



# Korea Culture Game(KCG)

## Security Assessment

CertiK Assessed on Dec 1st, 2025





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## Korea Culture Game(KCG)

The security assessment was prepared by Certik.

### Executive Summary

#### TYPES

ERC-20

#### ECOSYSTEM

Binance Smart Chain  
(BSC)

#### METHODS

Formal Verification, Manual Review, Static Analysis

#### LANGUAGE

Solidity

#### TIMELINE

Preliminary comments published on 11/18/2025

Final report published on 12/01/2025

### Vulnerability Summary



4

Total Findings

0

Resolved

0

Partially Resolved

4

Acknowledged

0

Declined

#### 2 Centralization

2 Acknowledged

Centralization findings highlight privileged roles & functions and their capabilities, or instances where the project takes custody of users' assets.

#### 0 Critical

Critical risks are those that impact the safe functioning of a platform and must be addressed before launch. Users should not invest in any project with outstanding critical risks.

#### 0 Major

Major risks may include logical errors that, under specific circumstances, could result in fund losses or loss of project control.

#### 0 Medium

Medium risks may not pose a direct risk to users' funds, but they can affect the overall functioning of a platform.

#### 0 Minor

Minor risks can be any of the above, but on a smaller scale. They generally do not compromise the overall integrity of the project, but they may be less efficient than other solutions.

#### 2 Informational

2 Acknowledged

Informational errors are often recommendations to improve the style of the code or certain operations to fall within industry best practices. They usually do not affect the overall functioning of the code.

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KCG-03 : Local Variable Shadowing

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# CODEBASE | KOREA CULTURE GAME(KCG)

## Repository

<https://bscscan.com/token/0x1a5093b6f1ef2fc4f45cb651cb2fb9ce14eb79a5>

## AUDIT SCOPE | KOREA CULTURE GAME(KCG)

mainnet



contracts/FixedSupplyToken.sol

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## APPROACH & METHODS | KOREA CULTURE GAME(KCG)

This audit was conducted for Korea Culture Game to evaluate the security and correctness of the smart contracts associated with the Korea Culture Game(KCG) project. The assessment included a comprehensive review of the in-scope smart contracts. The audit was performed using a combination of Static Analysis and Manual Review.

The review process emphasized the following areas:

- Architecture review and threat modeling to understand systemic risks and identify design-level flaws.
- Identification of vulnerabilities through both common and edge-case attack vectors.
- Manual verification of contract logic to ensure alignment with intended design and business requirements.
- Dynamic testing to validate runtime behavior and assess execution risks.
- Assessment of code quality and maintainability, including adherence to current best practices and industry standards.

The audit resulted in findings categorized across multiple severity levels, from informational to critical. To enhance the project's security and long-term robustness, we recommend addressing the identified issues and considering the following general improvements:

- Improve code readability and maintainability by adopting a clean architectural pattern and modular design.
- Strengthen testing coverage, including unit and integration tests for key functionalities and edge cases.
- Maintain meaningful inline comments and documentations.
- Implement clear and transparent documentation for privileged roles and sensitive protocol operations.
- Regularly review and simulate contract behavior against newly emerging attack vectors.

## FINDINGS | KOREA CULTURE GAME(KCG)



4

Total Findings

0

Critical

2

Centralization

0

Major

0

Medium

0

Minor

2

Informational

This report has been prepared for Korea Culture Game to identify potential vulnerabilities and security issues within the reviewed codebase. During the course of the audit, a total of 4 issues were identified. Leveraging a combination of Static Analysis & Manual Review the following findings were uncovered:

| ID     | Title  | Category       | Severity       | Status         |
|--------|--|----------------|----------------|----------------|
| KCG-01 | Initial Token Distribution                         | Centralization | Centralization | ● Acknowledged |
| KCG-02 | Centralization Risks In FixedSupplyToken.Sol       | Centralization | Centralization | ● Acknowledged |
| KCG-03 | Local Variable Shadowing                           | Coding Style   | Informational  | ● Acknowledged |
| KCG-04 | Token Name Misleading As Supply Is Not Truly Fixed | Coding Style   | Informational  | ● Acknowledged |

## KCG-01 | Initial Token Distribution

| Category       | Severity         | Location                           | Status         |
|----------------|------------------|------------------------------------|----------------|
| Centralization | ● Centralization | contracts/FixedSupplyToken.sol: 26 | ● Acknowledged |

### Description

All of the tokens are sent to the contract deployer or one or several externally-owned account (EOA) addresses. This is a centralization risk because the deployer or the owner(s) of the EOAs can distribute tokens without obtaining the consensus of the community. Any compromise to these addresses may allow a hacker to steal and sell tokens on the market, resulting in severe damage to the project.

