Structural modeling of Sama Bajo fishers social resilience in a marine national park

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Abstract
This article describes and compares three modelings of the relationship between Sama Bajo boat-dwellers Bagai land-dwellers social capital and the social resilience of Sama Bajo in three local social contexts of land-dwellers in Wakatobi National Park (WNP). The research was conducted from May 2018 until June 2019 in Mantigola Sama Bajo on Kaledupa Island, Lamanggau Sama Bajo on Tomia Island, and Mola Sama Bajo on Wangi-wangi Island. Information was collected from 240 respondents who were selected by spatial sampling technique. Using Structural Equation Modeling (SEM) analysis, we found that the structural model is effective for evaluating social resilience, particularly for Mantigola and Lamanggau Sama Bajo who interact with homogenous land-dwellers, namely Kaledupa and Tomia land-dwellers as well as a stepping stone to strengthen their social resilience capacity by taking into account social relation, livelihood, the human and financial capital of the land-dwellers in the marine preserve area. Despite the success shown, a key constraint is due to inadequacies when the structural modeling reflects the urban local social environment of Sama Bajo as stated by Mola Sama Bajo, who established their bridging capital to the heterogeneous land-dwellers. Future research should take limitations into account by identifying various land-dwellers who develop social ties with the boat-dwellers. Similar research should be taken into consideration to validate the modeling in Sama Bajo populations that live in open access types. This is crucial to determine if other characteristics of Sama Bajo social resilience appear in the social setting of a different kinds of marine preserve areas.

Keywords Modeling · Social resilience Sama Bajo · Social capital · Wakatobi

Introduction
For the last decade, social resilience in island communities has been intensively studied due to the high level of vulnerabilities in small islands. Much of the early work centers around the study of this concept. In the beginning, the resilience perspective appeared in ecology in the 1960s and early 1970s through the investigation of the interacting population like predators and prey and their functional response concerning the ecological stability theory (Holling 1961; Lewontin 1969; Rosenzweig 1971; May 1972 cited by Folke 2006). Janssen et al. (2006) point out that the idea of resilience was presented by Holling (1973) in the area of ecology. Referring to the founder, the resilience concept decides the continuance of interrelationships inside a system and is a measure of the capability of systems to pervade the change of driving variables, state variables, parameters, and insists. From the beginning, the concept of resilience was used in the study of managing ecosystems and the subject of population ecology. Glaser et al. (2015) argue that islanders have a deal with improved challenges for integrated social–ecological management to a sustainable future for the island's system. Furthermore, questions on women's roles on the islands, social vulnerability and resilience, and also the marine resource-related attitude and future vision of islanders in this quickly changing environment, appeared as significant further themes.
As we have shown earlier, a social resilience concept is widely used in ecology, nevertheless, the concept definition and measurement are contested (Adger 2000). Then, Aldrich (2012) cited by Pfefferbaum et al. (2017) elucidates that social capital, more than socio-economic condition, population density, degree of damage, or amount of aid, is the ‘core engine of recovery’ post-disaster. Interestingly, people who survive with connections to strong social networks have access to necessary information and recover faster than those without. Thereby, communities lacking strong social networks are likely to experience loss (Aldrich 2012 cited by Pfefferbaum et al. 2017).

More recently, researchers have started to point to social capital as perhaps the most significant driver of recovery and resilience (Kerr 2018). Resilient communities can strategically utilize their social relations to obtain access to capital beyond the community (Bakker et al. 2019). For fisher communities, this means using different forms of social capital to gain power in marine spatial planning negotiations, and to exercise influence in favor of community goals (Grafton 2005; Bakker et al. 2019). Later, social capital, in the context of community resilience, refers to the interconnectedness of community members and their willingness and ability to support too many activities that advance the community’s goals (Pfefferbaum et al. 2017). It is interesting to note that Rosado et al. (2022) discovered that a variety of economic opportunities, social networks, and strong cultural community-level governance contributed to the resilience of the fishing community, with the villagers changing their social, economic, and religious behaviors to slow the spread of COVID-19. These research results represent an increased recognition that more attention needs to be paid to social capital related to the social resilience capacity, particularly for the small-scale fisheries communities.

This research focuses on Sama Bajo who is a famous seafaring ethnic in Eastern Indonesia. There is a great deal of debate surrounding Sama Bajo maritime communities who mostly live in coastal and small islands in Eastern Indonesia. From Stacey et al. (2018), we found that recent estimates of Sama Bajo boat-dwellers exhibit a Sama Bajo total population of approximately 1.1 million, nearly 347,000 in Malaysia (Sabah), 564,000 in the Philippines and 200,000, living in areas of high biodiversity in the islands of eastern Indonesia. Particularly in Southeast Sulawesi, the vast majority of Sama Bajo inhabits the coastal islets of Wakatobi and Tiworo. In Wakatobi, they are essential actors who utilized the littoral areas of Kapota, Kaledupa, and Tomia reefs as gleaning and demersal fishers for groupers and other reef fish beside the Lia and Tomia land-dwellers fishers. Also, they are tuna fishers who do fishing in the Banda seas. In Tiworo, the Sama Bajo has the main producer of blue swimming crab. Historically, the Wakatobi (Stacey 2007), the Maginti Tiworo, and the Bahari Sampolawa Sama Bajo boat-dwellers were traditional shark fishers in the Timor seas.

Despite their significant role in supporting protein diets for the land-dwellers and the global market, these seafaring groups have been negatively labeled by the land-dwellers as the rule breakers. For example, in Sama Bajo Saponda, land people acknowledge them as a center of blast fishers. Later, in the Tiworo strait, the Sama Bajo has been considered dynamite fishers, mini bottom trawlers, and illegal miners of coastal sand. This stigmatization has brought them to marginalization and vulnerability to stuck up in chronic poverty. Notably, a recent work (McWilliam et al. 2021) and the results generally seem to support the hardest situation of the Sama Bajo fishers. (McWilliam et al. 2021) argued that the Sama Bajo way of life is in danger because of the competition from overfishing and increased hazards from marine pollution (especially poorly regulated purse seine fisheries and illegal trawl fishing). Additionally, they must contend with Indonesia’s tropical monsoon climate’s strong seasonality, which has an adverse seasonal impact on their ability to catch fish. In the southern seas, the southeast monsoon, which blows out of Australia from July to September, is accompanied by strong winds and high seas. Fishing is severely restricted by the weather for all homes with older boats (non-motorized, smaller [6–7 m], single-engine craft and rudimentary equipment).

