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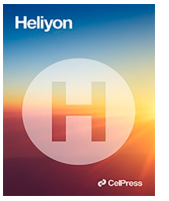

Research article

Improving small-scale fishermen's subjective well-being in Indonesia: Does the internet use play a role?

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ABSTRACT

The expansion of Internet access from urban to rural and coastal areas has changed all aspects of life, including lifestyles and work practices. Although several studies have shown that Internet use is essential in the fisheries sector, more information about the link between Internet usage and subjective well-being among small-scale fishermen is needed. This study is the first attempt to investigate the effect of Internet use on subjective well-being, particularly for small-scale fishers. This study used cross-sectional data from 220 respondents in East Java, Indonesia. Two-stage predictor substitution (2SPS) approaches were used to address the endogeneity issue in the estimation. The results revealed that fishing tools, access to credit, and region positively and significantly influenced small-scale fishers' determination to use the Internet. Savings and off-farm employment significantly and negatively affect adoption decisions. The main findings suggest that Internet use significantly increases small-scale fishermen's subjective well-being (proxied by happiness and life satisfaction). This suggests that improving the Internet infrastructure in coastal areas is needed to support economic activities in the fisheries sector and boost the well-being of small-scale fishers.

1. Introduction

The Internet has changed how people live, communicate, work, learn, and conduct business, and has driven the economy by enhancing productivity [1]. The Internet has transformed traditional industries, created new business models, and expanded markets [2]. It has fostered innovation, given rise to new sectors, and created job opportunities. Internet use is positively correlated with economic growth, stimulating development and innovation across all income groups, whether in urban or rural areas. The Internet has become a catalyst for economic progress, enabling a wide range of people to benefit from its advantages.

Moreover, previous studies have proven the benefits of the Internet on various economic outcomes. Internet use has been reported to improve rural household income and expenditure [1,3], increase farm productivity [4–6], prevent poverty [7], and enhance

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nutritional status [8]. Khan et al. [3] examined the impact of Internet use on farm income in Pakistan. This finding suggests that rural farmers' Internet use in Pakistan, such as online marketing and off-farm revenue, has increased their total income. In another study reported by Chaudhary and Suri Field [5], farmers who registered on India's Internet platform (such as an e-trading platform for agriculture commodities) increased the average wholesale price and the number of potential buyers. Likewise, Internet use positively impacts income and expenditure in rural households in China [1] and rural fish farming productivity in Ghana [4]. Nguyen et al. [7] found that Internet use helps reduce poverty by giving access to knowledge and other productive resources.

Broadband internet services allow households to use multiple information and communication technologies (ICTs), including smartphones, computers, and tablets, through wireless internet use. This enhances households' ability to access various ICTs concurrently and is viewed as crucial public infrastructure for social and economic development in the modern era. As a result, broadband internet networks have been extensively promoted through various telecommunication policies in developing countries. Internet use is perceived as an essential measure for boosting economic growth and improving social welfare [9]. Previous research has shown that the roles of Internet use and the Internet of Things (IoT) in fisheries are essential. Examples include using technology applications for collecting data and predicting sea pollutants in mussel farms in Italy [10], monitoring water quality in Malaysian fish ponds [11], supporting the self-management system in Japan's coastal fishery [12], using online marketing to create an alternative seafood market in Thailand [13] and Mexico [14], and using technology to share knowledge and ease communication between fishers' groups in the Rio de Aveiro coastal lagoon, Portugal [15]. Past research has also explored ways to promote fishermen's physical, financial, and knowledge capital to improve their quality of life [16].

Indonesia has 210 million Internet users in the second quarter of 2022, which is approximately 77.02% of the country's population [17]. The Internet is used for various purposes in Indonesia, with almost 90% of the users accessing social media and over 73% using online chats. However, only 21.26% of Internet users shop online, and 1.37% use e-money. This may be due to concerns about app security, such as mobile payments or e-wallet [18]. Despite these concerns, the Internet has become essential to people's lives and work in the digital age. Internet use has the potential to significantly increase rural household income levels in Indonesia [19]. However, previous studies in Indonesia have focused on digital transformation in the fishery sector, such as utilizing information technology for coastal development [20] and adopting technology-based strategies to improve fishermen's productivity [21,22].

Furthermore, many studies focus more on objective well-being measured from the economy, that is, productivity and income, than on subjective well-being. Currently, economic outcomes, such as income, poverty level, business management, and access to food, have been criticized for being narrow in terms of capturing quality of life and failing to consider non-financial factors such as happiness and life satisfaction. Consequently, researchers in related fields such as economics and social science have started examining how subjective well-being captures people's quality of life [23,24]. Subjective well-being (SWB) is the self-evaluation of emotions, perceptions, and feelings regarding the multidimensions of lives, and it is an essential predictor of health, wellness, and longevity [25,26].

