sustainability

MDPI

Article

A Lasso and Ridge-Cox Proportional Hazard Model Analysis of Thai Tourism Businesses' Resilience and Survival in the COVID-19 Crisis

Supareuk Tarapituxwong [1], Namchok Chimprang [2], Woraphon Yamaka [2,*] and Piangtawan Polard [1]

[1] Faculty of Management Sciences, Chiang Mai Rajabhat University, Chiang Mai 50200, Thailand; supareuk_tar@cmru.ac.th (S.T.); piangtawan_pol@cmru.ac.th (P.P.)
[2] Center of Excellence in Econometrics, Faculty of Economics, Chiang Mai University, Chiang Mai 50200, Thailand; namchok_c@outlook.co.th
* Correspondence: woraphon.econ@gmail.com; Tel.: +66-869226467

Abstract: This study aims to investigate the factors contributing to the survivability of Thai tourism businesses during the COVID-19 pandemic. In December 2021, a comprehensive survey was conducted among 400 tourism businesses across Thailand, coinciding with the heightening impact of the ongoing COVID-19 crisis. The study explores the perceptions of tourism businesses regarding the impact of COVID-19 and its influence on their chances of survival. To address this issue, the study employs the Lasso and Ridge Cox proportional hazards models. The findings reveal several significant factors. Firstly, businesses located in the Southern region, operating without physical premises and generating a substantial annual net income, face a lower risk of failure. Secondly, implementing strategies that prioritize consistent working hours and regular schedules, and reducing reliance on part-time employees, positively contribute to survival chances. Additionally, governments can effectively monitor high-risk businesses based on entrepreneurs' perception of failure risk and offer targeted assistance. Moreover, businesses targeting domestic tourists and engaging in import and export activities within their supply chains demonstrate higher survivability rates. The availability of raw materials and entrepreneurs' anticipation of a longer recovery time also play crucial roles in business survival. Government relief measures, such as tax relief and reduced Social Security Fund contributions, effectively increase the probability of business survival. Finally, timely adaptations and support within the initial period of from six months to a year are essential for building resilience in the face of challenges.

Keywords: lasso and ridge; business survival; tourism; COVID-19 pandemic; Cox proportional hazards model; Thailand

Citation: Tarapituxwong, S.; Chimprang, N.; Yamaka, W.; Polard, P. A Lasso and Ridge-Cox Proportional Hazard Model Analysis of Thai Tourism Businesses' Resilience and Survival in the COVID-19 Crisis. *Sustainability* **2023**, *15*, 13582. https://doi.org/10.3390/su151813582

Academic Editor: Kittisak Jermsittiparsert, Thanaporn Sriyakul, Krisada Chienwattanasook and Guido Perboli

Received: 16 August 2023
Revised: 4 September 2023
Accepted: 8 September 2023
Published: 11 September 2023

1. Introduction

In the aftermath of the global COVID-19 pandemic, businesses across various sectors have confronted unprecedented challenges. Although we have transitioned into the post-epidemic period, the enduring impact of the crisis on businesses and industries cannot be disregarded. Extensive research continues to explore the pandemic's effects on various aspects of the economy, encompassing financial distress, digitalization, market dynamics, and performance [1–5]. This body of evidence underscores the ongoing relevance and significance of studying the resilience and survival of businesses in the post-epidemic phase. Among the hardest-hit industries, the tourism sector necessitates a comprehensive examination of the factors that contribute to the resilience and survival of tourism businesses. Accordingly, our study specifically analyzes the resilience and survival of Thai tourism businesses during the COVID-19 crisis, employing advanced statistical models to provide valuable insights that can inform recovery strategies and contribute to the industry's long-term sustainability. By scrutinizing the strategies and adaptations implemented

by Thai tourism businesses amidst the crisis, we strive to make meaningful contributions to the development of effective frameworks for managing future challenges.

The adoption of pandemic prevention measures during the initial quarter of 2020 has unleashed an unprecedented wave of economic turmoil on a global scale. Developing nations heavily reliant on hospitality-based economies have borne the brunt of this impact, resulting in the widespread collapse of firms across borders [6,7]. Thailand has not been spared, as its vibrant tourism industry within the service sector has suffered immensely. Despite Thailand's immense potential to emerge as a leading global tourism destination, a fact supported by the United Nations World Tourism Organization's report highlighting it among the top 10 countries in terms of tourism visits and earnings, the industry's formidable contribution of approximately 11% to the nation's GDP [8] has been considerably hampered. The repercussions have been staggering, with revenues plummeting and the number of foreign tourists dwindling to a meager figure of fewer than 200,000 in 2020 and 2021, in stark contrast to the annual tally of over 30,000,000 during pre-pandemic years [9]. Against this backdrop, this study adopts a dynamic capabilities perspective to delve into the strategies employed by Thai tourism businesses to survive the prevailing COVID-19 crisis. Moreover, an essential aspect of this research entails evaluating the probability of business failure at any given point during the survey's follow-up period, while considering specific risk factors. This endeavor assumes the utmost importance as it enables the formulation of appropriate policies and recommendations aimed at bolstering and fortifying businesses during this ongoing crisis. In pursuit of these objectives, the Cox proportional hazards model [10] is employed to undertake a meticulous survival analysis of Thai tourism businesses.

The tourism industry in Thailand encompasses a diverse range of enterprises, such as hotels, travel agencies, transportation, food and beverage, souvenir shops, entertainment, and rural tourism, among others. Undeniably, further development of this industry will positively impact various other business sectors. However, Thailand's tourism industry has faced numerous challenges over the past two years, particularly a significant reduction in revenue and tourist inflows due to the pandemic. Unfortunately, this has resulted in the permanent closure of several business establishments [11]. Nonetheless, by implementing effective adaptation strategies and operational characteristics, certain tourism-related enterprises were able to weather the coronavirus crisis.

As the coronavirus has directly affected financial stability and tourist numbers, certain enterprises have adjusted their employment by reducing working hours or laying off employees. Some have also implemented changes in their business models, such as shortening working hours and days, adapting to social distancing measures, and transitioning into novel and high-demand products and services. Additionally, some businesses have chosen to operate through online markets or social media to maintain their market presence.

With the ultimate goal of preserving the financial stability and continuity of these enterprises, the Thai government aimed to alleviate the consequences of the COVID-19 pandemic on the tourism industry by launching a comprehensive set of relief measures, including soft loans, tax deductions, and relaxations, and additional benefits for domestic tourism. However, the substantial heterogeneity in survivability due to COVID-19's impact differs across tourism companies, which can be attributed to a range of factors, such as differences in their organizational characteristics, adaptation strategies, employment practices, and logistic chains, while government schemes to mitigate the impact may benefit some companies but not others [12].

Numerous previous studies have examined the significant survival factors for enterprises during the COVID-19 pandemic. For example, Leurcharusmee et al. [7] have shown that the survival of Micro- and Small Enterprises (MSEs) largely depends on factors such as location, number of employees, and business model adjustments, including social distancing measures and online marketing. Similarly, Yamaka et al. [6] focused on the impact of COVID-19 on MSMEs in Chiang Mai, Thailand. Their findings highlighted that the size of the business and government support initiatives, such as debt restructuring,

extensions for tax payment deadlines, and reduced social security contributions, played a significant role in extending the survival duration of non-surviving MSMEs. Farooq et al. [13] proposed an integrated approach in Supply Chain Operations Management that combined Industry 4.0 technologies, resilience strategies, and sustainability measures to effectively address the challenge of survival during a pandemic. Notably, the tourism industry faced a myriad of obstacles during the COVID-19 crisis, including a steep decline in demand, substantial profit losses, and severe disruptions in supply chains, as observed by Shafi et al. [14]. However, it was observed that enterprises capable of agilely adapting their products and services to meet evolving consumer demands and swiftly adjusting to new regulations and health guidelines demonstrated a higher likelihood of survival [15]. Furthermore, companies endowed with robust financial reserves, access to credit facilities, or the ability to swiftly curtail costs were better positioned to withstand the adverse economic consequences of the pandemic [16]. In a similar vein, Brunelli et al. [17] advocated that enterprises should exercise caution when altering their target customer base while modifying their value proposition during such crises, as these actions could have detrimental effects on overall business performance. Moreover, Sigala et al. [15] argued that enterprises receiving governmental support in the form of loans, grants, or tax relief exhibited a higher probability of survival. The significance of governmental policies in indirectly mitigating the pandemic's impact on small and medium-sized enterprises (SMEs) was elucidated by [18]. However, it is important to note that the implementation of lockdown measures by several countries resulted in the temporary or permanent cessation of operations for numerous enterprises, as revealed by Gregurec et al. [19].

The primary aim of this study is to empirically investigate the probability of business failure within the tourism industry, placing emphasis on an array of influential risk factors. These encompass a range of firm-specific characteristics [14,16,20], strategic adaptations implemented in response to the crisis [15,21], considerations related to target customer dynamics [17], intricate supply chain complexities [13,15], labor market dynamics [7], and the nuanced role of government support policies [18,19]. By meticulously examining these factors, this research endeavors to provide deeper insights into the underlying determinants of business survival and resilience in the tourism sector. These factors are essential in developing and refining appropriate policies to support businesses effectively during this unprecedented crisis. Furthermore, if the COVID-19 pandemic subsides and the tourism industry experiences a recovery, the findings of this study can serve as a crucial guideline for the government to promptly restructure the sector and align it with the new normal behavior of tourists. The study's insights can also aid tourism entrepreneurs in adjusting their business strategies to reflect the evolving preferences of travelers worldwide.

To accomplish this goal, this study employs the Cox proportional hazards model [10] along with the nonparametric Kaplan–Meier estimator [22] to identify the vulnerable Thai tourism-related enterprises who could not sustain their operation the in the first 12 months of the COVID-19 pandemic. This model can analyze the study's survey data by focusing on the factors that supported or hindered the survivability of Thai tourism-related enterprises during the COVID-19 crisis. Additionally, this study categorized supporting or inhibiting survival factors into six major factors, each with at least three minor parameters.

