

FY2023 Grant for International Project Research IMI Joint Use Research Report

2023/11/12

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Position: Associate Professor

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	Reference No.	2023b006
1. Title of Research Project	Survival Analysis in Insurance Industry	
2. New Proposal	New	
3. Type	Grant for International Project Research	
4. Category	Workshop (I) Online	
5. Principal Investigator	Name	Danardono
	Affiliation	Department mathematics, Universitas Gadjah Mada position Associate Professor
6. Project Period	2023/08/18 - 2023/08/19	
7. Key Words	Survival analysis, actuarial science, COVID-19	
8. Number of	147	

9. Abstract for Research Report

Survival analysis plays a crucial role in understanding customer behavior, risk assessment, and developing robust insurance products. Through this event, we aim to provide participants with valuable insights, practical knowledge, and hands-on experience in applying survival analysis techniques in the insurance sector.

The objectives and the expected results of the projects are the following:

- (1) Learn from industry experts: Engage with renowned experts who possess extensive experience in survival analysis and its applications in the insurance domain.
- (2) Gain practical knowledge: Discover the fundamental concepts and methodologies of survival analysis, including hazard functions, Kaplan-Meier estimators, Cox proportional hazards models, and more. Explore how these techniques can be effectively utilized in insurance-related scenarios.
- (3) Explore real-life case studies: Dive into real-world examples of survival analysis implementation in insurance companies. Analyze and interpret data to make informed decisions and mitigate risks in a dynamic insurance market.
- (4) Network with industry professionals: Connect with fellow participants, insurance practitioners, and researchers during interactive sessions, fostering valuable connections and potential collaborations within the field.
- (5) We invite professionals, researchers, and enthusiasts from the insurance industry to join us for this enlightening event. Let's unlock the power of survival analysis together, shaping the future of insurance analytics.

Report of the Workshop on Survival Analysis in Insurance Industries

We invited the following experts and researchers in the area of survival analysis to the workshop:

1. Danardono, M.Sc, Ph.D. (Associate Professor Statistics at Universitas Gadjah Mada)
2. Hirokazu Iwasawa, FIAJ (Teacher of Actuarial Science at Waseda Univ., Univ. of Tokyo and the Institute of Actuaries of Japan)
3. Danang Teguh Qoyyimi, M.Act.Sci, ASAI, Ph.D. (Actuarial Lecturer at Universitas Gadjah Mada)
4. Novitasari Linda Christanti, FSAI (Actuarial Officer at Sukoon Insurance, Dubai)
5. Nurin Haniah Asmuni, Ph.D. (Actuarial Lecturer at Universiti Teknologi MARA)
6. Atina Husnaqilati, M.Sc, Ph.D. (Statistics Lecturer at Universitas Gadjah Mada)

Day 1 (August 18, 2023):

In the first session, **Danardono, M.Sc., Ph.D.** discussed the concept, models, and methods in survival analysis which is an important tool used in actuarial science and insurance industries to evaluate and quantify risks related to events such as death, illness, accidents, natural disasters, and other situations that can impact financial outcomes. The key terms such as survival data, survival curve, hazard function, cumulative hazard function, and parametric models for survival data were discussed. Survival data analyses using different distributions and estimation methods were provided. The discussion concluded with a discussion on regression models for survival data, including the Cox regression model and parameter estimation using Partial Likelihood.

AGLM (Additive Generalized Linear Model) is a modeling method that combines the flexibility of Generalized Additive Models (GAM) with the regularization of Generalized Linear Models (GLM). **Hirokazu Iwasawa, FIAJ** further explained in the second session that AGLM utilizes step-function-like or piecewise linear functions as its nonlinear components, providing flexible and accurate nonlinear models. AGLM is available as the `aglm` R package, which is used for ordinary regression and classification problems, as well as survival analysis. Overall, AGLM is a powerful modeling method that combines the flexibility of GAM with the regularization of GLM. It provides flexible and accurate nonlinear models and can be applied to various types of data analysis problems. The `aglm` R package offers reliable and efficient computation, making AGLM accessible to researchers and practitioners in the field of Data Science and Actuarial Science.

Day 2 (August 19, 2023):

This first session welcomed **Danang Teguh Qoyyimi, M.Act.Sci, ASAI, Ph.D.** to present and discuss various concepts related to life contingencies. It discussed topics such as future lifetime random variables, survival functions, probabilities, curtate future lifetime, time value of money, premium calculation principles, and pricing of whole life insurance.

Life contingencies involve analyzing the probabilities and outcomes associated with future lifetimes. He introduced the concept of a future lifetime random variable, denoted as T , which represents the additional time a person aged x might survive beyond their current age. The survival function, denoted as $S(x)$, gives the probability that a person aged x will survive to a certain age. He also mentioned the probability density function (pdf) and cumulative distribution function (cdf) associated with the future lifetime random variable. Curtate future lifetime is another concept discussed in the session. It represents the integer portion

of the future lifetime random variable and is often used when considering ages as integers. The curtate future lifetime, denoted as K , represents the number of whole years of life of a person aged x .

