How to use Improvement Gap Analysis to identify which Incremental Innovations should be incorporated into Products: managerial recommendations*

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***Abstract* - This paper aims to show how the Improvement Gap Analysis method (IGA) evaluates the possible impact of incremental innovations on customer satisfaction, and to give guidelines about applying this technique in practice. Customers of two different products, that are used at home, answered questions about their current satisfaction, expected satisfaction, and expected dissatisfaction, with attributes for each product. The results show that IGA can suggest incremental innovations that could be offered in final products, and which ones may not.**

Keywords – **Customer Satisfaction, Incremental Innovations, Improvement Gap Analysis, Kano Model**

I. INTRODUCTION

The introduction of innovations in products and in services is one of the greatest factors for long term company survival. The phenomenons of adical and/or incremental innovations are being discussed and explored more often in the scientific literature. Some researchers defend that radical innovation can serve as a foundation for incremental innovations, which generate profit's income, which again enhances the company's ability to pursue radical innovation opportunities [1]. The earlier incremental innovations are introduced; the greater the impact on market share [2]. Due to fast technology development, high market competition, and ever crescent customer expectations, it is more important to use good methods to identify which innovations a company should offer for its' survival in the long term.

Among other methods, perhaps Importance-Performance Analysis (IPA) [3] is the most-used technique, used to identify what should be improved or offered in products or services. Although largely used, this method has several limitations [4] [5]. Even though some limitations have been overcome by different ways of using IPA [6], there are still limitations regarding the identification of which incremental innovations should be developed [7]. Improvement Gap Analysis [7], a fusion between IPA [3] and Kano Model [8], has the potential to overcome these limitations. It also has the advantage that it is simple enough to be used by companies that only need to interview its own customers.

This paper has as objectives to present IGA and to explore its ability to identify which incremental innovations should be incorporated in products. The paper first presents the IGA method. Then, it shows an application to two case studies. At the end a session of managerial guidelines is presented, in order to help companies put the application of this method into practice.

II. THE IMPROVEMENT GAP ANALYSIS METHOD - IGA

Using a quadrant analysis, IGA compares different attributes' relevance based on the expected impact on customer satisfaction if they are improved or offered, and on the expected dissatisfaction if they have a low performance. Basically, customers are asked to provide information about their estimated satisfaction or dissatisfaction with each attribute by responding to two hypothetical questions: a functional question (ESFQ), wherein the attribute is considered to have high performance; and a dysfunctional question (ESDQ), wherein it has low performance, or it is not present. A question regarding satisfaction with current attributes' performance is also asked. Fig. 1 shows examples of the three questions.

The answers are re-coded into a scale ranging from -4 (highly dissatisfied) to +4 (highly satisfied). The mean of expected satisfaction of all respondents with the functional question (AESFQ), the dysfunctional question (AESDQ) and the current satisfaction (ACS) with each attribute are calculated according to (1), where "n" = number of respondents.

$$AESFQ = \frac{\sum_{i=1}^{n} ESFQ}{n} \qquad AESDQ = \frac{\sum_{i=1}^{n} ESDQ}{n} \qquad ACS = \frac{\sum_{i=1}^{n} CS}{n} \tag{1}$$

Then, the possible improvement gap (IG) for each attribute is calculated, subtracting "current satisfaction" from "expected satisfaction", according to (4), where K is the number of attributes.

$$IG_k = AESFQ_k - ACS_k \quad \text{for } k = 1 \text{ to } K, \tag{2}$$

Improvement priorities depend on attributes' relevance that, in most cases, is identified in terms of stated importance [3]. As customers are reasoning about the importance of the attributes, stated importance tends to have low discrimination power, which may result in socially acceptable or "status quo" answers [9].

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To decrease reasoning, IGA uses expected

How would you feel if your TV set:	Highly Dissatisfied	Very Dissatisfied	Dissatisfied	Slightly Dissatisfied	Neutral	Slightly Satisfied	Satisfied	Very Satisfied	Highly Satisfied
Has a remote control?	○	○	○	○	○	○	○	○	○
Does not have remote control?	○	○	○	○	○	○	○	○	○
What is your current satisfaction with	Highly Dissatisfied	Very Dissatisfied	Dissatisfied	Slightly Dissatisfied	Neutral	Slightly Satisfied	Satisfied	Very Satisfied	Highly Satisfied
Remote control	○	○	○	○	○	○	○	○	○

Fig. 1. Example of Improvement Gap Analysis questions

dissatisfaction with attribute lack of performance (AESDQ) as a measure of attributes' relevance (1). In this case, customers imagine a bad situation and answer accordingly, with a lower reasoning if compared to stated importance.

$$Std.AESDQ_K = \frac{\overline{AESDQ} - AESDQ_K}{\sigma_{AESDQ}} \quad Std.IG_K = \frac{IG_K - \overline{IG}}{\sigma_{IG}} \quad (3)$$

IG and AESDQ, for all attributes, are standardized (3). The results plotted on the x-axis and y-axis of the matrix, with attributes analyzed according to their position on it (Fig. 2).

