

Some Results from our Survey

1 Data processing

Among the answers that we received, we selected the questionnaires of 20 developers with a long experience in the use of design patterns in software development.

Due to the high level of variations between answers, we chose to aggregate answers A and B and answers D and E:

Positive = A and B

Neutral = C

Negative = D and E

Answers F were not considered to assess the impact of design patterns on quality because we considered that the respondent did not know how the pattern impacts the quality attribute.

Using the previous three-point Likert scale, we computed the frequencies of the answers on each quality attribute: Positive, Neutral, and Negative.

2 Results

We present in the following the results for three design patterns: Abstract Factory, Composite, and Flyweight, and the three quality attributes related to design patterns: reusability, expandability, and understandability.

We chose the following three design patterns to illustrate the opinions of our respondents about the impact of design patterns on quality attributes firstly because of their popularity, they are among commonly used patterns thus we felt that their evaluation would be more accurate.

Composite. Table 1 presents the evaluations by the respondents of the impact of the Composite pattern on the quality attributes. Looking at the table, it appears that the Composite pattern is mostly perceived as having a positive impact on the quality of systems. All quality attributes are impacted positively but for the scalability and robustness that are not positive. Given the purpose of the Composite pattern, having a neutral impact on scalability is rather surprising.

Attributes	Positive	Neutral	Negative
Expandability	100.0	0.0	0.0
Simplicity	69.23	15.38	15.38
Generality	76.92	15.38	7.69
Modularity	71.43	21.43	7.14
Modularity at Runtime	53.85	38.46	7.69
Learnability	76.92	7.69	15.38
Understandability	69.23	15.38	15.38
Reusability	61.54	23.08	15.38
Scalability	41.67	41.67	16.67
Robustness	8.33	91.67	0.0

Table 1. Impact of Composite on quality attributes.

Abstract Factory. Table 2 presents the evaluations by the respondents of the impact of the Abstract Factory pattern on the quality attributes. The table shows that half the quality attributes is considered as positively impacted while the other half is not. It is not surprising that the pattern is overall judged as neutral given its purpose and complexity. However, it is striking that both learnability and understandability are felt negatively impacted.

Flyweight. Table 3 presents the evaluations by the respondents of the impact of the Flyweight pattern on the quality attributes. The table reports that this pattern is perceived as impacting negatively all quality attributes but for the scalability. Given the purpose of the pattern, it is not surprising that its impact on scalability is judged positively. The negative perception could be explained by the less frequent use of Flyweight in comparison with Composite and Abstract Factory.

Reusability. Table 4 presents the evaluations by respondents of the impact of design patterns on reusability. Overall, reusability is felt as being slightly more negatively impacted by design patterns. This is rather

Attributes	Positive	Neutral	Negative
Expandability	100.0	0.0	0.0
Simplicity	53.33	13.33	33.33
Generality	78.57	21.43	0.0
Modularity	85.71	7.14	7.14
Modularity at Runtime	46.15	38.46	15.38
Learnability	35.71	28.57	35.71
Understandability	38.46	30.77	30.77
Reusability	50.0	42.86	7.14
Scalability	21.43	64.29	14.29
Robustness	0.0	72.73	27.27

Table 2. Impact of Abstract Factory on quality attributes.

Attributes	Positive	Neutral	Negative
Expandability	22.22	44.44	33.33
Simplicity	0.0	22.22	77.78
Generality	11.11	44.44	44.44
Modularity	33.33	33.33	33.33
Modularity at Runtime	11.11	66.67	22.22
Learnability	0.0	20.0	80.0
Understandability	0.0	10.0	90.0
Reusability	37.5	12.5	50.0
Scalability	77.78	0.0	22.22
Robustness	22.22	66.67	11.11

Table 3. Impact of Flyweight on quality attributes.

surprising as the use of design patterns is claimed to improve reusability according to the GoF.

Expandability. Table 5 presents the evaluations by the respondents of the impact of design patterns on the expandability. All respondents felt that expandability is improved when using design patterns, in conformance with what is expected of using patterns.

Understandability. Table 6 presents the evaluations by the respondents of the impact of design patterns on the understandability. Similarly to reusability, respondents felt that the understandability was rather slightly negatively impacted by the use of patterns.

Patterns	Positive	Neutral	Negative
A.Factory	46.15	46.15	7.69
Builder	36.36	45.45	18.18
F.Method	60.0	20.0	20.0
Prototype	63.64	0.0	36.36
Singleton	18.18	54.55	27.27
Adapter	66.67	25.0	8.33
Bridge	41.67	16.67	41.67
Composite	58.33	25.0	16.67
Decorator	36.36	18.18	45.45
Facade	36.36	45.45	18.18
Flyweight	37.5	12.5	50.0
Proxy	45.45	36.36	18.18
Ch.Of.Resp	54.55	27.27	18.18
Command	30.0	20.0	50.0
Interpreter	50.0	0.0	50.0
Iterator	72.73	9.09	18.18
Mediator	20.0	50.0	30.0
Memento	28.57	42.86	28.57
Observer	53.85	23.08	23.08
State	20.0	40.0	40.0
Strategy	41.67	33.33	25.0
T.Method	58.33	33.33	8.33
Visitor	28.57	28.57	42.86

Table 4. Impact of design patterns on reusability.

Patterns	Positive	Neutral	Negative
A.Factory	100.0	0.0	0.0
Builder	90.91	9.09	0.0
F.Method	72.73	9.09	18.18
Prototype	63.64	27.27	9.09
Singleton	9.09	27.27	63.64
Adapter	50.0	41.67	8.33
Bridge	83.33	16.67	0.0
Composite	100.0	0.0	0.0
Decorator	90.91	0.0	9.09
Facade	58.33	16.67	25.0
Flyweight	22.22	44.44	33.33
Proxy	45.45	45.45	9.09
Ch.Of.Resp	91.67	8.33	0.0
Command	66.67	16.67	16.67
Interpreter	63.64	27.27	9.09
Iterator	90.91	9.09	0.0
Mediator	58.33	25.0	16.67
Memento	33.33	55.56	11.11
Observer	85.71	7.14	7.14
State	72.73	18.18	9.09
Strategy	76.92	15.38	7.69
T.Method	84.62	15.38	0.0
Visitor	71.43	7.14	21.43

Table 5. Impact of design patterns on expandability.

Patterns	Positive	Neutral	Negative
A.Factory	38.46	30.77	30.77
Builder	81.82	9.09	9.09
F.Method	45.45	27.27	27.27
Prototype	58.33	16.67	25.0
Singleton	91.67	8.33	0.0
Adapter	50.0	25.0	25.0
Bridge	50.0	33.33	16.67
Composite	75.0	16.67	8.33
Decorator	45.45	9.09	45.45
Facade	81.82	18.18	0.0
Flyweight	0.0	10.0	90.0
Proxy	33.33	50.0	16.67
Ch.Of.Resp	33.33	33.33	33.33
Command	33.33	33.33	33.33
Interpreter	63.64	0.0	36.36
Iterator	50.0	41.67	8.33
Mediator	58.33	25.0	16.67
Memento	33.33	55.56	11.11
Observer	42.86	35.71	21.43
State	54.55	0.0	45.45
Strategy	69.23	23.08	7.69
T.Method	38.46	38.46	23.08
Visitor	21.43	21.43	57.14

Table 6. Impact of design patterns on understandability.