However, in the context of our high-dimensional data, conventional Cox linear regression models may encounter limitations due to multicollinearity issues, resulting in unstable and unreliable parameter estimates. To overcome these challenges, we propose the utilization of Lasso and Ridge penalty techniques to enhance the performance of the conventional Cox proportional hazards model. Ridge regression addresses multicollinearity concerns by effectively handling correlated predictors, while the Lasso technique is particularly adept at selecting the most relevant predictors by shrinking or eliminating coefficients of variables that do not significantly contribute to the model [23]. These techniques have demonstrated efficacy in various research domains in improving survival regression analysis. For instance, Xu et al. [24] applied a Lasso-based Cox proportional hazards model to predict patient survival in cases of synchronous colorectal carcinomas based on the

Surveillance, Epidemiology, and End Results (SEER) database. Arashi et al. [25] proposed a ridge regression approach for genome regression modeling to address multicollinearity and outliers in the dataset. Additionally, Dang et al. [26] and Salerno and Li [27] developed novel approaches for feature selection, survival prognostication, and penalized models tailored to the analysis of high-dimensional survival data. These advancements aim to overcome the limitations associated with classical survival regression models, which may be challenging to fit or prone to overfitting, leading to a diminished predictive performance.

Our paper makes a significant contribution to the expanding body of literature that examines the profound ramifications of the COVID-19 pandemic on the real economy, with a specific focus on the tourism sector. While studies in recent years have shown a growing interest in research on COVID-19's impact on businesses, there has been limited exploration of its effects on the survival probability and length of survivability of tourism enterprises. The expected time to failure of tourism businesses, defined as the duration between the time of the interview and the cessation of their operations, has not been explicitly addressed. The existing literature has mainly relied on descriptive statistics to explore the consequences of COVID-19 [14], which fails to provide a comprehensive understanding of the actual impact. In contrast, our study takes advantage of recent financial statements and economic data to conduct a comprehensive evaluation of the impact of COVID-19 on the performance of tourism firms, utilizing precise accounting variables [28–30]. By considering the temporal dimension, our analysis contributes depth and relevance to the examination of COVID-19's impact on the survival and development of tourism enterprises.

In connection with our study, Pongsakornrungsilp et al. [30] previously examined the recovery of tourism businesses in Thailand from the impact of COVID-19 through brand management. However, their work primarily focused on utilizing a brand as a proactive strategy to mitigate crisis effects. In contrast, our research surpasses this scope by delving into a comprehensive analysis that extends beyond the immediate consequences of COVID-19. We explore the broader ramifications stemming from various firm attributes, crisis-induced adaptive measures, shifts in target customer behavior, intricacies within the supply chain, labor market considerations, and governmental support policies. This multi-faceted approach contributes to an in-depth understanding of the distinctive challenges and dynamics confronted by enterprises operating within the Thai tourism sector. Furthermore, our study employs advanced statistical tools to tackle the intricacies of the high-dimensional challenges intrinsic to the Cox proportional hazards model. Through the utilization of these sophisticated techniques, we adeptly manage the model's complexity, thereby boltering the robustness of our findings.

The organization of this study is as follows: Section 2 provides a comprehensive literature review, highlighting the existing research in the field. Section 3 outlines the methodology employed in this study. Section 4 details the data sources and collection methods utilized. Section 5 presents the empirical findings derived from the analysis. Section 6 offers a comprehensive discussion of the results, drawing connections and insights from the findings. Finally, Section 7 concludes the study by summarizing the key findings and providing policy implications based on the research outcomes.

2. Literature Review

This study aims to investigate the survival and development of tourism enterprises in Thailand amidst the COVID-19 pandemic. In order to comprehensively analyze the factors that influence these outcomes, we carefully identified and selected key factors that are highly relevant to the research context. The integrated theoretical framework we developed takes into account the following factors: fundamental business factors, business adaptation, employment, target customer, logistics and logistics supply chain, and government support policy factors. This section presents a theoretical review that justifies our selection of these factors and provides a rationale for their significance in the study.

Fundamental business factors serve as the bedrock for tourism enterprises, playing a vital role in navigating the challenges brought about by the COVID-19 pandemic. Extensive research consistently underscores the significance of these factors in shaping a firm's

success [14,16,20]. Access to adequate financial resources emerges as a critical driver for firms, enhancing the likelihood of success and facilitating accelerated growth [31]. In the context of microenterprises, the nexus between financial inclusion and economic growth assumes heightened importance, as it empowers businesses to bolster their human capital, fostering innovation and entrepreneurship [32]. Nevertheless, it is important to acknowledge that many MSMEs encounter obstacles in acquiring these fundamental business factors [33]. Moreover, within the tourism sector, the strategic positioning of enterprises near prominent tourist attractions emerges as a pivotal determinant in drawing visitors, influencing the survival prospects of micro- and small businesses [34,35].

A comprehensive understanding of the adaptations implemented by tourism enterprises is crucial, bringing our attention to the factors of business adaptation [15,21]. These factors encompass the changes in business models, product offerings, marketing strategies, and customer engagement approaches embraced by tourism enterprises to maintain competitiveness and relevance during the pandemic [36]. As highlighted by Najihah et al. [37] and Weidmann et al. [38], business adaptation during a pandemic becomes the most crucial strategy for enhancing survival prospects. They suggest that businesses have implemented various operational adjustments, including modified opening times, salary reductions, and flexible working hours, along with adapting their business models. These adaptations have enabled businesses to navigate the challenges posed by the pandemic and increase their chances of survival.

Employment factors hold significant importance in the survival and growth of tourism enterprises [7]. The impact of the COVID-19 pandemic on businesses varied, particularly affecting smaller firms with fewer employees. Research conducted by Katare et al. [39] reveals that firms with fewer than five employees have a lower likelihood of recovering from economic losses within a month compared to businesses with a larger workforce. This suggests that the scale of employment can influence the resilience and recovery trajectory of tourism enterprises in the face of the pandemic.

Examining the target customer of a business provides valuable insights into its primary customer groups. Understanding the various types of tourism enables businesses to customize their products, services, and marketing efforts to effectively attract and retain these customers. However, the COVID-19 pandemic has presented significant challenges for the tourism industry, particularly for businesses heavily reliant on international tourism. Travel restrictions and uncertainties surrounding the recovery timeline have resulted in a sharp decline in customer demand, posing a threat to the survival of these businesses. While governments and local initiatives have provided support for domestic tourism, businesses that primarily cater to international visitors have struggled to attract customers from the local market [17]. This shift in customer dynamics has forced businesses to adapt their strategies and find alternative ways to sustain their operations during these unprecedented times.

Logistics and logistics supply chain factors play a critical role in understanding the operational challenges faced by tourism enterprises, encompassing transportation, procurement, inventory management, and distribution. The COVID-19 pandemic further underscored the significance of these factors for business survival. The disruptions caused by the pandemic, such as lockdowns, travel restrictions, and supply chain interruptions, highlighted the importance of robust logistics and supply chain management. Enterprises with agile and resilient supply chains were better equipped to navigate the challenges, ensuring the continuity of operations, timely delivery of essential goods, and adaptability to changing market conditions. Efficient logistics and supply chain management became indispensable for mitigating disruptions, optimizing inventory levels, and maintaining customer satisfaction, ultimately enhancing the survival prospects of businesses during this challenging period [13,15].

Lastly, government support policy factors play a pivotal role in determining the survival and development of tourism enterprises, especially during times of crisis. The support policies implemented by governments are instrumental in enhancing the survival ability of

businesses. Measures such as financial assistance, tax relief, and incentives can alleviate the financial burdens faced by enterprises, improve cash flow, and increase their chances of survival. Employment support initiatives, such as wage subsidies and job retention schemes, help businesses retain their workforce and sustain their operations. These government interventions provide crucial lifelines for tourism enterprises, enabling them to overcome challenges and navigate through uncertain times [18,19].

By selecting these factors, we aim to construct an integrated theoretical framework that captures the multi-dimensional nature of the challenges faced by tourism enterprises in Thailand during the COVID-19 pandemic. This framework will facilitate a holistic analysis of the interrelationships between these factors and their collective impact on enterprise survival and development.

Drawing on the relevant literature and empirical evidence, our study will contribute to the advancement of knowledge in the field. The integrated theoretical framework will not only provide valuable insights for academia but also offer practical implications for policymakers, industry practitioners, and other stakeholders involved in the recovery and future planning of the tourism sector in Thailand.

3. Methodology

This section provides a comprehensive overview of the two-step approach adopted in this study. First, we discuss the theoretical underpinnings of Cox proportional hazards modeling and survival analysis in general. This step is widely regarded as an effective methodology to identify the risk factors affecting the survival probability of a Thai firm. However, as the coefficient estimates derived from this model cannot be interpreted directly, hazard ratios (HR) are computed for each coefficient to facilitate interpretation. Furthermore, Lasso and Ridge regression techniques were applied to effectively address multicollinearity and improve the robustness of the results in the conventional Cox's model. Second, the firm's probability of surviving for the coming 12 months is then investigated, considering the influence of individual variables. The firm's survival path can be obtained and illustrated by using the nonparametric Kaplan–Meier estimator [40].

3.1. Survival Analysis

Survival analysis is a popular statistical methodology modeling the duration of a unit until an event of interest occurs at time t, such as mortality, failure, or other unfavorable outcomes. In this study, the entities of interest are tourism enterprises. Thus, we aim to apply survival analysis to examine the survival of tourism enterprises one year after being interviewed during the ongoing COVID-19 pandemic. The survival time is a continuous random variable denoted by T. Then, the probability of tourism enterprises surviving at time t can be defined as follows:

$$P(t) = \Pr(T \leq t), \tag{1}$$

and probability density function is

$$p(t) = \frac{dP(t)}{dt}, \tag{2}$$

We can define the survival function of MSMEs $S(t)$ by the continuity of T as

$$S(t) = P(T > t) = 1 - P(t) \tag{3}$$

Given the challenge of characterizing the underlying failure pattern of the survival function, Liu [41] proposed the application of the hazard function as an alternative approach to gain insight into the failure mechanism. Note that the hazard function is a probability density function describing the probability of tourism enterprises surviving beyond a specific time t. It is expressed as follows:

$$h(t) = P(T = t|T \geq t) = \frac{P(T = t)}{S(t)} = \frac{f(t)}{S(t)}. \quad (4)$$

where $f(t) = d(S(t))/d(t)$ is the probability density of failure at time t. This implies that

$$h(t) = \frac{dS(t)/d(t)}{S(t)} = \frac{d}{dt}(-\log S(t)), \quad (5)$$

or, equivalently,

$$S(t) = e^{-H(t)}, \quad (6)$$

where $H(t)$ is the cumulative hazard function.