Higher-income countries use psychological analysis more than lower-income countries, which rely more on income-based measures to assess living standards and prosperity. Previous studies have revealed the role of internet use in improving subjective well-being. The general finding of these studies is that Internet users have significantly higher subjective well-being than non-Internet users; however, the findings are mixed. For example, Viklund and Forsman [27] used data from a German Family Panel Study and suggested that Internet users (engaged in leisure and entertainment-related activities) among older adults in Finland and Sweden had a positive link to SWB. Similarly, Silva et al. [28] drew on data from various European countries and found that Internet users aged 50 years and above were less likely to feel lonely than non-users. This finding is further reinforced by Hong and Chang Field [29], who claimed that forestry farm households in China that use the internet are associated with higher household life satisfaction. Accordingly, Internet use has a higher impact on future subjective well-being among rural households than urban households in Vietnam [30]. Internet use offers opportunities to access information, consume items and online services, and develop skills faster, which can increase subjective well-being [31]. Zheng and Ma [32] suggested that their study on Internet-based application payments significantly increased the happiness of rural women in China. Similarly, smartphone use, which is related to Internet access, is positively correlated with greater life satisfaction and happiness, even after accounting for potential endogeneity [33].

In contrast, studies have also shown that Internet use negatively affects subjective well-being. However, Internet use-related tools in the workplace environment contradict employees' psychological well-being due to techno-stressors, skill mismatch, and work-life balance [34]. This finding is reinforced by Brailovskaia and Margraf [35], who used survey data from Germany between 2016 and 2019, and found that smartphone use (online media) was negatively associated with SWB in a large sample of university freshmen. Yilmaz and Karaoglan Yilmaz [36] also confirmed that most individuals use the Internet to escape real-life unhappiness, which may lead to problematic Internet use situations for parents in Turkey. Furthermore, Panova et al. [37] found that smartphone behavior for Internet use-related activities was linked to an increased risk of depression and anxiety among university students in the USA, Spain, and Colombia.

Nevertheless, the studies above focused on rural households in general [29–33], university students [35,37], older adults [27,28], parents [36], and employees [34]. However, the association between Internet use and well-being is unique across all countries and sectors. Factors such as access to reliable Internet infrastructure, digital skills, regulatory environments, and socio-economic conditions can influence the magnitude and nature of the relationship. Based on the author's knowledge, the literature overlooked studies examining the effect of Internet use on fishermen's subjective well-being. Rahman et al. [38] reveals that small-scall fishermen have unique characteristics, such as depending on marine resources as the primary source of their livelihood, being vulnerable to environmental change, and having limited access to technological innovation. Therefore, the impact of internet use on fishermen's subjective well-being could differ in geography, infrastructure, and sociocultural aspects, which could affect an individual's knowledge and perspectives [39].

Theoretically, Internet use can increase opportunities and improve well-being by establishing a social connection between

fishermen and digitalization (see Fig. 1). By leveraging the power of internet use, fishermen can broaden their horizons and build robust social relationships [2,34,40]. Based on the heuristic illustrated in Fig. 1, the study assumes that society's socio-demographic and economic condition affects fishermen's decision to use the Internet, thereby maximizing households' utility (denoted by SWB measures–happiness and life satisfaction). Personal characteristics such as capabilities, psychological functioning, culture, and beliefs are crucial in determining the extent of the different benefits [31]. Moreover, Indonesia, the largest archipelago country, is home to a diverse sociocultural population with varying levels of ICT infrastructure. Furthermore, government policies on agricultural and fisheries issues differ across provinces, districts, and cities [39]. Thus, studying the relationship between internet use and subjective well-being in developing non-Western cultures and archipelagic countries is exciting. This research note provides the first attempt to explore the link between Internet use and Indonesian small-scale fishermen's subjective well-being.

This study defines happiness as short-term subjective well-being derived from daily experiences such as successful fishing, connecting with nature, and accessing climate information [41]. On the other hand, life satisfaction represents fishermen's long-term subjective well-being and reflects their overall evaluation of life, including financial stability, job security, family support, and fulfilling goals and aspirations [41]. These two factors contribute to fishermen's subjective well-being and shape their perceptions of contentment and fulfillment in fishing. Furthermore, this study examines the differences in characteristics between fishermen who use the Internet and those who do not in Indonesia.

This study extends the existing literature in three ways. First, it examines the predictors of Internet use among small-scale fishermen to corroborate the results of prior research on Internet users in developing and archipelagic countries and extends the literature by focusing on small-scale fishermen as providers of food supplies for communities. Small-scale fishermen possess unique characteristics such as educational level [42], economic conditions, limited livelihood diversification options [43], and access to the Internet, which makes them interesting research subjects.

