Available online at http://www.iorajournal.org/index.php/ijgor/index

International Journal of Global Operations Research

e-ISSN: 2722-1016
p-ISSN: 2723-1739

Vol. 5, No. 2, pp. 102-109, 2024

Markov Chain Analysis of Problematic Financing in Sharia Banks

Rini Cahyandari[1*], Weni Rahmawati[2], Aep Saepuloh[3]

[1,2,3]*Jurusan Matematika, Fakultas Sains dan Teknologi, UIN Sunan Gunung Djati Bandung*

**Corresponding author email: rini_cahyandari@uinsgd.ac.id*

Abstract

Indonesia is the country with the largest Muslim population in the world, which makes people start to switch to sharia banking services because they do not use the usury system. This can be seen from the role of the community in using sharia banking services, including in distributing funds. From financing activities, the more funds distributed, the greater the potential for risk to arise. If there are customers who do not comply with installment payments, this will create a problem in financing in sharia banking, which is called problematic financing. The classification and criteria for problematic financing are divided into three, namely substandard, doubtful and nonperforming. To overcome this risk, preventive measures are taken, one of which is by knowing the possibility of financing problems in the future, which can be calculated using Markov chain analysis. This research uses secondary data on substandard, doubtful and non-performing problematic financing in the period 2016 to 2021 at several sharia banks in Indonesia. The opportunity value is searched until it meets the balance condition (steady state). Based on the research results, it was found that Sharia Commercial Banks (BUS) will experience a state of balance at step 5, Sharia Business Units (UUS) will experience a state of balance at step 11, Sharia Rural Banks (BPRS) will experience a state of balance at step 6.

Keywords: Markov chains, problem financing, steady state opportunities, sharia banking.

1. Introduction

Based on a report by The Royal Islamic Strategic Studies Center (RISSC), Indonesia is a country with the largest Muslim population in the world, which means that the development of Islamic banks in Indonesia has great opportunities (Ayu Rizati, 2022). This development can be seen through the spread of Islamic banking which is increasingly rampant throughout Indonesia. One type of financial institution that offers various services related to financial transactions is sharia banking, which operates with an operational system that is very different from conventional banks and is based on sharia law. If viewed from various angles, currently there are various types of Islamic banks. However, Islamic banks can be divided into three categories from a functional point of view, namely Sharia Commercial Banks (BUS), Sharia Business Units (UUS), and Sharia People's Financing Banks (BPRS) (Lubis and Soemitra 2022).

The development of sharia banking in Indonesia has great opportunities with the increasing spread of sharia banking in various regions of Indonesia which makes the Indonesian Muslim population gradually realize that sharia banking is considered important because it does not use the riba (interest) system (Rahmawati et al., 2022). This is adapted to the explanation in the word of Allah SWT in Q.S Al-Baqarah verse 275 that Allah SWT permits the process of buying and selling and prohibits usury (Abdillah, 2023).

From financing activities in sharia banking, it is known that with the large number of funds that have been disbursed, there will be greater potential risks. In financing activities, sometimes there are customers who do not comply with installment payments, this has the potential to be detrimental to the bank. The existence of customers who do not comply with installment payments will become a problem in financing in sharia banking (Supriyatni and Nurjamil 2021; Nugraha and Setiawan 2018). This is called problematic financing. According to Kasmir, the classification and criteria for problematic financing can be divided into three, namely substandard, doubtful and nonperforming.

To overcome this risk, preventive measures are taken, one of which is by knowing the possibility of financing problems in the future, which can be done by carrying out calculations using Markov chain analysis. Markov chains are a method that can study the properties of a variable that occurs in the present in an attempt to estimate the properties of other variables in the future (Zahra et al., 2018; Wahyudi and Sakti 2018). In general, Markov chains can

be classified into two, namely discrete time Markov chains and continuous time Markov chains. A Markov chain is said to be discrete if state transfer occurs at fixed discrete time intervals (Hermanns and Hermanns 2002). Future information cannot be known with certainty, but can be estimated or predicted. There are various methods that can be utilized or used to identify problematic financing in the future, one of which is the Markov chain method.

In this research, a method will be carried out using Markov chains, but there is a development in this research, namely data on problematic financing in Islamic banks which is categorized into three states, Markovian properties are tested and the opportunity for problematic financing in the long term is calculated using steady state. Therefore, this research aims to predict financing problems that could occur in Islamic banks in Indonesia in the future using Markov chain analysis which can be useful for banks so that banks can anticipate problems in the future.

