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Teaching the Fundamental Attributes of IS Requirements

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ABSTRACT

Requirements are the building blocks of IS products. “If you don’t get the requirements right, it doesn’t matter how well you do anything else” (Wieggers, 2004). However, generically, IS requirements are complex. They have multiple attributes. To extract business information relevant to building a product, classifying IS requirements into functional and non-functional categories is not enough. Requirement gatherers and analysts should be conversant with the multifaceted nature of IS requirements and their attributes. Yet, currently, the MIS and Computer Science programs do not impart this knowledge to their students. To fill the gap, this paper describes the concepts which would be useful to include as a module in a Requirements Engineering/ Management course. In addition, the article provides an illustrative example of how these concepts can be taught to give students a flavor of the real world.

Keywords

Functional requirements, non-functional requirements, implied requirements, stated requirements, hedonic requirements, utilitarian requirements

INTRODUCTION

Stakeholder requirements come in all shades and colors. Some are clearly articulated, others are implied; some are functional, others are non-functional; some are purely utilitarian, others are hedonic; some are hygiene, while others are motivators; some fulfill the basic function, others delight the user and so on. To add to this complexity, a particular requirement may possess several of these characteristics. Research studies have shown that these attributes distinctly impact user outcomes and consequences. Also, often these attributes interact to produce counterintuitive effects.

Currently, there is a gap in teaching Requirements Management to MIS students. The course content focuses on identifying relevant stakeholders; techniques for eliciting requirements from these stakeholders; and models and tools for requirements analysis, tracking, validation and metrics. The generic properties of IS requirements are not fully elaborated. As a result, when students enter the real world they lack the knowledge to derive a full understanding of the stakeholders’ perspectives, goals and motivations. Consequently the impacts of building the requirement or not building the requirement into the product remain ambiguous. IS products may end up with either introducing features that do not provide real value to the user (gold plating) or dropping features that cause severe user dissatisfaction.

Yet students rarely get an opportunity to explore IS requirements from multiple points of view. Although students transition to the industrial environment armed with tools and techniques they often lack the depth and perspective required to effectively elicit and analyze stakeholder requirements to be built into an IS product. The aim of this article is to acquaint the reader with the relevant concepts and theories in the area and motivate academics to include them in the MIS curriculum. Guidance is also provided on how these models and theories can be used to provide students with a real world experience of scrutinizing stakeholder requirements to understand their true business value.

ATTRIBUTES OF IS REQUIREMENTS

In this section the attributes of IS requirements as viewed from various perspectives are described. The descriptions are illustrative and not exhaustive and are meant to provide the reader with an idea of what the suggested requirements management module should contain.

Functional vs. Nonfunctional requirements

Traditionally, software requirements have been classified either as functional or nonfunctional. Functional requirements pertain to what the system does, while the non-functional or quality requirements pertain to how well these functions are accomplished. The essential differences between functional and nonfunctional requirement can be illustrated in the Table 1 below:

Functional Requirements	Nonfunctional requirements
They relate to specific functions to be built into the system e.g. Issue purchase order if the inventory falls below reorder level	They usually affect several functions or even the whole system e.g. reliability, usability, efficiency, modifiability, portability.
These are properties that the systems must have	They are useless without functional requirements
When implemented into the system they either work or do not work	They often have a ‘sliding scale’ of good and bad
They may vary in importance among themselves e.g. between management reports used for making operations decisions and routine reports	They are often in conflict with each other, implying that trade-offs between these requirements must be made e.g. between modifiability and performance

Table 1: Characteristics of Functional and Nonfunctional requirements

There are some variations in this classification. The ISO/IEC 9126 (2001) model classifies attributes at the top level into functionality, reliability, usability, efficiency, modifiability, and portability instead of functional and nonfunctional requirements. Similarly, the IEEE Standard Glossary of Software Engineering Terminology (IEEE Standard 610.12-1990) distinguishes functional requirements on the one hand and design requirements, implementation requirements, interface requirements, performance requirements, and physical requirements on the other hand. The term ‘nonfunctional requirement’ is not listed in this glossary.

