4.2.10 Usability

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Usability is defined by ISO/IEC 25010:2011 SQuaRE -- System and Software Quality Models as the degree to which a product or system can be used by Stakeholder (i.e., specified users) to achieve specified goals within a specified context.

Goals

The goals are[1)]:

1. **Effectiveness** - The accuracy and completeness with which users achieve specified goals
2. **Efficiency** - The resources expended in relation to the accuracy and completeness with which users achieve goals.
3. **Satisfaction** - The comfort and acceptability of use.

- **Note:** See also

Sub-Characteristics

This characteristic is composed of the following sub-characteristics[2)]:

- ***Appropriateness Recognizability*** *- Degree to which users can recognize whether a product or system is appropriate for their needs.* (1)
- ***Learnability*** *- Degree to which a product or system can be used by specified users to achieve specified goals of learning to use the product or system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use.* (1)
- ***Operability*** *- Degree to which a product or system has attributes that make it easy to operate and control.* (1)
- ***user_error_protection*** *- Degree to which a system protects users against making errors.* (1)
- ***user_interface_aesthetics*** *- Degree to which a user interface enables pleasing and satisfying interaction for the user.* (1)
- ***Accessibility*** *- Degree to which a product or system can be used by people with the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use.* (1)

See:

- ISO/IEC 25010:2011 SQuaRE -- System and Software Quality Models
- https://iso25000.com/index.php/en/iso-25000-standards/iso-25010/61-usability
- ISO/IEC 9241-210:2019 Ergonomics of human-system interaction

Metrics

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Usability as a characteristic is often considered a subjective quality and left to “interpretation”, however, there are metrics which use to quantify these sub-characteristics. Before we delve into the definition of the specific metrics, it is important to understand why we need metrics rather than just rely on intuitive evaluations.

A core reason to collect Usability Metrics is to provide a data about stakeholder's understanding about a product's usability rather than the developer's understanding of usability. When the two understandings (i.e., interpretations) converge everyone is happy and a way forward can result. That result may be to either continue in the same direction or to have a reassessment of the user's needs.

The metrics must quantify that the system meets the goals of the overall system:

1. The Effectiveness Metrics of the communication between the system and the users
2. The Efficiency Metrics of the users use of the system to accomplish their work
3. The Satisfaction Metrics of the users that the sub-characteristics of the system are met.

Ultimately, the primary objective of usability metrics for evaluating a system or product is properly engineered (i.e., neither under- or over-engineered).

- 4.3.6.1 Effectiveness Metrics
- efficiency
- satisfaction

Efficiency Metrics

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Efficiency is measured in terms of the time it takes to complete a task from when the task is initiated to when it is successfully completed. The units used to record the time must be uniform for all tasks (i.e., milliseconds, seconds, minutes, etc).

Mathematically The time taken to complete a task can then be calculated by simply subtracting the start time from the end time:

$$Task\ Time = End\ Time \square Start\ Time$$

There are two ways to calculate Efficiency:

- Time-Based Efficiency
- Overall Relative Efficiency

Time-Based Efficiency

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In this calculation, the quotient from the division of the success of a task (either one or zero) divided by the time to accomplish a task is an indicator of the efficiency of the task. For example, if a tasks was not successful, then the success of the task is zero and the efficiency is zero. If the task is successful and it takes one minute to accomplish the task, then the efficient is one (i.e., 1/1). If it takes two minutes to accomplish the task, then the efficiency is one half (i.e., 1/2 = .5).

To calculate the Time-Based Efficiency for all tasks and all users, the following equation applies:

Where:

$$time\,Based\,Efficiency = \frac{\sum_{i=1}^{R}\sum_{j=1}^{N}\frac{n_{i,j}}{t_{i,j}}}{N \times R}$$

- **N** : The total number of tasks (goals)
- **R** : The number of users
- $\mathbf{n_{i,j}}$: The result of task i by user j; if the user successfully completes the task, then Nij = 1, if not, then Nij = 0
- $\mathbf{t_{ij}}$: The time spent by user j to complete task i. If the task is not successfully completed, then time is measured till the moment the user quits the task

Justin Mifsud[1] provides an excellent example of how for calculating time-based efficiency:

Suppose there are 4 users who use the same product to attempt to perform the same task (1 task). 3 users manage to successfully complete it – taking 1, 2 and 3 seconds respectively. The fourth user takes 6 seconds and then gives up without completing the task.

