Analysis of Rules for Islamic Inheritance Law in Indonesia Using Hybrid Rule Based Learning

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Abstract. Along with the development of human civilization in Indonesia, the changes and reform of Islamic inheritance law so as to conform to the conditions and culture cannot be denied. The distribution of inheritance in Indonesia can be done automatically by storing the rule of Islamic inheritance law in the expert system. In this study, we analyze the knowledge of experts in Islamic inheritance in Indonesia and represent it in the form of rules using rule-based Forward Chaining (FC) and Davis-Putman-Logemann-Loveland (DPLL) algorithms. By hybridizing FC and DPLL algorithms, the rules of Islamic inheritance law in Indonesia are clearly defined and measured. The rules were conceptually validated by some experts in Islamic laws and informatics. The results revealed that generally all rules were ready for use in an expert system.

1. Introduction

Before Islam, the law of succession was never fair. Children and women; for example, were never entitled the right of inheritance \[1\] \[2\]. The development of human civilization, especially in Indonesia whose population has reached 200 million people colored with diverse ethnics, customs, and cultures, influences the law of succession. Islamic inheritance jurisprudence has been implemented in Indonesia since the Islamic kingdoms ruled the archipelago. The inheritance laws were implemented in accordance with the madhhab followed by the kings \[3\]. Even in the period of Dutch, Islamic laws, including of the inheritance law, were still preserved and ratified along with customary laws \[4\]. Many have interpreted the reform of Islamic laws in Indonesia, including of the inheritance law; for instance, by returning a rational and empirical mission \[5\].

The knowledge of Islamic inheritance law in Indonesia can be automatically used using an expert system. An expert system is an artificial intelligence that can store expert knowledge so that computer can solve problems and make decisions based on the stored knowledge \[6\] \[7\] \[8\] \[9\]. The purpose is not to replace the experts. The expert system should be verified and validated functionally by experts. This verification and validation process is known as expert judgement. There have been many previous studies on expert systems and decision making systems for Islamic inheritance divisions \[10\] \[11\] \[12\] \[13\] \[14\]. However, these studies only discussed the inherited property divisions based on Quran, Hadiths, and Fiqh or Faraid.

The present study was focused on the acquisition of expert knowledge of Islamic inheritance law in Indonesia so as to generate the representation of the rules of Islamic inheritance law ready implemented in an expert system. The algorithm used in this study was a hybrid of Forward Chaining
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(FC) algorithm [9] [15] and Davis-Putnam-Logemann-Loveland (DPLL) algorithm [18] [19]. These algorithms were not only appropriate with the law of inheritance, but also simple, efficient, and having good performance. The FC algorithm is a rule-based algorithm using modus ponens as a proven valid argument and Breadth First Search [16] [17]. The FC algorithm was used because its input data were already available as the initialization problems. These data were the rules of Islamic inheritance per se, where both hypothesis and conclusion were available in them [15] [16]. The DPLL algorithm was used to measure the satisfiability of a proposition [20] [21] [22].

2. Characteristics of inheritance law in Indonesia

Islamic inheritance law, that has been around in Indonesia since the reign of Islamic kingdoms, has to date been ratified as a positive law for Indonesian citizens, especially for Muslims [23] [24]. There are several ways of dealing with inheritance prevailing in Indonesian society [24]. However, the majority of Indonesian Muslims implement Islamic inheritance law in accordance with the conditions and culture of Islamic society in Indonesia who adheres to the principles of bilateral. The bilateral principle prioritizes the principle of kinship based on both matrilinical and paternal lineages. Islamic inheritance law does not recognize gender discrimination; both men and women are entitled the right of inheritance. In addition, Islamic inheritance law in Indonesia embodied in the Compilation of Islamic Law (KHI) article 185 paragraphs (1) and (2) recognizes surrogate heirs (mawalis) who are entitled the right of inheritance in case the main heirs are dead [24] [25]. As a case in point, the descendants of sons and of daughters are entitled the right of inheritance of their grandparents if their parents have already passed away.