An attribute is classified as "attractive" when the improvement gap is higher than "0" and the possible dissatisfaction with the attribute's absence is lower than "0." It is classified as critical to improve if both, the improvement gap and expected dissatisfaction are higher than "0." It should be kept as it is when the improvement gap is lower than "0," and the dissatisfaction with its absence, or poor performance, is higher than "0". It should be evaluated if needed when both, the improvement gap and dissatisfaction, are lower than "0" (Fig. 2).

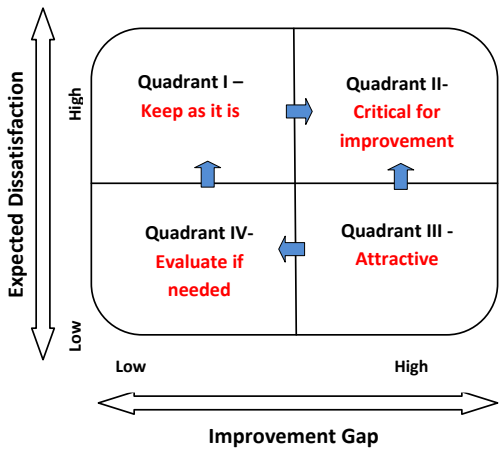

Fig. 2. Improvement Gap Analysis matrix

An attribute is considered critical if it falls on the border between quadrant II, and I or III. If it falls on the border between quadrants IV and I, it should be kept as it is, and if it falls between IV and III, it should be evaluated if needed. In any case, depending on the specific attributes in these situations, common sense and experience should indicate the final classification.

II. THEORETICAL ASPECTS

The reasoning behind IGA is that customers tend to imagine the ideal or desired situation and mark their expected satisfaction when answering the functional question. Then, the improvement gap indicates the possible gain in satisfaction if the attribute is improved to the desired situation. Similarly, when answering the dysfunctional question about dissatisfaction, customers imagine the worst-case scenario, and respond accordingly.

The use of "expected dissatisfaction", with attributes if they have low performance or are not present in the product, to identify attributes relevance, is different of statistically inferred methods and of the stated importance. In fact, previous researches already show that different methods for this identification are measuring different aspects [10]. Stated importance is based on customer memory and expectations, and can be staed as "predicted importance". Customers are rationalizing about the expected benefits of the attributes' good performance, the potential sacrifices due to low performance, and socially acceptable answers. Statistically inferred importance is called "experiential importance", and depends on customers' previous and present experiences with the attribute [10]. Expected dissatisfaction, used in the IGA, lies between "rational" and "experiential" importance [11].

On the other axis of IGA, the gap between expected satisfaction and current satisfaction (improvement gap) is different of the gap used on the SERVQUAL model [12]. In SERVQUAL the expectation-performance gap is based on the difference between "expected" minus "current" performances. In IGA the difference is between satisfaction with a "desired level" of performance and satisfaction with the current performance. "Expected performance" is more related to stated importance than "expected satisfaction" with the existence or high performance of an attribute [11]. In fact, some papers propose the evaluation of the SERVQUAL gap in terms of "stated importance minus current performance" [13]. Thus, these methods have different approaches and results [7][11].

III. METHODOLOGY

A. Collected Data

Customers of 2 products voluntarily accepted to take part of the present research. A total of two hundred and twenty respondents answered personal questions and two

other sections, one for satisfaction with the product's attributes and another about expected satisfaction with presence (or high performance) and with absence (or low performance) of each researched attribute.

Questionnaires with invalid or inconsistent answers were eliminated. It includes those in which the respondents answered all questions in the same way; those with excessive reverse answers (e.g. satisfied with "low courtesy" and dissatisfied with "high courtesy"), and those with an excess of blank answers.

Table I and II show final respondents' profiles. The present study has no intentions to identify what should be offered or improved on these products. Thus, the results are only valid for this research's respondents.

TABLE I
RESPODENTS PROFILE – MOSQUITO REPELLENT DEVICE

Do you use mosquito repellent device?		Age (years old)		
Yes	93	~	<=20	9
No	9	>20	<=25	45
Frequency of use:		>25	<=30	16
Daily	81	>30	<=35	12
Weekly	9	>35	<=40	8
Less than once a week	12	>40	~	12
Total Respondents: 102	Gender:	Male – 65	Female - 37	

*No respondent knows device's brand, manufacturer or model.

