CHAPTER 4

PERFORMANCE PARAMETERS CRITICALITY ASSESSMENT

This chapter provides information about the criticality assessment of performance parameters. Identification of performance requirements and parameters are discussed in chapter 3. Once the performance requirements and parameters are identified, it is also important to assess the critical performance parameters. Criticality assessment is an important task in software development which helps the people to identify the critical performance parameters. Critical means these parameters are most important to the system and the probability of getting failures with respect to these parameters is also high [121]. This assessment makes the developers to focus more on the critical performance parameters in order to avoid the risks that can occur in the near future.

4.1 Finding Critical Performance Parameters

Critical performance parameters play an important role in success or failure of software systems with respect to performance. The importance of parameters may vary from application to application. It is always better to identify the critical performance parameters for software systems so that, developers can predict the risks early in the software development. Performance parameters identified and considered in this research work are response time, throughput, resource utilization and execution demand. The traceability matrix is given in table 4.1 is used for finding critical performance parameters.
Table 4.1 Traceability matrix for finding the critical performance parameters

<table>
<thead>
<tr>
<th></th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>G4</th>
<th>......</th>
<th>Gm</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPR1</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>......</td>
<td></td>
</tr>
<tr>
<td>PPR2</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>......</td>
<td>X</td>
</tr>
<tr>
<td>PPR3</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>......</td>
<td></td>
</tr>
<tr>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>:</td>
<td>......</td>
<td>:</td>
</tr>
<tr>
<td>PPRn</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>......</td>
<td></td>
</tr>
</tbody>
</table>

In table 4.1, PPR1, PPR2, PPR3 ----- PPRn represents performance parameters and G1, G2, G3, G4 ----- Gm, represents goals. PPR2 is observed as the critical performance parameter from the table 4.1, since many goals require PPR2.

4.2 Metrics for of Performance Parameters Criticality Assessment

In this chapter four metrics are proposed for criticality assessment of performance parameters. Once the performance parameters are identified, it is also important to know which are critical to the system. This helps the developers to focus more on these parameters, so that performance problems that can occur in the future can be predicted. The main performance parameters [122] are Response time, Throughput, Execution demand, Resource utilization.

To evaluate the criticality of the performance parameters, four metrics are proposed. They are: MGPP_RT, MGPP_ED, MGPP_RU and MGPP_TP.
1. **MGPP_RT**: It is defined as the metric to compute the contribution of goals to performance parameter response time, that is, how many goals require response time performance parameter out of total number of goals.

\[
MGPP_{RT} = \frac{\text{Number of goals that require response time}}{\text{Total number of goals}} \quad (4.1)
\]

2. **MGPP_ED**: It is defined as the metric to compute the contribution of goals to performance parameter execution demand, that is, how many goals require execution demand performance parameter out of the total number of goals.

\[
MGPP_{ED} = \frac{\text{Number of goals that require execution demand}}{\text{Total number of goals}} \quad (4.2)
\]

3. **MGPP_RU**: It is defined as the metric to compute the contribution of goals to performance parameter resource utilization that is, how many goals require resource utilization performance parameter out of the total number of goals.

\[
MGPP_{RU} = \frac{\text{Number of goals that require resource utilization}}{\text{Total number of goals}} \quad (4.3)
\]

4. **MGPP_TP**: It is defined as the metric to compute the contribution of goals to performance parameter throughput that is how many goals require throughput performance parameter out of the total number of goals.

\[
MGPP_{TP} = \frac{\text{Number of goals that require throughput}}{\text{Total number of goals}} \quad (4.4)
\]
For each sub goal the corresponding performance requirements and performance parameters are identified. This information is presented using the traceability matrix. Using the information provided in the table 4.1, performance parameters criticality assessment is done. The performance parameters which are needed by more number of goals and sub goals are considered as critical performance parameter. The criticality assessment approach is applied on three case studies.