Premium calculation principles and pricing of whole life insurance were also covered. The pure risk premium, premium with safety loading, variance principle, exponential premium, and quantile premium were mentioned as different approaches to calculating premiums. The document provides formulas and equations for these calculations.

Overall, this session provides a comprehensive overview of various concepts and principles related to life contingencies, including future lifetime random variables, survival functions, curtate future lifetime, time value of money, premium calculation principles, and pricing of whole life insurance.

In the second session, **Novitasari Linda Christanti, FSAI** discussed various aspects related to life insurance contracts, pricing, and the impact of decrements on the profitability and cost of insurance products. Life insurance contracts often include additional benefits or riders, such as Accelerated Critical Illness, which provide a sum assured payout if a critical illness occurs. These riders can reduce the death sum assured and terminate the insurance contract. Decrement factors, such as death, lapse, disability, and withdrawal, are important considerations in modeling life insurance contracts. The occurrence of disabilities can reduce the number of in-force policies. Morbidity tables are used to reflect the decrement of disabilities in the modeling process.

The next two sessions discussed the application of Survival Analysis in longevity risk and the risk of the COVID-19 pandemic, which may also be implemented in the insurance business.

Nurin Haniah Asmuni, Ph.D. discussed the challenges and benefits of using life annuities as a means of protecting individuals from longevity risk. It highlighted the limited market for annuities and the need for optimal portfolio composition to achieve natural hedging, which involves offsetting risks in life insurance and annuity business. The strategic management of portfolio optimization requires effort from various divisions, management, actuaries, and agencies. The scarcity of old-age mortality rates poses a challenge, requiring a robust model for estimation. Additionally, the restructuring of pension provisions requires government support, potentially involving the conversion of employee retirement funding to annuity schemes. In summary, this session emphasizes the importance of managing longevity risk through life annuities and natural hedging. It highlights the need for optimal portfolio composition, robust estimation models for mortality rates, and government support in restructuring pension provisions. The competitive advantages of insurers with a natural hedge are also discussed.

Atina Husnaqilati, M.Sc, Ph.D. discussed a predictive survival time for COVID-19 using a stacked method in the last session of Day 2. She explained the concepts of survival analysis, censored observations, and the aims of survival analysis. She also introduced the Stacked Survival Model, which combines multiple models to estimate survival functions. The document presents the Brier score and IPCW-Brier score as loss functions for survival function estimation. It then applies the stacked method to analyze COVID-19 data, including the dataset description and the fitting of parametric probability survival distributions. The results show that the stacked model outperforms other survival models in predicting survival times for COVID-19 patients. The conclusion emphasizes the importance of the Stacked Survival model in developing strategies to reduce the death toll.

開催日：2023/08/18～2023/08/19

Survival Analysis in Insurance Industry | 2023b006

カテゴリー：イベント タグ：国際研究 研究集会!

開催概要

- 開催方法：Zoomミーティングによるオンライン開催
- 主要言語：英語
- 主催：九州大学マス・フォア・インダストリ研究所
- 種別・種目：国際プロジェクト研究-研究集会（I）オンライン型
- 研究計画題目：Survival Analysis in Insurance Industry
- 研究代表者：Danardono（Department mathematics, Universitas Gadjah Mada・Associate Professor）
- 研究実施期間：2023年8月18日（金）～2023年8月19日（土）
- 公開期間：2023年8月18日（金）～2023年8月19日（土）
- 研究計画詳細：https://joint1.imi.kyushu-u.ac.jp/research_chooses/view/2023b006

研究集会のWebページ

<https://sites.google.com/view/imi-survivalanalysis/home?authuser=0>

プログラム（インドネシア時間 JST-2）

8月18日（金）

10:00-10:40

Survival Analysis: Concept, Models and Methods
Danardono, M. Sc, P. hD.

10:40-11:25

Discussion

11:55-12:35

Break

12:35-13:15

Survival analysis in Insurance industry
Iwasawa Hirokazu

13:15-14:00

Discussion

8月19日（土）

09:30 – 10:15

Survival analysis in Insurance industry
Danang T. Qoyyimi, M.Act.Sci, ASAI, Ph.D.

10:15 – 11:00

Survival analysis in Insurance industry
Novitasari Linda Christanti, FSAI

11:00 – 12:00

Discussion

12:00-12:30

Break

12:30 – 13:15

Survival analysis for COVID-19 by Stacked method
Atina Husnaqilati, Ph.D.

13:15-14:00

Longevity Risk Mitigation for Developing Nations
Nurin Haniah Asmuni, Ph.D.

14:00-15:00

Discussion