2. Methodology

In this research, a study was conducted on discrete time Markov chains using steady state as a condition for obtaining long-term opportunities regarding problem financing in several banks in Indonesia using Markov chains.

2.1. Discrete Time Markov Chains

A stochastic process $\{X_n, n = 0,1,2, \dots\}$is called a discrete time Markov chain process if

$$P\{X_{n+1} = j | X_0 = i_0, X_1 = i_1, \dots, , X_{n-1} = i_{n-1}, X_n = i\} = P\{X_{n+1} = j | X_n = i\} \quad (1)$$

For every time $n = 0,1,2, \dots$and every state $i_0, i_1, \dots, i_{n-1}, i, j$

Matrix opportunity transition the arranged to in form matrix transition circumstances P(in size $m \times m$) namely:

$$P = P_{ij} = \begin{matrix} state \\ 0 \\ 1 \\ 2 \\ \vdots \\ m \end{matrix} \begin{matrix} \begin{matrix} 0 & 1 & 2 & \dots & m \end{matrix} \\ \begin{bmatrix} P_{00} & P_{01} & P_{02} & \cdots & P_{0m} \\ P_{10} & P_{11} & P_{12} & \dots & P_{1m} \\ P_{20} & P_{21} & P_{22} & \cdots & P_{2m} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ P_{m0} & P_{m1} & P_{m2} & \cdots & P_{mm} \end{bmatrix} \end{matrix} \quad (2)$$

System in state i is time n, so system will carry out the process to something state j at time $n + 1$. $P = P_{ij}$is the transition probability matrix of a process. The value P_{ij}must satisfy the conditions: $P_{ij} \geq 0; i, j = 0,1,2, \dots, m$and $\sum_{j=0}^{m} P_{ij} = 1; i, j = 0,1,2, \dots, m$.

2.2. Opportunity n-Step Transition

From theory matrix recognized that relation equality Chapman-Kolmogorov is a formula for multiplication matrix , so $P_{ij}^{(n)}$indicates that the transition probability matrix is n - step is :

$$P^{(n)} = P.P^{(n-1)} \quad (3)$$

2.3. Classification State

Transition probabilities associated with states play an important role in the study of Markov chains (Susanty et al., 2022). Following a number of characteristic state:

a) Accessible

A stochastic process $\{X(n), n = 1,2, \dots\}$, the situation j is said to be accessible (able achieved) from circumstances i notated with $i \rightarrow j$, if there is $n \geq 0$such that $P_{ij}^{n} > 0$, and the state $i$can be achieved by itself, is denoted by $i \rightarrow i$so$P_{ii}^{n} = 1$.

b) Recurrent and Transient

(i) Circumstances $i$is said to be recurring if and only If $\sum_{n=1}^{\infty} P_{ii}^{n} = \infty$

(ii) Circumstances $i$is said to be transient if and only If $\sum_{n=1}^{\infty} P_{ii}^{n} < \infty$

c) Absorbing stat

A state is said to be absorbing if $P_{ii} = 1$. According to Hillier and Lieberman, a state is said to be absorbing if after entering the state i, the process will never leave the state i this again. This means that there is no state that can be reached from that state.

d) Periodicity

Circumstances i It is said to be periodic if $d(i)$ it is the greatest common factor (FBP) or greatest common divisor (gcd) from $n = 1,2, ...$

$$d(i) = FPB\{n \geq 1 | P_{ii}^{n} > 0\} \tag{4}$$

If $d(i) = 1$, then the state $i$is called aperiodic, and if $d(i) > 1$, then the state $i$is called periodic.

2.4. Opportunity Steady State

Opportunity steady state (state fixed) $\pi = [\pi_0, \pi_1, \dots, \pi_n]$can be obtained by solving the stationary matrix equation. Steady state probability can interpreted that opportunities in every state No will changed along with walking time. Opportunity value will stable in period long written $\lim_{n\to\infty} P_{ij}^{n} = \pi_j$Where$i, j = 0,1,2, ...$ who does not depends on initial state, where $\{ \pi_j\}$ is distribution stationary from chain Markov solution unique And positive than $\pi_j = \sum_{i=0}^{\infty} \pi_i P_{ij}, j = 0,1,2$ ...with $\sum_{j=0}^{\infty} \pi_j = 1$.steady state probability can calculated with finish equality following:

$$[\pi_0\ \pi_1\ \pi_2] = [\pi_0\ \pi_1\ \pi_2] \begin{pmatrix} P_{00} & P_{01} & P_{02} \\ P_{10} & P_{11} & P_{12} \\ P_{20} & P_{21} & P_{22} \end{pmatrix} \tag{5}$$