3.2. The Cox Proportional Hazards Model

Understanding the impact of these covariates on the hazard function is a key focus of our investigation. To achieve this objective, we employ the well-established Cox proportional hazards model, originally developed by Cox [10]. This model is widely used for studying the relationship between covariates and the hazard function [42]. In its standard form, the Cox proportional hazards model is expressed as

$$h_i(t) = h_0(t) \exp(\beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_k x_{ik}), \quad (7)$$

The Cox model can be conveniently expressed in terms of a log–log regression model; thus, taking log on both sides of Equation (7) yields:

$$\log h_i(t) = \log(h_0(t)) + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_k x_{ik}, \quad (8)$$

or, again, equivalently,

$$\log h_i(t) = \alpha(t) + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_k x_{ik}, \quad (9)$$

where $h_i(t)$ is the conditional hazard function of continuous random variable. $h_i = 0$. k is the number of independent variables, β are the partial regression coefficients, x_i are the values of the covariates for individual observation i, and $h_0(t)$ is the hazard baseline. The present model can be classified as a semi-parametric regression, wherein the baseline hazard exhibits flexibility in its form and the covariates undergo linear regression with the log conditional hazard function. As the $h_0(t)$ is not easy to specify, the estimation of this model necessitates the use of partial likelihood.

3.3. Lasso and Ridge-Cox Proportional Hazard Model

As our study involves numerous socio-economic and government relief scheme parameters, these techniques are crucial for addressing the issue of multicollinearity, resulting in unstable and unreliable parameter estimates in the Cox Proportional Hazard model. To solve this problem, one or more of these correlated variables should be removed. However, if the variables that are significantly relevant to the survival probability of MSEs are removed, the traditional Cox proportional hazards model may produce biased and inconsistent estimates, known as the omitted variable bias. Yamaka, et al. [36] suggested that the omitted variable bias could lead to difficulties in the theoretical interpretation of empirical results in social science studies. As the omitted variable bias and multicollinearity problems are our main concerns in the study, we extend the Lasso and ridge estimation to fit the Cox proportional hazards model.

Lasso estimation shrinks the regression coefficients towards zero, leading to a simpler model with fewer predictors. As a result, a sparse model is produced in which a significant proportion of the coefficients are zero, which can facilitate variable selection. On the other hand, Ridge estimation shrinks coefficients like Lasso but does not force them to exactly zero. This is particularly useful for high-multicollinearity data and stabilizing regression coefficient estimates. Tibshirani [43] and Wang et al. [44] recommend maximizing the pe-

nalized log partial likelihood function to obtain the estimated parameters. These functions can be expressed as follows:

- Penalized partial likelihood with LASSO penalty

$$\log L(\beta) = \sum_{i=1}^{n} \delta_i X'\beta - \sum_{i=1}^{n} \delta_i \log\left(\sum_{j=R_r} \exp(X'\beta)\right) + \lambda\sum|\beta|, \quad (10)$$

- Penalized partial likelihood with LASSO penalty

$$\log L(\beta) = \sum_{i=1}^{n} \delta_i X'\beta - \sum_{i=1}^{n} \delta_i \log\left(\sum_{j=R_r} \exp(X'\beta)\right) + \lambda\sum\beta^2, \quad (11)$$

where $\beta = (\beta_1, \ldots, \beta_k)$ is the vector of unknown coefficients, and $X = (x_1, \ldots, x_k)$ is the vector of factors affecting the survival probability of the tourism enterprises. $\delta_i = I(T_i \leq C_i)$ is the censoring indicator, whereas T_i and C_i are, respectively, the failure time and censoring time of company, $i = 1, \ldots, n$ (in this study, $C_i = 12\ months$). $\lambda > 0$ is the tuning parameter.

3.4. Kaplan–Meier Estimator

The Kaplan–Meier estimator is a highly regarded tool for calculating survival probabilities based on a single predictor. Its popularity stems from its nonparametric nature and its ability to handle a wide range of survival scenarios with few limitations [44]. This estimator assumes well-defined events of interest and study periods, as well as homogeneous survival probabilities among all businesses and censored observations. In our analysis, we utilize only the significant factors identified from the Cox regression to construct the survival probability prediction curve during the COVID-19 crisis. By harnessing the capabilities of the Kaplan–Meier estimator, we gain deeper insights into the intricate survival patterns exhibited by Thai tourism firms. This approach allows us to unravel the nuanced dynamics of their response to the crisis, thereby providing a more advanced understanding of their resilience and adaptability in the face of adversity.

4. Data Description

This research focuses on Thai tourism enterprises amidst the unprecedented COVID-19 pandemic. Conducted in December 2021, the project aims to provide novel insights into the current state of the Thai tourism industry within the context of the ongoing pandemic. The survey questionnaire encompasses six distinct dimensions of the Thai tourism sector: firm characteristics, crisis-driven business adaptation, target customer, supply chain, employment, and government support policies. These dimensions serve as the independent variables for the study, enabling a comprehensive analysis of the factors influencing the survival of Thai tourism enterprises. A detailed exposition of each component can be found in Table 1, providing comprehensive and meticulous information.

Table 1. Descriptive statistics.

Variable	Abbreviation	Description	Percentage
Dependent variable: Survival data			
Business failure	*y*	1 = Business failure within 12 months	33.50
		0 = Business survives more than 12 months	66.50
Economic survival duration	*t*	Number of month that business can sustain operation	9.20
Independent variable: Fundamental business factors			
Types of business related to tourism sector	*tp_hotel*	Hotel/accommodations	21.25
	tp_tran	Transportation	8.25
	tp_souve	Souvenir	20.50
	tp_food	Food and beverage	24.00
	tp_tour	Travel agency/tour guide	17.50
	tp_oth	Other business in tourism sector	8.50

Table 1. *Cont.*

Variable	Abbreviation	Description	Percentage
Total fixed assets	*asst_less_*3	Fixed assets value less than THB 3 million	13.00
	*asst_*3_10	Fixed assets value of THB 3–10 million	36.75
	*asst_*11_20	Fixed assets value of THB 11–20 million	26.25
	*asst_more_*20	Fixed assets value more than THB 20 million	24.00
Net income (Annual)	*inc_less_*1	Net income less than THB 1 million	7.75
	*inc_*1_5	Net income of THB 1–5 million	42.25
	*inc_*6_10	Net income of THB 6–10 million	30.50
	*inc_more_*10	Net income more than THB 10 million	19.50
Location of business (Region)	*reg_central*	Central region	25.00
	reg_eastern	Eastern region	25.00
	reg_northern	Northern region	25.00
	reg_southern	Southern region	25.00
Location of business (Area)	*rural*	Rural area	27.75
	municipal	Municipal area	72.25
Business premises	*busi_prem_not*	Does not have/use a business premises	11.00
	busi_prem_rent	Rent/Lease a business premises	62.75
	busi_prem_own	Own a business premises	26.25
Decreased revenue/income change	*inc_change*	The percentage change in the business's revenue during the coronavirus pandemic, with a positive value indicating a decrease	54.53 *
Independent variable: Business adaptation factors			
Perceiving the risks of the coronavirus impact	*risk*	Entrepreneurial risk perception related to the impact of the coronavirus is categorized into five levels of awareness.	3.31 *
The current operation of a business	*oper_usual*	Open with regular working hours and days	68.50
	oper_short	Open with shortened working hours and days	25.00
	oper_WFH	Customer acceptance suspension but continues to operate with its employees working remotely.	4.00
	oper_close	The firm is closed and has not yet reopened	2.50
The operation of a business during the coronavirus pandemic's first wave.	*oper_co_usual*	Open as usual and regular working hours and days	26.25
	oper_co_short	Open with shortened working hours and days	41.00
	oper_co_WFH	Customer acceptance suspension but continues to operate with its employees working remotely.	32.75
Business model change.	*mdl_soci_dist*	Operate while incorporating social distancing protocols.	74.00
	mdl_h_demand	Diversified its product and service offerings by incorporating high-demand products and services.	43.25
	mdl_online	Operate through online markets or social media	64.50
	mdl_reduc_sal	Discussions with employees regarding salary reductions to retain all employees	23.50
	mdl_no	No adaption	13.00
Independent variable: Employment factors			
Number of employees	*empl_full*	Full-time employees	44.97 *
	empl_part	Part-time employees	11.75 *
Dismissal of employees	*dis_perm*	Number of laid-off permanent employees	10.26 *
	dis_part	Number of laid-off part time employees	8.06 *
	*dis_next*2*m*	The expected number of employees to be laid off within the next two months	1.27 *
Labor Management	*labor_reduc_w*	Reduction in working hours to alleviate the unemployment rate.	23.25
	labor_usual	Doing everything as usual	24.75
	labor_lay_off	Lay off employees (part/all)	46.50
	labor_tem_close	Temporarily closed	5.50
Independent variable: Customer			
Target customer	*tar_cus*	Domestic tourists' ratio	62.31 *
Change in the number of tourists	*tour_domestic*	The percentage change in the number of domestic tourists during the coronavirus pandemic, where a positive value indicates a decrease in the number of tourists.	58.38 *
	tour_foreign	The percentage change in the number of international tourists during the coronavirus pandemic, where a positive value indicates a decrease in the number of tourists.	90.13 *
The entrepreneur's vision	*vis_mth*	Entrepreneurs' vision regarding the timeline for the full recovery of tourist numbers to pre-COVID-19 levels. (Month)	12.19 *
Independent variable: Logistics and Supply Chain factors			
Import/export of goods and services	*logis_im*	Import	15.25
	logis_out	Export	7.75
	logis_imout	Import and export	12.00
	logis_no	No import and export	65.00