TABLE II
RESPODENTS PROFILE – UNIVERSAL AC POWER SOCKET

Age (years old)					
~	<=20	3	>30	<=35	12
>20	<=25	55	>35	<=40	10
>25	<=30	20	>40	~	5
Total Respondents: 105		Gender:	Male - 55	Female - 45	

*No respondent knows device's brand or manufacturer.

B. Researched Devices and Attributes

Customers of the "mosquito repellent device" and of the "universal AC power socket" answered questions about ten attributes for each product.

Attributes of "universal AC power socket" were analyzed: At01 – electrical ground terminal; At02 - safety to use; At03* - ability to fit various kinds of plugs; At04 – design; At05 - easiness of use; At06* – being made of recycled material; At07 - variety of models; At08 - electricity isolation; At09 – durability; At10* - wires storage support. Of these attributes, during the time of research innovations are: At03*, related to the capability of plugging different kinds of plugs standards on the same socket; At06*, to be made of recycled material; and At10*, support for storing wires. Figure 3 shows the proposition of this researched device.

For the "mosquito repellent device", attributes analyzed are: At01 – variety of repelled mosquitos; At02* – device being recyclable; At03 – variety of appearance design; At04 – weight; At05 – portability; At06* - device color options; At07 – protection range (area); At08 - resistance (not break); At09 – easiness of handling; At10 – device warranty. For these attributes, At02* and At06* were innovations during the time of research. Figure 4 shows an example of this device (already existing).

Fig. 3 – Universal AC Power Socket

Fig. 4 - Mosquito Repellent Device

IV. RESULTS

A. Universal AC Power Adaptor

Table III shows the results for the researched attributes.

TABLE III
RESULTS FOR UNIVERSAL AC POWER SOCKET

	Current Satisf. ACS	Std. Dev.	Expect. Satisf. AESFQ	Std. Dev.	Expect. Dissatisf AESDQ	Std. Dev.	Gap AESFQ - ACS
At01	-1.39	2.30	4.01	0.86	-3.72	1.07	5.40
At02	0.26	1.80	4.24	0.75	-4.19	0.83	3.98
At03*	-0.84	1.20	4.08	0.84	-2.51	1.17	4.92
At04	-0.64	1.02	3.32	1.05	-1.97	1.12	3.96
At05	3.19	1.10	3.93	0.90	-3.05	1.17	0.74
At06*	2.46	1.08	2.72	0.76	-2.21	1.09	0.26
At07	3.68	0.90	4.15	0.72	-2.41	1.07	0.47
At08	4.11	0.77	5.00	0.00	-4.90	0.69	0.89
At09	4.17	0.83	3.80	0.81	-4.41	0.65	-0.37
At10*	3.07	1.02	3.48	0.85	-2.92	1.07	0.41
Mean	1.81		3.87		-3.23		2.07
Std.Dev.	2.21		0.61		1.02		2.21

* Incremental Innovations at time of research.

As can be seen in table III, innovative attributes have different levels of current satisfaction (ACS) and expected satisfaction (AESFQ) if included. Customers are slightly dissatisfied with current sockets regarding “At3* - plugs' flexibility," and would be very satisfied with it existing. On the other hand, customers are satisfied with the current situation of “At6* - made with recycled material” (2.46) and “At10* - wires storage support” (3.07). They also do not expect to stay highly satisfied if these attributes are present. These three attributes have almost the same expected dissatisfaction by their absence.

Figure 5 shows the Improvement Gap Analysis matrix for all attributes. The attributes “At03* - plugs flexibility” and “At04 – design” are identified as attractive, meaning if offered, they bring satisfaction to customers, but if absent they do not bring high dissatisfaction.

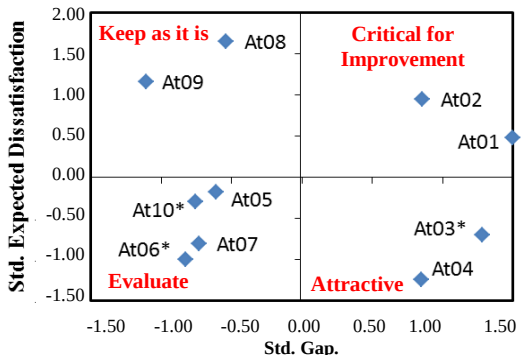

Fig. 5 – IGA Universal AC Power Socket

The attributes “At01 – electrical ground terminal” and “At02 – safety to use” are critical for improvement. IGA is dealing with customers' feeling. It means that, although standard rules about safety and engineers are always concerned about these attributes, respondents are still afraid of the danger with electricity.