2.5. Wide Sense Test

The WS (Wide Sense) test was used for test does the data meet? Markov properties or no. WS Test will inspect freedom of two variables, in study This means variable financing problematic year $t + 1$which is defined by state *j* to variable financing problematic year t which is defined state *i*.

Statistics:

$$WS = \frac{A + B - 1}{\sqrt{V(A + B - 1)}} \sim N(0,1) \tag{6}$$

3. Results and Discussion

The criteria for problematic financing at several sharia banks in Indonesia are differentiated based on 3 criteria, namely substandard financing, doubtful financing and bad financing. Criteria financing problematic can seen in Table 1, Table 2 and Table 3 below:

Table 1: Displacement Patterns Criteria Financing Problems at Sharia Commercial Banks (BUS)

From Criterion	Criteria Financing Problematic	Go to Criteria			Amount
		Not that smooth	Doubtful	Congested	
	Not that smooth	64,241	55,691	51,956	171,888
	Doubtful	30,005	26,816	26,973	8,3794
	Congested	113,790	105,378	111,324	33,0492

Table 2: Displacement Patterns Criteria Financing Problems in the Sharia Business Unit (UUS)

From Criterion	Criteria Financing Problematic	Go to Criteria			Amount
		Not that smooth	Doubtful	Congested	
	Not that smooth	12,377	12,130	22,364	46,871
	Doubtful	5,652	14,284	10,379	30,315
	Congested	36,857	43,662	71,820	152,339

Table 3: Pattern of Transfer of Problem Financing Criteria at Sharia Rural Financing Banks (BPRS)

From Criterion	Problem Financing Criteria	Go to Criteria			Amount
		Not that smooth	Doubtful	Congested	
	Not that smooth	4694036	5374655	4745478	14,814,169
	Doubtful	2904361	3473263	3386183	9,763,807
	Congested	8832812	12485001	13446940	34,764,753

After done categorization and grouping of data, next done calculation matrix opportunity transition. For example P is a transition probability matrix with 3 quality states financing problems in several sharia banks which stated opportunity displacement quality financing problems in several sharia banks in Indonesia, then based on Table 1, Table 2 and Table 3 you can written down For matrix opportunity transition as following:

1) Matrix opportunity P at Sharia Commercial Banks (BUS), namely

$$P = \begin{matrix} \\ 0 \\ 1 \\ 2 \end{matrix} \begin{matrix} \begin{matrix} 0 & 1 & 2 \end{matrix} \\ \begin{bmatrix} 0.373738 & 0.323996 & 0.302266 \\ 0.358081 & 0.320023 & 0.321896 \\ 0.344305 & 0.318852 & 0.336843 \end{bmatrix} \end{matrix}$$

2) Matrix opportunity P in the Sharia Business Unit (UUS), namely

$$P = \begin{matrix} \\ 0 \\ 1 \\ 2 \end{matrix} \begin{matrix} \begin{matrix} 0 & 1 & 2 \end{matrix} \\ \begin{bmatrix} 0.264065 & 0.258795 & 0.477140 \\ 0.186442 & 0.471186 & 0.342372 \\ 0.241941 & 0.286611 & 0.471448 \end{bmatrix} \end{matrix}$$

3) Matrix opportunity P at the Sharia People's Financing Bank (BPRS), namely

$$P = \begin{matrix} \\ 0 \\ 1 \\ 2 \end{matrix} \begin{matrix} \begin{matrix} 0 & 1 & 2 \end{matrix} \\ \begin{bmatrix} 0.316861 & 0.362805 & 0.320334 \\ 0.297462 & 0.355728 & 0.346810 \\ 0.254074 & 0.359128 & 0.386798 \end{bmatrix} \end{matrix}$$

Information:

0 : Smooth financial payment
1 : Financing Doubtful
2 : Bad Financing

3.1. Wide Sense Test

After determine matrix opportunity transition, step furthermore is testing Markov properties. Testing This using the wide sense test where testing done with objective does the data have Markov properties or No. For do testing This use equation (5), so obtained estimation mark wide sense in the table following:

