Abstract

As the emerging global market is triggering and escalating great business in software market, Japanese developers are driven to seek and grow the opportunities to be the leader in the world. As the second strongest player, Japan is far behind U.S as the first player. One of the main reasons of this is coming from the slow development practice performed by Japanese developers compared to the U.S. which is more innovative and has faster time to market. The Japanese has been putting too much emphasize on quality which lies on customer requirements management of System Development Life Cycle (SDLC) that results in inefficient design which leads to inefficient time, and cost. Currently, as one of Japanese developers, PT. XYZ plans to develop RAB-software who’s the research is done in PU – NTB. Hence, customer requirements are captured and identified by using Kano Model to classify and justify the priority of requirements in accordance to the level of satisfaction. They are then translated into House of Quality of Quality Function Deployment in order to design priority-based requirements in achieving time efficiency, cost reduction, and design optimization towards SDLC process. In the end, 48% of design to be developed is able to be reduced through this research.

Keywords: software development life cycle; kano model; quality function deployment; house of quality; time efficiency; cost reduction; design optimization

INTRODUCTION

Nowadays, information technology business sector is one of the fastest growing sectors in the world, mentioned by Forbes in its article The 10 Fastest-Growing Field in Business 2014. As higher competition in software market has been existing in the last decades, a better strategy to develop software is approached.

A System Development Life Cycle (SDLC) is a fundamental stage which administers design as well as life cycle of software development. It consists of several phases: problems, opportunities, and objectives identification; information requirements determination; system needs analysis; system development; software development and documentation; system test and maintainability; and system implementation and evaluation [1]. This process helps to establish a cost-efficient and high quality of software. However, in the implementation, it is found to have lack of efficiency which happens in the phase analysis and management of customer requirements toward software development features.

Currently, this problem is experienced by Japanese developers which are far behind U.S developers. The U.S. is able to grab more than 40% of software market shares and has been taking the title as the top player in the world [2-4]. One of the main reasons this could happen because of the weakness point of the Japanese in time strategy and too much concern in delivering best quality of software and providing all customer requirements in the features.
Presently, PT. XYZ wants to develop a construction detail budgeting or Rincian Anggaran Biaya (RAB) software whose the research is performed in Dinas Pekerjaan Umum (Department of Public Works), usually called PU, in Nusa Tenggara Barat. As a part of these Japanese developers which engages in developing and selling packaged software as well as planning and design information system, PT. XYZ intends to execute a better method to improve the strategy it has been performing in software development. In accordance to this matter, Quality Function Deployment (QFD) is used as Zeidler [5] states that this method does not only assure customer satisfaction with quality of product or service, but it also provides reduction in development time, startup cost, and expensive after-the-fact design change. It is an approach in gathering requirements from customer needs and translating them into product characteristics. In providing perfection for the execution of QFD, Kano Model analysis is proposed to equip the product attributes by categorizing the specifications into 3 types: must-be, one-dimensional, and attractive [6], which is then developed and resulted in 3 additional categories: reverse, indifferent, and questionable [7]. By the concept of Kano Model, QFD is modified to achieve the optimization of design in association with customer satisfaction.

METHODOLOGY
The methodology of the research is firstly done by performing initial observation which is conducted on the culture of Japanese developers in software development practice through discussions with software analysts of PT. XYZ. It is to evaluate the problem and/or the lack of their performance which let them always behind the U.S. as the top software player. This evaluation is then used as the basis consideration to perform a better way in developing software so that the Japanese is able to be in the front line of software market. In addition, supporting data from trusted sources in the internet is collected to perform better identification of problem. After executing the initial observation, problem occurred in the development process of software is identified. It is found that the problem appears in the SDLC process of analyzing the customer needs and transforming the model. It takes quite a long time and unconsciously allows the competitors to enter the market faster and grab more shares.

In order to have clear clarification to problem occurred on the practice of software development performed by Japanese developers, several discussions with software analysts who periodically monitor the situation of software development practice in Japan are done. In addition, the development practice of U.S. developers is evaluated as the basis for identifying the improvements to be executed. The data collected includes the information about current condition and situation of Japanese and U.S. SDLC process, and all related information to the requirement and the design of the development. Moreover, to provide deeper analysis to the problem, supporting data from books, journals, and trusted sources is gathered. This supporting data is used to investigate current procedures implemented by the Japanese and the U.S. in managing customer requirements and their weakness and strength points towards others.

As PT. XYZ intends to create RAB software whose the research is done in PU – NTB, questionnaire based on Software Requirement Specification (SRS) framework is made and distributed to the staffs which directly deal with project tender for public and the Head of Cipta Karya Department to appraise the performance of current RAB software and collect their needs towards a new RAB software, or in other words to gather their expectations to the lack of current RAB software and any additional values to create a superior RAB software. In addition, direct interview is also performed to complement the analysis of the questionnaire. It is to obtain clear definition of their needs in preventing any wrong interpretation defining their needs.