Table 1. *Cont.*

Variable	Abbreviation	Description	Percentage
Limitations and challenges during the coronavirus pandemic.	*restric_country*	Traveling restriction measures between the country.	59.75
	inter_trade	International trade prohibiting measures.	30.75
	restric_province	Travel prohibiting measures across provinces.	68.25
	avai_service	Availability of various services in the business.	52.25
	avai_ft_empl	Availability of full-time employees returning to work	65.25
	avai_pt_empl	Availability of part-time employees returning to work.	51.50
	avai_raw_mat	Availability of raw materials in production and services.	59.00
	obs_domes_tran	Obstacles/difficulties in domestic transportation	32.25
	obs_inter_tran	Obstacles/difficulties in transporting goods to international countries.	19.25
Independent variable: Government support policy factors			
Government support policies during the pandemic	*poli_loan*	Soft loan, loan interest 2%, and debt moratorium measure.	11.75
	poli_tax_empl	Tax-deductible incentive measure for businesses that maintain full employment levels	11.75
	poli_SSF	Measures to curtail contributions to the Social Security Fund for employees and employers.	64.50
	poli_tax_fi	Relaxation measure for the submission of personal and business tax filings.	26.25
	poli_tax_rate	Measures to decrease the withholding tax rates for services rendered.	23.50
	poli_tax_vat	Measures to extend the payment deadline for income taxes, including value-added tax (VAT) and excise taxes.	19.00
	poli_tax_travel	Measures to incentivize domestic tourism by offering additional benefits to participants "We Travel Together"	57.25
	poli_no	Not participating in any project	11.50

Note: The star (*) indicates the average value of continuous variable.

In our study, we employed a purposive sampling method, specifically targeting 400 tourism enterprises operating in Thailand during the COVID-19 pandemic. The rationale behind this purposive sampling approach was multifaceted. Firstly, it allowed us to capture a diverse cross-section of the industry, encompassing variations in scale, services, locations, and responses to the crisis. Secondly, our engagement with enterprises experiencing a wide range of pandemic-related scenarios, from temporary closures to innovative survival strategies, enriched our dataset and provided nuanced insights into the challenges and adaptations within this sector.

The selection criteria for our sample included the inclusion of micro- and small enterprises (MSEs) within the tourism sector, which are representative of the broader industry. To ensure diversity and a comprehensive representation, we employed a multi-stage sampling strategy. Initially, we randomly selected MSEs from the TripAdvisor website, which provided a pool of potential tourism enterprises. Additionally, we utilized the Thai Revenue Department's list of travel agents to identify and include relevant enterprises. This combination of sources enabled us to gather data from a range of tourism businesses operating in Thailand. However, it is worth noting that the distribution of samples across provinces within each region varied. To provide an accurate assessment of the survival probability of Thai tourism enterprises, it is crucial to evaluate the longevity of their existence and examine their capacity to maintain financial viability in the event of an extended period of the COVID-19 crisis in Thailand. This evaluation will help determine their resilience and ability to withstand future challenges.

To collect primary source data, we utilized a structured questionnaire as our primary data collection tool. This questionnaire was carefully designed to elicit relevant information and insights from the selected participants, allowing us to systematically gather data on their experiences, challenges, and responses during this critical period.

Table 1 presents the definitions of the variables utilized in this study, with continuous variables presented by their average and categorical variables presented by their corresponding percentages (%). Notably, the data in Table 1 reveal that 33.5% of the businesses failed to withstand the pandemic, whereas the corresponding average survival period of tourism businesses is 9.2 months.

Regarding the firm's fundamental independent variables, 24.00% of the surveyed tourism-serving establishments were classified as food and beverage enterprises, while the transportation type was the least represented, accounting for only 8.25% of the sample. Among the firms

surveyed, 42.25% reported earning a net income between THB 1 and 5 million, while 36.75% had total fixed assets of THB 3–10 million. Additionally, 62.75% of the establishments operated on rent/lease business premises, with 72.25% located in municipal areas. Furthermore, a significant proportion of the businesses surveyed (93.50%) reported experiencing a revenue loss of 54.53% due to the impact of the COVID-19 pandemic.

Regarding business adaptation, a significant portion of tourism firms, comprising more than 26.25%, reported operating under normal working conditions with regular hours. In contrast, 41.00% of businesses opted for shortened working hours during the initial wave of the coronavirus outbreak in March 2020. However, when assessing the current state of business adaptation in December 2021, it was found that 68.50% of firms had reverted to regular working hours and days. Notably, the survey also examined the entrepreneurial risk perception concerning the pandemic's impact on the Thai tourism industry. The findings indicate that respondents rated their level of awareness at 3.31 on a five-point scale, suggesting a moderate level of understanding regarding the risks associated with the pandemic.

In the context of the business employment factor, tourism businesses employ an average of 44.97 full-time personnel and 11.75 part-time personnel. In order to navigate the ongoing crisis, 46.5% of businesses resorted to staff layoffs, while 23.25% implemented reduced working hours as a means of minimizing the negative impact on their employees. A further 24.75% continued to maintain regular operations. In terms of layoffs specifically attributed to the coronavirus pandemic, the average number of permanent employees, part-time employees, and expected layoffs within the next two months stood at 10.26, 8.06, and 1.27 persons, respectively.

Regarding the target customer, 62.31% of tourism companies have traditionally focused on attracting domestic tourists. However, the ongoing COVID-19 pandemic severely impacted the number of both domestic and international tourists, resulting in a significant decline of 58.38% and 90.13%, respectively. Furthermore, a survey conducted among entrepreneurs in the tourism industry revealed that they anticipate tourist numbers to return to pre-COVID-19 levels within an average period of 12.19 months.

Interestingly, less than half of tourism businesses reported incorporating logistics and supply chain components that involved importing or exporting goods or services. This indicates that most tourism establishments in Thailand contribute significantly to the local economy and employment. Additionally, more than half of the surveyed tourism businesses indicate that limitations and challenges in logistic and supply chain operations are travel-prohibiting measures, as well as the availability of full-time employees returning to work, and access to raw materials for production and services.

In terms of government support policies, more than half of the tourism businesses surveyed participated in the government's support policy to reduce Social Security Fund contributions for employees and employers. Following this measure, a significant number of tourism businesses also participated in the "We Travel Together" scheme, which offers supplementary benefits for domestic tourism.

5. Empirical Results

5.1. Estimation Results of the Cox Proportional Hazards Model

In Table 2, we present the coefficients estimated from the Cox regression model using the penalized Lasso and Ridge methodologies. However, these coefficients may not be readily interpretable in their original form. To enhance the interpretability of the results, we applied the exponential function to transform the coefficients into hazard ratios. The exponential transformation of the coefficients allows for us to express their effects on the hazard rate in a more intuitive manner. By exponentiating the coefficients, we obtain hazard ratios that represent the multiplicative change in the hazard rate for a unit change in the corresponding predictor variable [6]. When the hazard ratio exceeds 1, it signifies that the factor under consideration is associated with a decreased survival probability for the business compared to the reference group. In other words, the factor has a negative impact on the business's ability to survive. Conversely, a hazard ratio less than 1 indicates that

the factor enhances the business's survival probability in relation to the reference group. This implies that the factor has a positive effect on the business's chances of enduring challenging circumstances and remaining operational [45].

Table 2. Results of the Cox regression model.

Variables	Coefficient			Hazard Ratio		
	LASSO	RIDGE	MLE	LASSO	RIDGE	MLE
Fundamental business factors						
Business type						
tp_hotel		−0.068	−0.924 ***		0.934	0.397
tp_tran	0.179	0.149 *	0.084	1.196	1.161	1.088
tp_souve		−0.061	−0.084		0.941	0.919
tp_food		−0.163	−0.944		0.849	0.389
tp_tour		0.026	0.001		1.026	1.001
Total fixed assets						
*asst_less_*3		0.093	0.028		1.098	1.028
*asst*_3_10		−0.031	−0.274		0.969	0.760
*asst*_11_20		0.037	0.002		1.038	1.002
Net income (Annual)						
*inc_less*_1	0.424	0.491 ***	0.567 *	1.528	1.635	1.763
*inc*_1_5	0.216	0.028 **	0.002 *	1.241	1.029	1.002
*inc*_6_10		−0.113 *	−0.034		0.893	0.967
Business location (Region)						
reg_northern	0.588	0.445 *	0.384 ***	1.800	1.560	1.468
reg_eastern		−0.093	−0.274 ***		0.911	0.760
reg_southern	−0.422	−0.286 **	−0.293 ***	0.656	0.752	0.746
Business location (Area)						
municipal	−0.029	−0.129 *	−0.193 *	0.971	0.879	0.824
Business premises						
busi_prem_not	−0.522	−0.412 ***	−0.794 ***	0.593	0.662	0.452
busi_prem_rent	0.445	0.212 *	0.081	1.560	1.237	1.084
inc_change	0.018	0.010	0.001	1.018	1.010	1.001
Business adaptation factors						
risk	1.042	0.369 ***		2.834	1.446	
The current operation of a business						
oper_usual	−0.103	−0.196 *	−0.404 **	0.902	0.822	0.668
oper_WFH		0.133	0.203 *		1.142	1.225
oper_close	0.949	0.805 **	0.793 **	2.583	2.237	2.210
The business operation during the first wave						
oper_co_usual		−0.061	−0.003		0.941	0.997
oper_co_WFH		−0.012	−0.093		0.988	0.911
Business model change from the coronavirus pandemic						
mdl_soci_dist		0.059	0.001		1.061	1.001
mdl_h_demand		0.062	0.003		1.063	1.003
mdl_online		−0.002	−0.001		0.998	0.999
mdl_reduc_sal		−0.002	−0.001		0.998	0.999
Employment factors						
Number of employees						
empl_full		0.001	0.001		1.000	1.001
empl_part		−0.001	0.001		1.001	1.001
Labor management						
labor_reduc_w	0.104	0.246 **	0.294 **	1.110	1.279	1.342
labor_usual	−0.752	−0.369 *	−0.192 *	0.471	0.691	0.825
labor_tem_close	0.432	0.580 **	0.024	1.540	1.785	1.024
Dismissal of employees						
dis_perm		0.002	0.330 **		1.002	1.391
dis_part	−0.003	−0.003 **	−0.034	0.997	0.997	0.967
*dis_next*2*m*		−0.001	−0.001		0.999	0.999
Customer						
Target customer						
tar_cus	−0.128	−0.115 **	−0.583 **	0.880	0.891	0.558
Change in the number of tourists						
tour_domestic		−0.002	−0.005		0.998	0.995
tour_foreign		0.003	0.038		1.003	1.039
The entrepreneur's vision						
vis_mth	−0.050	−0.031 *	−0.384 ***	0.951	0.969	0.681

