A Case of Soft System Methodology (SSM): Interacting Aspect Modelling of Customer Satisfaction in Video Stream Service Over Wireless and Mobile Network

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***Abstract*—Customer satisfaction has become essential in any service due to its positive influence to customer loyalty and further market opportunity. In video stream service over wireless and mobile network, customer satisfaction is determined by many interacting aspects. It includes objective Quality of Service (QoS) parameters and subjective Quality of user Experience (QoE) factors. In addition, customer satisfaction is also determined by business strategy that applied by service stakeholders e.g. pricing and customer care. Some issues arise due to interaction between these aspects. These issues are difficult to be addressed by *creative* and *logical* problem solving strategy. This paper discusses Soft System Methodology (SSM) to elucidate what the actual problem of these interacting aspects. It is expressed through seven consecutive stages of SSM that illustrate problem solving process from unstructured problem to structured problem. This paper also proposes a methodology to model the interacting aspects in determining customer satisfaction.**

Keywords-QoS; QoE; Soft System Methodology (SSM); Look-Up Table (LUT) Modelling

I. INTRODUCTION

Refer to Nolan in [1], problem is gap between current and desirable conditions. It can be differentiated into well-defined and ill-defined problem. Well-defined problem is characterized by certain current condition, certain desirable condition, and many alternatives to link the two conditions. The problem is about decision-making to select one of best solution among the alternatives. The ill-defined problem is identified by several different perceptions towards the problem conditions. Every perceptions leads to its own consideration to solve the problem. Problem solving strategy may be defined as endeavor to reach more desirable conditions from the current conditions [2]. *Creative* and *logical* problem solving strategies can be used to solve the well-defined problem. However, these strategies cannot solve the ill-defined problem. Soft system approach is one of major problem solving strategy to solve the ill-defined problem. Many researches develop problem solving strategy using this approach. Among of them are Beer's Viable System Model [3] and Soft System Methodology (SSM). However, SSM is the most developed strategy and widely applied [4].

Since introduced by Peter Checkland in *Systems Thinking, Systems Practice* [5], SSM has been extending by many research [6] [7] [8]. SSM emphasizes on system thinking idea for the ill-defined problem. It solves issue of irreducible complexity through holistic view of the problem (thinking based on wholes) [9]. It includes *soft* aspects e.g. organizational, political, and cultural system. Based on Pešl [10], SSM is identified as system of enquiry, process of enquiry, learning system, reflection in action, and structured way of thinking. SSM is mainly based on two pair ideas: emergence and hierarchy as one pair, and communication and control as the other pair [5] [11]. In order to solve the ill-defined problem, SSM uses seven stages of problem solving strategy. The stages are grouped into real world strand and system thinking strand as illustrated in Fig. 1.

SSM stages illustrate movement of problem solving from unstructured problem to structured problem in order to reach desirable changes [12]. The essential of SSM is about investigation and learning process around the seven stages in continually loops [9] [13]. Every stage evaluates the problem situation and provides input for the next stage. As it reaches the last stage, SSM offers backtracking and iteration process that aimed to improve output of some stages [10]. Finally, application of SSM leads to new insight and open up further investigation and changes.

This paper discusses SSM application in case of video stream service over wireless and mobile network. The focal point is how to elucidate interaction between many aspects of the service in order to improve customer satisfaction. The paper is divided into four sections including this first introduction section. Detail of background and motivation of the case study is described in the next section. The third section explains application of SSM that includes its seven consecutive stages. Finally, conclusion is provided in the fourth section.

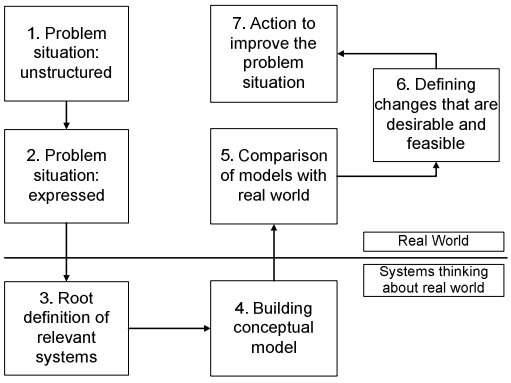

Figure 1. Seven stages of SSM.

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II. BACKGROUND AND MOTIVATION OF CASE STUDY

Customer satisfaction has become essential issue in any service. It influences customer loyalty and opens up further market opportunity. In video stream service over wireless and mobile network, customer satisfaction is influenced by Quality of Service (QoS). It is determined by objective QoS parameters i.e. network parameters (bandwidth, delay, jitter, packet loss, channel quality indicator), application parameters (video rate, audio rate, frame rate, coding mechanism), and device capabilities (brightness, deep of color, display size, processing speed, memory capacity). Based on some study in [14] [15] [16] [17], objective QoS parameters inherent with intermingled interrelations issue. This first aspect influences how well the streamed video is received by mobile device.

