

Lecture Notes in Civil Engineering

Han Ay Lie · Monty Sutrisna ·
Joewono Prasetijo ·
Bonaventura H.W. Hadikusumo ·
Leksmono Suryo Putranto *Editors*

Proceedings of the Second International Conference of Construction, Infrastructure, and Materials

ICCIM 2021, 26 July 2021, Jakarta,
Indonesia

 Springer

Lecture Notes in Civil Engineering

Volume 216

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ISSN 2366-2557

ISSN 2366-2565 (electronic)

Lecture Notes in Civil Engineering

ISBN 978-981-16-7948-3

ISBN 978-981-16-7949-0 (eBook)

<https://doi.org/10.1007/978-981-16-7949-0>

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Preface

This new volume of Lecture Notes in Civil Engineering contains the proceedings of the Second International Conference of Construction, Infrastructure, and Materials (ICCIM 2021). This book presents the latest development in civil engineering on a global scale. It highlights the conference scopes, such as Structural Engineering, Construction Materials, Geotechnical Engineering, Transportation System and Engineering, Constructions Management, Water Resources Engineering, and Infrastructure Development. The 55 articles published in this book went through peer-review processes double-blindly and plagiarism check. Manuscript assessments by the expert reviewers were based on the organizer's technical criteria, including technical criteria, quality criteria, and presentation criteria.

The Second International Conference of Construction, Infrastructure, and Materials (ICCIM 2021) was hosted by the Civil Engineering Undergraduate Study Program of Universitas Tarumanagara, Indonesia, on 26 July 2021. The conference brought together national and international experts to share their researches, knowledge, and experiences. ICCIM 2021 carried the theme "Research and Technology in Civil Engineering to Enhance the Sustainability of the Built Environment".

Due to the global COVID-19 pandemic, which has impacted all activities globally, ICCIM 2021 was held as an online conference. ICCIM 2021 online conference aimed to capture a broader range of participants. The Conference was also expected to facilitate researchers, practitioners, and students in their respective fields of expertise to share information and exchange ideas about the current state of civil engineering development.

ICCIM 2021 was supported by Massey University, New Zealand; Universiti Tun Hussein Onn Malaysia, Malaysia; Nihon University, Japan; fib Indonesia; Diponegoro University, Indonesia; Soegijapranata Catholic University, Indonesia; Universitas Sebelas Maret, Indonesia; and Universitas Atma Jaya Yogyakarta, Indonesia.

ICCIM 2021 has received papers from various countries, such as Indonesia, Japan, Thailand, the United Kingdom, the United States of America, the

Philippines, India, Nigeria, and Bangladesh. More than 600 researchers, practitioners, and students from all over the world registered to attend the Conference.

We are likewise grateful to the keynote speakers for bringing the exciting topics to ICCIM 2021: Prof. Roesdiman Soegiarso (Universitas Tarumanagara, Indonesia); Prof. Monty Sutrisna (Massey University, New Zealand); Dr.-Ing. Joewono Prasetijo (Universiti Tun Hussein Onn Malaysia, Malaysia); and Dr. Tam Chat Tim (National University of Singapore, Singapore).

We would also like to extend our appreciation to the supporting institutions. Secondly, thank you to the sponsors for the utmost support and kind contribution: PT. Waskita Karya (Persero) Tbk, PT. Pamapersada Nusantara, and PT. Bank Negara Indonesia Tbk.

Many people have worked very hard for the organization of this Conference. Special thanks are needed to the Organizing Committee, Steering Committee, Editorial Board, and Scientific Committee. All of whom have generously worked to make this Conference rich in content and pleasant for the attendees. We would also like to thank all the authors who have contributed to the success of this Conference.

Semarang, Indonesia
Auckland, New Zealand
Panchor, Malaysia
Klong Luang, Thailand
Jakarta Barat, Indonesia

Han Ay Lie
Monty Sutrisna
Joewono Prasetijo
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Contents

Additional Horizontal Movement of the Single Pile Foundation with Combined Loads	1
Sumiyati Gunawan, Niken Silmi Surjandari, Bambang Setiawan, and Yusep Muslih Purwana	
The Combined Effects of Terraces Slope Model and Geotextile Reinforcement Design in Sendangmulyo, Wonogiri	13
Siti Nurlita Fitri and Niken Silmi Surjandari	
Erosion and Distribution of Total Suspended Sediment (TSS) Using Landsat-8 in Krueng Pase Watershed	23
Ichwana Ramli, Ashfa Achmad, Hairul Basri, and Atika Izzaty	
Shoreline Change Cause of Abrasion in Bantan District Bengkalis Island as the Outstanding Beach Area	35
H. Tampubolon	
Nonlinear Effect of Fluid–Structure Interaction Modeling in the Rock-Fill Dam Jatiluhur	49
Albert Sulaiman, Wati A. Pranoto, Tati Zera, and Mouli De Rizka Dewantoro	
Assessment of Flooding Event in the Upper Sunter Watershed, Jakarta, Indonesia	59
Anasya Arsita Laksmi, Anthony Harly Sasono Putro, Wisnu Setia Dharma, Pungky Dharma Saputra, Nina Purwanti, and Muhammad Hamzah Fansuri	
Modeling of Flood Propagation in the Lower Citarum River Using a Coupled 1D-2D HEC-RAS Model	77
Angga Prawirakusuma, Sri Legowo Wignyo Darsono, and Arno Adi Kuntoro	

Review: Effects of Climate on the Geochemical Properties of Volcanic Rocks 85
 Novi Asniar, Yusep Muslih Purwana, Niken Silmi Surjandari,
 and Bambang Setiawan