### Recommendation

It is recommended that the team be transparent regarding the initial token distribution process. The token distribution plan should be published in a public location that the community can access. The team should make efforts to restrict access to the private keys of the deployer account or EOAs. A multi-signature (2/3, 3/5) wallet can be used to prevent a single point of failure due to a private key compromise. Additionally, the team can lock up a portion of tokens, release them with a vesting schedule for long-term success, and deanonymize the project team with a third-party KYC provider to create greater accountability.

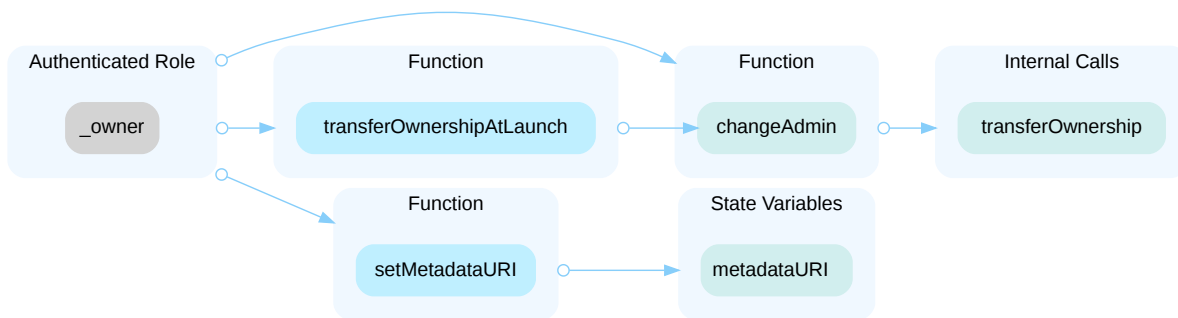


## KCG-02 | Centralization Risks In FixedSupplyToken.sol

| Category       | Severity         | Location                                   | Status         |
|----------------|------------------|--|----------------|
| Centralization | ● Centralization | contracts/FixedSupplyToken.sol: 30, 36, 41 | ● Acknowledged |

### Description

In the contract `FixedSupplyToken`, the role `_owner` has authority over the functions shown in the diagram below. Any compromise to the `_owner` account may allow the hacker to take advantage of this authority and exercise all associated privileges.



### Recommendation

The risk describes the current project design and potentially makes iterations to improve in the security operation and level of decentralization, which in most cases cannot be resolved entirely at the present stage. We advise the client to carefully manage the privileged account's private key to avoid any potential risks of being hacked. In general, we strongly recommend centralized privileges or roles in the protocol be improved via a decentralized mechanism or smart-contract-based accounts with enhanced security practices, e.g., multisignature wallets. Indicatively, here are some feasible suggestions that would also mitigate the potential risk at a different level in terms of short-term, long-term and permanent:

#### Short Term:

Timelock and Multi sign (2/3, 3/5) combination *mitigate* by delaying the sensitive operation and avoiding a single point of key management failure.

- Time-lock with reasonable latency, e.g., 48 hours, for awareness on privileged operations;  
AND
- Assignment of privileged roles to multi-signature wallets to prevent a single point of failure due to the private key compromised;  
AND
- A medium/blog link for sharing the timelock contract and multi-signers addresses information with the public audience.

#### Long Term:

Timelock and DAO, the combination, *mitigate* by applying decentralization and transparency.

- Time-lock with reasonable latency, e.g., 48 hours, for awareness on privileged operations;  
AND
- Introduction of a DAO/governance/voting module to increase transparency and user involvement.  
AND
- A medium/blog link for sharing the timelock contract, multi-signers addresses, and DAO information with the public audience.

### **Permanent:**

Renouncing the ownership or removing the function can be considered *fully resolved*.

- Renounce the ownership and never claim back the privileged roles.  
OR
- Remove the risky functionality.

