Fortune Cookie
Smart Contract Audit
Initial Report

IMMUNE BYTES

Audits

June 03, 2021

This audit does not provide a security or correctness guarantee of the audited smart contract. Securing smart contracts is a multistep process, therefore running a bug bounty program as a complement to this audit is strongly recommended.

Introduction

1. About Fortune Cookie

Fortune Cookie is a simple lottery based token. It is made by the community, for the community. We believe everyone can and should have a chance to win at a lottery. For months, the BSC ecosystem has seen countless people getting rich overnight, creating powerful buyers and sellers in the market. We want to make sure that both the less affluent and newcomers are able to participate in an active community and stand a chance to win big.

How it works: 10% of every transaction of $COOKIE goes to a central pot, which increases in quantity, for 50 transactions. On the 50th transaction, we randomly pick a winner from $COOKIE holders to win the entire pot. To prevent flooding, this user must have 2% of the pot amount. If they don't, the lottery is skipped and the minimum amount required to win is reduced proportionally. Due to integer division, we are guaranteed that at some point, a winner will be picked and the lottery will restart.

Visit https://fortunecookie.cc/ to know more about.

2. About ImmuneBytes

ImmuneBytes is a security start-up to provide professional services in the blockchain space. The team has hands-on experience in conducting smart contract audits, penetration testing, and security consulting. ImmuneBytes's security auditors have worked on various A-league projects and have a great understanding of DeFi projects like AAVE, Compound, 0x Protocol, Uniswap, dydx.

The team has been able to secure 15+ blockchain projects by providing security services on different frameworks. ImmuneBytes team helps start-up with a detailed analysis of the system ensuring security and managing the overall project.

Visit http://immunebytes.com/ to know more about the services.

Documentation Details

The Fortune Cookie team has given a short description of the contract on telegram.

Audit Process & Methodology

ImmuneBytes team has performed thorough testing of the project starting with analyzing the code design patterns in which we reviewed the smart contract architecture to ensure it is structured and safe use of third-party smart contracts and libraries.

Our team then performed a formal line-by-line inspection of the Smart Contract in order to find any potential issues like Signature Replay Attacks, Unchecked External Calls, External Contract Referencing, Variable Shadowing, Race conditions, Transaction-ordering dependence, timestamp dependence, DoS attacks, and others.

In the Unit testing phase, we run unit tests written by the developer in order to verify the functions work as intended. In Automated Testing, we tested the Smart Contract with our in-house developed tools to identify vulnerabilities and security flaws.

The code was audited by a team of independent auditors which includes -

1. Testing the functionality of the Smart Contract to determine proper logic has been followed throughout.
2. Analyzing the complexity of the code by thorough, manual review of the code, line-by-line.
3. Deploying the code on testnet using multiple clients to run live tests.
4. Analyzing failure preparations to check how the Smart Contract performs in case of bugs and vulnerabilities.
5. Checking whether all the libraries used in the code are on the latest version.
6. Analyzing the security of the on-chain data.

Audit Details

- Project Name: Fortune Cookie
- Languages: Solidity(Smart contract)
- Github commit hash for audit/Contract Address:
  - https://bscscan.com/address/0xca94698f5a683939700ea611d6ada30cae632a9d#code
- Platforms and Tools: Remix IDE, Truffle, Truffle Team, Ganache, Solhint, VScode, Contract Library, Slither, SmartCheck

This audit does not provide a security or correctness guarantee of the audited smart contract. Securing smart contracts is a multistep process, therefore running a bug bounty program as a complement to this audit is strongly recommended.

Audit Goals

The focus of the audit was to verify that the smart contract system is secure, resilient, and working according to its specifications. The audit activities can be grouped into the following three categories:

1. Security: Identifying security-related issues within each contract and within the system of contracts.
2. Sound Architecture: Evaluation of the architecture of this system through the lens of established smart contract best practices and general software best practices.
3. Code Correctness and Quality: A full review of the contract source code. The primary areas of focus include:
   a. Correctness
   b. Readability
   c. Sections of code with high complexity
   d. Quantity and quality of test coverage

Security Level References

Every issue in this report was assigned a severity level from the following:

High severity issues will bring problems and should be fixed.

Medium severity issues could potentially bring problems and should eventually be fixed.

Low severity issues are minor details and warnings that can remain unfixed but would be better fixed at some point in the future.