4.3 Formal Validation of Proposed Metrics

In general, a formal validation is performed by evaluating the metrics against the set of Weyuker’s properties [123]. The nine properties are: non-coarseness, granularity, non-uniqueness (notion of equivalence), design details are important, monotonicity, non-equivalence of interaction, permutation, renaming, and interaction increases complexity. Proposed metrics (MGPP_RT, MGPP_ED, MGPP_RU and MGPP_TP) are validated against Weyuker’s properties. Validation results for all the metrics are presented in table 4.2.

Property 1: Non-coarseness

For a given system M and a metric µ, another system N can always be found, such that µ(M) ≠ µ(N) (µ represents a metric under consideration). This property states that every system cannot have the same metric value under consideration.

Metrics under consideration are MGPP_RT, MGPP_ED, MGPP_RU, and MGPP_TP. In object oriented systems it can be assumed that different object oriented systems implement different functionalities. There is a nonzero probability that ∃M, ∃N such that µ(M) ≠ µ(N). Therefore, property 1 is satisfied by the proposed metrics. Consider two
examples, the library management system and ATM system. In the library management system, six goals out of eight goals require response time as the performance parameter. For this case, MGPP_RT is computed based on the equation (4.1).

\[ \text{MGPP RT} = \frac{6}{8} = 0.75. \]

The computed value for library management system is 0.75.

In ATM system, six goals out of six goals require response time as the performance parameter. For this case, MGPP_RT is computed based on equation (4.1).

\[ \text{MGPP RT} = \frac{6}{6} = 1. \]

The computed value for ATM system is 1.

The computed metric values obtained for library management system and ATM system are not same. Hence, property 1 is satisfied by metric MGPP_RT. It is found that from different examples, the other metrics MGPP_ED, MGPP_RU, and MGPP_TP satisfies property 1.

**Property 2: Granularity**

The property granularity requires finite number of cases which are having the same metric value. Since this world deals with a finite set of object oriented applications, there should be a finite set of systems, which must have the same metric value. Hence, property 2 is satisfied by the proposed metrics. Any metric that is defined or measured at the levels of system, will satisfy this property. In this thesis, the proposed metrics defined are at the levels of system.
Metrics under consideration are MGPP_RT, MGPP_ED, MGPP_RU and MGPP_TP.

Consider two examples, online shopping system and ATM system. In online shopping system, six goals out of six goals require response time as the performance parameter. For this case, MGPP_RT is computed based on the equation (4.1).

\[
\text{MGPP}_{\text{RT}} = \frac{6}{6} = 1.
\]

The computed value for online shopping system is 1. In ATM system six goals out of six goals require response time as the performance parameter. For this case, MGPP_RT is computed based on equation (4.1).

\[
\text{MGPP}_{\text{RT}} = \frac{6}{6} = 1.
\]

The computed value for ATM system is 1. The computed metric values obtained for online shopping system and ATM system are same. Hence, property 2 is satisfied by metric MGPP_RT. It is found from different examples that the other metrics MGPP_ED, MGPP_RU, and MGPP_TP satisfies property 2.

**Property 3: Non-uniqueness (notion of equivalence)**

There can exist distinct systems M and R such that \( \mu(M) = \mu(R) \). This implies that two systems can have the same metric value, i.e. the two systems are equally complex. There is a nonzero probability that \( \exists M \) and \( \exists R \) such that \( \mu(M) = \mu(R) \). Therefore, property 3 is satisfied by the proposed metrics.

Metrics under consideration are MGPP_RT, MGPP_ED, MGPP_RU and MGPP_TP. Consider two examples, ATM system and online shopping system. In ATM system two
goals out of six goals require resource utilization as the performance parameter. For this case, MGPP_RU is computed based on the equation (4.3).

\[
\text{MGPP}_\text{RU} = \frac{2}{6} = 0.33.
\]

The computed value for ATM system is 0.33. In online shopping system two goals out of six goals require resource utilization as the performance parameter. For this case, MGPP_RU is computed based on equation (4.3).

\[
\text{MGPP}_\text{RU} = \frac{2}{6} = 0.33.
\]

The computed value for online shopping system is 0.33. The computed metric values obtained for ATM system and online Shopping system are same. Hence, MGPP_RU satisfies property 3. It is found from different examples that the other metrics MGPP_ED, MGPP_RT, and MGPP_TP satisfies property 3.