Refering to [8-11], All of these collected data are directly classified into Kano Model categorization in distinguishing the level of satisfaction, dissatisfaction and importance level of customer towards a feature. It is done before generating the features into technical response of QFD. This is aimed to reduce the time duration taken for the long analysis in providing technical responses as the translation of those needs. Only needs with high priorities in which are able to create high satisfaction towards the fulfillment are next concerned to be translated into House of Quality (HOQ) of QFD. Afterwards, to provide the provision of customer requirements, capability of PT. XYZ is examined through discussions with stakeholders and software engineers to not
solely perform and consider the quality but also the strength, the expense, the time duration as well as the strategy to win the customers.

In this research, Kano Model is purposed to provide a better process in designing product attributes based on their impacts on the level of customer satisfaction, and HOQ of QFD is designed in systematic way to allow the developer team to get detail specifications and requirements of customer needs and their expectations. This Kano Model provides better approach in measuring the adjacent importance in QFD through the investigation of importance level of the features. Besides, the technical response conceptualized in QFD is associated with the result of Kano Model categorization, which is of the category that provides high satisfaction for the fulfillment, to perform a better analysis of HOQ – QFD in attaining optimized design. Hence, HOQ as a full integration of QFD matrix is created and associated with Kano Model to generate the final design of RAB software. As a full process of the research, the methodology to perform the research is done systematically as shown in Fig. 1. Research Framework below.

RESULT AND DISCUSSION
Before being able to perform the analysis to answer the problem, the design of questions in accordance to the approach of Kano Model is generated. This is aimed to obtain the detail opinion of customers towards availability of software features. By this, customers’ perceptions on functional (existence of feature), dysfunctional (absence of feature), and importance level of each feature are examined. In addition, current performance of RAB software used is assessed to make an ease positioning of proposed RAB software in customers preference. The review of current RAB software and problem faced by the customers are taken into the features to be questioned to customers. Fig. 2 Proposed Features are describing the proposed features that have been generated.

The questionnaire result collected is then processed and examined in detail to figure out the solutions to solve the problem faced by Japanese developers in analyzing customer requirements and to come up with the efficient RAB software features in which can satisfy the customers.

Fig. 1: Research Framework
The process of the analysis starts from the test to the reliability and validity of data; the translation of data into Kano Model – calculate CS-Coefficient and importance level interval, generate customer requirements into Quadrant Kano; the translation of customer requirements from Kano Model into House of Quality (HOQ) of Quality Function Deployment (QFD) – generate technical responses to fulfill customer needs, evaluate technical correlation of technical response towards the customer needs fulfillment, examine relationship among technical responses, calculate priority of technical response to be developed, and determine target and direction of improvement; which in the end, measure the improvement on the practice of software development.

Reliability Test
Reliability of the data is performed to check the consistency of data taken. It is tested by using Spearman Brown’s formula to calculate the correlation coefficient reliability \( r'_{xx} \) associated with the correlation coefficient between two sections \( r_{xy} \). Based on the theory of reliability stated [12], a reliable data is if \( r'_{xx} \geq 0.7 \). By the result of calculation, it is seen that all are having \( r'_{xx} > 0.7 \): 0.897 for functional reliability, 0.916 for dysfunctional reliability, and 0.887 for importance level reliability. In other words, this represents that the content of data is consistent and accurate.

Validity Test
Validity test in this research is performed qualitatively to the accuracy of the questions. This is a content validity test which the content of the questions are analyzed and justified directly by analysts and stakeholders of PT. XYZ using the approach of rational analysis. In addition, as all the questions are generated by the professionals of PT. XYZ, then it can be concluded that the content of questions are all valid. Quantitative test to the validity of the data is not performed as in accordance to the theory of construct validity, the validity level of a measurement tool can be determined by a study on the correlation of each item or sections between items with coefficient \( r_{xy} \geq 0.3 \) [13]. As the result shown in the reliability test indicates reliable result with \( r_{xy} 0.814 \) for functional, 0.845 for dysfunctional and 0.797 for importance level: thus, it is also concluded that the questions are valid.

Translation of Data into Kano Model
All the data collected from respondents are translated into Kano Category by using the rules in Kano Evaluation Table, to be then used to determine Kano Category and Customer Satisfaction-Coefficient (CS-Coefficient) as shown in Fig. 3. Translation of Data into Kano Model.
This is performed to analyze the value of customer satisfaction towards the accommodation of each feature in the development of RAB software. Dissatisfaction value of the absence of proposed features is also analyzed to provide an insight consideration of customer response to the importance of the features. These satisfaction and dissatisfaction values are then plotted to the graph of Quadrant Kano.