Issues	High	Medium	Low
Open	3	3	4
Closed	-	-	-

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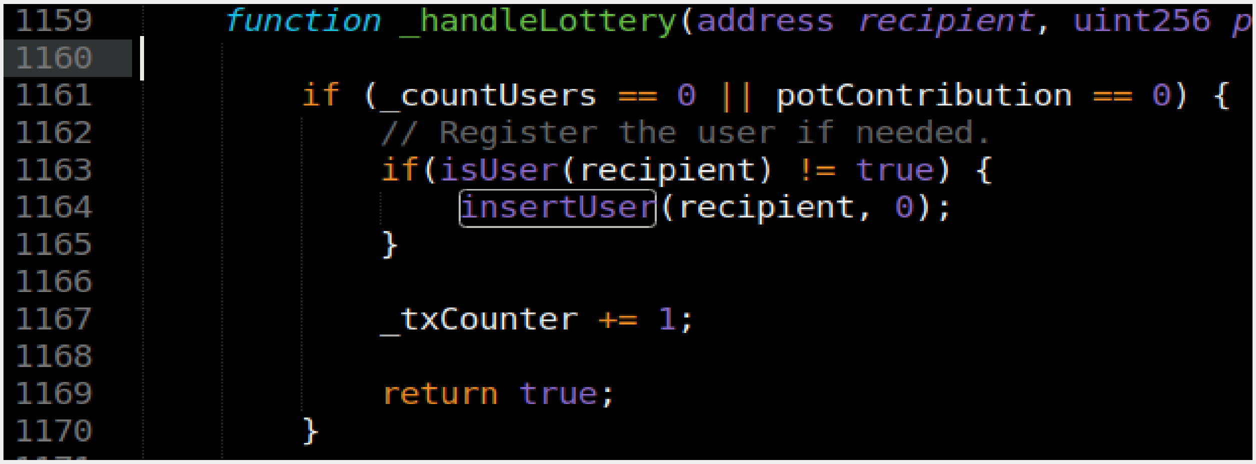
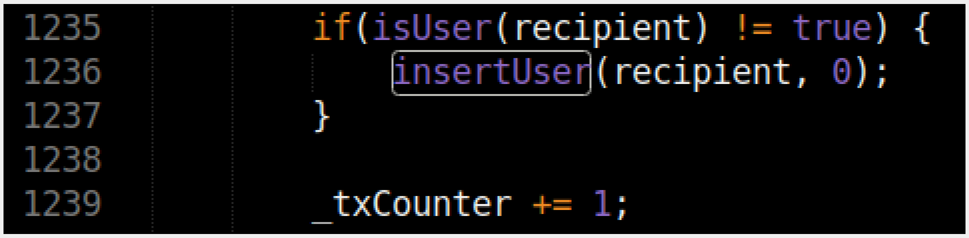
High severity issues

1. **_handleLottery function includes a similar operation twice in its function body**
   Line - 1159 - 1242
   Description:
   As per the current design of the **_handleLottery** function, it includes a call to the **insertUser** function to add the user details in the contract. It then increments the state variable **_txCounter** with 1.



```
1159        function _handleLottery(address recipient, uint256 p
1160
1161            if (_countUsers == 0 || potContribution == 0) {
1162                // Register the user if needed.
1163                if(isUser(recipient) != true) {
1164                    insertUser(recipient, 0);
1165                }
1166
1167                _txCounter += 1;
1168
1169                return true;
1170            }
```

However, an exact similar operation is being performed at the end of the function as well.(Line 1235-1239).



```
1235            if(isUser(recipient) != true) {
1236                insertUser(recipient, 0);
1237            }
1238
1239            _txCounter += 1;
```

While the call to **insertUser** function is being guarded by the if statements, the increment in the **_txCounter**(Line 1239) is not. This might lead to an undesirable situation where _txCounter state variable will be initialized twice.