Table 2. *Cont.*

Variables	Coefficient			Hazard Ratio		
	LASSO	RIDGE	MLE	LASSO	RIDGE	MLE
Logistics and Supply Chain factors						
Importing and exporting						
logis_im		−0.130	−0.344 **		0.878	0.709
logis_out		0.020	0.098		1.020	1.103
logis_imout	−0.179	−0.334 ***	−0.038	0.836	0.716	0.963
Limitations and challenges during the coronavirus pandemic.						
restric_country		0.047	0.002		1.049	1.002
inter_trade	0.117	0.148 ***	0.462 ***	1.124	1.160	1.587
restric_province	0.093	0.141 ***	0.293 ***	1.097	1.152	1.340
avai_service	−0.420	−0.204 ***	−0.274 ***	0.657	0.816	0.760
avai_ft_empl		−0.050	−0.672 ***		0.951	0.511
avai_pt_empl	−0.230	−0.109 **	−0.112 **	0.794	0.897	0.894
avai_raw_mat	−0.212	−0.201 **	−0.934 **	0.809	0.818	0.393
obs_domes_tran		−0.135 ***	−0.023		0.874	0.977
Government supporting policies factor						
poli_loan	0.580	0.401 **	0.244 **	1.786	1.493	1.276
poli_tax_empl		0.004	0.001		1.004	1.001
poli_SSF	−0.429	−0.215 ***	−0.623 ***	0.651	0.806	0.536
poli_tax_fi		0.077	0.027		1.080	1.027
poli_tax_rate	−0.116	−0.166 *	0.028	0.890	0.847	1.028
poli_tax_vat	−0.070	−0.098 *	−0.934 ***	0.932	0.907	0.393
poli_tax_travel		0.008	0.001		1.008	1.001
AIC	7320.639	7400.639	7930.9354			
BIC	7452.357	7692.016	8208.034			

Note: (1) '.' denotes that the variable is not selected by the Lasso model. (2) Reference variables for fundamental business factors are *tp_oth* for type, *asst_more*_20 for asset, *inc_more*_10 for income *reg_central* and *rural* for location, and *busi_prem_own* for premise. Reference variables for business adaptation factors consist of *oper_short*, *oper_co_short*, and *mdl_no*. The *labor_lay_off* is reference variable for employment factors. *logis_no* and *obs_inter_tran* are reference variables for logistics and supply chain factors, and *poli_no* for government supporting policies. (3) MLE is maximum likelihood estimation without ridge and lasso penalties. (4) ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 2 presents the estimated coefficients alongside their respective hazard ratios and provides a comprehensive evaluation of model performance. Notably, the results indicate that the Cox model with Lasso penalization exhibits a superior fit and precise variable selection. This is substantiated by the observation of the lowest values for both Akaike's Information Criterion (AIC) at 7320.639 and Bayesian Information Criterion (BIC) at 7452.357. Consequently, we opted to interpret the results derived from the Cox model with Lasso penalization. Furthermore, in a comparative analysis, the Lasso estimation outperforms the classical maximum likelihood estimation (MLE) without penalties. The results obtained through Lasso regression consistently demonstrate its superiority to MLE in terms of model performance and variable selection.

We present the statistically significant variables selected by the Lasso estimations in Table 2. Highlighting the fundamental characteristics of a tourism business, our findings indicate that business type, net income (per year), business location, and percent change in revenue significantly impact the probability of business survival.

The hazard ratio for the transportation service business is 1.196, suggesting a failure probability that is 1.196 times higher compared to other businesses in the tourism sector. Furthermore, businesses with lower annual net incomes appear to have a higher likelihood of failure. Specifically, businesses with net incomes of less than 1 million THB and between 1 and 5 million THB have a failure probability of 1.528 and 1.241 times, respectively, when compared to businesses with higher annual net incomes. Businesses situated in the northern region exhibit a significantly higher risk of failure, increased by 1.800 times compared to those in the central region. Conversely, businesses located in the southern region demonstrate a lower risk of non-survival by 34.40%, as evidenced by a hazard ratio of 0.656. Besides, we find that a 1% decrease in a business's revenue worsens its survival probability by 1.80%. Furthermore, businesses lacking physical establishments, such as stalls or storefronts, exhibit a lower risk of non-survival in comparison to those with their own premises, supported by a hazard ratio of 0.593.

Our analysis of business strategies for surviving the pandemic highlights three important factors. First, our findings indicate that an accurate risk awareness of the coronavirus impact is critical for business survival. We found that if the entrepreneurial risk perception increases by one level, the non-survival probability increases by 2.834 times. This factor could serve as an effective indicator for the government to monitor high-risk businesses and provide targeted assistance. Additionally, our results suggest that businesses maintaining regular working hours and days amidst the pandemic exhibit a considerably heightened likelihood of long-term viability, surpassing those shortening their working hours and days by a substantial margin of 10.8%. Conversely, businesses that close during the pandemic face a diminished probability of survival in comparison to those that operate for reduced working hours and days, with a notable decrease of 2.583 times.

Employment factors play a similar role in the survival of businesses to the business strategies factors. Specifically, businesses that adhere to traditional labor management practices by maintaining regular work schedules and duties are significantly more likely to survive the pandemic than companies that lay-off their employees., with a remarkable increase of 53.90% in survival probability. Conversely, businesses reducing their work hours or implementing temporary closures demonstrate a diminished survival probability in comparison to companies dismissing their employees, with a worsening of 11.00% and 54.00%, respectively. The study further suggests that the dismissal of one part-time employee can slightly increase the probability of business survival by 0.3%.

Market factors influencing business survivability have identified a substantial adverse effect on the target customer. Specifically, our findings indicate that a growth in the domestic tourist target ratio can enhance a firm's likelihood of survival by as much as 12.0%. Additionally, we discovered that entrepreneurs' expectations of the duration for the full recovery of tourist numbers to pre-pandemic levels are another crucial factor in determining firms' survival chances. A longer anticipated recovery time can boost a firm's possibility of survival by 4.90%.

Concerning logistics and supply chain factors, we found that businesses engaged in exporting and importing have a significantly greater probability of surviving, with an estimated increase of 17.40% (0.836 hazard ratio), than businesses with no such activities. Additionally, our analysis identifies several obstacles and difficulties that can impact businesses' survivability. These include challenges in travel prohibitions across provinces and international trade prohibitions, which can reduce the probability of survival by 9.70% and 12.40%, respectively. On the other hand, the availability of raw materials in production and services, the availability of part-time employees returning to work, and the availability of various services in the business are crucial factors that can significantly increase the probability of survival, with estimated increases of 19.10%, 20.60%, and 34.30%, respectively. Note that the parameter of obstacles and difficulties faced during the transportation of goods internationally serves as a reference variable.

Lastly, our analysis of various supportive governmental policies and measures reveals that tax-relief measures, such as extending payment deadlines and decreasing tax rates for services, are effective in increasing the survival probability of businesses, with estimated increases of 11.00% and 7.80%, respectively. Additionally, measures to curtail contributions to the Social Security Fund for employees and employers are also supportive of a business's survival, decisively increasing the probability of survivability by 34.90%. Conversely, our study reveals that debt-involving measures, such as low-interest loans, soft loans, 2% interest, and a 6-month moratorium on debt measures, have a significant negative impact on the probability of business survival, with an estimated decrease of 78.60%. This result suggests that such measures may not be effective in supporting businesses' long-term survival, as they may increase their debt burden and erode their financial stability over time.

5.2. Survival Path Analysis

This subsection presents an empirical analysis of the failure probability of tourism businesses over time. The estimation of the failure function of businesses was conducted using the widely used Kaplan–Meier estimator, which is a nonparametric approach. We in-

vestigate the impact of various individual variables on the failure of tourism businesses, specifically focusing on factors that have been identified as significant by the Lasso–Cox regression model. Our study places particular emphasis on analyzing the failure path of the most influential factors, and we provide corresponding estimates of failure probabilities over the course of the next 12 months (January to December 2022) in Figures 1–5. These figures offer visual representations of the changing failure probabilities associated with significant influential factors, providing valuable insights into the potential risks faced by tourism businesses in the upcoming year.

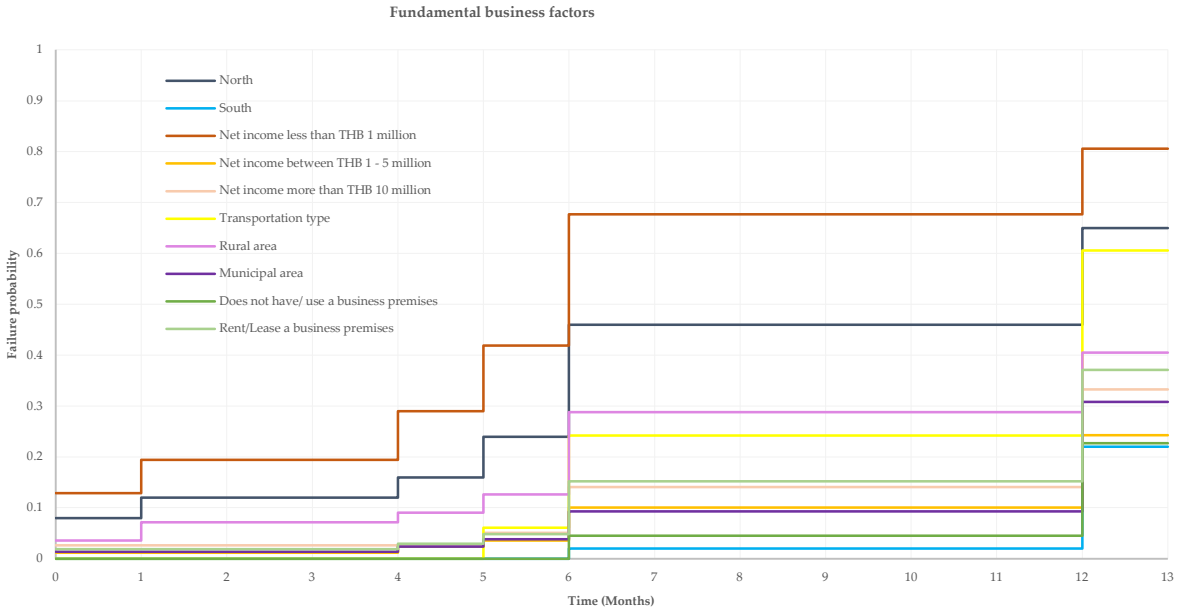

Figure 1. Failure probability of tourism businesses in different significant fundamental business factors.