## KCG-03 | Local Variable Shadowing

| Category     | Severity        | Location                               | Status         |
|--------------|-----------------|--|----------------|
| Coding Style | ● Informational | contracts/FixedSupplyToken.sol: 14, 15 | ● Acknowledged |

### Description

A local variable is shadowing another component defined elsewhere. This means that when the contract accesses the variable by its name, it will use the one defined locally, not the one defined in the other place. The use of the variable may lead to unexpected results and unintended behavior.

```
14         string memory _name,
```

- Local variable `_name` in `FixedSupplyToken.constructor` shadows the variable `_name` in `ERC20`.

```
15         string memory _symbol,
```

- Local variable `_symbol` in `FixedSupplyToken.constructor` shadows the variable `_symbol` in `ERC20`.

### Recommendation

It is recommended to remove or rename the local variable that shadows another definition to prevent potential issues and maintain the expected behavior of the smart contract.

## KCG-04 | Token Name Misleading As Supply Is Not Truly Fixed

| Category     | Severity        | Location                          | Status         |
|--------------|-----------------|-----------------------------------|----------------|
| Coding Style | ● Informational | contracts/FixedSupplyToken.sol: 6 | ● Acknowledged |

### Description

The contract is named FixedSupplyToken, which implies that the total token supply is immutable after deployment. However, the implementation includes both `burn()` and `burnFrom()` functions that allow any holder (or approved spender) to destroy tokens, reducing the total supply:

```
function burn(uint256 amount) external {  
    _burn(msg.sender, amount);  
}
```

```
function burnFrom(address account, uint256 amount) external { ... }
```

This means that although no additional minting is possible, the total supply is not fixed and can decrease over time. The behavior contradicts the expected semantics of a “fixed supply token,” which may mislead integrators, exchanges, and end users.

### Recommendation

Update the contract name to reflect the actual behavior, and ensure documentation clearly states that the supply can decrease via burning.

# FORMAL VERIFICATION | KOREA CULTURE GAME(KCG)

Formal guarantees about the behavior of smart contracts can be obtained by reasoning about properties relating to the entire contract (e.g. contract invariants) or to specific functions of the contract. Once such properties are proven to be valid, they guarantee that the contract behaves as specified by the property. As part of this audit, we applied formal verification to prove that important functions in the smart contracts adhere to their expected behaviors.

## Considered Functions And Scope

In the following, we provide a description of the properties that have been used in this audit. They are grouped according to the type of contract they apply to.

### Verification of ERC-20 Compliance

We verified properties of the public interface of those token contracts that implement the ERC-20 interface. This covers

- Functions `transfer` and `transferFrom` that are widely used for token transfers,
- functions `approve` and `allowance` that enable the owner of an account to delegate a certain subset of her tokens to another account (i.e. to grant an allowance), and
- the functions `balanceOf` and `totalSupply`, which are verified to correctly reflect the internal state of the contract.

The properties that were considered within the scope of this audit are as follows (note that overflow properties were excluded from the verification):

| Property Name                            | Title   |
|--|---|
| erc20-transferfrom-revert-zero-argument  | <code>transferFrom</code> Fails for Transfers with Zero Address Arguments               |
| erc20-transfer-revert-zero               | <code>transfer</code> Prevents Transfers to the Zero Address                            |
| erc20-transferfrom-correct-amount        | <code>transferFrom</code> Transfers the Correct Amount in Transfers                     |
| erc20-transferfrom-fail-exceed-allowance | <code>transferFrom</code> Fails if the Requested Amount Exceeds the Available Allowance |
| erc20-transfer-exceed-balance            | <code>transfer</code> Fails if Requested Amount Exceeds Available Balance               |
| erc20-allowance-change-state             | <code>allowance</code> Does Not Change the Contract's State                             |
| erc20-transferfrom-correct-allowance     | <code>transferFrom</code> Updated the Allowance Correctly                               |
| erc20-balanceof-change-state             | <code>balanceOf</code> Does Not Change the Contract's State                             |
| erc20-totalsupply-succeed-always         | <code>totalSupply</code> Always Succeeds  |
| erc20-transferfrom-never-return-false    | <code>transferFrom</code> Never Returns <code>false</code>                              |

