SERVQUAL divide service to 10 items with 5 classification that are tangibles reliability responsiveness, assurance and empathy. SERQUAL model identify the reasons of discrepancy between perception and customer's expectation called GAP. This gap will lead us to measure service quality level.

Nowadays, customer needs more customer-oriented service quality improvement that fit with their behaviour, Nagamachi (2007). We need method that capable to solve this matter, that is Kansei Engineering (KE). KE is technology which translate customer need to specific design, Nagamachi (2011). KE able to understand customer need, analyzed it by using statistical method and transfer it so specific design both service and product. KE can be strengthened and extended by incorporating potential quality tools, such as the Kano model and QFD, Chen (2015). Kano is created model by classifying attributes based on how well services could satisfy customer need. Attributes are categorized as one dimensional , attractive and must be dimension. While QFD will finalize the weighted, prioritized service attributes. Quality Function Deployment (QFD) known as service quality improvement method on design, service and process, Mazur (2014). This method use survey, focus group discussion, statistic pattern and others as tools. QFD provide structural methodology called House of Quality (HoQ).

Thus, the objective of this research is to improve service quality of GMF industrial gas turbine repair and motor & generator overhaul service by using KE, Kano and QFD concepts. All data gathered by using interview and forum group discussion with GMF customers which interacted on last 12 month.

2. LITERATURE REVIEW

KE Service

Nagamachi invented KE method at Hiroshima (1970) as customer's-oriented service improvement method. Now, there 3 types of KE are type I, II, III, IV, V and VI. Each type is improved model from previous model. There are 3 main point of KE, how to understand customer accurately, how reflect and translate it to service design, and how to build system and organization for Kansei oriented design. Recent KE research, more efficient approach is an extended model of KE, intended to solve potential contradiction in solutions, Hartono (2016)

KANO

The attributes of Kano are must be requirement, one dimensional requirement and attractive requirement. On must be requirement (M), customer never satisfied on both performance

low and high. Customer thought the service is standard and must be performed. On one dimensional requirement (O), customer satisfaction is linear with service performance. And on attractive requirement (A), customer satisfaction is not decrease even performance is lowering. Beside of 3 main attributes, there are 2 attributes that can be identified. These attributes are indifferent requirement (I) and reversal requirement (R).

Advantage obtained by classifying customer need with Kano model are service improvement priority and significant service terms well identified, customer satisfaction kano model could be combined with deployment quality optimally, solve problem in trade off situation of service improvement, and Kano attributes could penetrate on diverse customer, Hinterhuber (1996)

QFD

QFD found on 1960 at Japan for serving design process of big ships. Recently, QFD is applied on industry that interpreted as systematic process for understanding customer's need and translate it to process transformation that involve supply chain (sourcing, purchasing, operations, warehousing, distribution, logistic, support and after sales service, Mazur (2003). QFD finalize the weighted and priorities service which produce customer satisfaction ratio, goal and improvement ratio, sales point, raw weight, normalized raw weight, technical attribute and technical evaluation. These product help us to view improvement service quality highlight

3. METHODS

This research begins with literature review and field study to gather reliable data. Use descriptive analysis method with primary and secondary data analysis. Gather data by interview and forum group discussion with GMF customer. Focus on hybrid QFD analysis. Describe customer satisfaction by using kano model, finalized weight with QFD and translate it to service design using KE.

This research utilized a modified SERVQUAL as service domain with 14-service attributes which are deployed into five dimensions (tangible, responsiveness, reliability, empathy, and assurance). For example, "*Customer waiting room is comfortable*," "*Services finished on time*," "*Staff respond customer quickly*". Using Likert scale that range from "1=strongly disagree" to "5=strongly agree" for measure customer perception for each attribute.

There were 14 kansei words which are related to the attributes. Using Likert scale that range from "1=strongly unrelated" to "5=strongly related" for measuring relation kansei words with the attributes.

Service quality gap for obtaining perceived score and expected score deployed as questioner. And using Likert scale from "1=very low" to "5=very high". Service gap is formulated as perceived value minus expected value.

Kano model evaluated both functional and dis-functional questioner question. Using Likert scale that range from "1=unsatisfied" to "5=satisfied". The result combined on kano evaluation table and classified into six kano attributes.

Importance level of service measured importance level and implementation level. Using Likert scale that range from "1=very low" to "5=very high".