The pivotal role of Sama Bajo as one of the main actors who utilized the coastal and the coral triangle has been attracting social researchers from all over the world. The most commonly cited culprit in literature for this Sama Bajo issue range from social transformation sociological studies to ethnographic studies about their tenurial history (Stacey 2007; Chou 1997; Chia 2019), women and gender studies (Pauwelussen 2015), Sama Bajau local knowledge (Awang-Kanak et al. 2018; Yakin 2013), language (Donohue 1996), social transformations (Hoogervorst 2012; Wiandi et al. 2012); Sama Bajo livelihood institution and food system (Gibson et al. 2018 and McWilliam et al. 2021), and Sama Bajo identity and securitization (Acciaioli 2006; Stacey et al. 2018; Madlan 2014; Acciaioli et al. 2017).

Although extensive research has been carried out on the community in the social resilience issues like Pauwelussen (2016) in Sama Bajo Berau, nevertheless no single study had addressed the issue of Sama Bajo social resilience in the modeling analysis which adequately confirmed that there is a lack quantitatively research of the Sama Bajo boat-dwellers and Bagai land-dwellers identity, and bridging social capital between two groups, who live side by side, to coping with risk in different and unique socio-ecological landscapes.
Brown et al. (2003), Stedman (2003) cited by Khakzad and Griffith (2016) argued that place attachments are connections to particular social and physical backdrops that provide various types of psychological and social benefits as well as the range of human activities and social processes that are carried out there. Therefore, to address this research’s lacuna, in this paper we assess a variety of social fabrics concerning land-dwellers and the Sama Bajo boat-dwellers and in WNP that shape marginal Sama Bajo fishers’ social resilience using the analysis of Structural Equation Model (SEM) Partial Least Square (PLS).

**Methods**

In this investigation, data were gathered using a structured interview for 240 respondents at various sites for two years, from 2018 to 2019. In the former year, we collected data regarding the objective well-being of both the boat-dwellers and land-dwellers among the three Islands. Also, we observed to address the subjective well-being of Sama Bajo. Meanwhile, in the latest year, we carried out research for looking social capital of Sama–Bagai relations in all field sites.

Respondents had been chosen using the spatial sampling technique. For each field site, we surveyed 40 respondents who represented the particular Bagai land-dwellers and Sama Bajo. Besides geographical indicators, respondents were selected both from land-dwellers and boat-dwellers. Care was taken to ensure that we have properly selected the respondents, in both two communities living side by side, who at least carried out social interactions with each other within a month when data collection was carried out. Every research site was represented by 80 respondents, for example, on Kaledupa Island, 40 respondents represent Bagai Horuo land-dwellers, and the rest corresponds to Sama Bajo Mantigola. In sum, the total number of respondents were 240 head of household at three research fieldworks in Wakatobi National Park (WNP): (1) Wangi-wangi Island; (2) Kaledupa Island; and (3) Tomia Island. These islands have been selected because there are Sama Bajo villages: (1) Sama Bajo Lamanggau village on Tomia Island; (2) Sama Bajo Mantigola on Kaledupa Island; and (3) Sama Bajo Mola in Wangi-wangi Island (Fig. 1).

We selected those field sites with consideration of the existence of mutual bridging social relation between the land-dwellers and the Sama Bajo. We did not select Binongko Island because there is no Sama Bajo boat-dwellers village. In other words, the Binongko people have not intimately engaged with the Sama Bajo in their daily life.

We have designed a model for assessing the role of Sama-Bagai social relation in Sama Bajo social resilience in WMNP (Fig. 2).

The research framework (Fig. 2) later was translated to be structural modeling which describes the social resilience of Sama Bajo communities concerning their social relation to the varied land-dwellers (Fig. 3 and Table 1).

As seen in Figs. 2 and 3, the endogenous latent variable is Sama Bajo social resilience (Z). The Z factor is counted from 2 indicators: (1) subjective well-being of Sama Bajo (X3); and (2) objective well-being of the boat-dwellers (X2). The boat-dwellers subjective well-being is built from Sama-Bagai social identity and migration sub-indicators. These second-order factors were adapted from a 3D of social

![Research sites](sps:id::fig1||locator::gr1||mediaobject::0)
Fig. 2 Framework among objective well-being of the land-dwellers (X1), social resilience (Z), social relation of Sama Bajo to Bagai land-dwellers (Y1), and social relation of Bagai Land-dwellers to Sama Bajo (Y2)

Fig. 3 The Structural Model of Sama Bajo Social Resilience
well-being approach regarding values in small-scale fisheries for the Sama Bajo, designed by Stacey et al. (2018), as the ‘fluid values’. For a better understanding of the Sama Bajo social well-being, Stacey et al. (2018) have distinguished four main value attributes namely resource use, spatial mobility, autonomy and identity, and kinship as well as relational ties. Additionally, the boat-dwellers well-being is manifest across different spatial scales such as at a local or household level, as part of subregional membership of language groups, regionally in addition to transboundary across national states. Meanwhile, exogenous latent variables are language groups, regionally in addition to transboundary across household level, as part of subregional membership of languages. The first postulate (H1) stated that there is a significant and positive correlation between Bagai land-dwellers objective well-being (X1) and Sama Bajo social resilience (Z), (X1– > Z). The second postulate (H2) affirmed that there is a significant and positive correlation between Sama Bajo Social relation to Bagai land-dwellers (Y1) and Sama Bajo social resilience (Z), (Y1– > Z). The third postulate (H3) presumed a linear and significant relationship between Bagai land-dwellers social relation to Sama Bajo (Y2) and Sama Bajo social resilience (Z), (Y2– > Z). The fourth postulate (H4) surmised a positive and significant relationship between Sama Bajo social relation to Bagai land-dwellers (Y1) and Bagai land-dwellers social relation to Sama Bajo (Y2), which were also inspired by Stacey et al. (2018) as well as our previous work in WNP. Whereas, another exogenous latent variable categorized as Bagai land-dwellers objective well-being (X1) second-order factors were adapted from Khomsan et al. (2015) albeit selected and modified. In short, all of the endogenous latent variables and their factors are also for the exogenous latent variable factors presented in Table 2.