Secondly, this study supports the UN SDG "No One Left Behind," which aims to reduce inequality and improve mental health [44]. In developing countries, fishermen often encounter difficulties in accessing the latest technology and information, which can harm their chances of success [45]. Nonetheless, previous studies have demonstrated that the Internet can be instrumental in revolutionizing fisheries-related policymaking and yielding benefits for fishermen worldwide. Policymakers can leverage real-time updates on weather patterns, market trends, and innovative fishing techniques and tools to effectively and transparently communicate fishery development policies. Additionally, the Internet can foster knowledge sharing among fishermen, paving the way for collaboration and the exchange of best practices.

Third, this study employs two-stage predictor substitution (2SPS) to estimate the impact of Internet use on SWB among smallholder fishermen. The decision of fishermen to access the Internet can be influenced by observable factors (i.e., characteristics) and unobservable factors (i.e., motivation and skill) [46]. This issue results in an endogeneity problem in the estimation and cannot be neglected. Following Rahman et al. [47] and Nugroho et al. [48], this study addressed this issue using the 2SPS approach.

The study's findings are noteworthy because it estimates the effects of Internet use on happiness and life satisfaction through peer influence as an instrumental variable, providing insights into heterogeneous effects. The social and family groups' Internet users are instrumental variables in addressing the potential endogeneity of Internet adoption among small-scale fishers living in the communal sharing cycle. The findings are expected that promoting Internet access can be beneficial for economic optimism and positive attitudes in facing changing economic conditions. Finally, policymakers can use these insights to formulate policies that promote technology access in developing archipelagic countries.

The following sections of this paper are arranged in the following order: The methodology, including data, key variables, and empirical model used for the analysis, is presented in Section 2. Section 3 presents and discusses the empirical results, and the final section concludes the paper and proposes implications.

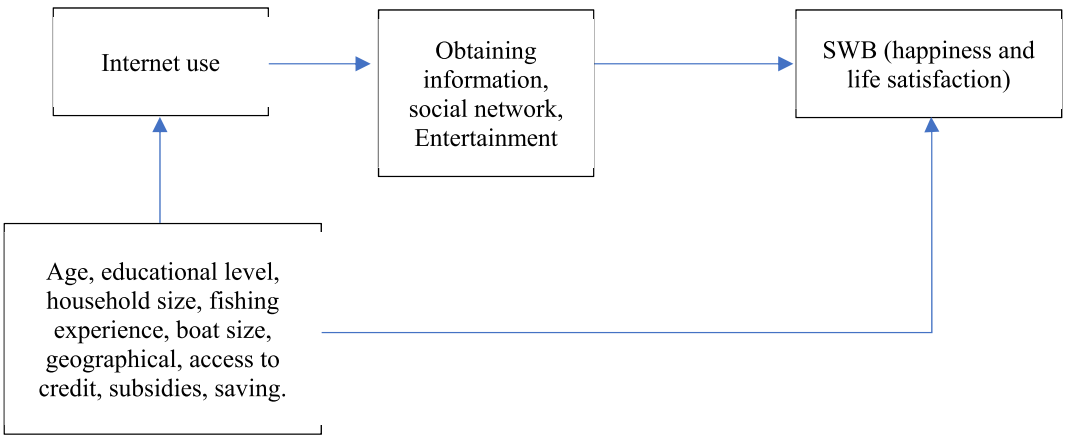

Fig. 1. Heuristics of the possible mechanism of Internet use on SWB by small-scale fishermen.

2. Methodology

2.1. Research data

Data were collected from 220 small-scale fishermen through a survey conducted in 2021. Using a multi-stage sampling technique, respondents were selected from two regencies with the highest fisheries production in East Java, Indonesia. First, we purposively selected two regencies: Probolinggo and Situbondo, as they have the most fishing communities [38] but low internet use. The sample areas were the main fishing ports in East Java, Paiton, and Mayangan in Probolinggo, and Besuki and Banyuglugur in Situbondo. They have comparative advantages in the fishery sector. Second, we purposively selected two central fishing villages in each regency based on data from the fishing port office. Then, assisted by fishing community leaders, we randomly selected 220 small-scale fishermen. The sample consisted of both Internet users and non-users.

The survey was conducted through face-to-face interviews with graduate students who speak Bahasa Indonesia and the local languages (Javanese and Madurese). The interview questions used in this study consisted of information on fishermen's characteristics, access to credit, off-farm employment status, Internet use status, happiness, and life satisfaction level. In terms of ethical considerations, the enumerators provided small-scale fishermen with a detailed explanation of the research before conducting interviews. Fishermen voluntarily agreed to participate, and consent was obtained from all participants for the research procedure. Additionally, we assured the respondents that the information was solely for academic purposes and that it would be kept confidential. This study was approved by the Institutional Review Board of the Universitas Negeri Malang's Research Ethics Committee. The data were cleaned to ensure consistency, correctness, and useable quality using Stata 14.