However, the categorization of features does not fully ensure the importance level of it on customer perspectives. Thus, importance level of each feature is also analyzed to attain deeper analysis before deciding the features to be developed and those to be either ignored or recorded for future development. This importance level is classified into 5 interval values and presented in Fig. 4. Interval Value – Importance Category.

To define the classification of each feature in Quadrant Kano, the mean value of satisfaction and dissatisfaction is calculated. These mean values differentiate the features plotted on graph into 4 Quadrant Kano: Must-be (low satisfaction and high dissatisfaction), One-dimensional (both high satisfaction and dissatisfaction), Attractive (high satisfaction and low dissatisfaction), and Indifferent (both low satisfaction and dissatisfaction). All the features are plotted based on their satisfaction and dissatisfaction coefficient as well as the importance level which is symbolized with the color. The result is performed in Fig. 5. Quadrant Kano based on CS-Coefficient.

As it is shown in Fig. 5. Quadrant Kano Mapping based on CS-Coefficient, even though the features are categorized in indifferent category, some features are still having quite important-subject level. This happens as this also reflects customer point of view towards features in the future. Quadrant Kano represents current assessment and needs of customers. On the other hand, importance level given by the customers towards features is a form of customer expectation for the availability of them that would probably bring huge advantages and preference in several years ahead.

An efficient software development practice does not only focus on reducing cost and time of the development, but also concerns about the way to grab the market. One of the ways is by providing superiority of software. This is taken into account as the number of competitors is increasing at all times. As a result, additional values of functions and/or features are complemented to the basic functions and compulsory features of software. Therefore, attractive and one-dimensional categories are decided to be further analyzed to provide superiority of software design and function as they are able to provide high satisfaction of customer through the provision of features.
Furthermore, the analysis of these categories is done by evaluating current features performance and the importance level, which is then calculated into Adjacent Importance to determine the priority of features to be translated into model and software system. The calculation is shown in Figure 6. **Adjacent Importance**.

**Translation of Kano Model into QFD**

After obtaining the adjacent importance of each feature, technical response of PT. XYZ in fulfilling this priority of customer requirements is performed. Technical response is transformation of customer needs into capability of software. The fulfillment of these needs is analyzed by combining the ability of PT. XYZ’s software engineers and the analysis of design and system towards features taken from the observation to current software and interview to customers. The technical response is generated in Fig. 7. **Technical Response**.

The next stage of the analysis is to measure the relations of technical response and customer requirements. It is to know how technical response correlated to the customer requirements fulfillment. The relationship is presented as strong when there is huge correlation of technical response to the accommodation of customer requirements (=); medium when there is medium correlation (o); and low when there is small correlation of technical response to fulfill customer requirements (X), with the weight of 9, 3, and 1 consecutively. Fig. 8 **HOQ Construction** explain about House of Quality.
Then, the relationship among these technical responses is being examined. This relationship shows the correlation of technical response towards other technical responses with (+) shows a linear correlation, while (-) shows contradictory correlation. It is assessed to consider the relationship of technical response before finalizing the design of software and to ensure that there is no technical response that would lower the quality of performance of other technical responses.

In consequent, Absolute Importance, the sum of all multiplication of each relationship occurred with the level of importance that is adjusted with weight of Kano and satisfaction coefficient, is calculated to determine the priority of technical responses to be developed. It is then represented by Relative Importance in the form of percentage. The higher the value of absolute importance and relative importance of a technical response, the higher the development priority of that technical response will be. This also means that the fulfillment of customer requirements has stronger impact on customer preference and satisfaction.

Respectively, target and direction of improvement to perform technical response is assessed qualitatively by PT. XYZ. The target represents the level of effort of PT. XYZ in fulfilling customer requirements through technical responses providing superiority of software, but does not overreact to the needs. In the other hand, the direction of improvement shows the contentment of customers towards the increment, constant, or decrement of technical response to be achieved. It is the guideline in figuring the target to be executed. Further consideration towards current performance of software used by PU-NTB and Absolute Importance are taken into account to perform a better approach in finalizing the design of target and improvement direction.