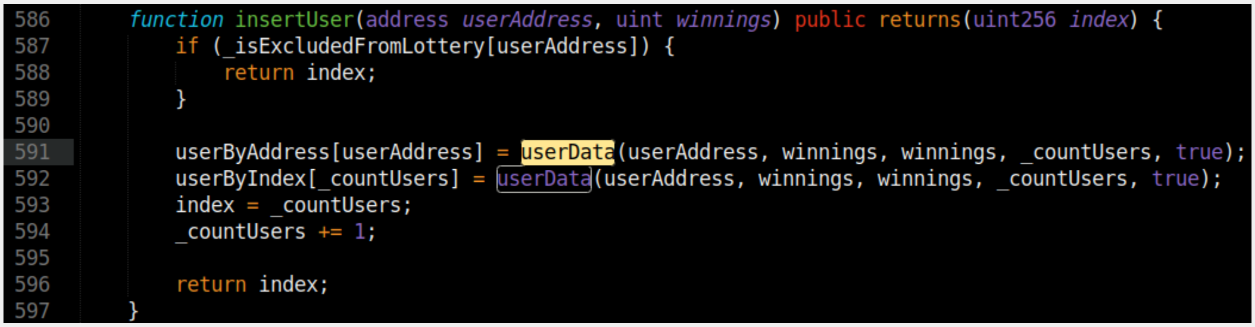
Recommendation:
If the above-mentioned scenario is not intended, the **_handleLottery** function must be redesigned to resolve the issue.

2. **insertUser function is made PUBLIC and Accessible to users**

   Line no - 586-597

   Description:

   The FortuneCookie V2 contract has a very crucial function, i.e., **insertUser** that initializes the **userData** struct and stores new users on the contract with the imperative details about the user like **address, winning counts, index etc**.



```
586     function insertUser(address userAddress, uint winnings) public returns(uint256 index) {
587         if (_isExcludedFromLottery[userAddress]) {
588             return index;
589         }
590 
591         userByAddress[userAddress] = userData(userAddress, winnings, winnings, _countUsers, true);
592         userByIndex[_countUsers] = userData(userAddress, winnings, winnings, _countUsers, true);
593         index = _countUsers;
594         _countUsers += 1;
595 
596         return index;
597     }
```

   However, the function has not been assigned any **onlyOwner** modifier and has been marked as **public**, which makes it accessible to all users. It will lead to an scenario where anyone can call this function with any arguments they want.

   Recommendation:

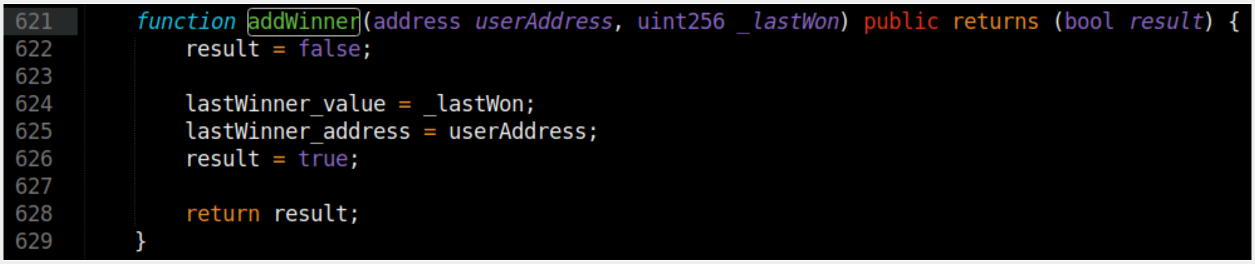
   If the above-mentioned scenario is not intended, it is recommended to make the **insertUser** function only accessible to the Owner of the contract.

3. **The function design of addWinner is inadequate**

   Line no - 621-629

   Description:

   In the FortuneCookie V2 contract, the **addWinner** function performs a crucial task of updating the last winner's value as well as the address.



```
621     function addWinner(address userAddress, uint256 _lastWon) public returns (bool result) {
622         result = false;
623 
624         lastWinner_value = _lastWon;
625         lastWinner_address = userAddress;
626         result = true;
627 
628         return result;
629     }
```

   However, despite the fact that these are imperative state variables of the contract, the **addWinner** function is not designed effectively.

   Mentioned below are the reason behind the poor design of **addWinner function**:

- The function has not been assigned an **onlyOwner** modifier which makes it accessible to every user.
- The function doesn't involve any **input validations** on the arguments passed to it.
- It involves a redundant variable update at Line 622 as every boolean variable is, by default, **false**.

Moreover, the **addWinner** function is being called once inside the **_handleLottery** function. Therefore, if the **addWinner** function is only supposed to be called from within the contract, the visibility keyword should be changed from **PUBLIC** to **INTERNAL**.