The attributes “At08 – electricity isolation” and “At09 – durability” should be kept as they are. It means customers would be very dissatisfied if the product has low performance, but they are already satisfied with the performance level of isolation and durability of the AC adaptors.

The attribute “At07 – variety of models” is on the “evaluate” region of IGA. It may be that this attribute is not really a relevant question for the respondents. The “At05 – easiness of use” fell in the border between “evaluate” and “keep as it is” regions. A reason why some attributes fall in this region may be due to the fact that respondents are used to it, not knowing how they would feel having low performance or not existing. The other two innovative attributes, “At10* - support for storing wires” and “At06* – made of recycled material” should also be evaluated if needed.

Three reasons may be the cause of an attribute falling in this region of IGA. One reason may be due to customers not knowing how they would feel with the presence of it (not knowing what it is). This may be a case of radical innovations. Another reason may be because customers do not care about it, meaning the company should not include it in the product. At last, but not less relevant, the company should evaluate if customers understood the question about the attribute.

B. The Mosquito Repellent Device

Table IV, and Fig 6, show the results for the researched attributes. The innovative attribute, “At02* – device being recyclable," has current customer satisfaction between slightly dissatisfied to neutral, being the lowest satisfaction level among the researched attributes.

TABLE IV

RESULTS FOR MOSQUITO REPELLENT DEVICE

	Current Satisf. ACS	Std. Dev.	Expect. Satisf. AESFQ	Std. Dev.	Expect. Dissatisf AESDQ	Std. Dev.	Gap AESFQ – ACS
At01	2,56	1,28	3,65	0,59	-3,13	1,54	1,09
At02*	-0,98	1,32	1,09	1,19	-0,94	1,30	2,07
At03	1,53	1,09	1,32	1,52	-0,24	0,87	-0,21
At04	2,52	0,85	2,70	0,89	-2,48	0,69	0,18
At05	3,15	0,91	2,47	1,01	-2,67	0,79	-0,68
At06*	0,48	1,46	1,83	1,49	-0,65	0,68	1,35
At07	2,89	0,79	3,60	0,78	-3,00	0,80	0,71
At08	2,46	1,15	3,76	0,47	-2,89	0,97	1,30
At09	2,17	0,69	2,23	1,27	-2,65	1,10	0,06
At10	2,13	1,52	3,82	0,45	-3,36	0,95	1,69
Mean	1,89		2,65		-2,20		0,76
Std.Dev.	1,26		1,03		1,14		0,89

* Incremental innovations at the time of the research

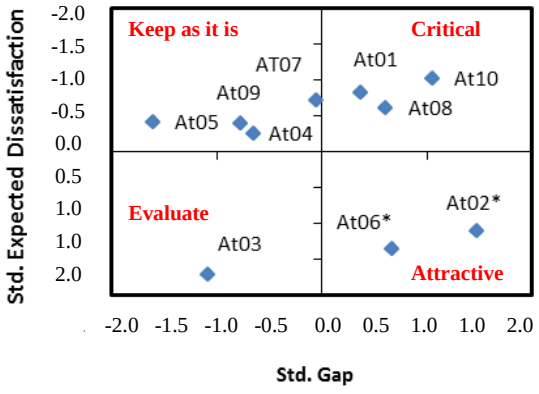

Fig. 6 – The IGA Mosquito Repellent Device

The other innovative attribute, “At06* - device color options," is also an incremental innovation in the researched market. Units and models of the same manufacturer have generally the same color, “white.” For this attribute, customers have close to neutral current satisfaction.

Both attributes, At02* and At06*, fall on the “attractive” quadrant of IGA matrix. If offered, customers

may recognize it, but they do not stay highly dissatisfied if the product stays as it is.

Attributes "At01 - variety of repelled mosquitos," "At08 – resistance" (not breaking), and "At10 – device warranty," are critical for improvement. Customers shall tend to recognize improvement, but become highly dissatisfied with these attributes having low performance.

The attribute "At03 - variety of design appearance" falls in the "evaluate" region of IGA. As every manufacturer makes products with its own design, customers have a great amount of variety to choose from. If they do not like the design of one brand, they look at the other. Nevertheless, if customers like the design and have a variety of colors to choose from (At06), they may be very satisfied.

The attributes "At04 – weight," "At05 – portability," and "At09 – easiness of handling" should be kept as they are. They achieved a level that, if improved, customers won't stay more satisfied. On the other hand, they may get very dissatisfied if these attributes have a low performance.