Data validation is tested by using Minitab 19 for Windows which compare value of r calculation with r table. If r calculation is higher than r table and value is positive, so the gathered

data are valid, Ghozali (2001). And data reliability is tested by using Cronbach's Alpha calculation. A variable or data is reliable when Cronbach's Alpha result is higher than 0.6.

Amount of response is 50 person which are interacted with GMF on last 12 month with 10% tolerance. So, total gathered response are 33 persons.

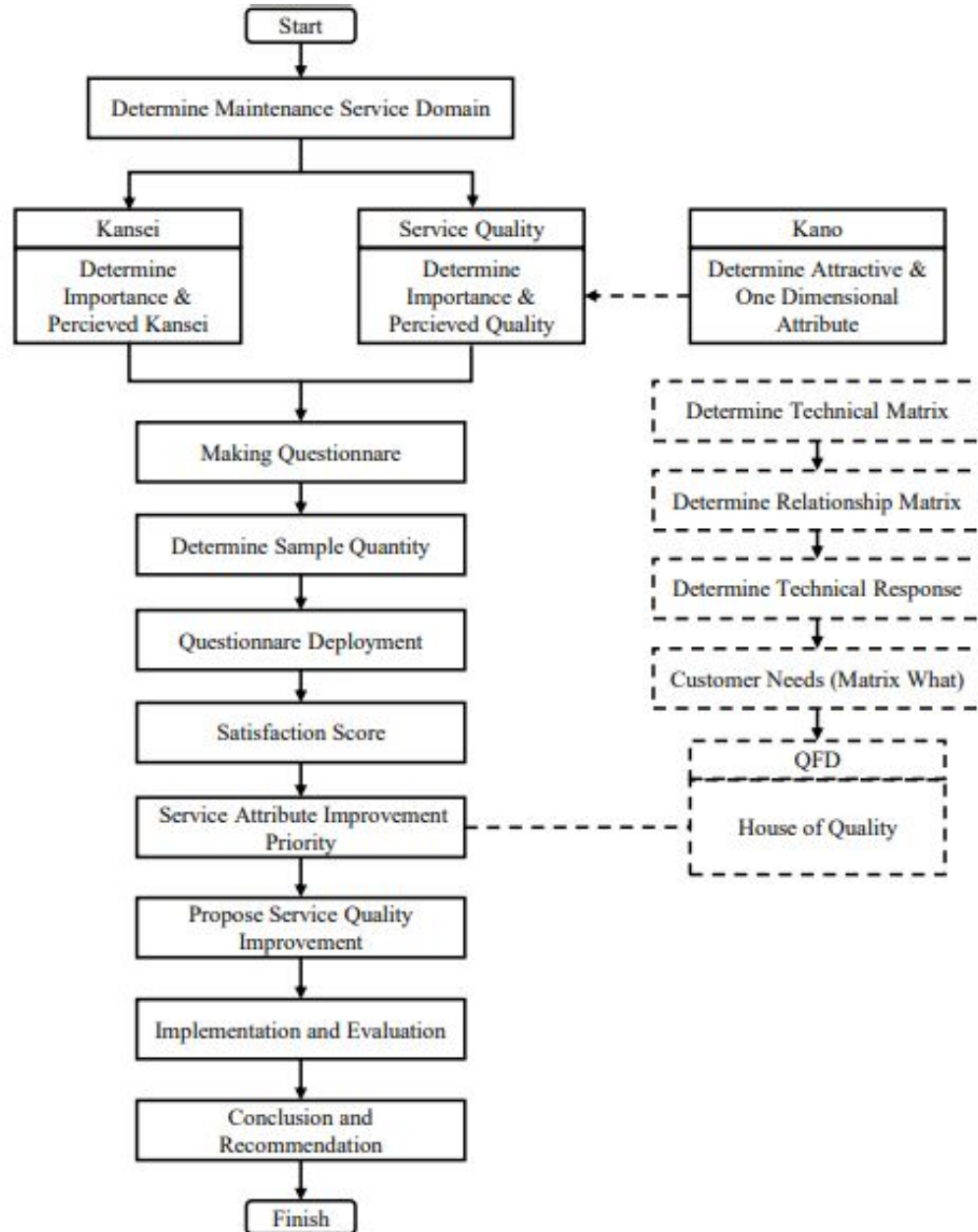


Figure 1. Flowchart Research

4. RESULTS

Most of kansei attributes have minus gap value see table1. It means that these attributes need improvement to reach the corporate goals as soon as possible. Top 3 kansei attributes that

under customer expectation are workshop facility, on time performance and respond. Meanwhile, just 2 attributes are over customer expectation, they are comfortable of waiting room and how staff explain the service.