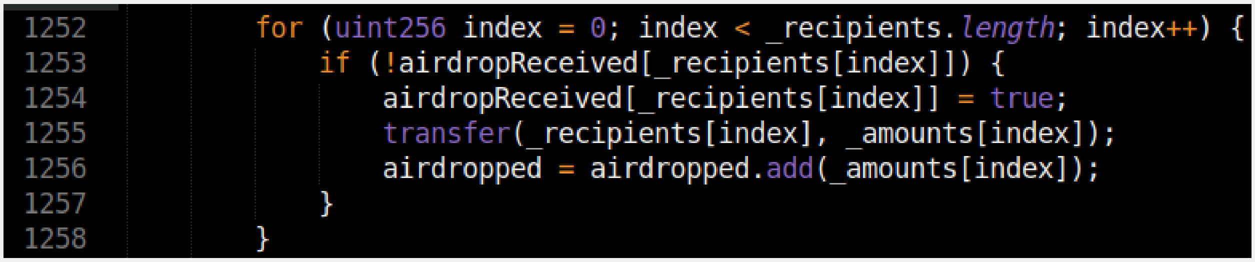
Recommendation:
The current function design of **addWinner** is not very effective. It is recommended to go through the above-mentioned issues and update the function accordingly, unless intended.

Medium severity issues

1. **Loops are extremely costly**
Line no -716, 797, 1251
Description:
The **FortuneCookie V2** contract has some **for loops** in the contract that include state variables like .length of a non-memory array, in the condition of the for loops.

As a result, these state variables consume a lot more extra gas for every iteration of the for loop.
The following function includes such loops at the above-mentioned lines:

- **includeInReward**
- **_getCurrentSupply**
- **airDrop**



```
        for (uint256 index = 0; index < _recipients.length; index++) {
            if (!airdropReceived[_recipients[index]]) {
                airdropReceived[_recipients[index]] = true;
                transfer(_recipients[index], _amounts[index]);
                airdropped = airdropped.add(_amounts[index]);
            }
        }
```

Recommendation:
It's quite effective to use a local variable instead of a state variable like .length in a loop. This will be a significant step in optimizing gas usage.
For instance,
local_variable = _recipients.length

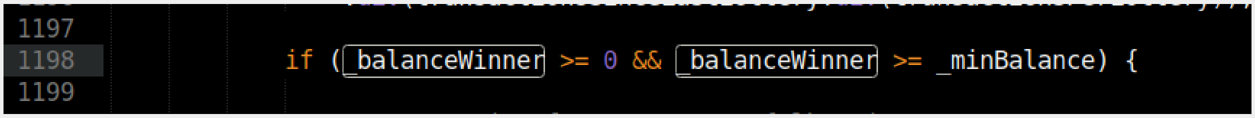
```
for (uint256 index = 0; index < local_variable; index++) {
        if (!airdropReceived[_recipients[index]]) {
            airdropReceived[_recipients[index]] = true;
            transfer(_recipients[index], _amounts[index]);
            airdropped = airdropped.add(_amounts[index]);
        }
    }
```

2. **No Input Validations performed on insertUser function**
   Line no - 586
   Description:
   The insertUser function initializes the **userData** struct with crucial information like address, index as well as win counts.

   However, no input validation is performed on any of the arguments passed to this function. This will lead to a situation where **zero addresses** can be passed as user's address as well as any uint value can be passed for the **totalWon** or **lastWon** elements of the userStruct of the user being added in the contract.

   Recommendation:
   Including input validation checks ensures that no invalid arguments are passed while calling the function.

3. **The _handleLottery function includes redundant IF Statement condition**
   Line no - 1198
   Description:
   The following IF statement in the **handleLottery function** includes a redundant conditional check with the **_balanceWinner** local variable.



```
1197
1198                if (_balanceWinner >= 0 && _balanceWinner >= _minBalance) {
1199
```

   It ensures that the **balanceWinner** variable must be greater than zero **and** greater the minBalance.
   However, the "**_balanceWinner >= 0**" validation is not necessary as it will automatically be ensured if the **balanceWinner is greater than the _minBalance** local variable.

   Recommendation:
   If the above mentioned scenario is not intended, it is recommended to modify the IF statements accordingly.