| Property Name                          | Title   |
|--|---|
| erc20-totalsupply-correct-value        | <code>totalSupply</code> Returns the Value of the Corresponding State Variable              |
| erc20-transfer-never-return-false      | <code>transfer</code> Never Returns <code>false</code>                                      |
| erc20-approve-never-return-false       | <code>approve</code> Never Returns <code>false</code>                                       |
| erc20-approve-false                    | If <code>approve</code> Returns <code>false</code> , the Contract's State Is Unchanged      |
| erc20-transferfrom-fail-exceed-balance | <code>transferFrom</code> Fails if the Requested Amount Exceeds the Available Balance       |
| erc20-allowance-succeed-always         | <code>allowance</code> Always Succeeds  |
| erc20-balanceof-succeed-always         | <code>balanceOf</code> Always Succeeds  |
| erc20-approve-succeed-normal           | <code>approve</code> Succeeds for Valid Inputs  |
| erc20-allowance-correct-value          | <code>allowance</code> Returns Correct Value  |
| erc20-approve-revert-zero              | <code>approve</code> Prevents Approvals For the Zero Address                                |
| erc20-balanceof-correct-value          | <code>balanceOf</code> Returns the Correct Value  |
| erc20-transferfrom-false               | If <code>transferFrom</code> Returns <code>false</code> , the Contract's State Is Unchanged |
| erc20-transfer-correct-amount          | <code>transfer</code> Transfers the Correct Amount in Transfers                             |
| erc20-totalsupply-change-state         | <code>totalSupply</code> Does Not Change the Contract's State                               |
| erc20-transfer-false                   | If <code>transfer</code> Returns <code>false</code> , the Contract State Is Not Changed     |
| erc20-approve-correct-amount           | <code>approve</code> Updates the Approval Mapping Correctly                                 |

## Verification Results

For the following contracts, formal verification established that each of the properties that were in scope of this audit (see scope) are valid:

**Detailed Results For Contract FixedSupplyToken (contracts/FixedSupplyToken.sol) In Commit 0x1a5093b6f1ef2fc4f45cb651cb2fb9ce14eb79a5**

## Verification of ERC-20 Compliance

Detailed Results for Function `transferFrom`

| Property Name                            | Final Result | Remarks |
|--|--------------|---------|
| erc20-transferfrom-revert-zero-argument  | ● True       |         |
| erc20-transferfrom-correct-amount        | ● True       |         |
| erc20-transferfrom-fail-exceed-allowance | ● True       |         |
| erc20-transferfrom-correct-allowance     | ● True       |         |
| erc20-transferfrom-never-return-false    | ● True       |         |
| erc20-transferfrom-fail-exceed-balance   | ● True       |         |
| erc20-transferfrom-false                 | ● True       |         |

Detailed Results for Function `transfer`

| Property Name                     | Final Result | Remarks |
|-----------------------------------|--------------|---------|
| erc20-transfer-revert-zero        | ● True       |         |
| erc20-transfer-exceed-balance     | ● True       |         |
| erc20-transfer-never-return-false | ● True       |         |
| erc20-transfer-correct-amount     | ● True       |         |
| erc20-transfer-false              | ● True       |         |

Detailed Results for Function `allowance`

| Property Name                  | Final Result | Remarks |
|--------------------------------|--------------|---------|
| erc20-allowance-change-state   | ● True       |         |
| erc20-allowance-succeed-always | ● True       |         |
| erc20-allowance-correct-value  | ● True       |         |

Detailed Results for Function `balanceOf`

| Property Name                  | Final Result | Remarks |
|--------------------------------|--------------|---------|
| erc20-balanceof-change-state   | ● True       |         |
| erc20-balanceof-succeed-always | ● True       |         |
| erc20-balanceof-correct-value  | ● True       |         |

Detailed Results for Function `totalSupply`

| Property Name                    | Final Result | Remarks |
|----------------------------------|--------------|---------|
| erc20-totalsupply-succeed-always | ● True       |         |
| erc20-totalsupply-correct-value  | ● True       |         |
| erc20-totalsupply-change-state   | ● True       |         |

Detailed Results for Function `approve`

| Property Name                    | Final Result | Remarks |
|----------------------------------|--------------|---------|
| erc20-approve-never-return-false | ● True       |         |
| erc20-approve-false              | ● True       |         |
| erc20-approve-succeed-normal     | ● True       |         |
| erc20-approve-revert-zero        | ● True       |         |
| erc20-approve-correct-amount     | ● True       |         |



## APPENDIX | KOREA CULTURE GAME(KCG)

### Finding Categories

| Categories     | Description  |
|----------------|--|
| Coding Style   | Coding Style findings may not affect code behavior, but indicate areas where coding practices can be improved to make the code more understandable and maintainable. |
| Centralization | Centralization findings detail the design choices of designating privileged roles or other centralized controls over the code.                                       |

### Details on Formal Verification

Some Solidity smart contracts from this project have been formally verified. Each such contract was compiled into a mathematical model that reflects all its possible behaviors with respect to the property. The model takes into account the semantics of the Solidity instructions found in the contract. All verification results that we report are based on that model.