2.2. Internet use

This study defines Internet use as a dichotomous variable that assumes a value of 1 if a household has access to broadband Internet, and 0 otherwise. Unlike previous research that relied solely on smartphones or mobile phones [18,27,33], this study concentrates on broadband Internet use, as it provides distinct advantages, such as facilitating the use of multiple devices such as computers, televisions, smartphones, and tablets. Furthermore, wireless networks supported by broadband Internet allow all household members to enjoy the benefits of the benefits concurrently [1]. To ensure the robustness of the variable, this study ties the Internet use variable to peer influence, which may influence internet adoption. This study included 220 participants, comprising 135 Internet users and 85 non-users.

2.3. Subjective well-being (SWB)

SWB is the second key variable, defined as the personal identification of the value, reflection, and appreciation of one's life [26]. This includes life satisfaction and happiness, which capture the nonmonetary components of well-being. In this study, the life satisfaction and happiness variables were measured using a 5-point Likert scale. The question to measure life satisfaction is, "Generally, how would you rate your life satisfaction?" ranging from 1 (very unsatisfied) to 5 (very satisfied). Meanwhile, the question to measure happiness is, "How would you rate your current happiness?" ranging from 1 = very unhappy to 5 = very happy. This measurement follows past studies that evaluated fishermen's perceptions of subjective well-being [49–51].

2.4. Empirical model selection

This study explored whether and how Internet use affects life satisfaction and happiness among small-scale fishermen. Technology adoption, such as internet use, is often self-selected. The decision to adopt is influenced by observed characteristics, such as age, education, and access to credit, as well as unobserved factors, such as motivation and digital literacy [1,52]. In other words, internet use is potentially endogenous. The endogeneity issue needs to be addressed when examining the link between Internet use and SWB.

Several approaches have been employed to address the endogeneity issue, including the Endogenous Switching Regression (ESR) [53,54], Two-Stage Least Squares (2SLS) [55], Two-Stage Predictor Substitution [38,56], Recursive Bivariate Probit (RBP) model [57], and Endogenous Ordered Probit (EOP) [32]. Nevertheless, there are some requirements that must be fulfilled regarding the data scale used. For instance, ESR and 2SLS require continuous outcome variable to be continuous [53–55]. The Recursive Bivariate Probit (RBP) model and Endogenous Ordered Probit (EOP) both require treatment and outcome models to be dichotomous [32,57]. Finally, Two-Stage Predictor Substitution (2SPS) is flexible, as it can be applied to nominal, ordinal, censored, or continuous variables in both treatment and outcome models [38,56]. Therefore, since our treatment variable is dichotomous and the outcome is ordinal, the 2SPS is more appropriate.

In the first stage of 2SPS, a decision made by a small-scale fisher is specified as a binary model. The aim was to identify the factors influencing decision-making. The selection and outcome can be written explicitly as in Equation (1):

Internet adoption equation (probit model)

$$I_i^* = \alpha_i X_i + \beta_i IV_i + \varepsilon_i, with\ I_i = \begin{cases} 1, if I_i^* > 0 \\ 0, otherwise \end{cases} \quad (1)$$

where I_i^* is a latent variable representing the probability of a fisher i adopting the Internet. An observable dichotomous variable can

capture I_i^* with the value 1 if fishers i adopters the Internet, and 0 for non-adaptors; X_i are the control variables indicating the sociodemographic characteristics of the fisherman; IV_i is the instrumental variable; α_i and β_i are the parameters to be calculated, and ε_i are the random error terms. Following a previous study [33], 'peer influence' was used as an instrumental variable to identify the influence of the adoption decision. This question is, "Do your relatives/friends use the Internet?" with answers coded as 1 = yes and 0 = no. The rationale for using this variable as an instrument is the influence of a social reference group (family/friends) in decision-making, but this does not significantly affect the fisher's subjective well-being.

Based on Equation (1), we used the probit model to calculate the determinants of the adoption decision and to predict the endogenous variable (Internet use). At this stage, we used the predicted Internet use variable ($I_i^{predict}$) to replace the original value of Internet use from Equation (1). Next, we estimated the effect of Internet use on subjective well-being (SWB), proxied by life satisfaction and happiness, using an ordered probit model. Subjective well-being is assumed to be a function of Internet use and sociodemographic characteristics. SWB_i^j denotes the subjective well-being of the respondent i has a specific level in terms of life satisfaction ($j = 1$) and happiness ($j = 2$); that is determined by a categorical variable SWB_i^j and limits $C_1, C_2, \ldots, C_{K-1}$, happiness and satisfaction $C_1 < C_2 < \ldots < C_{K-1}$. X_i is a previously defined variable; γ, ξ are parameters to be estimated; and e_i is a random error term. Hence, the specific model can be formulated as Equation (2):