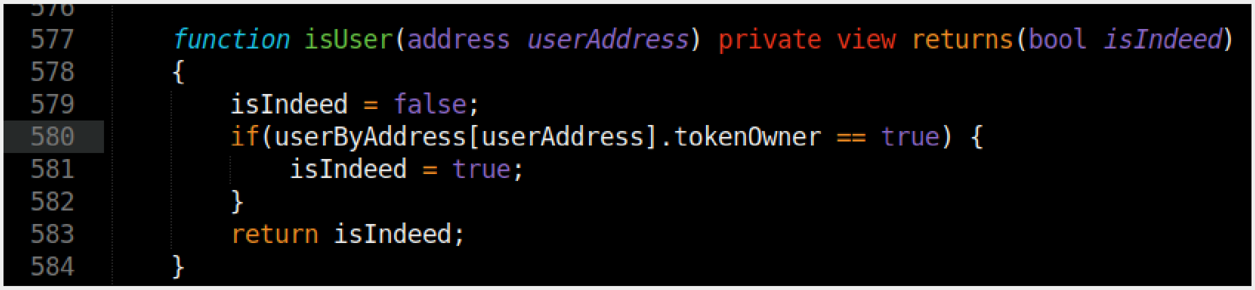
Low severity issues

1. **Comparison to boolean Constant**

   Line no: 580

   Description:

   Boolean constants can directly be used in conditional statements or require statements. Therefore, it's not considered a better practice to explicitly use **TRUE or FALSE** in the **require** statements.



```
576
577     function isUser(address userAddress) private view returns(bool isIndeed)
578     {
579         isIndeed = false;
580         if(userByAddress[userAddress].tokenOwner == true) {
581             isIndeed = true;
582         }
583         return isIndeed;
584     }
```

   Recommendation:

   The equality to boolean constants must be removed from the above-mentioned line.

2. **Absence of Zero Address Validation**

   Description:

   The **FortuneCookie V2** contract includes quite a few functions that update some of the imperative addresses in the contract like lastWinner_address,uniswapV2Pair etc. However, during the automated testing of the contact it was found that no Zero Address Validation is implemented on the following functions while updating the address state variables of the contract:

   - **addWinner**
   - **setUniswapPair**

   Recommendation:

   A **require** statement should be included in such functions to ensure no zero address is passed in the arguments.

3. **External Visibility should be preferred**

   Description:

   Those functions that are never called throughout the contract should be marked as **external** visibility instead of **public** visibility.

   This will effectively result in Gas Optimization as well.

Therefore, the following function must be marked as **external** within the contract:

- **insertUser**
- **getTotalWon**
- **getLastWon**
- **getCirculatingSupply**
- **addWinner**
- **getLastWinner**
- **isExcludedFromReward**
- **totalFees**
- **deliver**
- **reflectionFromToken**
- **excludeFromReward**
- **excludeFromFee**
- **includeInFee**
- **setSwapAndLiquifyEnabled**
- **isExcludedFromFee**

Recommendation:

If the PUBLIC visibility of the above-mentioned functions is not intended, then the EXTERNAL Visibility keyword should be preferred.

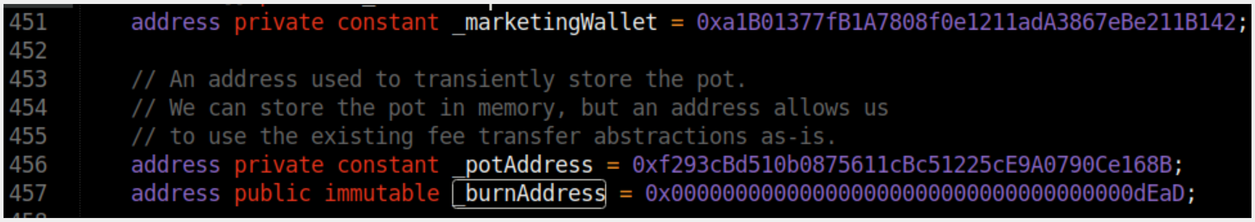
4. **Contract includes Hardcoded Addresses**

Line no - 451-457

Description:

Keeping in mind the immutable nature of smart contracts, it is not considered a better practise to hardcode any address in the contract before deployment.