Table 1. Service Gap Evaluation

| No | Kansei Attribute | Perceived (Mean) | Expected (Mean) | Gap (Perc-Exp) |
|----|--|------------------|-----------------|----------------|
| 1 | Customer waiting room is comfortable | 4.12 | 3.88 | 0.24 |
| 2 | Workshop is clean and neat | 4.03 | 4.30 | (0.27) |
| 3 | Workshop facilities are modern, complete, and well maintained | 2.85 | 4.24 | (1.39) |
| 4 | Marketing or production staff appearance is convinced | 4.09 | 4.21 | (0.12) |
| 5 | Repair or service on time performed | 3.15 | 4.52 | (1.36) |
| 6 | Documentations or reports are accurate and complete | 4.36 | 4.52 | (0.15) |
| 7 | Administration documents are complete | 4.21 | 4.39 | (0.18) |
| 8 | Repair or service quality as corresponding as customer need | 4.45 | 4.70 | (0.24) |
| 9 | Cost is proportionate with service | 4.30 | 4.42 | (0.12) |
| 10 | Staff always support the customer problem | 4.21 | 4.48 | (0.27) |
| 11 | Staff give response quickly | 3.21 | 4.39 | (1.18) |
| 12 | Staff explain the detailed service completely | 4.27 | 4.21 | 0.06 |
| 13 | GMF staff has knowledge and ability to work and support the customer | 4.45 | 4.48 | (0.03) |
| 14 | GMF staff and management concern on customer need | 4.12 | 4.39 | (0.27) |

Table 2 show level of importance of customer needs. Main concern of customer is repair or service quality (score 6.09). Second is staff response (score 5.9), there are 3 attributes with same score 5.78. They are staff support, workshop facility, cost, and on time performance.

Table 2. Attribute Importance Evaluation

| No | Kansei Attribute | SP | P | TP | STP | Score |
|----|--|----|----|----|-----|-------|
| 1 | Customer waiting room is comfortable | 9 | 19 | 5 | 0 | 5.24 |
| 2 | Workshop is clean and neat | 13 | 15 | 5 | 0 | 5.48 |
| 3 | Workshop facilities are modern, complete and well maintained | 14 | 18 | 1 | 0 | 5.78 |
| 4 | Marketing or production staff appearance is convinced | 9 | 19 | 5 | 0 | 5.24 |
| 5 | Repair or service on time performed | 14 | 18 | 1 | 0 | 5.78 |
| 6 | Documentations or reports are accurate and complete | 10 | 23 | 0 | 0 | 5.60 |
| 7 | Administration documents are complete | 12 | 16 | 5 | 0 | 5.42 |
| 8 | Repair or service quality as corresponding as customer need | 18 | 15 | 0 | 0 | 6.09 |
| 9 | Cost is proportionate with service | 15 | 16 | 2 | 0 | 5.78 |
| 10 | Staff always support the customer problem | 14 | 18 | 1 | 0 | 5.78 |
| 11 | Staff give response quickly | 15 | 18 | 0 | 0 | 5.90 |
| 12 | Staff explain the detailed service completely | 13 | 19 | 1 | 0 | 5.72 |
| 13 | GMF staff has knowledge and ability to work and support the customer | 12 | 19 | 2 | 0 | 5.60 |
| 14 | GMF staff and management concern on customer need | 10 | 21 | 2 | 0 | 5.48 |

Table 3 show priority of attribute based on its importance weight as result satisfaction, kano and kansei score. First priority is workshop facility with score 212.03. Second priority is on time performance with score 103.71. And third priority is staff appearance.

Table 3. Importance Weight each Attribute

| No | Kansei Attribute | Attribute | Satisfaction Score | Kano Weight | Kansei Score | Importance Weight |
|----|--|-----------|--------------------|-------------|--------------|-------------------|
| 1 | Customer waiting room is comfortable | A1 | 1.27 | 4 | 3.3 | 16.78 |
| 2 | Workshop facilities are modern, complete, and well maintained | A3 | 8.07 | 2 | 13.14 | 212.03 |
| 3 | Marketing or production staff appearance is convinced | A4 | 0.64 | 4 | 19.83 | 50.40 |
| 4 | Repair or service on time performed | A5 | 7.89 | 2 | 6.57 | 103.71 |
| 5 | Repair or service quality as corresponding as customer need | A8 | 1.48 | 2 | 11.46 | 33.84 |
| 6 | Cost is proportionate with service | A9 | 0.70 | 4 | 6.54 | 18.35 |
| 7 | GMF staff has knowledge and ability to work and support the customer | A13 | 0.17 | 4 | 7.09 | 4.82 |
| 8 | GMF staff and management concern on customer need | A14 | 1.50 | 4 | 6.51 | 38.95 |

Based on QFD analysis, GMF has strength and weakness compared with the competitors. 3 main strengths are staff knowledge, staff support and how staff explain the service. Meanwhile, 3 main weakness are workshop facility, on time performing and staff response.