This social resilience modeling is created by taking into account the social relations utilizing reciprocity between Sama Bajo and the land-dwellers who live side by side in an archipelagic area. Our comparative study outlines that the local social–economic context through social capital between Bagai land-dwellers and Sama Bajo boat-dwellers on each island will be different and has a critical role in the social resilience of Sama Bajo as a marginal community in WNP. To test this assumption, we hypothesized five postulates. The first postulate (H1) stated that there is a significant and positive correlation between Bagai land-dwellers objective well-being (X1) and Sama Bajo social resilience (Z), (X1– > Z). The second postulate (H2) affirmed that there is a significant and positive correlation between Sama Bajo Social relation to Bagai land-dwellers (Y1) and Sama Bajo social resilience (Z), (Y1– > Z). The third postulate (H3) presumed a linear and significant relationship between Bagai land-dwellers social relation to Sama Bajo (Y2) and Sama Bajo social resilience (Z), (Y2– > Z). The fourth postulate (H4) surmised a positive and significant relationship between Sama Bajo social relation to Bagai land-dwellers (Y1) and Bagai land-dwellers social relation to Sama Bajo (Y2), (Y1– > Y2). Lastly, the fifth hypothesis (H5) expected that there is a significant and positive correlation between Bagai land-dwellers objective well-being (X1) and Sama Bajo Social relation to Bagai land-dwellers (Y1), (X1– > Y1) (see Table 2).

Data management and analysis were performed using SEM PLS using Smart PLS 2.0. PLS is essentially a combination of path models and principal components (Lacobucci 2010). another argument was from Structural equation modeling (SEM) has become an important statistical tool in social and behavioral sciences (Benitez et al. 2020). It is capable of modeling nomological networks by expressing

### Table 1

| Structural model equation | Exogenous variable measurement model equation | Endogenous variable measurement model equation |
|---------------------------|----------------------------------------------|-----------------------------------------------|
| \( Y_1 = \beta_1 X_1 + \varepsilon_1 \) | \( X_{1.1} = \lambda_{1.1} \xi_1 + \delta_1 \) | \( Y_{11} = \lambda_{1.12} Y_{11} + \varepsilon_{12} \) |
| \( Y_2 = \beta_2 X_1 + \varepsilon_2 \) | \( X_{1.2} = \lambda_{1.2} \xi_1 + \delta_2 \) | \( Y_{12} = \lambda_{1.22} Y_{12} + \varepsilon_{22} \) |
| \( Y_3 = \beta_3 X_1 + \varepsilon_3 \) | \( X_{1.3} = \lambda_{1.3} \xi_1 + \delta_3 \) | \( Y_{13} = \lambda_{1.32} Y_{13} + \varepsilon_{32} \) |
| \( Y_4 = \beta_4 X_1 + \varepsilon_4 \) | \( X_{1.4} = \lambda_{1.4} \xi_1 + \delta_4 \) | \( Y_{14} = \lambda_{1.42} Y_{14} + \varepsilon_{42} \) |
| \( Y_5 = \beta_5 X_1 + \varepsilon_5 \) | \( X_{1.5} = \lambda_{1.5} \xi_1 + \delta_5 \) | \( Y_{15} = \lambda_{1.52} Y_{15} + \varepsilon_{52} \) |
| \( Y_{16} = \beta_6 X_1 + \varepsilon_6 \) | \( X_{1.6} = \lambda_{1.6} \xi_1 + \delta_6 \) | \( Y_{16} = \lambda_{1.62} Y_{16} + \varepsilon_{62} \) |
| \( Y_7 = \beta_7 X_1 + \varepsilon_7 \) | \( X_{1.7} = \lambda_{1.7} \xi_1 + \delta_7 \) | \( Y_{17} = \lambda_{1.72} Y_{17} + \varepsilon_{72} \) |
| \( Y_{18} = \beta_8 X_1 + \varepsilon_8 \) | \( X_{1.8} = \lambda_{1.8} \xi_1 + \delta_8 \) | \( Y_{18} = \lambda_{1.82} Y_{18} + \varepsilon_{82} \) |
| \( Y_9 = \beta_9 X_1 + \varepsilon_9 \) | \( X_{1.9} = \lambda_{1.9} \xi_1 + \delta_9 \) | \( Y_{19} = \lambda_{1.92} Y_{19} + \varepsilon_{92} \) |
| \( Y_{10} = \beta_{10} X_1 + \varepsilon_{10} \) | \( X_{1.10} = \lambda_{1.10} \xi_1 + \delta_{10} \) | \( Y_{110} = \lambda_{1.102} Y_{110} + \varepsilon_{102} \) |
| \( Y_{11} = \beta_{11} X_1 + \varepsilon_{11} \) | \( X_{1.11} = \lambda_{1.11} \xi_1 + \delta_{11} \) | \( Y_{111} = \lambda_{1.112} Y_{111} + \varepsilon_{112} \) |
| \( Y_{12} = \beta_{12} X_1 + \varepsilon_{12} \) | \( X_{1.12} = \lambda_{1.12} \xi_1 + \delta_{12} \) | \( Y_{112} = \lambda_{1.122} Y_{112} + \varepsilon_{122} \) |
| \( Y_{13} = \beta_{13} X_1 + \varepsilon_{13} \) | \( X_{1.13} = \lambda_{1.13} \xi_1 + \delta_{13} \) | \( Y_{113} = \lambda_{1.132} Y_{113} + \varepsilon_{132} \) |
| \( Y_{14} = \beta_{14} X_1 + \varepsilon_{14} \) | \( X_{1.14} = \lambda_{1.14} \xi_1 + \delta_{14} \) | \( Y_{114} = \lambda_{1.142} Y_{114} + \varepsilon_{142} \) |
| \( Y_{15} = \beta_{15} X_1 + \varepsilon_{15} \) | \( X_{1.15} = \lambda_{1.15} \xi_1 + \delta_{15} \) | \( Y_{115} = \lambda_{1.152} Y_{115} + \varepsilon_{152} \) |
| \( Y_{16} = \beta_{16} X_1 + \varepsilon_{16} \) | \( X_{1.16} = \lambda_{1.16} \xi_1 + \delta_{16} \) | \( Y_{116} = \lambda_{1.162} Y_{116} + \varepsilon_{162} \) |
| \( Y_{17} = \beta_{17} X_2 + \varepsilon_{17} \) | \( X_{1.17} = \lambda_{1.17} \xi_1 + \delta_{17} \) | \( Y_{117} = \lambda_{1.172} Y_{117} + \varepsilon_{172} \) |
| No | Type of Variables | Construct | Factor | Data Sources |
|----|-------------------|-----------|--------|--------------|
| 1  | Endogenous latent variable | *Sama Bajo social resilience (Z)* | Second order of *Sama Bajo social resilience (Z)* | Mola, Mantigola and Lamanggau |
|    |                    | **Objective well-being of *Sama Bajo (X3)** | | *Sama Bajo respondents* |
|    |                    | X3-1: *Sama Bajo fishing income* | | |
|    |                    | X3-2: *Sama Bajo’s non-fishing income* | | |
|    |                    | X3-3: *Sama Bajo food expenses* | | |
|    |                    | X3-4: *Sama Bajo non-food expenses* | | |
|    |                    | X3-5: *Sama Bajo social and custom expenses* | | |
|    |                    | X3-6: *Sama Bajo asset score of fishing catch technology* | | |
|    |                    | X3-7: *Sama Bajo asset score of fish aquaculture technology* | | |
|    |                    | X3-8: *Sama Bajo asset score of seaweed cultivation* | | |
|    |                    | X3-9: *Sama Bajo respondent formal education* | | |
|    |                    | X3-10: Formal education level of respondent’s family members | | |
|    |                    | X3-11: Informal education level of respondent’s family members | | |
|    |                    | X3-12: *Sama Bajo respondent’s household debt* | | |
|    | **Subjective well-being of *Sama Bajo (X2)** | (X2-1): *Sama Bajo’s social identity level* | | |
|    |                    | (X2-2): *Sama Bajo migration frequency* | | |