Subjective well-being equation (ordered probit model)

$$SWB_i^j = \gamma I_i^{predict} + \xi X_i + e_i, with\ SWB_i^j \begin{cases} 1\ if\ SWB_i^j \le C_1 \\ 2\ if\ C_1 < SWB_i^j \le C_2 \ldots \\ K\ if\ C_{K-1} \le SWB_i^j \end{cases} \quad (2)$$

3. Results and discussion

3.1. Descriptive statistics

Table 1 presents the variable definitions and the descriptive statistics used in the empirical analysis. The results show that about 61.4% of small-scale fishermen from Probolinggo and Situbondo use the Internet. The mean age of the study sample was 45 years, and the mean education level was 6.51 years (graduating from primary school, which takes six years). The mean values were 2.81 (life satisfaction) and 2.69 (happiness). This finding suggests that the SWB of small-scale fishermen in Indonesia is relatively good, in line with a previous study in Indonesia [58]. On average, respondents have been fishermen for 23 years, using a 2,7-gross-tonnage (GT) boat with one or two fishing tools. Some (39.5%) had another job outside the industry. Only 24.1% of respondents received government subsidies. More than half (59%) had savings, but only 41.8% had access to credit in financial institutions, which can be considered low. Finally, the distance to the fishing port was approximately 8 km.

The mean differences in the selected variables between Internet users and non-users are summarized in Table 2. Counterintuitively, Internet users' mean life satisfaction and happiness scores were not significantly different from those of non-users. However, these findings cannot be used to describe the relationship between internet use and SWB. The comparison of the mean values did not eliminate confounders that affected the relationship.

Meanwhile, the sociodemographic variables showed a significant difference between Internet users and nonusers. Internet users

Table 1
Definition and descriptive statistics for the variables.

Variables	Measurement	Mean	SD
Treatment variables			
Internet	Dummy; 1 if the fishermen uses Internet; 0 otherwise	0.614	0.488
Outcome			
Life satisfaction	A five-scale measurement from 1 = not at all satisfied to 5 = very satisfied	2.805	1.160
Happiness	A five-scale measurement from 1 = very unhappy to 5 = very happy	2.686	1.145
Control variables			
Age	Fishermen age (in years)	45.300	10.733
Family member	Total family member (person)	3.527	1.108
Education	The schooling years of fishermen (years)	6.505	2.853
Fishing experience	Experience in fishing activities (in years)	23.182	11.205
Boat size	Size of fishing boat (gross tonnage)	2.782	1.638
Fishing tool	Number of fishing tools owned (unit)	1.723	2.922
Subsidies	Dummy, 1 if the fishermen receive a government subsidy; 0 otherwise	0.241	0.429
Access to credit	Dummy, 1 if the fishermen have access to financial credit (micro finance, cooperative and bank); 0 otherwise	0.418	0.494
Saving	Dummy, 1 if the fishermen have saving; 0 otherwise	0.591	0.493
Off-farm employment	Dummy, 1 if the fishermen have off-farm employment outside capture fisheries; 0 otherwise	0.395	0.490
Region	Dummy, 1 if fishermen resides in Probolinggo; 0 if fishermen resides in Situbondo	0.500	0.501
Distance to the fishing port	Distance between the fisherman's house to the fishing port (Kilometer)	8.129	8.695
Instrumental variables			
Peer influence	Dummy, 1 if social reference group (family/friends) are internet users; 0 otherwise	0.409	0.493

Source: Survey results, 2021.

Table 2
Mean Difference of selected variables between fishermen who Internet user (IU) and non-internet users (NIU).

Variables	Internet user (IU) n = 135	Non-Internet users (NIU) n = 85	Mean differences	t-value
Life satisfaction	2.867	2.706	0.161	1.001
Happiness	2.674	2.706	−0.032	−0.200
Age	44.696	46.259	−1.563	−1.052
Family member	3.541	3.506	0.035	0.227
Education	6.785	6.059	0.726	1.849*
Fishing experience	21.822	25.341	−3.519	−2.290**
Boat size	2.874	2.635	0.239	1.053
Fishing tool	2.289	0.824	1.465	3.727***
Subsidies	0.259	0.212	0.047	0.800
Access to credit	0.570	0.176	0.394	6.231***
Saving	0.504	0.729	−0.226	−3.386***
Off-farm employment	0.230	0.659	−0.429	−6.980***
Region	0.607	0.329	0.278	4.152***
Distance to the fishing port	7.946	8.420	−0.474	−0.393
Peer influence	0.548	0.188	0.360	5.633***

Note: *$p \leq 0.10$, **$p \leq 0.05$.

have higher levels of education, fewer years of fishing experience, more fishing tools, a higher chance of accessing credit, fewer savings, and no off-farm employment. At the regional level, there are also significant and positive differences between Internet users and nonusers. Overall, the findings confirmed that small-scale fishermen's decisions to use the Internet and SWB are influenced by various confounding factors. It should be noted that the mean differences are not sufficient to conclude the effect of Internet use on SWB, because these analyses do not control for confounding attributes. Therefore, a rigorous econometric approach, such as the 2SPS model, was applied to estimate the actual effects of Internet use on SWB of small-scale fishermen.