Implied vs. Stated requirements

According to ISO 9000:2005 a requirement is a need or expectation that is stated, generally implied or obligatory. The stated requirements are what have been specified explicitly by the customer. On the other hand implied requirements are not specified by the customer but are necessary for intended use. Obligatory requirements may be stated or implied and include statutory or regulatory requirements.

The stated requirements are uppermost in the minds of the user. Thus users are satisfied when the stated requirements are met and dissatisfied when they are not met. The implied requirements are so basic to the IS product that it does not occur to the stakeholder to specify them. For example a customer would expect that the IS product will be easily modifiable when there are changes but he may not explicitly specify the requirement of modifiability. However, if this requirement is not satisfied because it has not been stated and the software product is not easily modifiable then the user will be highly dissatisfied. But meeting this requirement will not increase his satisfaction.

Hence the reward penalty outcomes are asymmetric for implied requirements while they are symmetric for stated requirements. Users cannot and may not specify all requirements. He simply assumes that some requirements will be taken care of by the developer. For example, it may not occur to the users to specify a requirement of choosing date from the calendar instead of having to enter it manually. This is because the users may take it for granted that it will be provided for in the system. Developers should therefore be very careful in identifying the implied requirements of the customer and meeting them. Not addressing the implied requirements would leave the customer highly dissatisfied.

Satisfiers vs. Dissatisfiers

Investigators of consumer satisfaction have frequently adapted models and techniques from studies of job satisfaction (Pfaff, 1973; Czeipiel, Rosenberg and Akerele, 1974). The adaptations have face validity because the concept of satisfaction is common to both types of studies (Maddox, 1981). Therefore, although the Motivation-Hygiene Theory was developed by

Frederick Herzberg (1966) as an alternative to Maslow's theory (1970) for studying job satisfaction, it has contributed to a body of knowledge on customer satisfaction.

According to the Motivation-Hygiene theory (Herzberg, 1966) job satisfaction and dissatisfaction must be separated into two different continua, and are determined by two different sets of factors. Factors found to affect job satisfaction (recognition, achievement, work itself, advancement, and responsibility) are called "motivation factors." Factors found to affect job dissatisfaction (salary, company policies, technical competence, interpersonal relations and working conditions), called "hygiene factors" (Brenner and Carmack, 1971). By implication, customer requirements can be classified into two categories, those that cause customer dissatisfaction if not fulfilled but no significant satisfaction if fulfilled and those that cause customer satisfaction if fulfilled but no dissatisfaction if not fulfilled. "Hygiene" factors are also called "Dissatisfiers" and "Motivation" factors are called "Satisfiers".

To illustrate, Zhang and von Dran (2000) in their study investigating Satisfiers and Dissatisfiers among the various factors affecting Webdesign found that from the users' point of view accuracy of information provided by the website is a Dissatisfier while web design exploration is a Satisfier. What this implies is that information inaccuracy can cause user dissatisfaction, but information accuracy does not increase satisfaction if provided. By contrast if the website is "fun" to explore it causes user satisfaction but no dissatisfaction if fun element is lacking in website exploration. The website designers thus need to minimize user dissatisfaction by improving the Information Quality while being aware that these factors are not sufficient to generate user satisfaction. However, to keep a competitive advantage in an increasingly competitive Web environment, Website designers need to make the website fun to explore. Thus, although dissatisfiers have higher priority and function as a prerequisite it is the satisfiers which motivate the users.

Basic vs. Performance vs. Excitement requirements

Earlier empirical studies (Swan and Combs, 1976; Maddox 1981; Cadotte and Turgeon, 1988; Johnston and Selvestro, 1990) of customer requirements found support for Herzberg's (Herzberg, 1966) two factors classification. However, later studies (Brandt, 1987; Brandt and Reffet, 1989; Stauss and Hentschel, 1992; Johnston, 1993; Anderson and Mittal, 2000) found empirical support for a three-factor theory, the third factor leading to dissatisfaction as well as satisfaction. Today the three factor theory is widely accepted. The three factor theory is popular in quality literature as the "theory of attractive quality" (Kano et al, 1993) and is based on Herzberg's two factor theory. The three factors in the three factor theory are:

Basic factors: They are prerequisites and must be satisfied first at least at threshold levels for the product to be accepted. The fulfillment of basic requirements is a necessary but not a sufficient condition for satisfaction. The customer takes Basic requirements for granted, and therefore does not explicitly ask for them. They are similar to Herzberg's "Hygiene factors" or "Dissatisfiers". The other names used for Basic factors are Minimum Requirements (Brandt, 1988) and Must-be requirements (Kano et al, 1993).