However, the contract does include some hardcoded addresses in the above-mentioned lines.



```
451     address private constant _marketingWallet = 0xa1B01377fB1A7808f0e1211adA3867eBe211B142;
452
453     // An address used to transiently store the pot.
454     // We can store the pot in memory, but an address allows us
455     // to use the existing fee transfer abstractions as-is.
456     address private constant _potAddress = 0xf293cBd510b0875611cBc51225cE9A0790Ce168B;
457     address public immutable _burnAddress = 0x000000000000000000000000000000000000dEaD;
```

Recommendation:

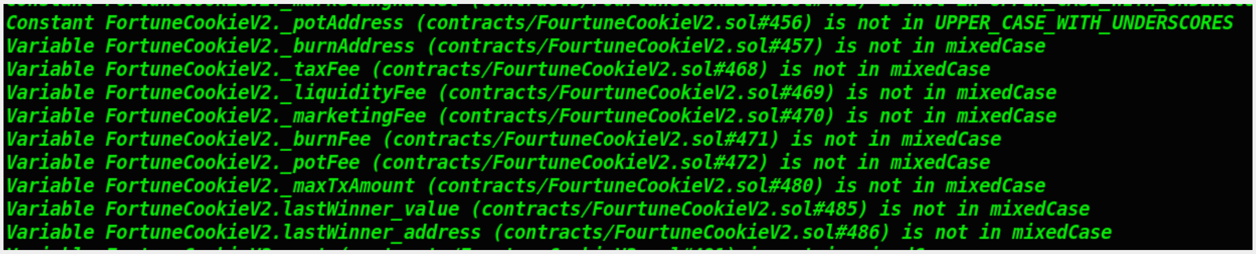
By including hardcoded addresses in the contract, it would be an effective approach to initialize those addresses within the constructors at the time of deployment.

Recommendations

1. **Coding Style Issues in the Contract**

   Description:

   Code readability of a Smart Contract is largely influenced by the Coding Style issues and in some specific scenarios may lead to bugs in the future.



```
Constant FortuneCookieV2._potAddress (contracts/FourtuneCookieV2.sol#456) is not in UPPER_CASE_WITH_UNDERSCORES
Variable FortuneCookieV2._burnAddress (contracts/FourtuneCookieV2.sol#457) is not in mixedCase
Variable FortuneCookieV2._taxFee (contracts/FourtuneCookieV2.sol#468) is not in mixedCase
Variable FortuneCookieV2._liquidityFee (contracts/FourtuneCookieV2.sol#469) is not in mixedCase
Variable FortuneCookieV2._marketingFee (contracts/FourtuneCookieV2.sol#470) is not in mixedCase
Variable FortuneCookieV2._burnFee (contracts/FourtuneCookieV2.sol#471) is not in mixedCase
Variable FortuneCookieV2._potFee (contracts/FourtuneCookieV2.sol#472) is not in mixedCase
Variable FortuneCookieV2._maxTxAmount (contracts/FourtuneCookieV2.sol#480) is not in mixedCase
Variable FortuneCookieV2.lastWinner_value (contracts/FourtuneCookieV2.sol#485) is not in mixedCase
Variable FortuneCookieV2.lastWinner_address (contracts/FourtuneCookieV2.sol#486) is not in mixedCase
```

   During the automated testing, it was found that the FortuneCookieV2 contract had quite a few code style issues.

   Recommendation:

   Therefore, it is highly recommended to fix the issues like naming convention, indentation, and code layout issues in a smart contract.