3.2. Empirical results

3.2.1. Predictors of internet use among Small-scale Fishermen

The first stage of the 2SPS estimation explored the predictors of Internet use among small-scale fishermen, as presented in Table 3. The results reveal that the ownership of fishing tools significantly and positively impacts Internet use, followed by access to credit, region, and peer influence. Savings and off-farm employment negatively and significantly affect internet use.

The coefficient of the fishing tool variable is positive and statistically significant at the 1% level, suggesting that fishermen with fishing tool ownership are more likely to use the internet. Previous studies have shown that small-scale fishermen earn significantly more income when they can leverage suitable fishing tools [22,59]. Fishermen with more tools tend to have a higher income, so they can afford Internet devices and access.

Surprisingly, access to credit has a positive and statistically significant impact on Internet use, suggesting that the more credit received, the more likely a small-scale fisher is to use the Internet. A tentative explanation is that fishermen may use the loans they

Table 3
Parameter estimates from the probit model for estimating determinants.

Variable	Probit Dummy Internet Use		$p > \|z\|$
	Coef.	Std. Err	
Age	−0.008	0.015	0.613
Family member	0.031	0.092	0.734
Education	0.001	0.045	0.975
Fishing experience	−0.004	0.013	0.768
Boat size	0.042	0.114	0.711
Fishing tool	0.128	0.051	0.012***
Subsidies	−0.197	0.302	0.514
Access to credit	0.726	0.242	0.003***
Saving	−0.779	0.253	0.002***
Off-farm employment	−1.513	0.254	0.000***
Region	0.729	0.313	0.020**
Distance to the fishing port	0.010	0.020	0.618
Peer influence	0.943	0.242	0.000***
Cons.	0.488	0.810	0.547
Log likelihood	−85.026		
LR chi2(13)	123.470		
Prob > chi2	0.000		
Pseudo R2	0.421		
Obs.	220		

Note: **$p \leq 0.05$, ***$p \leq 0.01$.

receive to access the Internet. They enhance their knowledge and skills by learning from online platforms or by finding new technology and fishing tools. This is similar to the finding in a study by Twumasi et al. [4], who showed that fishermen in Ghana use the Internet to access financial services.

Savings and off-farm employment had a negative and significant impact on Internet use. Having a side job and attempting to save money reduce the probability of Internet use. A possible explanation is that the side job is offline, so fishermen do not have enough time and urgency to access the Internet. Internet penetration varies in every region [29], including Indonesia. In terms of region, fishermen in Probolinggo use the Internet more than those in Situbondo. Finally, for the peer influence variable, the results show a positive and statistically significant coefficient, suggesting that Internet use by friends, relatives, or neighbors influences adoption decisions, which also confirms the instrumental variable's validity in previous studies [1,33].

3.2.2. The impact of internet use on Small-scale Fishermen's subjective well-being

This study estimated the impact of using the Internet on the subjective well-being of fishermen (Eq. (2)). The results are presented in Table 4, specifically in the first row of the second column for life satisfaction and in the first row of the third column for happiness. This finding indicated a positive and statistically significant effect on happiness and life satisfaction at the 1% level. This implies that fishermen who use the internet are happier and more satisfied with their lives. Hence, they have higher subjective well-being than those who do not use the internet.

This finding supports the results of previous studies by Liang and Li [30] in Vietnam. [60], Li and Zhou [51], and Lei et al. [61] in China; Viklund and Forsman [27] in Finland and Sweden; and Omar [62] in Malaysia. According to these studies, Internet usage can empower fishermen to contribute more to their communities and environment, which, in turn, leads to increased happiness and life satisfaction. Fishermen's subjective well-being can be improved by gaining access to communication and fisheries-related information, allowing them to learn and share their fishing-related problem solving and other needs, which could make them happier and more satisfied with their lives. The Internet also provides a practical and time-saving communication tool for fishermen to connect with family members, fishing communities, and business partners [51].

This study's findings have important theoretical and practical implications. First, previous research has shown that internet use does not significantly impact subjective well-being (SWB). However, the frequency of Internet use can significantly improve SWB [63]. This suggests that the relationship between Internet use and SWB is complex and uncertain [64]. One possible reason is that people self-select to become Internet users or non-users, making the decision to use the Internet potentially endogenously. Therefore, when exploring the association between internet use and SWB, it is essential to address this potential endogeneity. The empirical findings of our study suggest that Internet use, as estimated by the existence of social reference groups among fishermen, can enhance well-being. This highlights the importance of education and training on Internet use among coastal communities to reduce the digital divide and accelerate the achievement of SDG that focus on improving the quality of life.