The customer satisfaction is also influenced by Quality of user Experience (QoE). It is determined by subjective QoE factors. They can be categorized into intrinsic factors (customer experience, customer expectation, and customer interest) and extrinsic factors (saliency awareness, frame rate-to-frame loss awareness, and frame loss distribution awareness). These factors contribute to bring nonlinearity in customer satisfaction [18]. This second aspect influences how well the service quality is perceived by the mobile customer.

As the third aspect, customer satisfaction is also determined by business strategy that applied by the service stakeholders. The service stakeholders are service provider, network provider, device manufacturer, and content provider. Each of these stakeholders has different perception in determining how the service should be provided. It depends on their respective business interest. More detail of this aspect is explained in the next section.

Due to interaction between those three aspects, some issues are arisen. These issues are difficult to be handled using *creative* and *logical* problem solving strategies. It is because the existence of ill-defined problem characteristic and different problem perception coming from each service stakeholders. For that reason, this paper is motivated to address the problem by applying SSM.

III. APPLICATION OF SOFT SYSTEM METHODOLOGY

The objective of SSM is to understand the customer satisfaction issue in relation to interacting three aspects of video stream service over wireless and mobile network i.e. objective QoS parameters, subjective QoE factors, and service stakeholders' business strategy. The following is seven consecutive stage of SSM to handle the issue.

A. Problem Situation: Unstructured

The first SSM stage is to collect all data and information that is related to the ill-defined problem. From the first aspect, there are problem of intermingled interrelations among objective QoS parameters. Bandwidth allocation as one of QoS parameters influences other network parameters. Narrow bandwidth probably results on high delay and occurrence of jitter. In consequences, the delay prolongs time for streaming process while the jitter results on jerky video. The jitter also introduces disorganized of video packet that may lead to packet loss. The packet loss causes blockiness, image artifacts, and color error in the streamed video.

Configuration of video rate, audio rate, and frame rate also has intermingled interrelations. Configuration with high level of application parameters contributes to good quality of streamed video. However, it increases size of video packet. In managing video packet size, coding mechanism is used to encode and decode the video packet in order to stream the video packet through limited bandwidth. However, this mechanism tends to reduces quality of streamed video. In relation to device capabilities, quality of streamed video is also influenced by device brightness, deep of color, and display size.

Analysis on intermingled interrelations among objective QoS parameters has been studied in some of previous research. Braun et al. in [19] has found that application parameters affect overall streamed video quality, while network parameters only affect limited area of streamed video quality. In other research, Mohamed et al. [20] observes that influence of network parameters have bigger impact in streamed video quality than effect of application parameters.

From the second aspect, customer satisfaction relates to subjective QoE factors. Mobile customer has different experience towards streamed video quality [21]. In sequential video sighting, previous streamed video experience influences current and following streamed video experience. For example, if mobile customer has view good quality of streamed video in previous video sighting, it is hard to please with lower quality of streamed video in current video sighting. Customer experience is the first intrinsic factor that is studied in this paper. The second factor is customer expectation. It is a personal standard in perceiving streamed video quality. This factor varies among the mobile customers. In mobile customer's mind, there is different expectation on how the streamed video should be played. If the quality of streamed video fulfills their expectation, then the mobile customer will be satisfied. Otherwise, if the quality is far below their expectation, they will be dissatisfied. The third factor is customer interest to specific content. It can be illustrated by comparing two kind of mobile customers that have different interest over streamed video content. An action movie fans prefers streamed video with high detail and smooth scene changes, while the customer that eager to update latest news would prefer news video with clear audio than high video quality [15].

In contrast to intrinsic factor, extrinsic factor influences customer perception of streamed video quality based on specific condition in the streamed video. Saliency awareness is one of the factors. Saliency is a region in the streamed video that catches more customer attention [22]. The region may be a focused spot or a moving object inside video frame. For instance, center of the field (focused spot) in football match may become a salient region during kick off time. The saliency awareness is related to quality of the salient region in the streamed video. When the salient region

has some distortion, it degrades level of customer perception even if the other region is distortion-free.

As the third aspect that determines customer satisfaction, each of service stakeholders runs their specific business strategy. They have different focal point and interest on customer satisfaction. Service provider considers price, packet of service to be offered, as well as total service quality. Network provider also concerns with price and network resource such as bandwidth. Device manufacturer more focuses on device capability in relation to mobile customer demand and trend. In addition, content provider considers their diversity of streamed video content in relation to the latest trend.

