Chapter 21
Software quality metrics
Product metrics

Product metrics refer to the software system's operational phase – years of regular use of the software system by customers, whether "internal" or "external" customers.

- In most cases, the software developer is required to provide customer service during the software's operational phase.

Customer services are of two main types:

- **Help desk services (HD)** – software support by instructing customers regarding the method of application of the software and solution of customer implementation problems.
- **Corrective maintenance services** – correction of software failures identified by customers/users or detected by the customer service team prior to their discovery by customers. The number of software failures and their density are directly related to software development quality.

- The array of software product metrics presented here is classified as follows:

- ■ HD quality metrics

- ■ HD productivity and effectiveness metrics

- ■ Corrective maintenance quality metrics

- ■ Corrective maintenance productivity and effectiveness metrics.

- It should be remembered that software maintenance activities include:

- ■ Corrective maintenance – correction of software failures detected during regular operation of the software.

- ■ Adaptive maintenance – adaptation of existing software to new customers or new requirements.

- ■ Functional improvement maintenance – addition of new functions to theexisting software, improvement of reliability, etc.

- HD quality metrics

- The types of HD quality metrics discussed here deal with:

- ■ HD calls density metrics – the extent of customer requests for HD services as measured by the number of calls.

- ■ Metrics of the severity of the HD issues raised.

- ■ HD success metrics – the level of success in responding to these calls. A success is achieved by completing the required service within the time determined in the service contract.

Table 21.6: HD calls density metrics

Code	Name	Calculation formula
HDD	HD calls Density	$HDD = \dfrac{NHYC}{KLMC}$
WHDD	Weighted HD calls Density	$WHDD = \dfrac{WHYC}{KLMC}$
WHDF	Weighted HD calls per Function point	$WHDF = \dfrac{WHYC}{NMFP}$

Key:
- NHYC = number of HD calls during a year of service.
- KLMC = thousands of lines of maintained software code.
- WHYC = weighted HD calls received during one year of service.
- NMFP = number of function points to be maintained.

Success of the HD services

The most common metric for the success of HD services is the capacity to solve problems raised by customer calls within the time determined in the service contract (*availability*).

For example, the availability of help desk (HD) services for an inventory management software package is defined as follows:

- The HD service undertakes to solve any HD call within one hour.
- The probability that HD call solution time exceeds one hour will not exceed 2%.
- The probability that HD call solution time exceeds four working hours will not exceed 0.5%.

One metric of this group is suggested here, **HD Service Success (HDS):**

$$HDS = \frac{NHYOT}{NHYC}$$

where NHYOT = number of HD calls per year completed on time during one year of service.

- software maintenance metrics are classified as follows:
  ■ **Software system failures density metrics** – deal with the extent of demand for corrective maintenance, based on the records of failures identified during regular operation of the software system.
  ■ **Software system failures severity metrics** – deal with the severity of software system failures attended to by the corrective maintenance team.

- ■ **Failures of maintenance services metrics** – deal with cases where maintenance services were unable to complete the failure correction on time or that the correction performed failed.

- ■ **Software system availability metrics** – deal with the extent of disturbances caused to the customer as realized by periods of time where the services of the software system are unavailable or only partly available.

Table 21.8: Software system failures density metrics

Code	Name	Calculation formula
SSFD	Software System Failure Density	$SSFD = \dfrac{NYF}{KLMC}$
WSSFD	Weighted Software System Failure Density	$WSSFD = \dfrac{WYF}{KLMC}$
WSSFF	Weighted Software System Failures per Function point	$WSSFF = \dfrac{WYF}{NMFP}$

Key:
- NYF = number of software failures detected during a year of maintenance service.
- WYF = weighted number of yearly software failures detected during a year of maintenance service.
- KLMC = thousands of lines of maintained software code.
- NMFP = number of function points designated for the maintained software.

Software system availability metrics
User metrics distinguish between:

- Full availability – where all software system functions perform properly
- Vital availability – where no vital functions fail (but non-vital functions may fail)
- Total unavailability – where all software system functions fail.

Table 21.9: Software system availability metrics

Code	Name	Calculation formula
FA	Full Availability	$FA = \dfrac{NYSerH - NYFH}{NYSerH}$
VitA	Vital Availability	$VitA = \dfrac{NYSerH - NYVitFH}{NYSerH}$
TUA	Total Unavailability	$TUA = \dfrac{NYTFH}{NYSerH}$

Key:
- NYSerH = number of hours software system is in service during one year. For an office software system that is operating 50 hours per week for 52 weeks per year, NYSerH = 2600 (50×52). For a real-time software application that serves users 24 hours a day, NYSerH = 8760 (365×24).
- NYFH = number of hours where at least one function is unavailable (failed) during one year, including total failure of the software system.
- NYVitFH = number of hours when at least one vital function is unavailable (failed) during one year, including total failure of the software system.
- NYTFH = number of hours of total failure (all system functions failed) during one year.
- $NYFH \geq NYVitFH \geq NYTFH$.
- $1 - TUA \geq VitA \geq FA$.

Table 21.10: Software corrective maintenance productivity and effectiveness metrics

Code	Name	Calculation formula
CMaiP	Corrective Maintenance Productivity	$CMaiP = \dfrac{CMaiYH}{KLMC}$
FCMP	Function point Corrective Maintenance Productivity	$FCMP = \dfrac{CMaiYH}{NMFP}$
CMaiE	Corrective Maintenance Effectiveness	$CMaiE = \dfrac{CMaiYH}{NYF}$

Key:
- CMaiYH = total yearly working hours invested in the corrective maintenance of the software system.
- KLMC = thousands of lines of maintained software code.
- NMFP = number of function points designated for the maintained software.
- NYF = number of software failures detected during a year of maintenance service.