|    |                    | **Data Sources** | |
|    |                    | Mola, Mantigola and Lamanggau | |
|    |                    | *Sama Bajo respondents* | |

*Table 2 Type of variables, factors, and research hypotheses*
Table 2 (continued)

| No | Type of Variables | Construct | Factor | Data Sources |
|----|-------------------|-----------|--------|--------------|
| 2  | Exogenous latent variable | *Bagai* land-dwellers objective well-being (X1) | (X1-1) | *Bagai* land-dwellers fishing income | Mandati Wangi-wangi, Kaledupa Horuo, and Tomia Land-dwellers |
|    |                   |           | (X1-2) | *Bagai* land-dwellers non-fishing income | |
|    |                   |           | (X1-3) | *Bagai* land-dwellers food expenses | |
|    |                   |           | (X1-4) | *Bagai* land-dwellers non-food expenses | |
|    |                   |           | (X1-5) | *Bagai* land-dwellers social and custom expenses | |
|    |                   |           | (X1-6) | *Bagai* land-dwellers formal education level | |
|    |                   |           | (X1-7) | *Bagai* land-dwellers informal education level | |
|    |                   |           | (X1-8) | *Bagai* land-dwellers household member formal education | |
|    |                   |           | (X1-9) | *Bagai* land-dwellers asset score of fishing catch technology | |
|    |                   |           | (X1-10) | *Bagai* land-dwellers fish aquaculture technology | |
|    |                   |           | (X1-11) | *Bagai* land-dwellers field asset size of seaweed aquaculture | |
|    |                   |           | (X1-12) | *Bagai* land-dwellers extent of the farmland | |
|    |                   |           | (X1-13) | *Bagai* land-dwellers number of poultry | |
|    |                   |           | (X1-14) | *Bagai* land-dwellers number of goats | |
|    |                   |           | (X1-15) | *Bagai* land-dwellers number of cows | |
|    |                   |           | (X1-16) | *Bagai* land-dwellers respondent’s household debt | |
|    |                   |           | (X1-17) | *Bagai* land-dwellers respondent’s household migration frequency | |
|    | **Hypothesis** |   | (H1) | A positive and significant relationship between *Bagai* land-dwellers objective well-being (X1) and *Sama* Bajo social resilience (Z) | |
|    |                   |   | (H5) | A positive and significant relationship between *Bagai* land-dwellers objective well-being (X1) and *Sama* Bajo Social relation to *Bagai* land-dwellers (Y1) | |
| 3  | Endogen latent variable | *Sama* Bajo Social relation to *Bagai* land-dwellers (Y1) | (Y1-1) | Collective action dan cooperation level of *Sama* Bajo to *Bagai* land-dwellers | Mola, Mantigola and Lamanggau *Sama* Bajo respondents |
|    |                   |           | (Y1-2) | Trustworthiness level of *Sama* Bajo migration frequency | |
|    |                   |           | (Y1-3) | Bridging the social networking level of *Sama* Bajo to *Bagai* land-dwellers | Mandati Wangi-wangi, Kaledupa Horuo, and Tomia Land-dwellers respondents |
|    |                   |           | (Y1-4) | Bounding social networking level of *Sama* Bajo | |
theoretical concepts through constructs and connecting these constructs via a structural model to study their relationships (Bollen 1989 cited by Benitez et al. 2020). Therefore, PLS-SEM develops a good alternative for the following situations encountered: (1) sample size is small; (2) application has little available theory; (3) predictive accuracy is foremost; and (4) correct model specification cannot be ascertained (Wong, 2013).

**Results**

**Verification of Mola, Mantigola, and Lamanggau Sama Bajo social resilience measurement modelings**

Several authors have attempted, regarding research SEM model validity, that the researcher who uses SEM PLS initially has to assess the models to figure out the average variance extracted (AVE), loading factor, and the composite reliability for every construct among the models. These analyses are in terms of the acceptability of the measurement model (Rela et al. 2020). Furthermore, the composite reliability criterion has to be conducted to verify the internal consistency (Oliveira et al. 2020). In this section, particularly in Tables 3 and 4, we provide full details of the loading factor for every item construct, AVE and the composite reliability, also the discriminant validity for every construct of the research models.