Taking the above equation:

N = The total number of tasks = 1
R = The number of users = 4

User 1: Nij = 1 and Tij = 1
User 2: Nij = 1 and Tij = 2
User 3: Nij = 1 and Tij = 3
User 4: Nij = 0 and Tij = 6

Placing the above values in the equation:

$$time\,Based\,Efficiency = \frac{\left(\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\frac{0}{6}\right)}{1\times 4} = 0.46\frac{goals}{\mathrm{sec}}$$

Overall Relative Efficiency

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The overall relative efficiency uses the ratio of the time taken by the users who successfully completed the task in relation to the total time taken by all users. The equation can thus be represented as follows[3]:

$$Overall\ Relative\ Efficiency = \frac{\sum_{i=1}^{R}\sum_{j=1}^{N} R_{ij} \times t_{ij}}{\sum_{i=1}^{R}\sum_{j=1}^{N} t_{ij}} \times 100\%$$

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Placing the above values into the equation yields the following:

$$Overall\ Relative\ Efficiency = \left(\frac{\left(\left(1\times1\right)+\left(1\times2\right)+\left(1\times3\right)+\left(1\times6\right) \right)}{\left(1+2+3+6\right)} \right) \times 100 = 50\,\%$$

Satisfaction Metrics

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Usability Metrics are generally done using through standardized questions designed to capture a the user's sentiments about the application, product or system. The survey's pose questions to the users and provide a scale of acceptability they user choses in assessing a particular attribute. The most common scale is based on the Likert Scales originally proposed in 1032 [4].

Figure 1 gives a few of the Scales that Lickert defined. There are more available here:

Scale	Attitude / Sentiment				
Agreement	**Strongly Disagree**	**Disagree**	**Undecided**	**Agree**	**Strongly Agree**
Frequency	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**
Importance	**Unimportant**	**Important**	**Moderately Important**	**Important**	**Very Important**
Quality	**Very Poor**	**Poor**	**Fair**	**Good**	**Excellent**

Likelihood	Almost Never True	Usually Not True	Occasionally True	Usually True	Almost Always True
Score	1	3	3	4	5

Figure 1: The Lickert Scale

There are two ways that user satisfaction can be measured:

- **Task Level Satisfaction** - The Task Level Satisfaction is made at the end of each task attempted by the user. Note, a task may be attempted but it may not be completed. Therefore, it is important o record not just the attitude or sentiment about the task, but also the status of the task when the user takes the survey.
- **Test Level Satisfaction** - Similar to the **Task Level Satisfaction**, but Test Level Satisfaction is conducted at the end of a Test which can be comprised of multiple tasks. Therefore, in order to properly assess the Test Level, an evaluation of the Task assessments also needs to be made. For example, a test assessment might be low because some of the tasks were assessed as poor.

ISO also provides some guidance in how to assess User Satisfaction. See:

- ISO 10001:2018 Quality management — Customer satisfaction — Guidelines for codes of conduct for organizations
- ISO 10002:2018 Quality management — Customer satisfaction — Guidelines for complaints handling in organizations
- ISO 10003:2018 Quality management — Customer satisfaction — Guidelines for dispute resolution external to organizations
- ISO 10004:2018 Quality management — Customer satisfaction — Guidelines for monitoring and measuring

- **Note:** For more information, see: https://blog.ansi.org/2018/07/customer-satisfaction-iso-10002-quality/#gref

DDS Specifics Metrics

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1)
Justin Mifsud, Usability Metrics – A Guide To Quantify The Usability Of Any System, Accessed 18 November 2020, https://usabilitygeek.com/usability-metrics-a-guide-to-quantify-system-usability/
2)
International Organization for Standardization (ISO), Usability, ISO25000, Accessed: 17 November 2020, https://iso25000.com/index.php/en/iso-25000-standards/iso-25010/61-usability
3)
UI Designer, Efficiency, Accessed 19 November 2020, http://ui-designer.net/usability/efficiency.htm
4)
Saul McLeod, Likert Scale Definition, Examples and Analysis , Simply Psychology, 2019, Accessed 20 November 2020, https://www.simplypsychology.org/likert-scale.html