Beside of benchmarking, importance items as result of QFD analysis is technical response priority. Table 4 show priority of technical responses after QFD weight calculation. Main priority technical response is about workshop facilities both completing and new development. Second is work delivery correspondent with contract or purchase order and the third is on time performance proportionate with cost.

Table 4. Technical Responses Priority

| No | Attribute | Weight | % |
|----|--|---------|-------|
| 1 | Completing facility for surface treatment, welding, electrical and mechanical test | 1908.23 | 18.66 |
| 2 | New development facility for surface treatment, welding, electrical and mechanical test | 1908.23 | 18.66 |
| 3 | Develop maintenance system and calibration for controlled and documented facility | 1908.23 | 18.66 |
| 4 | Work delivery correspondent with contract or purchase order | 933.37 | 9.13 |
| 5 | On time performance proportionate with cost | 476.30 | 4.66 |
| 6 | Marketing appearance representatively | 453.63 | 4.44 |
| 7 | Production uniform representatively, complete safety device, clean and well maintained | 453.63 | 4.44 |
| 8 | Customer accommodation is fulfilled well during cooperate with GMF, such as hotel, entertainment, and transportation | 350.57 | 3.43 |
| 9 | Repair corresponding with work scope and comply testing repair parameters | 304.59 | 2.98 |
| 10 | Repairs comply minimum determined running hours | 304.59 | 2.98 |
| 11 | Maintenance quality proportionate with cost | 266.71 | 2.61 |
| 12 | Work warranties proportionate with cost | 165.18 | 1.62 |
| 13 | Standard cost of GMF services is stated well | 165.18 | 1.62 |
| 14 | Waiting or meeting rooms are facilitated well such as chair, table, TV, AC and foods. | 150.98 | 1.48 |
| 15 | Facilities are clean and maintained well | 150.98 | 1.48 |
| 16 | Waiting or meeting room appropriate COVID-19 protocols | 150.98 | 1.48 |
| 17 | GMF staff has knowledge appropriate with project or capability | 43.36 | 0.42 |
| 18 | GMF staff has experiences and skills appropriate with project and capability | 43.36 | 0.42 |
| 19 | GMF staff respond and support the customer need | 43.36 | 0.42 |
| 20 | GMF staff concern on after sales service after their work | 43.36 | 0.42 |

| HOUSE OF QUALITY | | Ruang tunggu / meeting dengan fasilitas mendukung seperti kursi, meja, LCD / TV, AC dan konsumsi | Fasilitas meeting terawat dan bersih | Ruang tunggu / meeting memiliki standard Protokol Kesehatan Covid 19 | Memiliki fasilitas lengkap untuk surface treatment, welding, electrical dan mechanical test | Memiliki fasilitas terbaru untuk surface treatment, welding, electrical dan mechanical test | Memiliki system maintenance dan kalibrasi untuk fasilitas yang terkontrol dan terdokumentasi | Penampilan marketing yang representatif | Kostum produksi yang representatif, menggunakan APD lengkap, bersih, dan terawat | Delivery pekerjaan ke customer sesuai dengan tanggal sesuai dengan kontrak/ purchase order | Perbaikan sesuai dengan workscope dan memenuhi parameter-parameter pengujian perbaikan | |
|------------------|--|--|--------------------------------------|--|---|---|--|---|--|--|--|-------|
| Attribute | | Importance Weight | HOWS | | | | | | | | | |
| A1 | Ruang tunggu / meeting untuk customer nyaman | 16.78 | 9 | 9 | 9 | | | | | | | |
| A3 | Fasilitas workshop modern, lengkap dan terpelihara | 212.03 | | | | 9 | 9 | 9 | | | | |
| A4 | Penampilan karyawan produksi / marketing meyakinkan | 50.40 | | | | | | | 9 | 9 | | |
| A5 | Perbaikan / jasa selesai pada waktu yang disepakati | 103.71 | | | | | | | | | 9 | |
| A8 | Hasil perbaikan / jasa berkualitas, sesuai pesanan | 33.84 | | | | | | | | | 9 | |
| A9 | Biaya yang dikeluarkan sebanding dengan jasa yang didapatkan | 18.35 | | | | | | | | | | |
| A13 | Karyawan GMF memiliki pengetahuan dan kemampuan untuk bekerja dan membantu pelanggan | 4.82 | | | | | | | | | | |
| A14 | Karyawan dan perusahaan GMF memperhatikan kebutuhan customer secara individu | 38.95 | | | | | | | | | | |
| Total Weight | | | 151.0 | 151.0 | 151.0 | 1,908.2 | 1,908.2 | 1,908.2 | 453.6 | 453.6 | 933.4 | 304.6 |
| Percentage | | | 1.48% | 1.48% | 1.48% | 18.66% | 18.66% | 18.66% | 4.44% | 4.44% | 9.13% | 2.98% |