AVE is used to measure the convergent validity and must be higher than a standard minimum level of 0.5 (Fornell and Larcker 1981 cited by Navimipour et al. 2018). In other words, the model requirements have good validity if each latent variable with a reflective indicator has an AVE above 0.5. It is apparent from Table 2 that the AVE value of each latent variable for all social resilience models has a value of > 0.5 and it can be said that the PLS research models meet the requirements of good convergent validity.

The next measurement is the reliability test of the models which is used to prove the consistency and accuracy of the instrument in measuring constructs. Reliability test by measuring composite reliability to a latent variable, which has a value more than (>) 0.7, is reliable. Rahman et al. (2013) note from Hulland’s argument (1999) that discriminant validity designates the extent to which a provided construct is different from other constructs. It is verified through analysis of average variance extracted by applying the criteria that a construct should share more discrepancy with its measures than it shares with other constructs in the model (Rahman et al. 2013). The specific details of the reliability measurement result have been reported in Table 4. The results illustrated show that all of the latent constructs have good, consistent and accurate reliability due they meet the
requirements with the composite reliability value for every latent construct of more than 0.7.

**Evaluation of Mola, Mantigola and Lamanggau social resilience structural models**

In this study, we postulate that every land-dwellers local social context through their bridging social capital and economic sphere of life has a significant impact on the *Sama Bajo* community’s social resilience in WNP small islands in different ways. This section outlines the results of the study on every site.

### Mola Sama Bajo structural model evaluation

For Mola *Sama Bajo* social resilience model, Fig. 3 and Table 4 have shown that X1 has a direct and significant relationship to Y1 (t-score = 3.583) > t-table (1.96) at α = 0.05. Similarly, Y1 has significantly correlated to Y2 and Z (t-score = 7.119; t = 3.292) > t-table (1.96) at α = 0.05, respectively. Nonetheless, X1 has not correlated to Z (t-score = 0.978) < t-table (1.96) at α = 0.05. In the same way, Y2 has no relationship to Z (t-score = 0.457) < t-table (1.96) at α = 0.05. In sum, three hypotheses have been supported (H2, H4, and H5), except two hypotheses have been rejected (H1 and H3).

From the data in Fig. 4, it is apparent that X1 correlates directly whereas negatively to Y1 (β = −0.421). It means that the higher X1 which was measured with a high value of X1.6, X1.8, X1.12, and X1.17, interestingly, will decrease the bridging social relation of Mola Sama Bajo to the *Bagai* Mandati land-dwellers (Y1). Besides this, the correlation Y1 to Y2 (β = 0.797) means that the greater bridging relation of Mola Sama Bajo to the *Bagai* Mandati land-dwellers (Y1) will improve the bridging relation of Mandati *Bagai* land-dwellers to Mola Sama Bajo (Y2). As well Y1 has a relationship to Z (β = 0.645). In a similar vein, a significant increase in Y1 will improve the social resilience of Mola *Sama Bajo* social resilience (Z).

PLS-SEM does not have a standard goodness-of-fit statistic, and efforts to establish a corresponding statistic have proven highly problematic (Sarstedt, et al. 2014). Thereby, the assessment of the quality of the model is based on its ability to predict the endogenous constructs. Despite the structural model of Y1 having an R-square of 25.1%, nevertheless, the structural model of Y2 and Z have an R-square of 62.9% and 65% in a row. For Y2 R-square, indicates that the Y2 variety can be explained by 62.9% by the Y2 structural model. Meanwhile, the rest of the value 37.1% can be justified with other factors from outside the model. Equally, another endogen factor, Z has an R-square of 65%, while 35% of the Z structural model can be explained by other factors (Table 5).

### Mantigola Sama Bajo structural model evaluation

Strong evidence of the relationship between *Sama–Bagai* social capital and the *Sama Bajo* social resilience was found in the Mantigola Sama Bajo community which relates to the Bagai Horuo Kaledupa land-dwellers. Overall, based on the result of the analysis in Fig. 5 and Table 6, all of the hypotheses are significant and have positive correlations. Bootstrapping result has shown that X1 has a direct and significant relation to the Y1, with the t-test (9.22) > t-table (1.96) or p < 0.05, at α 5%. Likewise, Y1 and X1 have significant associations with Y2 with the t-score (38.33; 5.44) > t-table (1.96) at α 5% in a row. The t-score value of Y1 to Y2 is the highest compared to Mola and Lamanggau. Also, Y1 and Y2 have strong correlation with Z (t-score 6.87; t-score 11.72) > t-table (1.96), respectively.

Another important finding was that the Mantigola *Sama Bajo* social resilience (Z) has a strong R-square of nearly 69.1%. This indicates that the model can explain the Z data variety for almost 69.1%, and the rest of 30.9% is explained by other factors outside the model. As well as that, the structural modeling of Y2 produced an R-square of 52.2%. In contrast, the model of Y1 only created an R-square of 15.2%. While 84.8% of diversity in Y1 was explained by other factors beyond the structural model of Y1.

### Lamanggau Sama Bajo structural model evaluation

In this section, we will explain the findings in Lamanggau, Tomia Island which increasingly reinforced the previous results that the land-dwellers, through bridging relation, are essential factors for shaping the bonding social capital and resilience of marginal *Sama Bajo* in the WMNP. Result illustrated (in Table 7 and Fig. 6) show that strong correlations existed among constructs X1, Y1, and Y2 to Z (t-score 5.150; 4.529; 2.264 > t-table 1.96, respectively). Moreover, there was a strong and direct correlation observed between X1 and Y1 with a value of t-score (10.164) > t-table (1.96) at α 5%. As well that the highest value of correlation was between Y1 and Y2 (t-score 11.161 > t-table 1.96).