Performance factors: These are requirements that the customer deliberately seeks to fulfill. They are uppermost in her consciousness. Fulfilling these requirements lead to customer satisfaction and not fulfilling them leads to dissatisfaction. The other name for Performance factors is One-dimensional requirements (Kano et al, 1993).

Excitement factors: Excitement requirements are those that the customer did not expect. They surprise the user by adding unexpected value to the product thereby delighting her. The Excitement factors are similar to Herzberg's "Motivation factors" or "Satisfiers". The other names for Excitement requirements are Attractive requirements (Kano et al, 1993) and Value enhancing requirements (Brandt, 1988).

Extant research (Robertshaw, 1995; Mazler and Sauerwein, 2002) has suggested that amongst the three categories of requirements, Excitement factors should be given the least priority, Performance factors should be given the next higher priority and Implied needs should be given the highest priority from the user perspective. The main reason for the suggested priority is that user dissatisfaction should be precluded first before aiming for customer satisfaction and delight.

The examples of Basic, Performance and Excitement factors are elaborated in the class exercise section.

Utilitarian vs. Hedonic Requirements

Utilitarian features are defined as “useful, practical, functional, something that helps you achieve a goal” (Strahilevitz and Myers 1998), Hedonic features are defined as “Pleasant and fun, something that is enjoyable and appeals to your senses” (Holbrook and Hirschman, 1982). From the literature review a comprehensive set of characteristics of Hedonic and Utilitarian features/ benefits of the product are compiled and summarized in Table 2:

UTILITARIAN PRODUCT FEATURES	HEDONIC PRODUCT FEATURES
They represent “shoulds” (Bazerman Tenbrunsel, and Wade-Benzoni, 1998)	They represent “wants” (Bazerman Tenbrunsel, and Wade-Benzoni, 1998)
They are functional and practical (Stelmaszewska, Fields, and Blanford, 2004)	Represent novelty, aesthetics, unexpectedness, fun (Stelmaszewska, Fields, and Blanford, 2004)
Limited (Bazerman Tenbrunsel, and Wade-Benzoni, 1998)	Unlimited (Bazerman Tenbrunsel, and Wade-Benzoni, 1998)
Are means to an end (Babin and Harris, 2011).	Are an end in itself (Babin and Harris, 2011).
Generates cognitive response (Berman, 2005).	Generates affective response (Berman, 2005).
Elicitation requires understanding of customer needs	Elicitation requires innovation and creativity
Can be objectively appraised (Chitturi, 2009)	Subjective, Experiential(Chitturi, 2009)
Represent Maslow’s Lower level needs	Represent Maslow’s Higher Level needs
Represent Herzberg’s Hygiene factors (Zhang, and von Dran, 2000)	Represent Herzberg’s Motivators (Zhang, and von Dran, 2000)
Pain avoidance (Higgins, (1997, 2001); Chernev ,2004)	Pleasure seeking (Higgins, (1997, 2001), Chernev ,2004)
Fulfills Preventive goals (Higgins, 1997, 2001).	Fulfills Promotional goals (Higgins, 1997, 2001).
Results in Satisfaction when fulfilled (Chitturi, (Raghunathan and Mahajan 2008)	Results in Delight when fulfilled (Chitturi, Raghunathan and Mahajan 2008)
Results in Disgust/ Anger when unfulfilled (Chitturi, (Raghunathan and Mahajan 2008)	Results in Dissatisfaction when unfulfilled (Chitturi, (Raghunathan and Mahajan 2008)