| HOUSE OF QUALITY | | Perbaikan memenuhi running hours minimum yang ditetapkan | Kualitas maintenance, sebanding dengan biaya yang dikeluarkan | Ketepatan waktu sebanding dengan biaya yang dikeluarkan | Garansi pekerjaan sebanding dengan biaya yang dikeluarkan | Standard biaya dari jasa yang diberikan oleh GMF sehingga pelanggan bisa memperkirakan biaya yang dikeluarkan. | Karyawan GMF memiliki pengetahuan sesuai dengan project atau capability | Karyawan GMF memiliki experience dan skill sesuai dengan project atau capability | Karyawan GMF merespon dan membantu masalah customer | Karyawan GMF memperhatikan After Sales Service atas jasa yang sudah dikirimkan ke pelanggan. | Customer dipenuhi akomodasi selama bekerjasama dengan GMF, baik berupa hotel, entertainment dan transportasi | |
|------------------|--|--|---|---|---|--|---|--|---|--|--|-------|
| Attribute | | Importance Weight | HOWS | | | | | | | | | |
| A1 | Ruang tunggu / meeting untuk customer nyaman | 16.78 | | | | | | | | | | |
| A3 | Fasilitas workshop modern, lengkap dan terpelihara | 212.03 | | | | | | | | | | |
| A4 | Penampilan karyawan produksi / marketing meyakinkan | 50.40 | | | | | | | | | | |
| A5 | Perbaikan / jasa selesai pada waktu yang disepakati | 103.71 | | | 3 | | | | | | | |
| A8 | Hasil perbaikan / jasa berkualitas, sesuai pesanan | 33.84 | 9 | 3 | | | | | | | | |
| A9 | Biaya yang dikeluarkan sebanding dengan jasa yang didapatkan | 18.35 | | 9 | 9 | 9 | 9 | | | | | |
| A13 | Karyawan GMF memiliki pengetahuan dan kemampuan untuk bekerja dan membantu pelanggan | 4.82 | | | | | 9 | 9 | 9 | 9 | | |
| A14 | Karyawan dan perusahaan GMF memperhatikan kebutuhan customer secara individu | 38.95 | | | | | | | | | 9 | |
| Total Weight | | | 304.6 | 266.7 | 476.3 | 165.2 | 165.2 | 43.4 | 43.4 | 43.4 | 43.4 | 350.6 |
| Percentage | | | 2.98% | 2.61% | 4.66% | 1.62% | 1.62% | 0.42% | 0.42% | 0.42% | 0.42% | 3.43% |

All attributes priority were identified well. So, innovations and programs for improving service quality could be determined. There are some ideas about it. Do investment on welding, surface treatment, and bench test especially electrical and mechanical test. Create maintenance system and calibration apps for monitoring and documenting facilities correspond with ISO. Review internal processes for improving delivery time such as supply chain, project management optimization, and production process. Designing staff development based on customer service excellent and service standard in order to serve the customer properly. Completing safety devices for production staff. Do review of work instruction and quality check based on manual parameters. And the last is reviewing service pricelist compares to the competitors.

6. CONCLUSIONS

Most of GMF services are below customer expectation, it is big challenge for improving service quality. Intermediate and long terms improvement program shall be planned based on importance priority carefully. Project management shall be controlled as tools to help GMF projects, in the end of service could be delivered correspond with the customer needs. Few research examines GMF service quality especially on power services. Customer survey and other research should be made periodically in order to view what exactly customer needs. Because of customer needs always change by time.