**Improvement on Software Development Practice**

By the analysis of customer requirements management using Kano Model and QFD, a design optimization is able to be achieved. This results from the precise portion of customer needs fulfillment. By the approach of QFD, all customer needs are gathered and translated into specification of technical responses. Then, by the help of Kano model, a deeper analysis towards a feature is attained in which restricts the concern to the maximization in providing customer satisfaction: only those which would bring high satisfaction are further developed by PT.XYZ.
The overview of features to be developed with the priority of importance level, satisfaction, and dissatisfaction coefficient is shown in Fig. 9. *Summary of RAB Software*

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Technical Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Provide connectivity of system to a direct search of available, trusted and legal data online.</td>
</tr>
<tr>
<td>2</td>
<td>Provide an installed-offline master data.</td>
</tr>
<tr>
<td>3</td>
<td>Provide field to manually input source data.</td>
</tr>
<tr>
<td>4</td>
<td>Provide space memory and field for sets of documentation and records of all calculated RAB.</td>
</tr>
<tr>
<td>5</td>
<td>Organize documentation and records based on date, name of projects, and name of person in.</td>
</tr>
<tr>
<td>6</td>
<td>Provide search function for word, function and calculation formula detection.</td>
</tr>
<tr>
<td>7</td>
<td>Provide an installed formula of calculation on cell.</td>
</tr>
<tr>
<td>8</td>
<td>Provide direct free-input formula on cell.</td>
</tr>
<tr>
<td>9</td>
<td>Provide field to input and save additional calculation formula.</td>
</tr>
<tr>
<td>10</td>
<td>Provide options to activate, non-activate, or edit the calculation formula installed on cell.</td>
</tr>
<tr>
<td>11</td>
<td>Link interrelated cell by inputing key word.</td>
</tr>
<tr>
<td>12</td>
<td>Provide field to input the estimation of construction working period.</td>
</tr>
<tr>
<td>13</td>
<td>Provide Time Schedule planning by the approach of PERT/CPM.</td>
</tr>
<tr>
<td>14</td>
<td>Provide simple and understandable explanation of functions and examples.</td>
</tr>
<tr>
<td>15</td>
<td>Provide example's display pictures.</td>
</tr>
<tr>
<td>16</td>
<td>Automatically save the data when changes performed.</td>
</tr>
<tr>
<td>17</td>
<td>Provide escalation method in calculating more accurate estimation of price.</td>
</tr>
<tr>
<td>18</td>
<td>Automatically translate the calculation of volume and area from consultant analysis into input.</td>
</tr>
</tbody>
</table>

*Fig. 7: Technical Response*

In accordance to this, from the total 25 features proposed, only twelve features that are found to have high satisfaction and preference of customers, with one compulsory feature. This is taken as in the concern is to success in the market with the right portion of action. Only those with category of attractive and one-dimensional are further considered to be translated into technical responses. In other words, waste of design that would not bring any or less satisfaction is eliminated, and an efficient design is achieved and shown in Fig. 10. *Summary of RAB Software Features Realization* in accordance to its priority of development.

As a linear correlation, an efficient design also has a good impact on the reduction of development time in the process of analyzing and managing customer requirements as well as developing the software. As the design to be developed is reduced, the time is automatically decreased as the process taken for analyzing the translation of the needs into technical responses is reduced and the realization of the design is diminished. PT. XYZ is able to reduce the use of time by only analyzing and executing the fulfillment of customer requirements which have huge impacts on their satisfaction while ignoring those with less or no satisfaction.

Moreover, it cannot be denied that the efficiency of design and the reduction of duration time have linear effect to the reduction of cost. It is the expense of all processes taken. As the number design is decreased, the time duration for analysis and development is reduced in which will construct less process of the execution. As a consequence, the expense is gradually decreased. This cost reduction would not have any interruption on the performance of product quality as there is no reduction of quality occurred because the one being cut is the design feature, not the quality of product as what other competitors do. On top of that, PT. XYZ is aimed to make superior RAB software while can also improve the slow development practice it applies.

In the end, it can be confirmed that these are able to improve the slow practice in software development performed by Japanese developers as the analysis process in managing customer needs and the design product can be optimized. In other words, it improves the implementation of the analysis phase of SDLC process, which indirectly would also improve the development process. Moreover, faster time to market and cost efficiency while maintaining the quality of product can be achieved.
Fig. 8: HOQ Construction

Fig. 9: Summary of RAB Software

Fig. 10: Summary of RAB Software Features Realization
CONCLUSIONS
The integration of Kano Model and QFD is able to improve the practice of software development by reducing the number of development features through classification of customer requirements’ priority. This priority is attained in accordance to the level of importance, customer satisfaction and dissatisfaction towards the existence and the absence of the features, and capability to fulfill customer needs.

Out of 25 features, only twelve that are further concerned and developed in which two of them are of included in attractive category representing those of significant satisfaction of customer needs fulfillment and further if not existing there will be no dissatisfaction at all. Meanwhile, the other ten are of one-dimensional category or in other words providing higher satisfaction, but if they do not exist there will be high dissatisfaction. Then, out of those 12 features, there is also one feature that is compulsory or of the must-be category. As a result, the features to be developed are able to be reduced by 48% in which can affect the development time and cost.

In the end, an improvement of Japanese developers practice in software development is achieved as the phase of analysis is able to perform a better way in analyzing and managing customer requirements, and an optimized design of software to be developed – RAB software is attained.

REFERENCES