B. Problem Situation: Expressed

In this second stage of SSM, the unstructured problem is expressed in a nontechnical description. According to Peter Checkland [5], the description can be made using a rich picture. Fig.2 depicts rich picture for the unstructured problem that previously has explained.

Fig. 2 groups the stakeholders into two types. There are service stakeholders that consist of service provider, network provider, device manufacturer, and content provider as the first type and mobile customer as the second type. Each of service stakeholders has capability to control and manage service components, i.e. wireless and mobile network infrastructure, streamed video, and mobile device. That means the stakeholders can take active role in customer satisfaction by managing certain objective QoS parameters. Fig.2 also shows relationship between stakeholders and their focal point as well as their interest in satisfying mobile customer.

Technically, service provider has cooperation with network provider, device manufacturer, and content provider. It is aimed to formulate variety of service, regarding reasonable price that will be offered to the mobile customer. As mentioned by Watson and Sasse et al. [23], there is an implicit assumption by network provider that the customer satisfaction issue will be resolved by implementing bandwidth reservation [24]. As consequences of this assumption, service price will be increased due to scarcity of bandwidth. Otherwise, study by Podolsky [25] has recognized that there is customer demand for lower price of service even if they got lower quality of streamed video. In addition, service provider also considers business strategy such as customer care in order to maintain customer satisfaction.

Device manufacturer involves with the problem of device capability e.g. processing speed and memory capacity of the mobile device. In term of device capability, network provider has unique relationship with device manufacturer. It has to maintain network compatibility for as many as possible mobile device. Service provider also has interest with device capability. The challenge is how to develop service that can optimize capability of the device. One of service provider strategy is by offering bundling product that combines specific device features with dedicated service.

Content provider manages video content variety in order to attract customer interest. Content provider updates any trend and popular video content that preferred by the customer. In relation with service provider, content provider will consider codec compatibility for their streamed video content.

C. Root Definition of Relevant Systems

The system thinking strand is began in the third stage of SSM. This stage formulates root definition of the relevant system. Root definition may be defined as concise description of essential nature of the problem [26]. Root definition for customer satisfaction problem in relation with the three interacting aspects is:

"Stakeholders responsible to find out optimal compromise from the three interacting aspects, by elaborating and weighting influence of the interacting aspects, in order to satisfy mobile customer, optimize utilization of available resource, as well as increase benefit of the business."

Peter Checkland argues that the root definition should contain number of elements, in mnemonic of CATWOE [27]. It comprises **C**ustomer/**C**lients, **A**ctors, **T**ransformation, **W**eltanschauung/**W**orldview, **O**wners, and **E**nvironmental. The CATWOE element of the aforementioned issue is presented in Table 1.

As the rich picture has identified involved stakeholders, the root definition is also a way to derive the stakeholder perception on the problem situation. Therefore, each stakeholder should have its own root definition and CATWOE element [28]. Fig. 3 presents the developed root definition and CATWOE element for each of stakeholders.

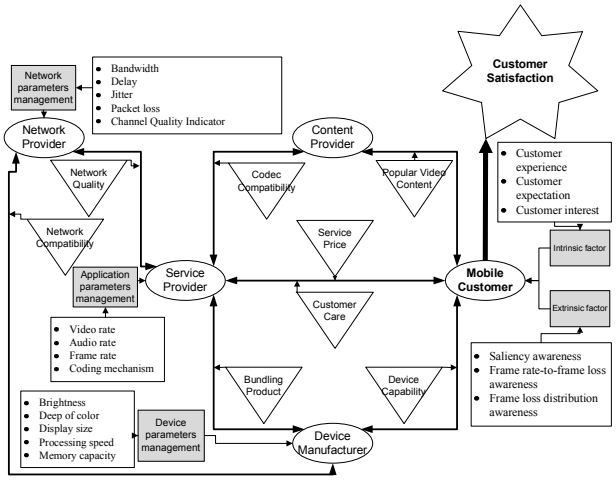

Figure 2. Rich picture of the problem.