REFERENCES

- A. Prakasha, & R.P. Mohanty, (2012), Understanding service quality, *Production Planning and Control* , 1-16.
- Akao, Y., & Glenn, M., (2003), The leading edge in QFD: past, present, and future, *International Journal of Quality and Reliability Management, Vol. 20 No. 1*, 20-35.
- Boger, & Davis, (1993), Kano's Method for Understanding Customer-defined, *Center for Quality of management Journal.* , 2 (4). .
- Elmar Sauerwein, E., Bailom, F., Matzler, K., & Hans H. Hinterhuber, H., (1996), The Kano Model: How to Delight Your Customer, *International Working Seminar on Production Economics*, 313 -327.
- Ghozali, I., (2001), *Aplikasi Analisis Multivariat dengan Program SPSS*, Semarang: Badan Penerbit Universitas Diponegoro.
- Hartono, M., (2012), Applying Kansei engineering to design logistics services e A case of. *International Conference on Small and Medium Enterprises Development*, 201 – 212.
- Hartono, M., (2016a), The Extended Integrated Model of Kansei Engineering, Kano, and TRIZ Incorporating Cultural Differences into Services, *International Journal of Technology, Volume 7(1)*, 97–104.
- Hartono, M., Santoso, A., & Prayogo, D. N., (2017), HOW KANSEI ENGINEERING, KANO AND QFD CAN IMPROVE LOGISTICS SERVICES, *International Journal of Technology*, 1070-1081.
- Hartono, M., Tan, K.C., (2011), How Kano Model Contributes to Kansei Engineering in Services, *Ergonomics, Volume 54(11)*, 987–1004.
- Kano, N., Seraku, N, Takahashi, F, & Tsuji, S., (1984), Attractive quality and mustbe quality, *Hinshitsu. Vol.14.,* pp.39-48.
- Lovelock, C., (1994), *Product Plus: How Product + Service = Competitive Advantage*, New York: McGraw Hill.
- Lovelock, C. a., (2011), *Services Marketing, New Jersey: Pearson.*
- Mazur, G., (2014), QFD 2000: Integrating QFD and Other Quality Methods. *12th Symposium on QFD/6th International Symposium on QFD 2000 - Novi.*
- Mu-Chen Chen, Chia-Lin Hsu, Kuo-Chien Chang, Man-Chi Chou., (2015), Applying Kansei engineering to design logistics services e A case of. *International Journal of Industrial Ergonomics 48*, 46-59.

- Nagamachi, M., (1995), Kansei Engineering: A new ergonomic consumer-oriented, *International Journal of Industrial Ergonomics* 15, 3-11.
- Nagamachi, M., (2002), Kansei engineering as a powerful consumer-oriented technology, *Applied Ergonomics* 33, 289–294.
- Nagamachi, M., (2007), Perspectives and new trend of Kansei/Affective Engineering, *The TQM Journal Vol 20 No 4*, 290-298.
- Nagamachi, M., (2011), *Kansei / Affective Engineering*, Boca Raton: CRC Press Taylor and Francis Group.
- Nagamachi, M., & Lokman, A. M., (2011), *Innovation of Kansei Engineering*. New York: CRC Press Taylor & Francis Group.
- Nishino, T., Nagamachi, M., Ishihara, K., Ishihara, S., Ichitsubo, M., Komatsu, K., (1999), Internet Kansei Engineering System with Basic Kansei Database and Genetic Algorithm, *Proceedings of TQM and Human Factors (Linkoping, Sweden: Centre for Studies of Humans, Technology and Organization)*, 367–372.
- Parasuraman, A., Zeithaml, V. A., & Berry, L. L., (1985), *Journal of Marketing. A Conceptual Model of Service Quality and Implications for Future Research*, 41-50.
- Raid Al-Aomar, H. A.-M., (2012), Quality Function Deployment for Service: A Case Study of Enhancing the Planning, *International Journal of Advanced Trends in Computer Science and Engineering*, 2278-3091.
- Ravichandran, K., (2010), Influence of service quality on customer satisfaction application of SERVQUAL, *International Journal of Business and Management* , 117-1243.
- Wang, Kun-Chieh, (2011), A hybrid Kansei engineering design expert system based on grey system theory, *Expert Systems with Applications*, 8738–8750.
- Yuexiang Huang, Chun-Hsien Chen, Li Pheng Khoo, (2012), Kansei clustering for emotional design using a combined design structure matrix, *International Journal of Industrial Ergonomics*, 416-427.