![Diagram of Property divisions based on Islamic inheritance law in Indonesia](image-url)

Figure 1. Property divisions based on Islamic inheritance law in Indonesia
This is a legal conclusion based on the ijtihad of ulama in interpreting Sura an-Nisa Aya 33 [26]. Based on their interpretation, there are four mawalis: mawali of father or mother, mawali of son or daughter, mawali of brother or sister, and mawali of non-relative inheritors who are entitled the right of inheritance based on a will. Crimes committed by the main or surrogate heirs against the deceased such as killing, defaming, or ill-treatment will result in the loss of rights of inheritance. In addition, the main heirs must be descendants born to the deceased parents who are legitimate married. Figure 1 illustrates inheritance divisions in Indonesia based on the law of inheritance in Quran and KHI [24] [25]. Figure 1 also illustrates the rule representation of property divisions based on Islamic inheritance law in Indonesia using FC and DPLL algorithms. In detail, this will be discussed in Section 3.

3. Rules for Islamic inheritance law in Indonesia with forward chaining algorithm
FC algorithm is one of algorithm for inference engine that generates reasoning with logic-based rule representations [16]. Its algorithm is modus ponens, which is a proven valid argument [15] [17]. All hypotheses and conclusions are asserted to be true and the value of the implications of hypotheses and conclusions is tautology. FC algorithm provides a solution to a problem by collecting information. It is used when all conditions (rules) and results (goals) have been clearly defined. Rules can be used to solve new problems (facts) by matching the existing rules and goals [15] [17] [16]. Islamic inheritance law in Indonesia is based Quran and the result of ijtihad of ulama embodied in KHI is represented by rules in Table 2. Table 1 contains codes for main heirs, surrogate heirs (mawalis), and obstructed heirs (kalalah). The existence and number of heirs determine the share of each heir.

| Code | Heirs | Code for Share |
|------|-------|----------------|
| H1-H6 | son, daughter, wife, husband, father, mother | DFH1-DFH6 |
| H7-H9 | half-brother, sister, half-sister | DFH7-DFH9 |
| H10-H16 | late son, late daughter, late father, late mother, late half-sibling with same mother, late half-sibling with same father, late sibling | DFH10-DFH16 |
| H17-H20 | grandson and granddaughter as mawalis of late son and late daughter | DFH17-DFH20 |
| H21-H24 | grandfather and grandmother as mawalis of late father and late mother | DFH21-DFH24 |
| H25-H30 | nephew and niece as mawalis of late half-sibling with same mother, late sibling, and late half-sibling with same father | DFH25-DFH30 |
| H31-H32 | brother, half-brother with same father | DFH31-DFH32 |
### Table 2. Rules for Property divisions based on Islamic inheritance law in Indonesia