TABLE I. CATWOE ELEMENT FOR THE PROBLEM

CATWOE	In context of: Customer satisfaction in video stream service over wireless and mobile network
Customer/Clients	Mobile customer as well as service stakeholders
Actors	Video stream service stakeholders
Transformation	Unmanaged customer satisfaction into well managed customer satisfaction
Worldview	By means of the transformation, it improves customer satisfaction, optimizes utilization of available resource (bandwidth etc.), and increase benefit of business.
Owners	Joint decision of video stream service stakeholders
Environmental	Experts in QoS and QoE of the system, video quality standard organization

D. Building Conceptual Model

The conceptual model illustrates ideal activities that need to be done by each of stakeholders as a compromise on different perception of customer satisfaction's issues, different focal point, and different interest between them. Checkland [29] defines two aspects to determine good conceptual model, the relevance and competency of the model. The relevance of model relates to how strong the built models improve understanding of the issue. The competency assures that the built models have been derived systematically from identified issue in the rich picture. Fig. 4 shows conceptual model of the customer satisfaction problem in video stream service over mobile and wireless network.

Fig. 4 illustrates the conceptual model including activities that should be performed by stakeholders to achieve their respective objectives. Link between stakeholders illustrate interacting activity that should be done. Fig. 4 also shows the objective QoS parameters that can be managed by stakeholders (managed parameter) when perform the activities.

E. Comparison the Model with the Real World

This stage returns the process to the real world. It is to compares the conceptual model (Stage 4) with real world of problem situation (Stage 2). In problem situation, interaction between the three aspects of customer satisfaction has been expressed. The stakeholders also have been identified that have their own perception of customer satisfaction as well as different focal point and interest. In conceptual model, the ideal activities that should be performed by each of stakeholders have been also elaborated.

Unfortunately, a problem arises, as there is biases of how strong influence of each interacting aspects to the customer satisfaction. The stakeholders may give their best service to the customer. For instance, the network provider may allocate large bandwidth (network parameter adjustment) for the service and service provider may configure high quality of streamed video (application parameter adjustment). These adjustments will lead to higher price of offered service to the mobile customer. In addition, it is impractical due to aforementioned circumstance that has explained in the first stage of SSM.

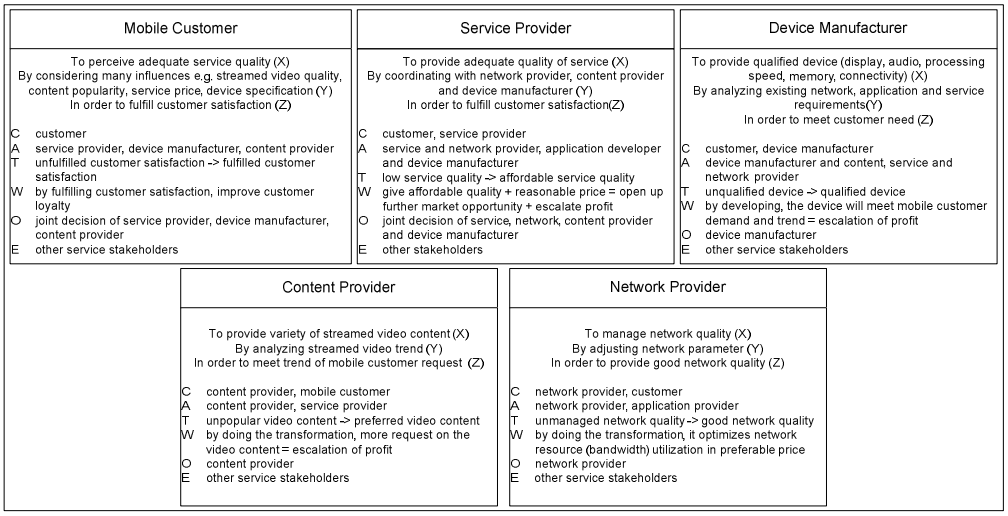

Figure 3. Root definition and CATWOE elements for each of the stakeholders.

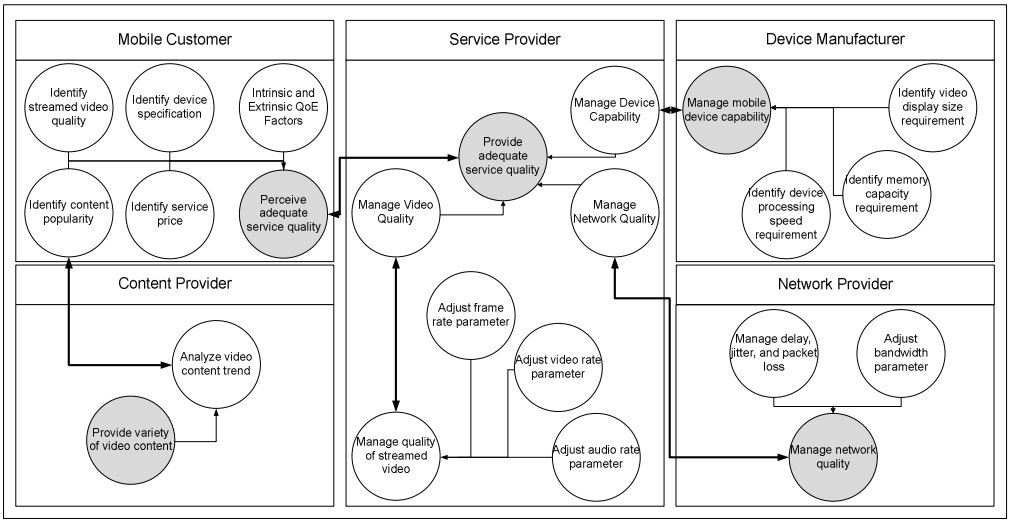

Figure 4. Conceptual model for the customer satisfaction problem.