**Property 4: Design Details are Important**

Given two system designs M and N which provide the same functionality, does not imply that \( \mu(M) = \mu(N) \). The specifics of the system design must influence the metric value. This property states that, if the design of system M is different from that of system N even if their functionalities are same their metric values may not be the same. The proposed MGPP_RT, MGPP_ED, MGPP_RU and MGPP_TP metrics does not depend on design of the system, hence, they do not satisfy property 4.

**Property 5: Monotonicity**

This property indicates that the metric for individual systems should be less than the metric for combination of two systems. For all systems M and N, the following should
hold i.e., $\mu(M) \leq \mu(M+N) \text{ and } \mu(N) \leq \mu(M+N)$. This indicates that the metric for individual systems should be less than the metric for combination of two systems. Metrics under consideration are $\text{MGPP}_R$, $\text{MGPP}_E$, $\text{MGPP}_U$, $\text{MGPP}_T$.

Consider two examples, library management system ($M$) and the online shopping system ($N$). In the library management system two goals out of eight goals require throughput as the performance parameter. For this case, $\text{MGPP}_T(M)$ is computed based on equation (4.4).

$$\text{MGPP}_T = \frac{2}{8} = 0.25.$$  

The computed value is 0.25. In the online shopping system two goals out of six goals require throughput as the performance parameter. For this case, $\text{MGPP}_T(N)$ is computed based on the equation (4.4).

$$\text{MGPP}_T = \frac{2}{6} = 0.33.$$  

The computed value is 0.33. After combining the two systems, library management system and online shopping system, the value obtained is

$$\text{MGPP}_T(M+N) = \frac{2}{8} + \frac{2}{6} = \frac{7}{12} = 0.58.$$  

This indicates, $\text{MGPP}_T(M+N) > \text{MGPP}_T(M)$. Hence, property 5 is satisfied by $\text{MGPP}_T$. It is found from different examples that the other metrics $\text{MGPP}_E$, $\text{MGPP}_U$, and $\text{MGPP}_R$ satisfies the property 5.

**Property 6: Non-equivalence of interaction**

This property states that two systems of the same complexity need not have the same complexity after being concatenated with a third system. $\exists M, \exists N, \exists R$, such that $\mu(M) = \mu(N)$ does not imply that $\mu(M+R) = \mu(N+R)$. This suggests that interaction between $M$
and R can be different than interaction between N and R resulting in different complexity values for (M + R) and (N + R).

Metrics under consideration are MGPP_RT, MGPP_ED, MGPP_RU, MGPP_TP. Consider three examples, library management system (M), ATM system (N), and online shopping system (R). In a library management system (M) six goals out of eight goals require response time as the performance parameter. For this case, MGPP_RT (M) is computed based on equation (4.1).

\[
\text{MGPP}_{\text{RT}}(M) = \frac{6}{8} = 0.75.
\]

The computed value is 0.75. In ATM system six goals out of six goals require response time as the performance parameter. For this case, MGPP_RT (N) is computed based on equation (4.1).

\[
\text{MGPP}_{\text{RT}}(N) = \frac{6}{6} = 1.
\]

The computed value is 1. In online shopping system (R), six goals out of six goals require response time as the performance parameter. For this case, MGPP_RT (R) is computed based on equation (4.1).

\[
\text{MGPP}_{\text{RT}}(R) = \frac{6}{6} = 1.
\]

The computed value is \( \frac{6}{6} = 1 \). After combining, R with M ie., (M+R) and R with N ie., (N+R), the obtained metric values are not same.

\[
\text{MGPP}_{\text{RT}}(M+R) = \frac{7}{4} = 1.75.
\]

and

\[
\text{MGPP}_{\text{RT}}(N+R) = \frac{12}{6} = 2.
\]
This indicates that the property 6 is satisfied by MGPP_RT. It is found that from
different examples, the other metrics MGPP_ED, MGPP_RU, and MGPP_TP satisfies
property 6.