2. **NatSpec Annotations must be included**

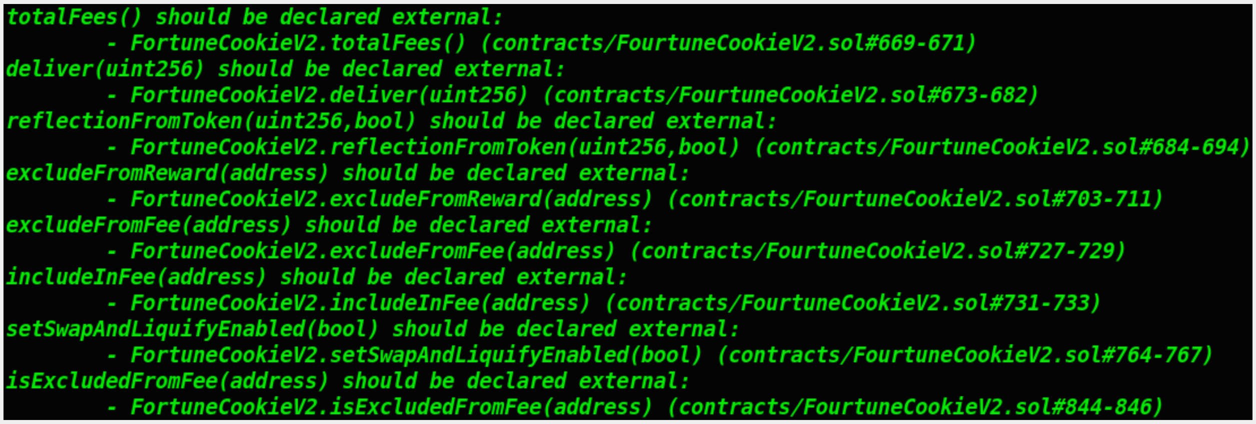
   Description:

   The smart contracts do not include the NatSpec annotations adequately.

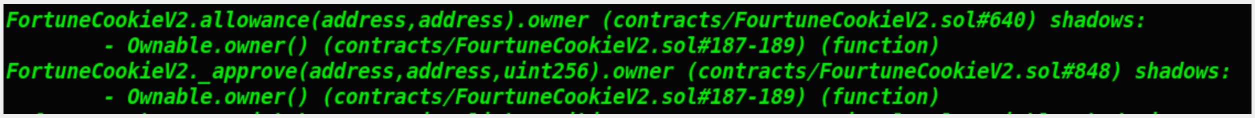
   Recommendation:

   Cover by NatSpec all Contract methods.