| Rule Code | Rules for Property Divisions |
|-----------|------------------------------|
| **Share of Children (Son and Daughter)** | IF H1>=1 AND H2>=1 THEN ‘Ashabah bi al-Ghaer, DFH1:DFH2 = 2:1 (and so on according to Holy Quran and KHI) |
| **Share of Mawali of Late Son (Grandson and Granddaughter)** | IF H10>=1 AND H17>=1 AND H18>=1 THEN DFH17:DFH18 = 2:1 of DFH10 (and so on according to Holy Quran and KHI) |
| **Share of Mawali of Late Daughter (Grandson and Granddaughter)** | The logic is the same as R5-R8 |
| **Share of mother:** | IF H6=1 AND (H1>=1 OR H2>=1 OR H17>=1 OR H18>=1 OR H19>=1 OR H20>=1) THEN DFH6 = 1/6 (and so on according to Holy Quran and KHI) |
| **Share of Mawali of Late Mother (Grandfather and Grandmother):** | IF H13=1 AND H24=1 AND H1=0 AND H2=0 AND H17=0 AND H18=0 AND H19=0 AND H20=0 AND H7=0 AND H8=0 AND H9=0 AND H25=0 AND H26=0 AND H27=0 AND H28=0 AND H29=0 AND H30=0 THEN DFH24 = DFH13 (and so on according to Holy Quran and KHI) |
| **Share of Father:** | IF H5=1 AND (H1>=1 OR H2>=1 OR H17>=1 OR H18>=1) THEN DFH5 = 1/6 (and so on according to Holy Quran and KHI) |
| **Share of Mawali of Late Father (Grandfather and Grandmother):** | The logic is the same as R18-R19 |
| **Share of Husband:** | IF H4=1 AND H1=0 AND H2=0 AND H17=0 AND H18=0 AND H19=0 AND H20=0 THEN DFH4 = 1/2 (and so on according to Holy Quran and KHI) |
| **Share of Wife** | IF H3=1 AND H1=0 AND H2=0 AND H17=0 AND H18=0 AND H19=0 AND H20=0 THEN DFH3 = 1/4 (and so on according to Holy Quran and KHI) |
| **Share of Half-Sibling (Brother and Sister with Same Mother):** | IF H7=1 AND H1=0 AND H2=0 AND H17=0 AND H18=0 AND H19=0 AND H20=0 AND H5=0 THEN DFH7 = 1/6 (and so on according to Holy Quran and KHI) |
| **Share of Mawali of Late Half-Sibling with Same Mother (Nephew and Niece):** | The logic is the same as R5-R8 |
| **Share of Sibling (Brother and Sister):** | IF H8=1 AND H1=0 AND H2=0 AND H17=0 AND H18=0 AND H19=0 AND H20=0 AND H5=0 AND H31=0 THEN DFH8 = 1/2 (and so on according to Holy Quran and KHI) |
| **Share of Mawali of Late Sibling (Nephew and Niece):** | The logic is the same as R5-R8 |
| **Share of Sibling (Brother and Sister):** | The logic is the same as R5-R8 |
| **Share of Half-Sibling (Brother and Sister with Same Father):** | The logic is the same as R35-R38 |
| **Share of Mawali of Late Half-Sibling with Same Father (Nephew and Niece):** | The logic is the same as R5-R8 |

### 4. Evaluation of the satisfiability of inheritance law in Indonesia using Davis-Putnam-Lovemann-Loveland algorithm

DPLL algorithm is one of SATisfiable solver (SAT) algorithm used to see if facts, clauses, premises, hypotheses or propositions are satisfiable [21] [22] [20] [18] [19]. DPLL algorithm is the most frequently used SAT to solve problems and determine if a propositional logic formula is satisfiable [18]. The input of DPLL is a proposition, and the output is the conclusion of the satisfiability of the proposition in question[22]. DPLL is a complete algorithm to determine the satisfiability of a propositional logic formula using depth-first search for all possible input variables to find a model[20] [19] [18]. If a model is found, the proposition is said to be satisfiable. The rules of analysis result in Section 3 are changed into logic symbols by FC algorithm and evaluated by DPLL algorithm to determine the satisfiability of every rule.
5. Results and discussion
Conceptual evaluation and validation of the rules were done in a Focus Group Discussion (FGD) [27] [28] [29] with informatics lecturers at UIN Sunan Gunung Djati Bandung. The validation of rules for Islamic inheritance law in Indonesia involved two experts in the field from the Department of Family Law of UIN Sunan Gunung Djati Bandung. The results revealed that the rules had met the condition of inherited property division based on Islamic inheritance law in Indonesia. Overall, the rules were ready for use in an expert system. However, improvement needed to be made to the FC algorithm since there was no decision tree yet to facilitate the implementation the rules[15]. In addition, DPLL algorithm has not fully evaluated the satisfiability of every rule.

6. Conclusion
The majority of Indonesian Muslims apply Islamic laws in every aspect of their life, one of which is the law of inheritance. Islamic inheritance law in Indonesia has developed and has adjusted to the condition and culture of Muslim society in Indonesia; it is not only based on Quran and Fiqh, but also based on ijtihad of ulama embodied in the KHI. In the present study, Islamic inheritance law in Indonesia was represented in rules using FC algorithm and evaluated using DPLL algorithm. Based on the results of evaluation and validation in the FGD and validation by experts in Islamic inheritance law, it could be concluded that all rules have represented Islamic inheritance law in Indonesia. Generally, all rules were ready for use in an expert system despite lacking decision tree. However, not all rules were evaluated using DPLL algorithm. Therefore, further studies should evaluate them if the satisfiability of every rule is to be measured and involve more experts in Islamic inheritance law in Indonesia.

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