Second, this study offers valuable insight into promoting subjective well-being, not only for urban, rural, or farmers, but also for other vulnerable societies, such as fishermen in developing countries with the same characteristics, an archipelago country, or having a blue economy potential, which has rarely been explored. Finally, since subjective well-being has been linked to socioeconomic

Table 4
The impact of internet use on small-scale fishers' subjective well-being.

Variables	2SPS	
	Life satisfaction (coefficients)	Happiness (coefficients)
Internet predict	0.516 (0.166)***	0.471 (0.166)***
Age	0.010 (0.009)	0.004 (0.009)
Family member	−0.009 (0.068)	−0.060 (0.068)
Education	0.098 (0.030)***	0.064 (0.029)**
Fishing experience	0.016 (0.008)**	0.002 (0.008)
Boat size	−0.004 (0.070)	−0.061 (0.070)
Fishing tool	−0.067 (0.033)**	−0.020 (0.033)
Subsidies	0.070 (0.195)	−0.059 (0.195)
Access to credit	−0.458 (0.216)**	−0.627 (0.218)***
Saving	0.270 (0.197)	0.353 (0.197)*
Off-farm employment	1.102 (0.313)***	0.883 (0.310)***
Region	−0.166 (0.257)	−0.272 (0.255)
Distance to the fishing port	0.009 (0.011)	0.002 (0.011)
Cut1	0.637 (0.530)	−0.626 (0.512)
Cut 2	1.854 (0.532)	0.651 (0.509)
Cut 3	2.780 (0.540)	1.585 (0.517)
Cut 4	3.255 (0.551)	1.882 (0.521)
Log likelihood	−302.870	−299.005
LR Chi2(13)	39.330	21.880
Prob > Chi2	0.000	0.057
Pseudo R2	0.061	0.035
Obs.	220	220

Note: *$p \leq 0.10$, **$p \leq 0.05$, ***$p \leq 0.01$.
Standard errors are presented in parentheses.

indicators, geographical factors can be integrated into programs to reduce inequalities.

3.2.3. The impact of control variables on Small-scale Fishermen's subjective well-being

The second stage of the 2SPS estimation also examined the impact of the control variables on fishermen's subjective well-being. The results show that the variables affect both SWB indicators, life satisfaction and happiness. More specifically, fishing experience and fishing tool variables only affect life satisfaction, while savings affect happiness. Other variables, such as age, number of family members, boat size, subsidy, region, and distance to the fishing port, did not affect life satisfaction and happiness.

However, an interesting result was that fishermen's years of formal education were strongly associated with happiness and life satisfaction. The variable positively and significantly affects SWB at the 5% level. In general, long education periods significantly affect happiness and life satisfaction, in line with Anna et al. [58], who stated that education affects happiness more significantly than health and marital status in Indonesia, among both fisher and non-fisher communities. Regarding Internet use, educated fishermen can optimize the internet for knowledge and skill upgrades, which can contribute to increased life satisfaction and happiness. Correspondingly, Long et al. [65] reported that combining Internet access and education periods might compensate for the lack of education on psychological well-being in China's non-agricultural and agricultural hukou holders. In contrast, Rahman et al. [66] reported that the level of education has a significant effect only in urban areas compared to rural areas, with mostly fishermen or farmers tending to have low levels of education. Considering this study, it is possible that fishermen with higher education levels have a higher prestigious social status.

The fishing experience variable significantly affected life satisfaction, suggesting that experience leads to long-term well-being. This may be because experienced fishers tend to be more productive. For example, Twumasi et al. [4] showed that experienced aquaculture farmers in Ghana had a high level of agricultural productivity. Meanwhile, for short-term happiness, the impact of the experience may vary depending on the quality of the fishing day [14]. By contrast, the fishing tool variable had a significantly negative effect on life satisfaction. Therefore, fishermen tend to use fishing gear that they are familiar with. A previous study in southern Benin found that familiar fishing gear and methods play an essential role in shaping life satisfaction [50].

Access to credit from a formal institution has a significant coefficient, suggesting that it may reduce life satisfaction. Table 4 shows that access to credit is negatively related to fishermen's subjective well-being [67]. This finding may reflect the issue of microcredit systems in developing countries, as shown in a study by Bhuiyan and Ivlevs [68] on rural households in Bangladesh. The results reveal that microcredit loans caused anxiety, which reduced life satisfaction. In contrast, objective well-being may explain another possibility that fishermen feel burdened by debt because they tend to use it only for consumption. Proctor and Anand [69] offer one explanation for the existence of unhappy borrowers and argue that borrowers' use of credit is likely essential for their objective well-being. For example, studies by Zheng et al. [6] on banana farmers in China and farmers in Ghana by Issahaku and Abdulai [70] reported that credit accessibility helps farmers obtain essential capital to boost their productivity.