**Property 7: Permutation**

This property requires that permutations of elements within the item or entity being
measured can change the metric value. That is, if there are two systems M and N such
that N is formed by permuting the order of the statements of M, then this property
requires that $\mu(M) \neq \mu(N)$. The goals in the system are the list of functionalities.
Changing the order in which they are declared is not going to affect the end result. It is
suggested in [124] that this property is not applicable to object oriented systems. Hence,
this property is not considered for validation.

**Property 8: Renaming**

When the name of the measured entity changes the metric should remain unchanged.
That is if M is renamed to N, then $\mu(M) = \mu(N)$. The proposed metrics are not dependent
on the names of systems. Hence, the proposed metrics satisfy this property.

**Property 9: Interaction increases complexity**

This property states that at least in some cases the complexity of two systems
combined, is greater than the sum of their complexities. This reflects the fact that there
may be interaction between the combined systems, i.e., $\exists M$ and $\exists N$ such that $\mu(M) +
\mu(N) < \mu(M+N)$. Proposed metrics does not satisfy this property.
Table 4.2: Formal validation results of proposed metrics

<table>
<thead>
<tr>
<th>Property Metric</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
<th>P6</th>
<th>P7</th>
<th>P8</th>
<th>P9</th>
</tr>
</thead>
<tbody>
<tr>
<td>MGPP_RT</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>MGPP_ED</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>MGPP_RU</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>MGPP_TP</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

The metrics proposed are validated against Weyukur’s principles. The validation results are presented in table 4.2. Proposed metrics are validated against Weyuker’s nine properties. For object oriented systems, property 7 is not applicable. [123], hence, it is not considered for evaluation. Out of eight applicable properties majority of the properties are satisfied.

4.4. Case Studies

It is shown how the proposed approach is used to assess critical performance parameters from layered model. The proposed approach is applied on three case studies. These are online shopping system, library management system and ATM System. Different stakeholders may use these systems with different goals from different perspectives.

Criticality assessment has been done on three different case studies. These are online shopping system, library management system and ATM system. The assessment is done based on the information which is provided in the figures 3.1, 3.2 and 3.3 from chapter 3.
4.4.1 Online Shopping System

Online shopping system is an application which includes many numbers of live shops. The customer can login into website and they can choose the shop whatever they want. Once the shop is chosen, the customer can search the product and he can select the product from the existing list. Once the product is selected, system will display all the details of the product, the customer will go through the product details and if he satisfies with the details then he can add the product to the cart. The system will process the order. Then the customer will provide all the necessary details for checkout. Finally, the customer will make the payment through credit card or any other mode. In online shopping system the main stakeholders are customer and system. Here, an effort is made for identifying critical performance parameters.

Table 4.3 Traceability matrix for finding critical performance parameters for the online shopping system

<table>
<thead>
<tr>
<th></th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>G4</th>
<th>G5</th>
<th>G6</th>
</tr>
</thead>
<tbody>
<tr>
<td>RT</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>TP</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>ED</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>RU</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Critical performance parameters identification is done based on the information provided in the traceability matrix shown in table 4.3 for online shopping system. The notations used in rows RT, TP, ED and RU represents Response time, Throughput, Execution demand and Resource utilization. The corresponding columns represent goals, these are login, search product, add to cart, checkout, display product category, process the order, which are considered from the figure 3.4 in chapter 3.
The identification of critical performance parameters is done based on the metric values obtained. The metric value is computed based on the equations (4.1), (4.2), (4.3) and (4.4) from the information provided in the table 4.3. The computation of metric is given below. In online shopping system, six goals out of six goals require response time as the performance parameter. For this case, MGPP_RT is computed based on the equation (4.1).