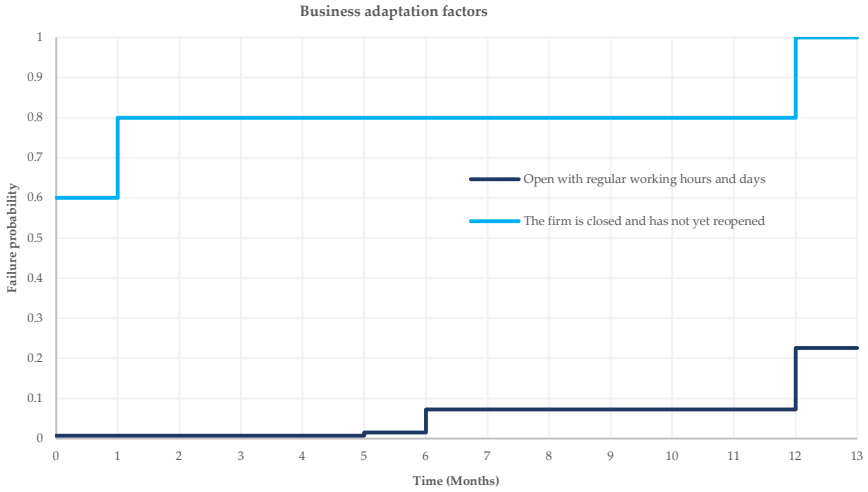

Figure 2. Failure probability of tourism businesses in different significant business adaptation factors.

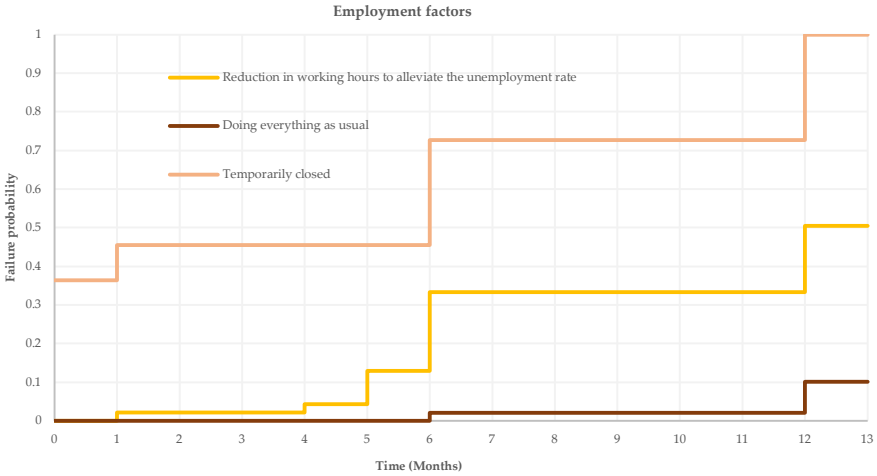

Figure 3. Failure probability of tourism businesses in each significant labor management operation variable.

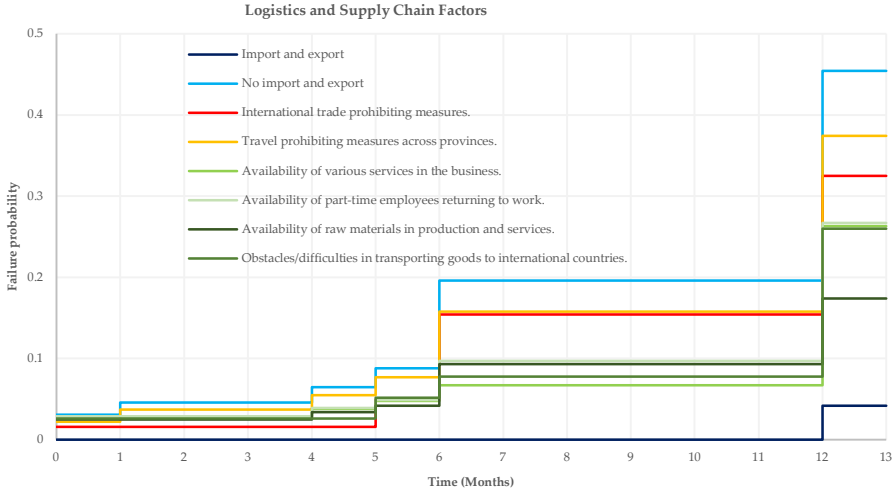

Figure 4. Failure probability of tourism businesses in different significant logistics and supply chain factors.

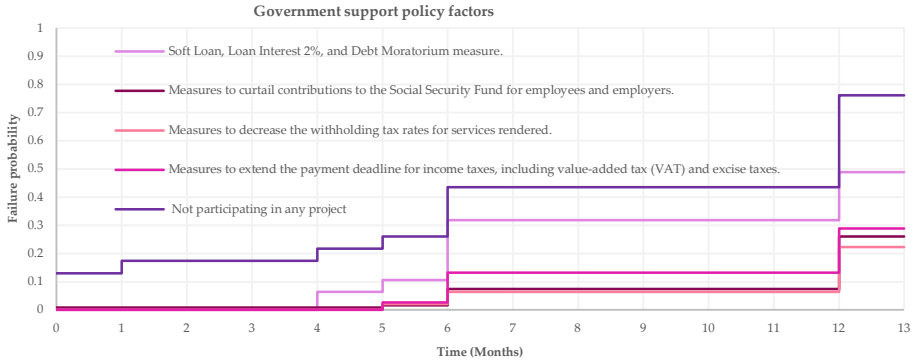

Figure 5. Probability of failure of tourism businesses with significant government support policy factors.

Figure 1 presents a detailed analysis of the failure curves for tourism businesses across key fundamental business factors, including establishment type, net income, location, and business premises type. Our result reveals that the failure paths of these variables exhibit an initial stair-shaped upward slope during the first six months, followed by a horizontal steady increase until the twelfth month. Furthermore, we find that the failure probability increases sharply after the sixth month, by 12.00% on average. Then, the failure probability again sharply increases, by 19.50% on average, after the twelfth month, with the transportation sector being the most affected. The impact of fundamental factors on the

probability of business failure varies across different categories and is most pronounced during the first six months. This implies the critical importance of early adaptation and effective government support, particularly for small businesses with an annual net income of less than THB 1 million. According to our results, these small businesses are particularly vulnerable, with an 80.60% probability of failure.

Figure 2 presents the failure probability associated with significant business adaptation factors. Our results indicate that firms that have closed and have not yet reopened are particularly vulnerable to failure, with a failure probability of 60.00% at the beginning of the study period that increases to 100.00% by the end of the observation window. In contrast, businesses that maintain regular working hours and days demonstrate a significantly higher probability of survival, with a failure probability of only 22.60% over the next 12 months, indicating the best survival adaptation approach.

The probabilities of failure associated with significant labor management operations within the context of employment factors are depicted in Figure 3. The findings indicate that temporary closures represent a crucial risk factor that significantly contributes to business failure within the first year, with an alarming increase of over 27.2% observed during the sixth and twelfth months. Similarly, reducing working hours has a comparable impact on the likelihood of business failure, albeit with a lower magnitude. Notably, our results indicate that these two employment adaptation strategies do not affect business failure rates between the sixth and twelfth month, highlighting the importance of implementing such measures within the first six months. Moreover, the study demonstrates that businesses that maintain their labor-management practices consistently are more likely to sustain low failure rates beyond the twelfth month, with the lowest failure probability at 10.10%.

Figure 4 illustrates the failure probability paths of import and export variables and limitation and challenge variables. These variables are significantly derived for the Lasso–Cox regression model within the employment factor context. The figure indicates that companies that incorporate both importing and exporting components into their supply chain demonstrate the lowest probability of failure, with a rate of 4.17%. This suggests that increased distribution channels can diminish business failure. Conversely, businesses that lack import and export operations exhibit the highest failure probability. Additionally, our study reveals that travel restrictions between provinces are the primary limitation and challenge variable that contributed to a 37.40% rise in the business failure rate the following year. Conversely, the availability of raw materials for production and services can significantly reduce the likelihood of business failure, with a rate of 17.4%.

Lastly, the empirical results depicted in Figure 5 are compelling, revealing that businesses participating in significant government support policies, comprising debt relief, tax relief, and Social Security Fund contribution reduction measures, exhibit a lower failure rate of at least 27.20% compared to non-participating businesses. Notably, the outcomes also demonstrate that, among the various government support policies, debt-relieving measures pose the highest risk of failure, at 48.9% after 12 months, exceeding the failure probability of 31.40% observed in non-participating entities. These findings suggest that while financial relief measures, including low-interest loans, soft loans, 2% interest, and a 6-month moratorium on debt, may provide short-term benefits to businesses by preventing bankruptcy, they may not necessarily facilitate long-term survival. Furthermore, businesses participating in the scheme to decrease withholding tax rates for services rendered significantly reduce their probability of failure to 22.30%.