The following assumptions and simplifications apply to our model:

- Certain low-level calls and inline assembly are not supported and may lead to a contract not being formally verified.
- We model the semantics of the Solidity source code and not the semantics of the EVM bytecode in a compiled contract.

### Formalism for property specifications

All properties are expressed in a behavioral interface specification language that CertiK has developed for Solidity, which allows us to specify the behavior of each function in terms of the contract state and its parameters and return values, as well as contract properties that are maintained by every observable state transition. Observable state transitions occur when the contract's external interface is invoked and the invocation does not revert, and when the contract's Ether balance is changed by the EVM due to another contract's "self-destruct" invocation. The specification language has the usual Boolean connectives, as well as the operator `\old` (used to denote the state of a variable before a state transition), and several types of specification clause:

Apart from the Boolean connectives and the modal operators "always" (written `[]`) and "eventually" (written `<>`), we use the following predicates to reason about the validity of atomic propositions. They are evaluated on the contract's state whenever a discrete time step occurs:

- `requires [cond]` - the condition `cond`, which refers to a function's parameters, return values, and contract state variables, must hold when a function is invoked in order for it to exhibit a specified behavior.
- `ensures [cond]` - the condition `cond`, which refers to a function's parameters, return values, and both `\old` and current contract state variables, is guaranteed to hold when a function returns if the corresponding requires condition held when it was invoked.

- `invariant [cond]` - the condition `cond`, which refers only to contract state variables, is guaranteed to hold at every observable contract state.
- `constraint [cond]` - the condition `cond`, which refers to both `\old` and current contract state variables, is guaranteed to hold at every observable contract state except for the initial state after construction (because there is no previous state); constraints are used to restrict how contract state can change over time.

## Description of the Analyzed ERC-20 Properties

### Properties related to function `transferFrom`

#### erc20-transferfrom-correct-allowance

All non-reverting invocations of `transferFrom(from, dest, amount)` that return `true` must decrease the allowance for address `msg.sender` over address `from` by the value in `amount`.

Specification:

```
ensures \result ==> allowance(\old(sender), msg.sender) == \old(allowance(sender,
msg.sender)) - \old(amount)
           || (allowance(\old(sender), msg.sender) == \old(allowance(sender,
msg.sender)) && \old(allowance(sender, msg.sender)) == type(uint256).max);
```

#### erc20-transferfrom-correct-amount

All invocations of `transferFrom(from, dest, amount)` that succeed and that return `true` subtract the value in `amount` from the balance of address `from` and add the same value to the balance of address `dest`.

Specification:

```
requires recipient != sender;
requires balanceOf(recipient) + amount <= type(uint256).max;
ensures \result ==> balanceOf(\old(recipient)) == \old(balanceOf(recipient) +
amount)
           && balanceOf(\old(sender)) == \old(balanceOf(sender) - amount);
also
requires recipient == sender;
ensures \result ==> balanceOf(\old(recipient)) == \old(balanceOf(recipient));
```

#### erc20-transferfrom-fail-exceed-allowance

Any call of the form `transferFrom(from, dest, amount)` with a value for `amount` that exceeds the allowance of address `msg.sender` must fail.

Specification:

```
requires msg.sender != sender;  
requires amount > allowance(sender, msg.sender);  
ensures !\result;
```

#### erc20-transferfrom-fail-exceed-balance

Any call of the form `transferFrom(from, dest, amount)` with a value for `amount` that exceeds the balance of address `from` must fail.

Specification:

```
requires amount > balanceOf(sender);  
ensures !\result;
```

#### erc20-transferfrom-false

If `transferFrom` returns `false` to signal a failure, it must undo all incurred state changes before returning to the caller.

Specification:

```
ensures !\result ==> \assigned (\nothing);
```

#### erc20-transferfrom-never-return-false

The `transferFrom` function must never return `false`.

Specification:

```
ensures \result;
```

#### erc20-transferfrom-revert-zero-argument

All calls of the form `transferFrom(from, dest, amount)` must fail for transfers from or to the zero address.

Specification:

```
ensures \old(sender) == address(0) ==> !\result;  
also  
ensures \old(recipient) == address(0) ==> !\result;
```

#### Properties related to function `transfer`

##### erc20-transfer-correct-amount

All non-reverting invocations of `transfer(recipient, amount)` that return `true` must subtract the value in `amount` from

the balance of `msg.sender` and add the same value to the balance of the `recipient` address.