\[ MGPP_{RT} = \frac{6}{6} = 1. \]

In online shopping system, no goal out of six goals requires execution demand as the performance parameter. For this case, MGPP_ED is computed based on the equation (4.2).

\[ MGPP_{ED} = \frac{0}{6} = 0. \]

In online shopping system, two goals out of six goals require resource utilization as the performance parameter. For this case, MGPP_RU is computed based on the equation (4.3).

\[ MGPP_{RU} = \frac{2}{6} = 0.33. \]

In online shopping system, two goals out of six goals require throughput as the performance parameter. For this case, MGPP_TP is computed based on the equation (4.4).

\[ MGPP_{TP} = \frac{2}{6} = 0.33. \]
Table 4.4 Metrics computation of performance parameters for online shopping system

<table>
<thead>
<tr>
<th>Performance parameter</th>
<th>Computed Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response time</td>
<td>1</td>
</tr>
<tr>
<td>Throughput</td>
<td>0.33</td>
</tr>
<tr>
<td>Execution demand</td>
<td>0</td>
</tr>
<tr>
<td>Resource utilization</td>
<td>0.33</td>
</tr>
</tbody>
</table>

It is observed from the table 4.4, the metric value for response time is high, compare to other performance parameters. Hence, response time is more critical than other parameters. The metrics is computed from the equations (4.1), (4.2), (4.3) and (4.4). The identified critical performance parameters must be focused, in order to avoid the problems that may occur during the development of the system.

4.4.2 Library Management System

The library management system is the system which includes different books, journals, articles, software and other items which are useful for different people. People can login into the system they can make use of all the facilities provided by the system. It includes many stakeholders like borrower, librarian and others. These people can perform different activities for the sake of barrowing books and returning the books. Some of the activities are captured in the form of goals and sub goals which are shown in the figure 3.3. Not only the goals and sub goals the corresponding performance requirements and parameters are also identified for the library management system which is shown in figure 3.3 presented in chapter 3. Criticality assessment is done based on the information provided in figure 3.3 in chapter 3.
Table 4.5 Traceability matrix for finding critical performance parameters of library management system

<table>
<thead>
<tr>
<th></th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>G4</th>
<th>G5</th>
<th>G6</th>
<th>G7</th>
<th>G8</th>
</tr>
</thead>
<tbody>
<tr>
<td>RT</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>TP</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RU</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Critical performance parameters identification is shown in table 4.5 is for library management system. The notations used in rows RT, TP, RU and ED represents Response time, Throughput, Resource utilization and Execution demand. The goals are represented in columns. These are Login, Return book, Search book, Receive Book, Borrow book, Add Member, Issue Book, and Add Item which are presented in figure 3.3 from chapter 3.

The identification of critical performance parameters is done based on the metric values obtained. The metric value is computed based on the equations (4.1), (4.2), (4.3) and (4.4) and information provided in the table 4.5. The computation of metric is given below. In library management system, six goals out of eight goals require response time as the performance parameter. For this case, MGPP_RT is computed based on the equation (4.1).

\[
\text{MGPP}_\text{RT} = \frac{6}{8} = 0.75.
\]
In library management system, no goal out of eight goals requires execution demand as the performance parameter. For this case, MGPP_ED is computed based on the equation (4.2).

\[
\text{MGPP ED} = 0/8 = 0.
\]

In library management system, two goals out of eight goals require resource utilization as the performance parameter. For this case, MGPP_RU is computed based on the equation (4.3).

\[
\text{MGPP RU} = 2/8 = 0.25.
\]

In library management system, two goals out of eight goals require throughput as the performance parameter. For this case, MGPP_TP is computed based on the equation (4.3).

\[
\text{MGPP TP} = 2/8 = 0.25.
\]

Table 4.6 Metrics computation of performance parameters for library management system

<table>
<thead>
<tr>
<th>Performance parameter</th>
<th>Computed Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response time</td>
<td>0.75</td>
</tr>
<tr>
<td>Throughput</td>
<td>0.25</td>
</tr>
<tr>
<td>Execution demand</td>
<td>0</td>
</tr>
<tr>
<td>Resource utilization</td>
<td>0.25</td>
</tr>
</tbody>
</table>

So from the table 4.6 it is observed that metric value for response time is high, compare to other performance parameters. The metrics is computed from the equations (4.1), (4.2), (4.3) and (4.4). Hence, response time is more critical than other performance
parameters. The critical performance parameters which are identified must be focused in order to avoid the problems that may occur during the development of the system.