Turning now to the statistical evidence of Lamanggau R-square, from Table 6, the structural model of Y1 resulted in an R-square of approximately 36.8%, while the R-square of Y2 was nearly 41.9%. Just almost like Mantigola, the structural model of Z produced R-square nearly to 65.7%. It means that the *Sama Bajo* social resilience (Z) construct diversity that could be elucidated by the model was 65.7%. Meanwhile, the rest of the 34.3% of data diversity was justified by other factors outside the model.
Table 3  Item codes, the value of loading factors, the value of average variance extracted (AVE), and the value of composite reliabilities among Mola, Mantigola, and Lamanggau Sama Bajo social resilience model’s construct

| The Mola Sama Bajo social resilience model | Item code | Loading factor | AVE     | Composite reliability |
|------------------------------------------|-----------|----------------|---------|-----------------------|
| **X1. Bagai land-dwellers objective well-being** | X1-6      | 0.970          | 0.727   | 0.912                 |
|                                           | X1-8      | 0.730          |         |                       |
|                                           | X1-12     | 0.714          |         |                       |
|                                           | X1-17     | 0.961          |         |                       |
| **X2. Subjective well-being of Sama Bajo**  | X2-1      | 0.937          | 0.762   | 0.864                 |
|                                           | X2-2      | 0.806          |         |                       |
| **X3. Objective well-being of Sama Bajo**  | X3-2      | 0.666          | 0.527   | 0.816                 |
|                                           | X3-9      | 0.683          |         |                       |
|                                           | X3-11     | 0.820          |         |                       |
|                                           | X3-12     | 0.727          |         |                       |
| **Y1. Sama Bajo Social relation to Bagai land-dwellers** | Y1-1      | 0.820          | 0.603   | 0.855                 |
|                                           | Y1-2      | 0.585          |         |                       |
|                                           | Y1-3      | 0.936          |         |                       |
|                                           | Y1-4      | 0.723          |         |                       |
| **Y2. Bagai land-dwellers social relation to Sama Bajo** | Y2-1      | 0.795          | 0.559   | 0.835                 |
|                                           | Y2-2      | 0.741          |         |                       |
|                                           | Y2-3      | 0.764          |         |                       |
|                                           | Y2-4      | 0.723          |         |                       |

| The Mantigola Sama Bajo social resilience model | Item code | Loading factor | AVE     | Composite Reliability |
|-----------------------------------------------|-----------|----------------|---------|-----------------------|
| **X1. Bagai land-dwellers objective well-being** | X1-1      | 0.733          | 0.555   | 0.934                 |
|                                               | X1-2      | 0.538          |         |                       |
|                                               | X1-4      | 0.498          |         |                       |
|                                               | X1-5      | 0.581          |         |                       |
|                                               | X1-7      | 0.609          |         |                       |
|                                               | X1-8      | 0.835          |         |                       |
|                                               | X1-10     | 0.895          |         |                       |
|                                               | X1-11     | 0.911          |         |                       |
|                                               | X1-13     | 0.699          |         |                       |
|                                               | X1-15     | 0.552          |         |                       |
|                                               | X1-16     | 0.980          |         |                       |
|                                               | X1-17     | 0.928          |         |                       |
| **X2. Subjective well-being of Sama Bajo**    | X2-1      | 0.936          | 0.881   | 0.936                 |
|                                               | X2-2      | 0.940          |         |                       |
| **X3. Objective well-being of Sama Bajo**     | X3-1      | 0.564          | 0.507   | 0.888                 |
|                                               | X3-4      | 0.804          |         |                       |
|                                               | X3-6      | 0.851          |         |                       |
|                                               | X3-7      | 0.772          |         |                       |
|                                               | X3-8      | 0.706          |         |                       |
|                                               | X3-9      | 0.587          |         |                       |
|                                               | X3-11     | 0.502          |         |                       |
|                                               | X3-12     | 0.822          |         |                       |
| **Y1. Sama Bajo Social relation to Bagai land-dwellers** | Y1-1      | 0.961          | 0.691   | 0.898                 |
|                                               | Y1-2      | 0.636          |         |                       |
|                                               | Y1-3      | 0.850          |         |                       |
|                                               | Y1-4      | 0.844          |         |                       |
Discussion

Several landmark studies observed that community social capital dimensions have been an important power with concerns to community-level of resilience capacities (Kerr 2018). In our research, after rigorous SEM examination among the Sama Bajo communities in WNP, it was discovered that social resilience is shaped by several endogenous latent variables. In general, the objective well-being of the boat-dwellers variables (X3) is strongest shaped by the Sama Bajo asset score of fishing catch technology (X3-6), Sama Bajo respondent formal education (X3-9); informal education level of respondent’s family members (X3-11), and Sama Bajo respondent’s household debt (X3-12). One of the most important findings in this paper is related to the X3-12. Many authors, for instance, described how the boat-dwellers have been involved in complicated indebtedness. The Sama fishers are truly considered the Punggawa-Sawi, through patron–client relationships, as a crucial source of assistance or, if necessary, informal social protection or a significant impact on dependent households’ ability to access and maintain the abundant benefits they can derive from the sea (McWilliam et al. 2021). Nevertheless, while the crew (Sawi) of the Punggawa are laboring directly for their patrons, the semi-independent fisher is, thus, somewhat better off in terms of income, autonomy, and a sense of well-being than the Sawi (McWilliam et al. 2021; Stacey et al. 2018). The indebtedness is also found in the Sama Bajo livelihood which relates to aquaculture, for instance in seaweed cultivation social relations (Aslan et al. 2022). The results are interesting and help to justify how to measure as well as improve the social resilience capacity of the boat-dwellers communities in the marine preserve area.