Table 2: Characteristics of Utilitarian and Hedonic features

Implementing hedonic features into the product lead to user delight, while not fulfilling them lead to dissatisfaction, whereas fulfilling Utilitarian requirements lead to satisfaction, while not fulfilling them requirements lead to disgust or anger (Chitturi et al., 2008). The work of Higgins (1997, 2001), Chernev (2004), and Chitturi, Raghunathan and Mahajan (2008), indicate that the goals served by Utilitarian benefits are primarily to avoid pain, whereas the goals served by Hedonic benefits are primarily to seek pleasure. As Keiningham and Vavra (2001) state, “Creating delight for your customers first requires knowing and eliminating their points of pain, and then listening to their desires.” Chitturi et al. (2007) document that consumers attach greater importance to the Hedonic (versus Utilitarian) dimension, but only after a “necessary” level of functionality is satisfied. Kivetz and Simonson (2002a) note that consumers attach greater weight to the Utilitarian (versus Hedonic) dimension, unless they believe that they have “earned the right to indulge.”

An IS product may have superior hedonic features such as visually attractive screen layout but if the required functionality is not delivered or the product is unreliable then the user will be highly dissatisfied. But if an IS product provides the necessary utilitarian features then providing hedonic benefits will delight her and user delight is known offers multiple benefits such as increased voluntary systems usage, higher creativity at work and better decision making than users who are merely satisfied (Hirt, Melton, McDonald, & Harackiewicz, 1996; Isen, 2000; Murray, Sujan, Hirt, & Sujan, 1990; Isen 2001; Brave and Nass, 2003). Providing Hedonic benefits is thus a necessary but not a sufficient condition for user delight.

CLASS EXERCISE

To demonstrate the benefits of understanding the attributes of IS requirements we describe an exercise with senior undergraduate class of MIS students of a large public university as participants. The exercise involved an actual and widely used software product – the Astrid Task Manager. 15 feature requests were chosen from amongst all pending feature requests posted on the Astrid user community forum (http://getsatisfaction.com/todoroo/products/todoroo_astrid). A sample of the feature requests written in a standardized style is shown below in Table 3:

No	Feature description
1	Choose from a calendar Allow dates to be chosen from a calendar. Currently the user has to manually enter the date
2	Auto Color Task As the user browses through the pending task the color of the task should visually indicate to him how far it is from the due date.
3	Creating tasks that repeat yearly Allow creation of yearly recurring tasks to remind users about important events such as birthdays, anniversaries etc. Currently the application allows daily, weekly and monthly recurring tasks only
4	Geolocation reminders Provide a feature to remind users that they are passing through an important geolocation. For example if the user is passing a favorite supermarket, then remind her that she is doing so and ask whether she needs to purchase anything.
5	Grocery shopping list Provide a feature to enable users to create and update a regular grocery list. This will enable the users to tick off the items purchased from the stores, so that they do not miss anything
6	Make Quiet Hours completely quiet Have a new option - "Super Quiet Hours" - during which all reminders should be disabled. Currently during "Quiet Hours" the vibrator is enabled

Table 3: Sample of feature descriptions used in the class exercise

The students responded to two questions of the Kano survey, a widely used method for classifying requirements into three categories: Basic, Performance and Excitement. First, they were asked to give their opinion if the proposed requirement "IS" included in the next release of Astrid. Second, they were asked to give their opinion if the requirement "IS NOT" included in the next release. The first question reflects the user reward for including the feature into the product and the second question reflects his penalty for not including the feature into the product. The customer has to choose one of the five possible options for the answers for both the functional and dysfunctional question:

1. I like it this way
2. I expect it this way
3. I am neutral
4. I can live with it this way
5. I dislike it this way

Based on the student responses to the questions in both functional and dysfunctional form for each of his requirements, the quickest way to assess the responses is to map each response in Table 4 and determine the category. Aggregating this response across users will then determine the category to which a particular requirement belongs according to the majority of students.

		Dysfunctional question				
		Like	Expect	Neutral	Live with	Dislike
Functional question	Like	Q	E	E	E	P
	Expect	R	I	I	I	B
	Neutral	R	I	I	I	B
	Live with	R	I	I	I	B
	Dislike	R	R	R	R	Q

Table 4: Matrix for categorizing requirements

B-Must have or Basic requirements

P-Linear or Performance requirements

E-Excitement requirements

R-Reverse, i.e. wrong features, that would make the user experience worse

Q-Questionable, i.e. the user answers is inconsistent

I-Indifferent, i.e. the user does not care about this feature

User responses which fall in the 'Q' or questionable category are dropped from further analysis because they represent an improbable category due to wrong responses given by the user to the Kano survey. The feature requests classified in the 'R' or Reverse category should not be implemented in the system as it would lead to user dissatisfaction. For example, some users might feel that geolocation reminders on the mobile are unnecessary nuisance. However, in our class exercise none of the features got categorized in the Reverse category. Indifferent features are those that the users do not care about. Hence there is no benefit to the developer in investing in such features. In the class exercise 'making quiet hours completely quiet' (Table 3) got categorized in the Indifferent category. The features that get classified in the Basic, Performance and Excitement category are important to the developer and should be considered for implementation into the IS product.