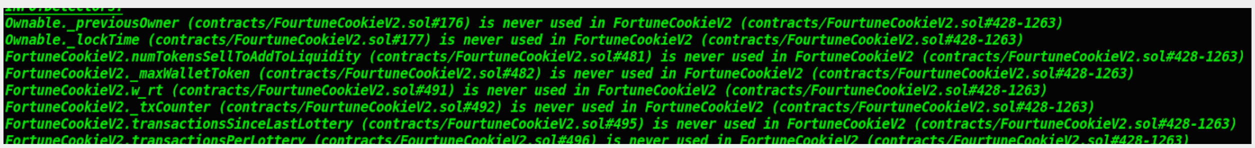
Automated Test Results



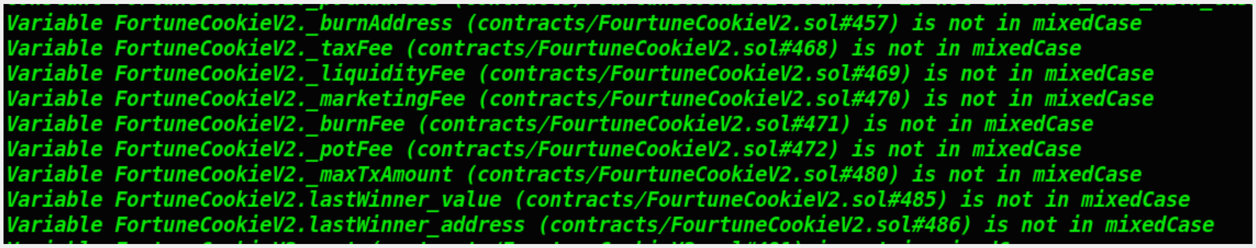
```
totalFees() should be declared external:
        - FortuneCookieV2.totalFees() (contracts/FourtuneCookieV2.sol#669-671)
deliver(uint256) should be declared external:
        - FortuneCookieV2.deliver(uint256) (contracts/FourtuneCookieV2.sol#673-682)
reflectionFromToken(uint256,bool) should be declared external:
        - FortuneCookieV2.reflectionFromToken(uint256,bool) (contracts/FourtuneCookieV2.sol#684-694)
excludeFromReward(address) should be declared external:
        - FortuneCookieV2.excludeFromReward(address) (contracts/FourtuneCookieV2.sol#703-711)
excludeFromFee(address) should be declared external:
        - FortuneCookieV2.excludeFromFee(address) (contracts/FourtuneCookieV2.sol#727-729)
includeInFee(address) should be declared external:
        - FortuneCookieV2.includeInFee(address) (contracts/FourtuneCookieV2.sol#731-733)
setSwapAndLiquifyEnabled(bool) should be declared external:
        - FortuneCookieV2.setSwapAndLiquifyEnabled(bool) (contracts/FourtuneCookieV2.sol#764-767)
isExcludedFromFee(address) should be declared external:
        - FortuneCookieV2.isExcludedFromFee(address) (contracts/FourtuneCookieV2.sol#844-846)
```



```
FortuneCookieV2.allowance(address,address).owner (contracts/FourtuneCookieV2.sol#640) shadows:
        - Ownable.owner() (contracts/FourtuneCookieV2.sol#187-189) (function)
FortuneCookieV2._approve(address,address,uint256).owner (contracts/FourtuneCookieV2.sol#848) shadows:
        - Ownable.owner() (contracts/FourtuneCookieV2.sol#187-189) (function)
```



```
INFO:Detectors:
Ownable._previousOwner (contracts/FourtuneCookieV2.sol#176) is never used in FortuneCookieV2 (contracts/FourtuneCookieV2.sol#428-1263)
Ownable._lockTime (contracts/FourtuneCookieV2.sol#177) is never used in FortuneCookieV2 (contracts/FourtuneCookieV2.sol#428-1263)
FortuneCookieV2.numTokensSellToAddToLiquidity (contracts/FourtuneCookieV2.sol#481) is never used in FortuneCookieV2 (contracts/FourtuneCookieV2.sol#428-1263)
FortuneCookieV2._maxWalletToken (contracts/FourtuneCookieV2.sol#482) is never used in FortuneCookieV2 (contracts/FourtuneCookieV2.sol#428-1263)
FortuneCookieV2.w_rt (contracts/FourtuneCookieV2.sol#491) is never used in FortuneCookieV2 (contracts/FourtuneCookieV2.sol#428-1263)
FortuneCookieV2._txCounter (contracts/FourtuneCookieV2.sol#492) is never used in FortuneCookieV2 (contracts/FourtuneCookieV2.sol#428-1263)
FortuneCookieV2.transactionsSinceLastLottery (contracts/FourtuneCookieV2.sol#495) is never used in FortuneCookieV2 (contracts/FourtuneCookieV2.sol#428-1263)
FortuneCookieV2.transactionsPerLottery (contracts/FourtuneCookieV2.sol#496) is never used in FortuneCookieV2 (contracts/FourtuneCookieV2.sol#428-1263)
```



```
Variable FortuneCookieV2._burnAddress (contracts/FourtuneCookieV2.sol#457) is not in mixedCase
Variable FortuneCookieV2._taxFee (contracts/FourtuneCookieV2.sol#468) is not in mixedCase
Variable FortuneCookieV2._liquidityFee (contracts/FourtuneCookieV2.sol#469) is not in mixedCase
Variable FortuneCookieV2._marketingFee (contracts/FourtuneCookieV2.sol#470) is not in mixedCase
Variable FortuneCookieV2._burnFee (contracts/FourtuneCookieV2.sol#471) is not in mixedCase
Variable FortuneCookieV2._potFee (contracts/FourtuneCookieV2.sol#472) is not in mixedCase
Variable FortuneCookieV2._maxTxAmount (contracts/FourtuneCookieV2.sol#480) is not in mixedCase
Variable FortuneCookieV2.lastWinner_value (contracts/FourtuneCookieV2.sol#485) is not in mixedCase
Variable FortuneCookieV2.lastWinner_address (contracts/FourtuneCookieV2.sol#486) is not in mixedCase
```

Concluding Remarks

While conducting the audits of the Fortune Cookie smart contract, it was observed that the contracts contain High, Medium, and Low severity issues, along with several areas of recommendations.

Our auditors suggest that High, Medium, Low severity issues should be resolved by Fortune Cookie developers. Resolving the areas of recommendations are up to the team's discretion. The recommendations given will improve the operations of the smart contract.

Disclaimer

ImmuneBytes's audit does not provide a security or correctness guarantee of the audited smart contract. Securing smart contracts is a multistep process, therefore running a bug bounty program as a complement to this audit is strongly recommended.

Our team does not endorse the Fortune Cookie platform or its product nor this audit is investment advice.
Notes:

- Please make sure contracts deployed on the mainnet are the ones audited.
- Check for the code refactor by the team on critical issues.

ImmuneBytes Pvt Ltd.