Subsequently, besides the objective welfare dimension, the Sama Bajo social resilience capacities are also formed by the communities’ subjective well-being namely the identity as a part of the Sea Nomads tribe (X2-1); and migration frequency (X2-2). Both of these variables are the core cultural value of the boat-dwellers communities. The influential work of (Stacey et al. 2018), gave rise to a renewed interest in the identity of the boat-dwellers which is other strongly

| Table 3 (continued) | Model constructs | Item code | Loading factor | AVE | Composite reliability |
|---|---|---|---|---|---|
| **The Mola Sama Bajo social resilience model** | | | | | |
| Y2. Bagai land-dwellers social relation to Sama Bajo | Y2-1 | 0.819 | 0.681 | 0.864 |
| | Y2-3 | 0.894 | | |
| | Y2-4 | 0.757 | | | |
| | | | | | |
| **The Lamanggau Sama Bajo social resilience model** | | | | | |
| X1. Bagai land-dwellers objective well-being | X1-5 | 0.570 | 0.621 | 0.886 |
| | X1-6 | 0.515 | | |
| | X1-8 | 0.940 | | |
| | X1-9 | 0.909 | | |
| | X1-17 | 0.899 | | |
| X2. Subjective well-being of Sama Bajo | X2-1 | 0.811 | 0.707 | 0.828 |
| | X2-2 | 0.870 | | |
| X3. Objective well-being of Sama Bajo | X3-1 | 0.865 | 0.592 | 0.849 |
| | X3-6 | 0.530 | | |
| | X3-9 | 0.848 | | |
| | X3-10 | 0.786 | | |
| Y1. Sama Bajo Social relation to Bagai land-dwellers | Y1-1 | 0.813 | 0.660 | 0.885 |
| | Y1-2 | 0.889 | | |
| | Y1-3 | 0.832 | | |
| | Y1-4 | 0.705 | | |
| Y2. Bagai land-dwellers social relation to Sama Bajo | Y2-1 | 0.723 | 0.576 | 0.844 |
| | Y2-2 | 0.731 | | |
| | Y2-3 | 0.755 | | |
| | Y2-4 | 0.822 | | |

Source: Primary data processed, 2019
Table 4  Discriminant validity of latent variables of Mola, Mantigola, and Lamanggau *Sama* Bajo social resilience models

| Code of constructs | X1  | X2  | X3  | Y1  | Y2  |
|-------------------|-----|-----|-----|-----|-----|
| X1                |     | √AVE = 0.853 |     |     |     |
| X2                | −0.192 |     | 0.169 | √AVE = 0.726 |     |
| X3                | −0.421 | 0.320 | 0.705 |     |     |
| Y1                | −0.382 | 0.313 | 0.570 | 0.717 | √AVE = 0.777 |
| Y2                | −0.421 | 0.320 | 0.705 |     |     |

The Mantigola *Sama* Bajo social resilience model

| Code of constructs | X1    | X2  | X3  | Y1  | Y2  |
|-------------------|-------|-----|-----|-----|-----|
| X1                |     | √AVE = 0.788 |     |     |     |
| X2                | 0.486 |     | 0.509 | √AVE = 0.769 |     |
| X3                | 0.560 | 0.679 | 0.526 | √AVE = 0.813 |     |
| Y1                | 0.374 | 0.617 | 0.368 | 0.645 | √AVE = 0.759 |
| Y2                | −0.421 | 0.320 | 0.705 |     |     |

The Lamanggau *Sama* Bajo social resilience model

| Code of constructs | X1    | X2  | X3  | Y1  | Y2  |
|-------------------|-------|-----|-----|-----|-----|
| X1                |     | √AVE = 0.788 |     |     |     |
| X2                | 0.486 |     | 0.509 | √AVE = 0.769 |     |
| X3                | 0.560 | 0.679 | 0.526 | √AVE = 0.813 |     |
| Y1                | 0.374 | 0.617 | 0.368 | 0.645 | √AVE = 0.759 |
| Y2                | −0.421 | 0.320 | 0.705 |     |     |

Source: Primary data processed, 2019

Fig. 4  Structural model of Mola *Sama* Bajo social resilience

Table 5  Structural Model of Mola *Sama* Bajo social resilience postulates, path coefficient, $T$-statistic $R$-square for endogen variables, and conclusion

| Postulates     | Path coefficient | $T$-statistic | $R$-square | Conclusion     |
|----------------|------------------|---------------|------------|----------------|
| X1 $\rightarrow$ Y1 | H5  | −0.421             | 3.583*       | 0.251          | Negative       | Supported      |
| Y1 $\rightarrow$ Y2  | H4  | 0.797             | 7.119*       | 0.629          | Positive       | Supported      |
| X1 $\rightarrow$ Z   | H1  | −0.116             | 0.978*       | 0.650          | Negative       | Unsupported    |
| Y1 $\rightarrow$ Z   | H2  | 0.645             | 3.292*       | 0.650          | Positive       | Supported      |
| Y2 $\rightarrow$ Z   | H3  | 0.067             | 0.457*       | 0.650          | Positive       | Unsupported    |

*) $T$-statistic $> 1.96$ The statistical significance level was set at $\alpha = 0.05$
subjective dimensions of their autonomy. According to the initial work, we postulate that the identity of being the land-dwellers as well as maintaining to be a *Sama* community is a source of the community’s social resilience. We assume, on the contrary, that if the *Sama* identity is too strong as well as leaving their identity as *Sama* or being *Bagai*, it can reduce the resilience capacity of the boat-dwellers. In light of this, human and financial assets and also cultural dimensions have created the social resilience capacity of the boat-dwellers community in WNP.

Besides the aforementioned, a closer look at an endogenous latent variable of *Sama* Bajo social relation to the land-dwellers (Y1) among all three islands concerning the *Sama* social resilience (Z) shows that the *Sama* has a great impact on the social resilience capacity of the boat-dwellers in the Mantigola and Lamanggau islands. This relationship is supported by the statistical analysis results presented in Tables 6 and 7. The results show that the *Sama* identity is positively correlated with the social resilience capacity of the boat-dwellers, with the statistical significance level set at $\alpha = 0.05$.
dependency on the land-dwellers who settle side by side with them. For instance, in Mola and Mantigola Sama Bajo communities, the social relation of Sama Bajo (Y1) has significantly shaped their social resilience (Z) with $t$-score $= 3.292; \ p = 0.645$ and $t$-score $= 6.87; \ p = 0.279$ in a row. Importantly, as it is presented in the structural model of Mola Sama Bajo (Fig. 4), although no direct significant association is found between both the objective economic well-being of land-dwellers (X1) and the social resilience dimension of the boat-dwellers (Z), the Y1 has been a catalyst for X1 to support the social resilience of the Sama Bajo community (Z) in the Mola through indirect association. On the structural model analysis, the X1 correlates with the Y1 albeit negative ($t$-score $= 3.583$ and $p = -0.421$). This is because mostly the low class of Mandati Bagai land-dwellers who are stapled food farmers and wholesalers in central Mola Market have an intimate relationship with the Mola Sama Bajo rather than the upper class of Mandati land-dwellers.