Table 4: Estimated WS Value

Bank Type	Wide sense value
Sharia Commercial Bank (BUS)	18.86
Sharia Business Unit (UUS)	-509.09
Financing Bank (BPRS)	18178.56

Because the WS test results in table 4 show that the value $|WS| > Z_{\propto/2} = 1{,}96$, then it can be concluded that the data fulfills Markov properties. This can be interpreted as that the data on problematic financing that occur consecutively are not independent of each other, meaning that problematic financing on a day $t + 1$ depends on the occurrence of problematic financing on that day t, with a probability of error of 5%.

3.2. Opportunity n-Step Transition

With use Chapman-Kolmogorov equation viz $P^{(n)} = P^n$where $P^n$is obtained by raising the n matrix to the power opportunity transition One step P. On research This opportunity transition done as many as 3 steps.

Sharia Commercial Bank (BUS)

$$P = P^1 = \begin{matrix} \\ 0 \\ 1 \\ 2 \end{matrix} \begin{matrix} \begin{matrix} 0 & 1 & 2 \end{matrix} \\ \begin{bmatrix} 0.373738 & 0.323996 & 0.302266 \\ 0.358081 & 0.320023 & 0.321896 \\ 0.344305 & 0.318852 & 0.336843 \end{bmatrix} \end{matrix}$$

$$P^2 = P \times P = \begin{matrix} \\ 0 \\ 1 \\ 2 \end{matrix} \begin{matrix} \begin{matrix} 0 & 1 & 2 \end{matrix} \\ \begin{bmatrix} 0.3597686 & 0.3211539 & 0.31907 \\ 0.3592530 & 0.3210687 & 0.31967 \\ 0.3588314 & 0.3209965 & 0.32017 \end{bmatrix} \end{matrix}$$

$$P^3 = P^2 \times P = \begin{matrix} \\ 0 \\ 1 \\ 2 \end{matrix} \begin{matrix} \begin{matrix} 0 & 1 & 2 \end{matrix} \\ \begin{bmatrix} 0.3593040 & 0.3210763 & 0.31961 \\ 0.3593035 & 0.3210762 & 0.31962 \\ 0.3593031 & 0.3210762 & 0.31962 \end{bmatrix} \end{matrix}$$

Sharia Business Unit (UUS)

$$P = P^1 = \begin{matrix} \\ 0 \\ 1 \\ 2 \end{matrix} \begin{matrix} \begin{matrix} 0 & 1 & 2 \end{matrix} \\ \begin{bmatrix} 0.264065 & 0.258795 & 0.4771 \\ 0.186442 & 0.471186 & 0.3423 \\ 0.241941 & 0.286611 & 0.4714 \end{bmatrix} \end{matrix}$$

$$P^2 = P \times P = \begin{matrix} \\ 0 \\ 1 \\ 2 \end{matrix} \begin{matrix} \begin{matrix} 0 & 1 & 2 \end{matrix} \\ \begin{bmatrix} 0.2334203 & 0.3270329 & 0.43 \\ 0.2199155 & 0.3683941 & 0.41 \\ 0.2313871 & 0.3327824 & 0.43 \end{bmatrix} \end{matrix}$$

$$P^3 = P^2 \times P = \begin{matrix} \\ 0 \\ 1 \\ 2 \end{matrix} \begin{matrix} \begin{matrix} 0 & 1 & 2 \end{matrix} \\ \begin{bmatrix} 0.2281101 & 0.3430865 & 0.428 \\ 0.2276082 & 0.3446371 & 0.427 \\ 0.2280400 & 0.3433030 & 0.428 \end{bmatrix} \end{matrix}$$