4.4.3 ATM System

ATM system is the system which provides various financial services to users. These are withdrawing money, transferring money and depositing money etc. Customer and system administrator are main stakeholders in ATM system. There are some goals for each stakeholder in the system. Some constraints are posed on each goal. The performance parameters identified for stakeholders customer and system administrator are presented in figure 3.5. For all stakeholders’ performance requirements are identified and given in table 3.3. Criticality assessment is done based on the information provided in figure 3.5 presented in chapter 3.

Table 4.7 Traceability matrix for finding critical performance parameters for ATM system

<table>
<thead>
<tr>
<th></th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>G4</th>
<th>G5</th>
<th>G6</th>
</tr>
</thead>
<tbody>
<tr>
<td>RT</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>TP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RU</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>ED</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Critical performance parameters are identified for ATM system based on the information presented in the table 4.7. The notations represented in rows RT, TP, RU and ED are Response time, Throughput, Resource utilization, and Execution demand. The goals are represented in the respective columns. These are withdraw money, transfer
money, Check balance, Deposit Money, Manage cash, and Maintain system which are considered from figure 3.5 from chapter 3.

The identification of critical performance parameters is done based on the metric values obtained. The metric value is computed based on the equations (4.1), (4.2), (4.3) and (4.4) and information provided in the table 4.7. The computation of metric is given below. In ATM system, six goals out of six goals require response time as the performance parameter. For this case, MGPP_RT is computed based on the equation (4.1).

\[ \text{MGPP}_\text{RT} = \frac{6}{6} = 1. \]

In ATM system, no goal out of six goals requires execution demand as the performance parameter. For this case, MGPP_ED is computed based on the equation (4.2).

\[ \text{MGPP}_\text{ED} = \frac{0}{6} = 0. \]

In ATM system, two goals out of six goals require resource utilization as the performance parameter. For this case, MGPP_RU is computed based on the equation (4.3).

\[ \text{MGPP}_\text{RU} = \frac{2}{6} = 0.33. \]

In ATM system, no goal out of six goals requires throughput as the performance parameter. For this case, MGPP_TP is computed based on the equation (4.4).

\[ \text{MGPP}_\text{TP} = \frac{0}{6} = 0. \]
Table 4.8 Metrics computation of performance parameters for ATM system

<table>
<thead>
<tr>
<th>Performance parameter</th>
<th>Computed Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response time</td>
<td>1</td>
</tr>
<tr>
<td>Throughput</td>
<td>0</td>
</tr>
<tr>
<td>Execution demand</td>
<td>0</td>
</tr>
<tr>
<td>Resource utilization</td>
<td>0.33</td>
</tr>
</tbody>
</table>

So from the table 4.8 it is observed that the metric values of response time and resource utilization are high compare to other parameters. Hence, the response time and resource utilization are more critical than other performance parameters. The metrics is computed from the equations (4.1), (4.2), (4.3) and (4.4). The critical performance parameters which are identified must be focused in order to avoid the problems that may occur during the development of the system.

4.5 Summary

In this chapter criticality assessment of the performance parameters is presented. Four metrics are proposed for criticality assessment of performance parameters. The metrics proposed are analytically validated against the Weyuker’s properties. Majority of the properties (six out of eight applicable properties) are satisfied by the metrics. Criticality assessment using these proposed metrics is done on three cases studies and found the critical performance parameters successfully. These parameters need to be given special attention during the software development.