We may say that the attribute "At07 – protection range" falls in the border between "critical for improvement" and "keep as it is" regions. As indicated by Fig. 2, in this case the attribute should be considered as critical for improvements.

V. DISCUSSION

Both of the case studies of the present research show that IGA can indicate what should and what should not be improved or offered. It can suggest which incremental innovations may be attractive to customers and which ones do not. Furthermore, besides dealing with incremental innovations, IGA is capable of indicating critical attributes for improvement, which ones should be kept as they are, and which ones should be evaluated if needed, or not.

We notice that, mathematically speaking, for the Mosquito Repellent Device customers have current satisfaction in a level that is above the expected satisfaction with presence or superior performance of two attributes ("At03 - variety of design appearance," "At05 – portability"). It does not mean that existing performance is above the desirable level. We may say that these attributes' performance is already fulfilling customer needs. The statistical paired t-test and the Wilcoxon Signed Ranks Test [14] do not confirm a difference between satisfaction with desired level and current satisfaction, for both attributes (At03: t-test p-value = 0.25; Wilcoxon Signed Ranks Test p-value = 0.15. At05: t-test p-value = 0.14; Wilcoxon Signed Ranks Test p-value = 0.10).

VI. *MANAGERIAL GUIDELINES AND RECOMMENDATIONS*

Being a simple method, IGA also has limitations. Attributes' classifications are relative to each other, and customers are answering according to their expected feelings. It is important to know that, in real situations, there are interactions between attributes' performance and between product's attributes and external factors (ex: price, competitors, etc.). Some aspects will be observed to enhance its performance for helping companies to identify what should be improved or offered:

- Put in the research different type of attributes, from basic to attractive ones.

The division of regions in the IGA method is relative. It is based on the mean values of the attributes' improvement gap and of expected dissatisfaction. If, for example, only innovative attributes are put under analysis, some will be classified as "critical for improvement" and others as "attractive," "keep as it is" and "evaluate." It is important to include the research attributes which classifications are already known, covering basic, critical, etc. ones. In the present case studies of "Universal AC power Socket," attributes "At08 - electricity isolation," – durability," and "At02 - safety to use" are very basic. They are in the research to equilibrate results.

- Keep the number of researched attributes per questionnaire around 10 to 20.

The questionnaire to be answered by customers must have at least three sections (Current satisfaction, Expected satisfaction, Expected dissatisfaction). Thus, for 10 attributes, it shall have a minimum of 30 questions, besides the stratification questions (age, gender, frequency, etc.). More questions may bring stress to respondents because it then becomes too long. If a larger number of attributes needs to be researched, make more than one investigation with different attributes in each.

- Questions of Expected Satisfaction and Dissatisfaction must be in a section separated from questions about Current Satisfaction.

As questions related to expected satisfaction and dissatisfaction, with presence and absence of attributes, are related to hypothetical situations, they should be in a different section of questions about current satisfaction with attributes. It is related to the existing feeling of respondents.

- Questions about Expected Satisfaction and Dissatisfaction shall be in a random order.

IGA focuses on customers feeling, not reasoning. Thus, a random order of questions reduces customers' reasoning about answering for the existence and non-existence of an attribute.

- Each question must ask about one attribute only.

Avoid putting in the same question more than one attribute. Questions must be specific. For example, do not put: "How do you feel if the restaurant has a private and roofed parking area." Separate the attributes in different questions (private parking and roofed parking area separately).

VII. FINAL CONSIDERATIONS

Both case studies show that IGA can indicate what should and what should not be improved or offered in products. It can suggest which incremental innovations may be attractive to customers and which ones are not. Furthermore, besides dealing with incremental innovations, IGA is capable of indicating critical attributes for improvement, which ones should be kept as they are, and which ones should be evaluated if needed or not. Thus, this method may be used not only to evaluate innovative ideas, but also to direct improvement efforts.

IGA shows a capability of discerning incremental innovations, not about radical innovations. Radical innovations, as the name already says, are not known by customers. They can't answer about their feelings with the existence and non-existence of attributes. In this case, it is very probable that the attribute would fall in the "evaluate" region.

The present paper has no intention to prove scientific applicability of IGA. The objective is to present how to use it. Other papers have presented, gradually developed, and scientifically defended it. For more scientific analysis, and a comparison with other methods for identification of what should or could be improved in products and services, see references [7][11].

Although showing what should/could be included in the products, based on the expected increase of satisfaction with the attribute, this method is not evaluating the final impact on general customer satisfaction. Thus, more research should be conducted to evaluate it.

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