Financing Bank (BPRS)

$$P = P^1 = \begin{matrix} \\ 0 \\ 1 \\ 2 \end{matrix} \begin{matrix} \begin{matrix} 0 & 1 \end{matrix} \\ \begin{bmatrix} 0.316861 & 0.362805 \\ 0.297462 & 0.355728 \\ 0.254074 & 0.359128 \end{bmatrix} \end{matrix}$$

$$P^2 = P \times P = \begin{matrix} \\ 0 \\ 1 \\ 2 \end{matrix} \begin{matrix} \begin{matrix} 0 & 1 & 2 \end{matrix} \\ \begin{bmatrix} 0.2897101 & 0.3590596 & 0.3512 \\ 0.2881851 & 0.3590123 & 0.3528 \\ 0.2856084 & 0.3588412 & 0.3555 \end{bmatrix} \end{matrix}$$

$$P^3 = P^2 \times P = \begin{matrix} \\ 0 \\ 1 \\ 2 \end{matrix} \begin{matrix} \begin{matrix} 0 & 1 & 2 \end{matrix} \\ \begin{bmatrix} 0.2877219 & 0.3589659 & 0.3533 \\ 0.2877155 & 0.3589656 & 0.3533 \\ 0.2877045 & 0.3589650 & 0.3533 \end{bmatrix} \end{matrix}$$

3.3. Classification State

3.3.1. Recurrent or Transient States

Classification transient state or recurring at Sharia Commercial Banks (BUS) see in Table 5.

Table 5: Classification transient state or recurring at Sharia Commercial Banks (BUS)

State	Sharia Commercial Bank (BUS)
0 (Not fluent)	$\sum_{n=1}^{\infty} P_{00}^n = P_{00}^1 + P_{00}^2 + P_{00}^3 + \cdots = 0.373738 + 0.3597686 + 0.3593040 = \infty$
1 (Doubtful)	$\sum_{n=1}^{\infty} P_{11}^n = P_{11}^1 + P_{11}^2 + P_{11}^3 + \cdots = 0.320023 + 0.3210687 + 0.3210762 = \infty$
2 (Traffic)	$\sum_{n=1}^{\infty} P_{22}^n = P_{22}^1 + P_{22}^2 + P_{22}^3 + \cdots = 0.336843 + 0.3201721 + 0.3196208 = \infty$

Based on the table above, it can be said that problem financing in Sharia Commercial Banks (BUS) states 0, 1, and 2 are recurrent states because after entering state *i*, the process will definitely return to state *i* again and $\sum_{n=1}^{\infty} p_{ii}^n = \infty$.

Table 6: Classification transient state or recurring in the Sharia Business Unit (UUS)

State	Sharia Business Unit (UUS)
0 (Not fluent)	$\sum_{n=1}^{\infty} P_{00}^n = P_{00}^1 + P_{00}^2 + P_{00}^3 + \cdots = 0.264065 + 0.2334203 + 0.2281101 = \infty$
1 (Doubtful)	$\sum_{n=1}^{\infty} P_{11}^n = P_{11}^1 + P_{11}^2 + P_{11}^3 + \cdots = 0.471186 + 0.3683941 + 0.3446371 = \infty$
2 (Traffic)	$\sum_{n=1}^{\infty} P_{22}^n = P_{22}^1 + P_{22}^2 + P_{22}^3 + \cdots = 0.471448 + 0.4358305 + 0.4286570 = \infty$

Based on the table above, it can be said that there is a problem with financing in the state Sharia Business Unit (UUS). 0, 1, and 2 are recurrent state Because After entering state *i*, the process will definitely return to state *i* again and $\sum_{n=1}^{\infty} p_{ii}^n = \infty$.

Table 7: Classification transient state or recurring at the Sharia People's Financing Bank (BPRS)

State	Financing Bank (BPRS)
0 (Not fluent)	$\sum_{n=1}^{\infty} P_{00}^n = P_{00}^1 + P_{00}^2 + P_{00}^3 + \cdots = 0.316861 + 0.2897101 + 0.2877219 = \infty$
1 (Doubtful)	$\sum_{n=1}^{\infty} P_{11}^n = P_{11}^1 + P_{11}^2 + P_{11}^3 + \cdots = 0.355728 + 0.3590123 + 0.3589656 = \infty$
2 (Traffic)	$\sum_{n=1}^{\infty} P_{22}^n = P_{22}^1 + P_{22}^2 + P_{22}^3 + \cdots = 0.386798 + 0.3555504 + 0.533305 = \infty$

Based on the table above, it can be said that problematic financing at Sharia Rural Banks (BPRS) states 0, 1 and 2 are recurrent states because after entering state *i*, the process will definitely return to state *i* again and $\sum_{n=1}^{\infty} p_{ii}^{n} = \infty$.

3.3.2. Absorbing State

Based on the transition opportunity matrix P it can be seen that there is no absorbing state, because $P_{ii} \neq 1$. This means that after entering state *i*, the process will leave the state *i*.