Specification:

```
requires recipient != msg.sender;
requires balanceOf(recipient) + amount <= type(uint256).max;
ensures \result ==> balanceOf(recipient) == \old(balanceOf(recipient) + amount)
  && balanceOf(msg.sender) == \old(balanceOf(msg.sender) - amount);
  also
requires recipient == msg.sender;
ensures \result ==> balanceOf(msg.sender) == \old(balanceOf(msg.sender));
```

#### erc20-transfer-exceed-balance

Any transfer of an amount of tokens that exceeds the balance of `msg.sender` must fail.

Specification:

```
requires amount > balanceOf(msg.sender);
ensures !\result;
```

#### erc20-transfer-false

If the `transfer` function in contract `FixedSupplyToken` fails by returning `false`, it must undo all state changes it incurred before returning to the caller.

Specification:

```
ensures !\result ==> \assigned (\nothing);
```

#### erc20-transfer-never-return-false

The transfer function must never return `false` to signal a failure.

Specification:

```
ensures \result;
```

#### erc20-transfer-revert-zero

Any call of the form `transfer(recipient, amount)` must fail if the recipient address is the zero address.

Specification:

```
ensures \old(recipient) == address(0) ==> !\result;
```

**Properties related to function `allowance`****erc20-allowance-change-state**

Function `allowance` must not change any of the contract's state variables.

Specification:

```
assignable \nothing;
```

**erc20-allowance-correct-value**

Invocations of `allowance(owner, spender)` must return the allowance that address `spender` has over tokens held by address `owner`.

Specification:

```
ensures \result == allowance(\old(owner), \old(spender));
```

**erc20-allowance-succeed-always**

Function `allowance` must always succeed, assuming that its execution does not run out of gas.

Specification:

```
reverts_only_when false;
```

**Properties related to function `balanceOf`****erc20-balanceof-change-state**

Function `balanceOf` must not change any of the contract's state variables.

Specification:

```
assignable \nothing;
```

**erc20-balanceof-correct-value**

Invocations of `balanceOf(owner)` must return the value that is held in the contract's balance mapping for address `owner`.

Specification:

```
ensures \result == balanceOf(\old(account));
```

**erc20-balanceof-succeed-always**

Function `balanceOf` must always succeed if it does not run out of gas.

Specification:

```
reverts_only_when false;
```

#### Properties related to function `totalSupply`

##### erc20-totalsupply-change-state

The `totalSupply` function in contract FixedSupplyToken must not change any state variables.

Specification:

```
assignable \nothing;
```

##### erc20-totalsupply-correct-value

The `totalSupply` function must return the value that is held in the corresponding state variable of contract FixedSupplyToken.

Specification:

```
ensures \result == totalSupply();
```

##### erc20-totalsupply-succeed-always

The function `totalSupply` must always succeeds, assuming that its execution does not run out of gas.

Specification:

```
reverts_only_when false;
```

#### Properties related to function `approve`

##### erc20-approve-correct-amount

All non-reverting calls of the form `approve(spender, amount)` that return `true` must correctly update the allowance mapping according to the address `msg.sender` and the values of `spender` and `amount`.

Specification:

```
requires spender != address(0);  
ensures \result ==> allowance(msg.sender, \old(spender)) == \old(amount);
```

##### erc20-approve-false

If function `approve` returns `false` to signal a failure, it must undo all state changes that it incurred before returning to the caller.

Specification:

```
ensures !\result ==> \assigned (\nothing);
```

#### erc20-approve-never-return-false

The function `approve` must never returns `false`.

Specification:

```
ensures \result;
```

#### erc20-approve-revert-zero

All calls of the form `approve(spender, amount)` must fail if the address in `spender` is the zero address.

Specification:

```
ensures \old(spender) == address(0) ==> !\result;
```

#### erc20-approve-succeed-normal

All calls of the form `approve(spender, amount)` must succeed, if

- the address in `spender` is not the zero address and
- the execution does not run out of gas.

Specification:

```
requires spender != address(0);  
ensures \result;  
reverts_only_when false;
```

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# Elevating Your **Web3** Journey

Founded in 2017 by leading academics in the field of Computer Science from both Yale and Columbia University, CertiK is the largest blockchain security company that serves to verify the security and correctness of smart contracts and blockchain-based protocols. Through the utilization of our world-class technical expertise, alongside our proprietary, innovative tech, we're able to support the success of our clients with best-in-class security, all whilst realizing our overarching vision; provable trust for all throughout all facets of blockchain.