The categories of the 15 features in the class exercise are summarized in Table 5 below:

Feature Categories	No. of features
Basic (B)	3
Performance (P)	3
Excitement (E)	1
Indifferent (I)	8
Total	15

Table 5: Categories derived from Kano survey

A qualitative analysis of the results show that the users classified the following three of the fifteen requirements of the Mobile app as Basic requirements:

1. Choose date from a calendar – currently users enter the date manually
2. Purging completed tasks - currently tasks have to be purged one by one
3. Create tasks that repeat yearly - presently system allows creation of daily, weekly and monthly tasks only

Intuitively it makes sense to classify these three requirements in the Basic category since the features are so basic that they may be entirely taken for granted by the users that the developer will provide for them in the application. For example “choosing date from a calendar” is now a commonly available feature across applications and users do not expect to enter date manually. But not providing a calendar feature will cause extreme dissatisfaction as the developer has failed to provide an essential product feature.

The following sets of three features out of fifteen were classified by respondents under the Performance requirements category:

4. Auto color Tasks – to indicate to the users how far it is from due date
5. Shortcut to create tasks – currently it requires 3 clicks to go to the task creation option
6. Color tasks based on priority – to enable users to visually see task priority

This classification also made sense because these are user specific requirements that are not basic to this product (a task tracking system) or even this class of products. Satisfying them will enhance user satisfaction while not satisfying them will result in user disappointment.

One requirement was classified in the Excitement (Unstated) category:

7. Grocery shopping list – to enable users to create and update a regular grocery shopping list that will enable them to check and tick off the items purchased from the store.

This is an innovative feature which a typical user would not normally expect, but would be thrilled to have if provided.

To summarize, the features classified in the Basic category are prerequisites. If they are not fulfilled they lead to extreme dissatisfaction. Hence they are absolutely necessary for the product to survive in the market. But as they are taken for granted by the customer fulfilling them does not increase customer satisfaction. The performance features generate symmetric user response. If they are fulfilled they increase customer satisfaction but if they are not fulfilled they lead to customer dissatisfaction. Developers should therefore be competitive with respect to fulfilling Performance requirements of the user. The excitement factors lead to customer delight and are differentiators in the market place. Developers should therefore ensure that they at least have some features in the product that excite their customers.

Thus through such class exercises students can get an idea of how the attributes of IS requirements can be analyzed to make product decisions by selecting product features to target specific business goals. The students also learn how waste can be prevented by identifying those features which customers are Indifferent to.

CONCLUSION

IS organizations today, whether they represent an internal IS department or a software development house, have to fulfill IS requirements of rapidly rising numbers of external users in addition to internal users. They have to increasingly contend with anonymous customers, large markets, limited contact with end-users, strong competition and short time-to-market (Karlsson, Dahlstedt, Natt Och Dag, Regnell and Persson, 2007). This creates special challenges for eliciting, selecting and planning the features that software products should have. The differences are so all-pervading that traditional requirement engineering practices are unusable for market-driven company (Karlsson, Dahlstedt, Natt Och Dag, Regnell and Persson, 2007).

Traditional requirement engineering techniques assume day to day interactions, negotiations and conflict resolution with customers. However when dealing with external users these assumptions do not hold. Extracting business intelligence from the requirements of a large number of anonymous customers requires new approaches. This in turn requires an in-depth understanding of the attributes of IS requirements and the various ways in which stakeholders assess their value. In this article an attempt has been made to bring together the multiple perspectives from which stakeholders requirements can be looked at. The objective is to give students an edge as they transition to the rapidly evolving world of IS.

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