Table 8: Classification absorbing state at Sharia Commercial Banks (BUS)

State	Sharia Commercial Bank (BUS)	Classification
0 (Not fluent)	$P_{00} = 0.373738$	Not absorbing
1 (Doubtful)	$P_{11} = 0.320023$	Not absorbing
2 (Traffic)	$P_{22} = 0.336843$	Not absorbing

Because $P_{ii} \neq 1$ then at the Sharia Commercial Bank (BUS) state 0 " not enough fluent ", state 1 " doubtful ", state 2 " stalled " is said No absorbing. This means that after entering state 0 " not enough fluent ", state 1 is " doubtful ", state 2 is " stalled " then the process will leave the state 0 " not enough fluent ", state 1 is " doubtful ", state 2 is " stuck".

Table 9: Classification absorbing state in the Sharia Business Unit (UUS)

State	Sharia Business Unit (UUS)	Classification
0 (Not fluent)	$P_{00} = 0.264065$	Not absorbing
1 (Doubtful)	$P_{11} = 0.471186$	Not absorbing
2 (Traffic)	$P_{22} = 0.471448$	Not absorbing

Because $P_{ii} \neq 1$ then in the Sharia Business Unit (UUS) state 0 " not enough fluent ", state 1 " doubtful ", state 2 " stalled " is said No absorbing . This means that after entering state 0 " not enough fluent ", state 1 is " doubtful ", state 2 is " stalled " then the process will leave the state 0 " not enough fluent ", state 1 is " doubtful ", state 2 is " stuck ".

Table 10: Classifications absorbing state at Sharia People's Financing Bank (BPRS)

State	Financing Bank (BPRS)	Classification
0 (Not fluent)	$P_{00} = 0.316861$	Not absorbing
1 (Doubtful)	$P_{11} = 0.355728$	Not absorbing
2 (Traffic)	$P_{22} = 0.386798$	Not absorbing

Because $P_{ii} \neq 1$ then at the Sharia People's Financing Bank (BPRS) state 0 " not enough fluent ", state 1 " doubtful", state 2 " stalled " is said No absorbing. This means that after entering state 0 " not enough fluent ", state 1 is " doubtful ", state 2 is " stalled " then the process will leave the state 0 " not enough fluent ", state 1 is " doubtful ", state 2 is " stuck ".

3.3.3. The Nature of Periodicity

Table. 11 Classification characteristic periodicity in Sharia Commercial Banks (BUS)

State	Sharia Commercial Bank (BUS)	Classification
0 (Not fluent)	$d(0) = FPB\{n \geq 1 \mid P_{00}^{n} > 0\} = FPB\{1,2,3,4,5\} = 1$	aperiodic
1 (Doubtful)	$d(1) = FPB\{n \geq 1 \mid P_{11}^{n} > 0\} = FPB\{1,2,3,4,5\} = 1$	aperiodic
2 (Traffic)	$d(2) = FPB\{n \geq 1 \mid P_{22}^{n} > 0\} = FPB\{1,2,3,4,5\} = 1$	aperiodic

Based on the table above, it can be said that problematic financing at Sharia Commercial Banks (BUS) states 0, 1 and 2 are aperiodic states because $d(0) = d(1) = d(2) = 1$.

Table 12: Classification characteristic periodicity in Sharia Business Units (UUS)

State	Sharia Business Unit (UUS)	Classification
0 (Not fluent)	$d(0) = FPB\{n \geq 1 \mid P_{00}^{n} > 0\} = FPB\{1,2 \ldots,11\} = 1$	aperiodic
1 (Doubtful)	$d(1) = FPB\{n \geq 1 \mid P_{11}^{n} > 0\} = FPB\{1,2 \ldots,11\} = 1$	aperiodic

2 (Traffic)	$d(2) = FPB\{n \geq 1 \mid P_{22}^{n} > 0\} = FPB\{1,2 \ldots,11\} = 1$	aperiodic

Based on the table above, it can be said that financing problems in the Sharia Business Unit (UUS) states 0, 1, and 2 are aperiodic states because $d(0) = d(1) = d(2) = 1$.