6. Discussion

Firstly, our research findings demonstrate that businesses situated in the northern region, characterized by greater distances between tourist attractions, exhibit a higher likelihood of non-survival compared to their counterparts in the southern region. Undoubtedly, businesses with a lower annual net income face an elevated probability of failure, in line with the negative impact that declining revenue has on a business's survival prospects. Our findings align with prior studies conducted by Weaver [20] and Leurcharusmee et al. [7]. It is worth noting that insufficient liquidity may prove inadequate for sustaining business

operations during a crisis. In contrast, businesses without physical premises, such as stalls, experience a lower risk of non-survival compared to those with rented locations, given their ability to swiftly adapt to their surroundings and their relatively minimal sunk costs. This finding resonates with the research conducted by Huynh et al. [28].

In terms of business strategy factors, our research reveals that entrepreneurs have the ability to accurately assess the risk level of company failure. This finding presents a promising opportunity for governments to monitor high-risk businesses and offer targeted assistance accordingly. Additionally, businesses that adhere to regular working hours and days demonstrate a higher likelihood of survival. Moreover, maintaining consistent work schedules and duties within the employment context helps companies withstand the impact of the pandemic. Furthermore, our findings indicate that reducing the number of part-time employees slightly improves the probability of business survival. These findings corroborate previous studies highlighting the long-term impacts of the COVID-19 pandemic on all tourism-related businesses, with medium- and small-sized companies being particularly vulnerable [14,39].

In terms of target customers, increasing the focus on domestic tourists and considering a longer projected recovery period for entrepreneurs can enhance a firm's chances of survival. Regarding logistics and supply chain factors, our findings reveal a significant reduction in the likelihood of failure for businesses involved in exporting and importing. This discovery carries a noteworthy element of surprise. Our results differ from those of Ando and Hayakawa [46], as well as Wang and Mo [47]. They highlight a significant impact of the COVID-19 epidemic on import trade rather than the export trade for most countries. A possible explanation for our distinct findings is that our study was conducted during the recovery period of COVID-19. Many countries have implemented plans to reopen, thereby restoring normalcy to various service activities. Consequently, our business respondents may hold a more positive outlook toward the current state of COVID-19. Additionally, the networks and relationships cultivated through international trade in the tourism sector play a crucial role in bolstering adaptability and resilience.

Lastly, extending tax payment deadlines, decreasing tax rates for services, and curtailing contributions to the Social Security Fund effectively increases the survival probability of businesses. These findings suggest that such policies can alleviate financial burdens on businesses, reducing labor costs and enhancing their liquidity, enabling them to weather economic downturns and market uncertainties and enhance businesses' competitiveness and viability. This is similar to Ma, Liu, and Gao [18], who also showed that government rules can indirectly help small businesses improve, even during a tough time like the pandemic. However, it is important to note that policies involving debt can have a detrimental impact on the long-term viability of businesses. Such measures may result in increased debt burdens and a gradual erosion of financial stability over time.

Consequently, it is evident that a significant number of tourism enterprises that managed to survive multiple waves of the pandemic were unable to sustain temporary operations in the long term. Moreover, medium- and small-sized enterprises encountered additional challenges in dealing with fiscal measure shortages amid the ongoing pandemic. Ma, et al. [18] proposed that small enterprises had to adopt their own strategies to overcome these challenges, recognizing that financial policy responses at the local level might have limitations in strengthening the survival capacity of local businesses [28].

Furthermore, the analysis of individual factors' failure paths using the Kaplan–Meier estimator aligns with the findings obtained from the Lasso–Cox regression. Moreover, the failure probability trajectory for all variables exhibits a stair-shaped upward trend during the initial six months, followed by a significant increase, a period of relative stability until the twelfth month, and then another sharp rise. This pattern is depicted in Figures 1–5, illustrating that all significant factors exert a diverse impact on the probability of failure for tourism businesses within the first six months, with a more pronounced effect after the sixth and twelfth months. Consequently, any adaptations made by businesses or government support should be implemented promptly within the first six months, or at the latest, within

a year. These heterogeneous effects are consistent with the findings of Crossley et al. [12] and Leurcharusmee et al. [7].

7. Conclusions and Recommendations

This research seeks to advance our understanding of the impact of the COVID-19 pandemic on business failures in Thailand, with a particular focus on the tourism sector. The pandemic has caused unprecedented disruptions to the country's economy due to its lockdowns and travel restrictions. In Thailand, because of a country heavily reliant on tourism, those prevention measures have severely affected tourism-related businesses, leading to a substantial decline in revenue and a heightened risk of failure. Given the possibility of a prolonged crisis and the potential for numerous businesses to collapse, it is crucial to identify the resilience factors supporting or inhibiting the survival of tourism businesses during this challenging time.

The theoretical contribution of this research is two-fold. Firstly, it provides a comprehensive investigation into how the COVID-19 pandemic impacts businesses, focusing on the tourism sector in Thailand. By analyzing factors like firm attributes, adaptation strategies, customer targeting, supply chains, employment patterns, and government support, the study advances our understanding of business resilience during crises. Secondly, the research introduces innovative analytical methods. The Cox proportional hazards model, enhanced by Lasso and Ridge regression techniques, tackles complex data issues effectively. The Kaplan–Meier estimator offers insights into the trajectory of business failure probabilities. These methodological advancements shed light on risk factors associated with business survival, enriching theoretical insights and providing practical implications for policymakers and industry stakeholders dealing with crises.

The study aims to examine the multifaceted aspects contributing to the probability of tourism businesses surviving during the COVID-19 pandemic. This investigation will concentrate on six major factors: firm-specific characteristics, business adaptation strategies, target customer segments, logistics and supply chain, employment patterns, and government support policies. All data were obtained from in-depth interviews with 400 tourism businesses in Thailand. To establish the research methodology, we employed a rigorous and innovative approach to identify the risk factors associated with non-survival businesses. Specifically, we utilized the Cox proportional hazards model to analyze the survivability of businesses as a function of multiple covariates. To address multicollinearity due to high imensional study data, Lasso and Ridge regression techniques were utilized to improve the performance of the conventional regression in the Cox proportional hazards model. Then, we used the Kaplan–Meier estimator to estimate the businesses' failure probability path of individual significant parameters over the next 12 months (January–December 2022).

The study's key results highlight important factors influencing the survival of tourism businesses during the COVID-19 pandemic. The Cox model with Lasso regression proved to be more effective in predicting survival probabilities. Among the risk factors identified, businesses in the transportation sector faced a significant risk of non-survival due to widespread lockdowns and travel restrictions. Furthermore, businesses situated in the northern region, characterized by greater distances between tourist attractions, exhibited a higher likelihood of non-survival compared to their counterparts in the southern region. A lower annual net income was found to elevate the probability of failure, emphasizing the negative impact of declining revenue on business survival. Insufficient liquidity was also identified as a crucial factor hindering sustained operations during a crisis. On the other hand, businesses without physical premises, such as stalls, experienced a lower risk of non-survival compared to those with rented locations, as they could swiftly adapt to their surroundings with minimal sunk costs. These findings provide valuable insights for policymakers and stakeholders in designing targeted interventions to support the survival and resilience of tourism businesses.

Based on our research findings, the following policy implications can be derived:

(1) Develop proactive crisis management strategies and early intervention mechanisms: Establish systems to detect early signs of business distress and provide timely support, such as financial counseling, mentoring, or advisory services. This will help businesses navigate challenging situations before they escalate, ultimately improving their chances of survival.
(2) Provide targeted financial support for businesses with a lower annual net income: Recognize the elevated risk of failure faced by these businesses and design financial support programs tailored to their specific needs. This could include access to low-interest loans, tax incentives, or grants to help them sustain their operations during difficult times.
(3) Focus on developing and promoting tourism in the northern region: Implement policies and programs that support infrastructure development, marketing campaigns, and investment incentives in the northern region. This region has been identified as having a higher risk of non-survival compared to the southern region, so targeted support can help businesses thrive in these areas.
(4) Provide specific support for businesses in the transportation sector: Acknowledge the significant impact of widespread lockdowns and travel restrictions on businesses in this sector. Develop support programs such as financial assistance, grants, or subsidies to help them sustain their operations during the crisis and facilitate their recovery.
(5) Balance stability and flexibility in the labor market: Explore measures that allow businesses to adjust their workforce based on fluctuating demand while ensuring adequate protection for workers. This can involve implementing flexible labor regulations, offering training programs, or introducing wage subsidy schemes that enable businesses to adapt their workforce size and composition as needed.
(6) Encourage businesses to target domestic tourists: Implement promotional campaigns and incentives that encourage businesses to focus on domestic tourists. Develop marketing strategies highlighting local attractions, cultural experiences, and the benefits of supporting domestic tourism. This diversifies customer bases and reduces reliance on international tourists during travel restrictions or uncertainties.

Lastly, the study has the inherent limitations of data. Notably, the reliance on the firm owner's perspective to extrapolate business failure events introduces a potential source of bias, as the survival probability may not accurately reflect the firm's actual insolvency. Consequently, further investigation utilizing actual data on business failures resulting from the coronavirus pandemic could be intriguing, providing a more robust and comprehensive analysis of the impact of the pandemic on the tourism industry.

Author Contributions: S.T., N.C., W.Y. and P.P. carried out the literature review, statistical analysis, and drafted the manuscript. W.Y. and P.P. helped with the data collection, data analysis, and discussion. S.T. and N.C. made major contributions to writing the manuscript. N.C. and W.Y. prepared the computer code and estimation. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Chiang Mai University and Chiang Mai Rajabhat University.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data are available upon request.