Essentially in the other two cases, the X1 showed a positive significant association with the Y1 variable. Take the Lamanggau Sama Bajo, who live together with the Tomia land-dwellers who are the high-skill demersal fishers as well as main producers of the staple food for the boat-dwellers on the island, as an example. In that case, the $t$-score of X1 to Y1 has shown a high association with a positive value path coefficient of 0.560. These results are in agreement with our expectations that the land-dwellers have a significant role, using the social-economic relation in both the Sama and the Bagai, in creating the social resilience of the boat-dwellers communities. Eventually, the relation among X1, Y1, and Z has confirmed what was recently suggested by the results (Richmond and Casali 2022) that several scholars have found concerning strong social capital in many different forms which is essential for a community to achieve sustainable livelihood, well-being, and economic growth.

Subsequently, only on Tomia Island, the occupation of the land-dwellers as a fisherman has a positive relationship with the Lamanggau Sama Bajo community. The technology of Sama Bajo fishing activity (X1-9), as a second-order construct of X1 (objective well-being), has a positive and strong correlation ($t = 0.909$) with the economics of Bagai Tomia land-dwellers (X1). This relation is a sign that identical livelihood can facilitate mutual interaction. This similarity has fostered Sama Bajo's social relation to the land-dwellers (Y1), and social resilience (Z). This relation encourages equal position, collective action between them, and improved sharing of knowledge for doing sustainable fishing activities like Tomia fishers do. This fact is similar to Bakker et al. (2019). His finding in the Orkney Islands that ties the fishermen together is, thus, their shared passion for the sea and a shared understanding of the adversity of their occupation, the challenges they cope with daily and the working mentality necessary to thrive in fisher livelihood. Through this shared understanding, fishers can achieve a sense of belonging to the community. Furthermore, Bakker et al. (2019) stated that this sense of belonging is reinforced by indicating the boundaries of the fisher community: those who do not support the same norms and values, or who are unable to cope with the severe working condition at sea, are outsiders and will not become a genuine part of the community.

Conversely to the Lamanggau, the Mola Sama Bajo loading factor values, we presented the negative correlation between the objective well-being of the Mandati land-dwellers (X1) to the Sama Bajo Mola social relation to the land-dwellers (Y1) and also for the Mola Sama Bajo social resilience (Z). Another most intriguing finding is that, in the Mola Sama Bajo structural modeling (Fig. 3 and Table 4) which is represented an urban Sama Bajo local social context, the result does not demonstrate a direct correlation between the social relation of the Bagai community to the Sama (Y2) to the Z endogenous latent variable ($t$-score $= 0.457; \ p = 0.067$). It means that in Mola Sama Bajo’s case, the bridging capital created by the Mandati
land-dwellers does not considerably work for strengthening Mola Sama Bajo’s social resilience. Comparing the results in both Mantigola and Lamanggau structural modeling, the Y2 has significantly associated with the Z (t-score = 11.72; \( p = 0.506 \) and \( t \)-score = 2.264; \( p = 0.165 \), respectively).

These findings demonstrate that the structural model may be a useful tool in assessing the social resilience of Sama Bajo and the social relation between the boat-dwellers and the homogenous land-dwellers communities. We commence with some examples of the Kalidupa land-dwellers and Tomia land-dwellers. Despite the success demonstrated the complex relationship among exogenous and endogenous latent variables, a significant limitation of the structural modeling is when they describe the urban local social context of Sama Bajo as revealed by Mola Sama Bajo who build their bridging capital to the heterogeneous land-dwellers. Particularly, we only focused on observing the Mandati land-dwellers who live closely to the Mola Sama Bajo and the majority of the land-dwellers in Wangi-wangi Island, and we overlooked other land-dwellers communities such as Lia and Waha land-dwellers. This has impacted the failure for confirming the role of land-dwellers in terms of causal pathways from their objective well-being (X1) as well as their social cohesion to the boat-dwellers (Y2) to strengthen the boat-dwellers social resilience (Z). Thereby, the limitation of this study must be considered in future studies. It is also important to take into account in future research for comparing these structural modeling of social resilience of Sama Bajo communities in a marine protected area and Sama Bajo who lives in an open resource area.

Despite this limitation, the findings of this study are important because those structural modelings have tried for quantifying the Sama Bajo subjective well-being (X2-3) dimensions which have been constructed by Stacey et al (2018) together with Sama Bajo objective well-being (X2-2). Importantly, this research is a stepping stone toward a more profound understanding of the role of land-dwellers capital not only in their objective well-being but also in their social capital to the boat-dwellers to form the Sama Bajo social resilience. Moreover, this research has found an innovative pathway for the Sama Bajo to improve their social and livelihood resilience in small islands by involving pre-existing bridging social capital between land-dwellers and the Sama Bajo as well as supporting collaboration management in a marine national park.

**Conclusion**

In summary, this novel study shows our contribution advances by revealing the critical significance of interdependency analysis to measure the social resilience of Sama Bajo communities. Using the three structural models of Sama Bajo social resilience, we present that using the community social capital perspective in the different levels of relationship based on the Bagai land-dwellers unique social contexts (X1, Y1, Y2), we have shown that the structural model works for examining social resilience (Z), specifically Mantigola and Lamanggau Sama Bajo who interact with homogenous land-dwellers, to be specific Kaledupa and Tomia land-dwellers, as well as a stepping stone to strengthen their social resilience capacity by taking into account social relation, livelihood, the human and financial capital of the land-dwellers in the marine preserve area. The main limitation, however, is inaccuracies when the structural modeling describes the urban local social context of Sama Bajo as indicated by Mola Sama Bajo, who built their bridging capital to the heterogeneous land-dwellers. Regarding the research results, future research should consider the limitation, particularly for urban Sama Bajo, by identifying varied land-dwellers who build social relations with the urban boat-dwellers. Equally important, similar work should be considered to validate the modeling in Sama Bajo communities who live in open access type. This is essential to examine whether other aspects emerge in Sama Bajo social resilience in the opposite type of marine preserve social context.

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