Table 13: Classification characteristic periodicity at Sharia People's Financing Banks (BPRS)

State	Financing Bank (BPRS)	Classification
0 (Not fluent)	$d(0) = FPB\{n \geq 1 \mid P_{00}^{n} > 0\} = FPB\{1,2, \ldots,6\} = 1$	aperiodic
1 (Doubtful)	$d(1) = FPB\{n \geq 1 \mid P_{11}^{n} > 0\} = FPB\{1,2, \ldots,6\} = 1$	aperiodic
2 (Traffic)	$d(2) = FPB\{n \geq 1 \mid P_{22}^{n} > 0\} = FPB\{1,2, \ldots,6\} = 1$	aperiodic

Based on the table above, it can be said that problematic financing at Sharia People's Financing Banks (BPRS) states 0, 1, and 2 are aperiodic states because $d(0) = d(1) = d(2) = 1$.

3.4. Opportunity Steady State

For look for opportunity period long from Markov chain with matrix opportunity transition P. By using the help of the *R* application it is obtained

Table 14: Long Term Value of each Sharia Bank

Criteria	Sharia Commercial Bank (BUS)	Sharia Business Unit (UUS)	Financing Bank (BPRS)
Not that smooth	35.93%	32.11%	31.93%
Doubtful	22.79%	34.38%	42.83%
Congested	28.77%	35.89%	35.34%

4. Conclusion

Prediction transfer opportunity value for each problem financing criterion (less smooth , doubtful , and stuck) will experiencing a state of balance (steady state). Sharia Commercial Banks (BUS) will experience a state of balance at this time step 5th with substandard problem financing at 35.93%, doubtful problem financing at 32.11%, and bad problem financing at 31.96%. Financing problems in the Sharia Business Unit (UUS) are experiencing a state of balance at the moment step 11th with substandard problem financing of 22.79%, doubtful problem financing of 34.38%, and bad problem financing of 42.83%. Problem financing at the Sharia Rural Bank (BPRS) experienced a balanced situation at step 6 with substandard problem financing at 28.77%, doubtful problem financing at 35.89%, and non-performing problem financing at 35.34%.

References

Abdillah, MF (2023). Buying and Selling Gold from a Non-Cash Sharia Perspective (Analytical Study of National Sharia Council Fatwa Number 77 of 2010). *Al-Arfa: Journal of Sharia, Economics and Islamic Law, 1*(1), 1-11.

Ayu Rizaty, M. (2022), *"Jumlah Penduduk Muslim Indonesia Terbesar di Dunia pada 2022", indonesia data.* Avaliable: https://dataindonesia.id/ragam/detail/populasi-muslim-indonesia-terbesar-di-dunia-pda-2022. Accessed: 27 November 2022.

Hermanns, H., & Hermanns, H. (2002). Markov Chain. *Interactive Markov Chains: And the Search for Quantified Quality,* 35-55.

Kasmir. (2008) *"Dasar-Dasar Perbankan*", Jakarta: PT Raja Grafindo Persada, 2008.

Lubis, ME, & Soemitra, A. (2022). The Impact of Dual Banking Systems on the Financial Performance of Sharia Banks in Indonesia: Literature Review and Perspectives of Sharia Economics Postgraduate Students. *International Journal of Cultural and Social Sciences, 3*(2), 168-176.

Nugraha, E., & Setiawan, A. (2018). Problematic financing factors in general sharia banking in Indonesia. *International Journal of Trade and Finance, 4*(1), 27-39.

Rahmawati, F., Ulama'i, A.H.A.A., & Din, M.U. (2022). Usury in the Perspective of Sharia Bank Customers: A Systematic

Literature Review. *Velocity: Journal of Islamic Finance and Banking, 2*(1), 73-90.

Supriyatni, R., & Nurjamil, N. (2021). The Urgency of Handling Non-Performing Financing in Sharia Banks in the Development of the Indonesian Sharia Economy. *PADJADJARAN Journal of Legal Studies (Law Journal), 8*(1), 26-46.

Susanty, A., Akshinta, P.Y., Ulkhaq, M.M., & Puspitasari, N.B. (2022). Analysis of transition tendencies between environmentally friendly consumer behavior segments using the Markov chain approach. *Journal of Management Modeling, 17*(4), 1177-1212.

Wahyudi, I., & Sakti, A. (2016). Analyzing production sharing contracts with Markov models. *Communication in Science and Technology, 1*(2).

Zahra, SF, Ascarya, A., & Huda, N. (2018). Measuring the stability of the dual banking system in Indonesia: A Markov switching approach. *Al-Iqtishad: Journal of Sharia Economics, 10*(1), 25-52.