Acknowledgments: This paper is supported by the Center of Excellence in Econometrics, Faculty of Economics, Chiang Mai University and Faculty of Management Sciences, Chiang Mai Rajabhat University.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Abidi, N.; El Herradi, M.; Sakha, S. Digitalization and resilience during the COVID-19 pandemic. *Telecommun. Policy* **2023**, *47*, 102522. [CrossRef]
2. Aljughaiman, A.A.; Nguyen, T.H.; Trinh, V.Q.; Du, A. The COVID-19 outbreak, corporate financial distress and earnings management. *Int. Rev. Financ. Anal.* **2023**, *88*, 102675. [CrossRef]

3. Che, Z.; Kong, M.; Wang, S.; Zhuang, J. How Does the COVID-19 Pandemic Impact Internal Trade? Evidence from China's Provincial-Level Data. *Sustainability* **2023**, *15*, 10769. [CrossRef]
4. Makni, M.S. Analyzing the impact of COVID-19 on the performance of listed firms in Saudi market. *Technol. Forecast. Soc. Chang.* **2023**, *187*, 122171. [CrossRef] [PubMed]
5. Sudjatmoko, A.; Ichsan, M.; Astriani, M.; Mariani; Clairine, A. The impact of COVID-19 pandemic on the performance of Indonesian MSME with innovation as mediation. *Cogent Bus. Manag.* **2023**, *10*, 2179962. [CrossRef]
6. Yamaka, W.; Lomwanawong, S.; Magel, D.; Maneejuk, P. Analysis of the Lockdown Effects on the Economy, Environment, and COVID-19 Spread: Lesson Learnt from a Global Pandemic in 2020. *Int. J. Environ. Res. Public Health* **2022**, *19*, 12868. [CrossRef] [PubMed]
7. Leurcharusmee, S.; Maneejuk, P.; Yamaka, W.; Thaiprasert, N.; Tuntichiranon, N. Survival analysis of Thai micro and small enterprises during the COVID-19 pandemic. *J. Bus. Econ. Manag.* **2022**, *23*, 1211–1233. [CrossRef]
8. United Nation World Tourism Organization [UNWTO]. *International Tourism Highlights*; UNWTO: Madrid, Spain, 2020.
9. Tourism Authority of Thailand. *Annual Year Report*; Thailand Ministry of Tourism and Sports: Bangkok, Thailand, 2021.
10. Cox, D.R. Regression models and life-tables. *J. R. Stat. Soc. Ser. B (Methodol.)* **1972**, *34*, 187–202. [CrossRef]
11. Webster, A.; Khorana, S.; Pastore, F. The labour market impact of COVID-19: Early evidence for a sample of enterprises from Southern Europe. *Int. J. Manpow.* **2021**, *43*, 1054–1082. [CrossRef]
12. Crossley, T.F.; Fisher, P.; Low, H. The heterogeneous and regressive consequences of COVID-19: Evidence from high quality panel data. *J. Public Econ.* **2021**, *193*, 104334. [CrossRef]
13. Farooq, M.U.; Hussain, A.; Masood, T.; Habib, M.S. Supply chain operations management in pandemics: A state-of-the-art review inspired by COVID-19. *Sustainability* **2021**, *13*, 2504. [CrossRef]
14. Shafi, M.; Liu, J.; Ren, W. Impact of COVID-19 pandemic on micro, small, and medium-sized Enterprises operating in Pakistan. *Res. Glob.* **2020**, *2*, 100018. [CrossRef]
15. Sigala, M.; Gretzel, U.; Xiang, Z.; Koo, C. Tourism and COVID-19: Impacts and implications for advancing and resetting industry and research. *J. Bus. Res.* **2021**, *117*, 312–321. [CrossRef] [PubMed]
16. Xu, F.; Gursoy, D. Effects of COVID-19 pandemic on hospitality industry: Review of the current situations and a research agenda. *J. Hosp. Tour. Manag.* **2021**, *47*, 17–28.
17. Brunelli, S.; Gjergji, R.; Lazzarotti, V.; Sciascia, S.; Visconti, F. Effective business model adaptations in family SMEs in response to the COVID-19 crisis. *J. Fam. Bus. Manag.* **2023**, *13*, 101–117. [CrossRef]
18. Ma, Z.; Liu, Y.; Gao, Y. Research on the impact of COVID-19 on Chinese small and medium-sized enterprises: Evidence from Beijing. *PLoS ONE* **2021**, *16*, e0257036. [CrossRef]
19. Gregurec, I.; Tomičić Furjan, M.; Tomičić-Pupek, K. The impact of COVID-19 on sustainable business models in SMEs. *Sustainability* **2021**, *13*, 1098. [CrossRef]
20. Weaver, R.L. The Impact of COVID-19 on the Social Enterprise Sector. *J. Soc. Entrep.* **2020**, *14*, 177–185. [CrossRef]
21. Vărzaru, A.A.; Bocean, C.G.; Cazacu, M. Rethinking tourism industry in pandemic COVID-19 period. *Sustainability* **2021**, *13*, 6956. [CrossRef]
22. Kaplan, E.L.; Meier, P. Nonparametric estimation from incomplete observations. *J. Am. Stat. Assoc.* **1958**, *53*, 457–481. [CrossRef]
23. Zou, H.; Hastie, T. Regularization and variable selection via the elastic net. *J. R. Stat. Soc. Ser. B (Stat. Methodol.)* **2005**, *67*, 301–320. [CrossRef]
24. Xu, Y.; Wang, X.; Huang, Y.; Ye, D.; Chi, P. A LASSO-based survival prediction model for patients with synchronous colorectal carcinomas based on SEER. *Transl. Cancer Res.* **2022**, *11*, 2795. [CrossRef] [PubMed]
25. Arashi, M.; Roozbeh, M.; Hamzah, N.A.; Gasparini, M. Ridge regression and its applications in genetic studies. *PLoS ONE* **2021**, *16*, e0245376-8. [CrossRef] [PubMed]
26. Dang, X.; Huang, S.; Qian, X. Penalized cox's proportional hazards model for high-dimensional survival data with grouped predictors. *Stat. Comput.* **2021**, *31*, 77. [CrossRef]
27. Salerno, S.; Li, Y. High-dimensional survival analysis: Methods and applications. *Annu. Rev. Stat. Its Appl.* **2023**, *10*, 25–49. [CrossRef]
28. Huynh, D.V.; Truong, T.T.K.; Duong, L.H.; Nguyen, N.T.; Dao, G.V.H.; Dao, C.N. The COVID-19 pandemic and its impacts on tourism business in a developing city: Insight from Vietnam. *Economies* **2021**, *9*, 172. [CrossRef]
29. Abbas, J.; Mubeen, R.; Iorember, P.T.; Raza, S.; Mamirkulova, G. Exploring the impact of COVID-19 on tourism: Transformational potential and implications for a sustainable recovery of the travel and leisure industry. *Curr. Res. Behav. Sci.* **2021**, *2*, 100033. [CrossRef]
30. Pongsakornrungsilp, S.; Pongsakornrungsilp, P.; Kumar, V.; Maswongssa, B. The art of survival: Tourism businesses in Thailand recovering from COVID-19 through brand management. *Sustainability* **2021**, *13*, 6690. [CrossRef]
31. Adelino, M.; Ma, S.; Robinson, D. Firm age, investment opportunities, and job creation. *J. Financ.* **2017**, *72*, 999–1038. [CrossRef]
32. Anthanasius Fomum, T.; Opperman, P. Financial inclusion and performance of MSMEs in Eswatini. *Int. J. Soc. Econ.* **2023**, *51*, 1–17. [CrossRef]
33. Crane, F. Why MSMEs are failing: Evidence from the real world. *J. Int. Counc. Small Bus.* **2020**, *1*, 139–147. [CrossRef]
34. Ashworth, G.J.; Tunbridge, J.E. *The Tourist-Historic City*; Routledge: New York, NY, USA, 2000.

35. Vivel-Búa, M.; Lado-Sestayo, R.; Otero-González, L. Influence of firm characteristics and the environment on hotel survival across MSMES segments during the 2007–2015 period. *Tour. Manag.* **2019**, *75*, 477–490. [CrossRef]
36. Yamaka, W.; Maneejuk, P.; Phadkantha, R.; Puntoon, W.; Tarkhamtham, P.; Sudtasan, T. Survival and Duration Analysis of MSMEs in Chiang Mai, Thailand: Evidence from the Post-COVID-19 Recovery. *Mathematics* **2023**, *11*, 794. [CrossRef]
37. Najihah, N.; Permatasari, D.; Mutoharoh. Survival and sustainability strategies of small and medium enterprises (SMEs) during and after COVID-19 pandemic: A conceptual framework. In Proceedings of the 15th International Conference on Complex, Intelligent and Software Intensive Systems (CISIS-2021), Asan, Republic of Korea, 1–3 July 2023; Springer International Publishing: Berlin/Heidelberg, Germany, 2021; pp. 534–543.
38. Weidmann, S.; Filep, S.; Lovelock, B. How are tourism businesses adapting to COVID-19? Perspectives from the fright tourism industry. *Tour. Hosp. Res.* **2023**, *23*, 121–126. [CrossRef] [PubMed]
39. Katare, B.; Marshall, M.I.; Valdivia, C.B. Bend or break? Small business survival and strategies during the COVID-19 shock. *Int. J. Disaster Risk Reduct.* **2021**, *61*, 102332. [CrossRef]
40. Prentice, R.L. Introduction to Cox (1972) regression models and life-tables. In *Breakthroughs in Statistics: Methodology and Distribution*; Springer: Berlin/Heidelberg, Germany, 2012; pp. 519–526.
41. Liu, X. *Survival Analysis: Models and Applications*; John Wiley Sons: Hoboken, NJ, USA, 2012.
42. Gemar, G.; Moniche, L.; Morales, A.J. Survival analysis of the Spanish hotel industry. *Tour. Manag.* **2016**, *54*, 428–438. [CrossRef]
43. Tibshirani, R. The lasso method for variable selection in the Cox model. *Stat. Med.* **1997**, *16*, 385–395. [CrossRef]
44. Wang, D.; Wu, T.T.; Zhao, Y. Penalized empirical likelihood for the sparse Cox regression model. *J. Stat. Plan. Inference* **2019**, *201*, 71–85. [CrossRef]
45. Kavkler, A.; Danacica, D.E.; Babucea, A.G.; Bicanic, I.; Bohm, B.; Tevdovski, D.; Borsic, D. Cox regression models for unemployment duration in Romania, Austria, Slovenia, Croatia, and Macedonia. *Rom. J. Econ. Forecast.* **2009**, *10*, 81–104.
46. Ando, M.; Hayakawa, K. Impact of COVID-19 on trade in services. *Jpn. World Econ.* **2022**, *62*, 101131. [CrossRef]
47. Wang, R.; Mo, Y. The impact of COVID-19 on global import and export trade. *Rev. Bus.* **2022**, *42*, 19–40.