F. Defining Changes that are Desirable and Feasible

This stage addresses and evaluates feasible solution for the arisen problem. Inspired by solution for similar case in other research, it is considered to model the interacting aspects that determine customer satisfaction. The most possible one is by formulating mathematical model. However, due to existence of many QoS parameters and many QoE factors that interact with each other, the mathematical model is unpractical. The mathematical model will involve many variables and functions that may lead to multivariate nonlinear function.

As alternative, this paper proposes a Look Up-Table (LUT). LUT comprises list of video samples with different combination of QoS parameters (video content, network parameters, application parameters, and device capabilities). The combination is designed carefully by considering the intermingled interrelationship between the parameters. All video samples are evaluated using objective quality measurement and subjective quality assessment consecutively. The evaluation comes up with short list of videos that combination of their QoS parameters delineates compromise between the first two aspects of customer satisfaction. LUT can be used by each of service stakeholders as a reference to control and manage QoS parameters to achieve their respective objective.

G. Action to Improve Problem Situation

Based on recommendation from the previous stage, SSM process has reached its final stages. This stage explains action to improve the problem situation. In the context of customer satisfaction in video stream service, this stage devises detail methodology for generating LUT. To compromise all interacting aspects, the LUT has to fulfill some requirements. First requirement, the methodology should consider objective QoS parameters and subjective QoE factors in determining customer satisfaction. Second requirement, the methodology should weigh up role of video stream service stakeholders. The third requirement, the methodology and all process when implementing the methodology should meet international standard and recommendation for quality of streamed video.

Fig. 5 illustrates methodology for generating LUT. At the initial step, some video samples (original video) are prepared to form a basic LUT. The preparation involves adjustment of application parameter (e.g. bandwidth, video rate, audio rate and frame rate) and variation of video content. Then, original video is streamed through wireless and mobile network that will come up with streamed video. Parallel with preparation of video samples, mobile and wireless network environment has been conditioned before streaming process. It involves network parameter adjustment for every streaming process. In addition, the streaming process also includes device configuration.

Generating LUT continues with objective video quality measurement. The measurement filters out the videos that their quality, technically, could not be accepted after streamed through wireless and mobile network. Due to existence of subjective QoE factors, streamed videos that have passed objective video quality measurement must undergo subjective video quality assessment. The assessment will make sure only video that can be accepted by user can be listed in LUT.

IV. SUMMARY

This paper has applied SSM problem solving strategy to elucidate three interacting aspects that determine customer satisfaction in video stream service over wireless and mobile network. SSM has provided a way to go through which the complexity of the interacting aspects can be investigated, described and understood.

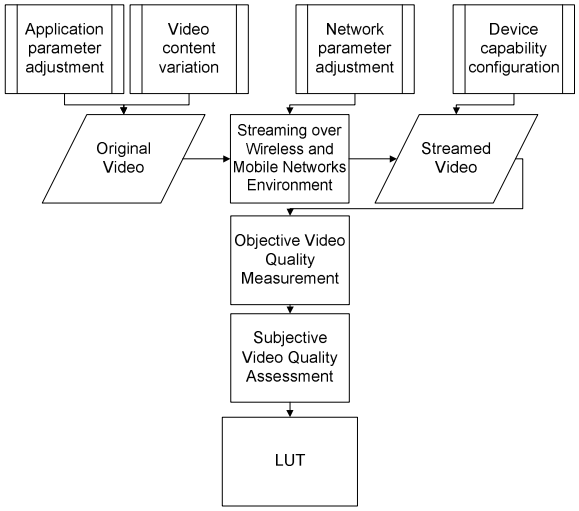

Figure 5. Methodology for Generating LUT.

This paper has applied seven stages of SSM considering objective QoS, subjective QoE, and stakeholders' business strategy. To reach compromise between the three interacting aspects, this paper proposes a Look-Up Table that can be used by each of service stakeholder as reference to satisfy mobile customer, optimize utilization of available resource, as well as increase benefit of their business.

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