By contrast, savings have a positive coefficient and significantly impact happiness. The positive impact on short-term subjective well-being is likely because fishermen can use their savings when needed. A study by Chen et al. [71], involving households in China, revealed that household savings impact subjective well-being in an inverted U-shape. Saving is financial capital that increases fishermen's happiness by providing financial support when there is an urgent or unexpected financial need. However, at some point, when savings are spent continuously, the positive impact on subjective well-being declines, which translates into declining long-term subjective well-being (life satisfaction). A study by Jabeen and Khan [72] confirms this finding, stating that saving only increases subjective well-being at the beginning of the survey years (from 1995 to 1998) but has an insignificant impact over time (from 1999 to 2014).

The coefficient of off-farm employment is significant and positive (see Table 4). This result means that small-scale fishermen with jobs other than fishing tend to be happier and more satisfied with their lives. Jobs in the fisheries sector are high-risk because workers may have to handle heavy equipment, are prone to injury, face uncertain weather, and have high workloads [58]. A previous study in Norway by Haugen and Blekesaune [73] showed that farm women associate off-farm work with higher quality of life. Health is an essential indicator for assessing women's level of life satisfaction. In addition, Kousar and Abdulai [74] showed that farmers with off-farm work can earn more income for physical investments, such as land and agricultural tools, which can increase their agricultural productivity. As they gain more income, their happiness increases [75].

4. Conclusion

This study investigated the effect of Internet usage on small-scale fishermen's perceived happiness and life satisfaction in Indonesia. To overcome the endogeneity issue arising from both observed and unobserved factors associated with Internet use, we use a 2SPS model.

Our study showed that there are systematic differences between Internet and non-Internet users. Small-scale fishermen are encouraged to use the Internet through factors such as access to credit, geography based on region, and fishing tools. However, savings and off-farm employment were found to negatively influence their decision to use the Internet. The empirical results indicate that the subjective well-being of small-scale fishermen, including happiness and life satisfaction, is positively affected by Internet use. The basic characteristics of fishermen, such as education, off-farm work, savings, and fishing experience, were found to positively and significantly impact their subjective well-being. Conversely, access to credit and fishing tools undermined subjective wellbeing.

Our findings generally highlight a positive relationship between Internet use and the subjective well-being of small-scale fishermen, which underscores the need for policies promoting the regional coordination of Internet strategies for coastal development. Further interventions and policy programs are necessary to improve internet services and telecommunication infrastructure. Such actions

could positively impact the economy and quality of life as well as encourage technological innovation and training. By enhancing Internet services and telecommunication infrastructure, the use of the Internet can be fostered, which, in turn, can lead to increased economic productivity. Moreover, it can facilitate better access to educational and research resources, thus contributing to advancing knowledge and skills. Therefore, it is important to prioritize the development of Internet services and telecommunications infrastructure to promote growth and progress in various sectors.

This study had some limitations. These limitations highlight interesting avenues for future research. First, since the analysis is based on cross-sectional data, it is not possible to accurately determine the dynamic impact of Internet usage on fishermen's subjective well-being. Despite this, the study provides valuable empirical evidence from small-scale Indonesian fishermen. Future longitudinal studies are required to draw more precise conclusions regarding the relationship between internet usage and subjective well-being. Second, according to Liang and Li [30], there is a close relationship between people's well-being and the accuracy of their self-reported use of digital technology. These findings emphasize the importance of considering differences in the degree of the digital divide, such as the skills and abilities required to use ICTs or take advantage of them, which could affect the multidimensional well-being of fishermen's households.

Ethics approval and consent to participate

The paper is part of research involving the participation of several small-scale fishermen. In Indonesia, their age is considered to be adulthood; therefore, neither their parents nor a legal guardian's permission is required. The fishermen voluntarily agreed to participate, and consent was obtained from all participants for the research procedure. The ethical research committee of Universitas Negeri Malang reviewed the research questionnaire regarding the institutional review board statement number 21.12.1/UN32.20/PB/2023.

Data availability statement

The data supporting this study's findings are available from Moh Shadiqur Rahman upon reasonable request.

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CRediT authorship contribution statement

Rizky Dwi Putri: Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Moh Shadiqur Rahman:** Resources, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Annur Ahadi Abdillah:** Writing – review & editing, Methodology, Investigation, Funding acquisition, Formal analysis. **Wen-Chi Huang:** Writing – review & editing, Supervision, Resources.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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