Analysis of the Utilization of the Embung Klampeyan, Tlogoadi Village, Mlati District, Sleman Regency, Indonesia 93
 Edy Sriyono

Analysis of Shift Pile Foundation on Mall and Hotel Projects in Bontang, East Kalimantan 105
 Nicholas Joshua and Alfred Jonathan Susilo

Analysis of Diaphragm Wall Stability with Dewatering and Ground Freezing Treatment 117
 Eduard Teja and Aniek Prihatiningsih

Analysis of Hollow Concrete Column with CFRP Wrapping Using Finite Element Method 129
 William Supardjo and Sunarjo Leman

The Use of Fly Ash in Pervious Concrete Containing Plastic Waste Aggregate for Sustainable Green Infrastructure 141
 Steve W. M. Supit and Priyono

Artificial Aggregate Made from Expanded Polystyrene Beads Coated with Cement Kiln Dust—An Experimental Trial 153
 A. P. Wibowo, M. Saidani, and M. Khorami

Load Transfer Shear Wall to Pile Cap Modelling Partially for Group Precast Pile 165
 Daud Rahmat Wiyono, Roi Milyardi, Yosafat Aji Pranata,
 Asriwiyanti Desiani, Ginardi Husada, and Maria Christine Sutandi

Effect of Cement–Water Ratio on the Mechanical Properties of Reactive Powder Concrete with Marble Powder as Constituent Materials 177
 Widodo Kushartomo, Henny Wiyanto, and Daniel Christianto

Structural Analysis Using Matched Acceleration Time Histories 187
 Windu Partono

Non-linear Analysis of Steel Shear Key at Epoxy Joint 199
 Khairunnisa Masturoh, Nuraziz Handika, and Heru Purnomo

On-Field Testing of the Monolith Joint of the Full Slab on a Slab-on-Pile Bridge 213
 Ahmad Zaki Risadi, Josia Irwan Rastandi, Bastian Okto Bangkit Sentosa,
 and Nuraziz Handika

Seismic Design Load Comparison of Reinforced Concrete Special Moment Frame and Dual Systems Based on SNI 1726:2019 231
 Suradjin Sutjipto and Indrawati Sumeru

Analysis of Asphalt Damping Ratio on Shear Test 239
 Sunarjo Leman, Maria Kevinia Sutanto, Elizabeth Ivana Harsono, Vryscilia Marcella, Anugerah Tiffanyputri, and Yuskar Lase

Analysis of the Sand Grains Influence on Damping Ratio Using Shear Test 247
 Daniel Christianto, Vryscilia Marcella, Channy Saka, Alvira Nathania Tanika, and Yuskar Lase

Parametric Study on Neutral Axis Growth of Concrete Beams Reinforced with Fiber-Reinforced Polymer and Steel Bars 255
 Ahmad Zaki and Rendy Thamrin

Dr. Saharjo Road Condition Audit Using IRAP Method to Achieve 3 Star Rating 265
 Ni Luh Putu Shinta Eka Setyarini and Garry Edison

Analyzing Zones and Accessibility of Public Senior High School in Makassar City 277
 Ardiansyah, Syafruddin Rauf, and Sumarni Hamid Aly

Evaluation Readiness of Contractor and Government in Implementing the Road Preservation Program: Case Study National Road in Indonesia 289
 Maharani Pasha Umar, Ayomi Dita Rarasati, and R. Jachrizal Sumabrata

Analysis of Travel Behavior Under Flooding Condition Based on Probe Data in Ubon Ratchathani City, Thailand 303
 Noriyasu Tsumita, Kohga Miyamura, Sittha Jaensirisak, and Atsushi Fukuda

Modeling Movement of Rice Commodities Between Provinces in Indonesia 317
 Dwi Novi Wulansari, Saskia Kanisaa Puspanikan, and Zafir Istawa Pramoeodya

Single Tariff System to Provide Incentive for Longer Distance Users and to Keep Efficient Toll Gates Operations 329
 Apta Sampoerna and Leksmono Suryo Putranto

Analysis of Transportation Accessibility in Shopping Areas in Makassar City 341
 Jefryanto Londongsalu, Syafruddin Rauf, and Sumarni Hamid Aly

Priority of Sustainable Transport Policy Implementation in Expert Perspective	353
Nindyo Cahyo Kresnanto, Ricko Nasrianda Sinaga, Risdiyanto, and Wika Harisa Putri	
Prioritizing District Road Maintenance Using AHP Method	363
Nindyo Cahyo Kresnanto	
Overview of Side Friction Factors for Evaluation of Capacity Calculation at Indonesian Highway Capacity Manual	373
Najid and Tamara Marlianny	
Thickness Pavement Design Based on Heavy Vehicle Loads	385
Anita Rahmawati, Emil Adly, and Wahyu Widodo	
Performance of Polymer Modified Asphalt Mixture Using Gypsum Filler	399
Rindu Twidi Bethary, Dwi Esti Intari, and Siti Asyiah	
Resistance of Modified Concrete-Wearing Course Mixture Using LDPE Polymer Against Damage Due to Water Immersion	411
Indah Handayasari, Dyah Pratiwi Kusumastuti, and Arief Suardi Nur Chairat	
Experimental Study on the Self-healing Ability of Wearing Course-Asphalt Concrete Mixes Reinforced with Steel Particles	421
Anissa Noor Tajudin, Arif Sandjaya, Daniel Christianto, and M. Bagas Haris Kurniawan	
The Use of Gauss-Jordan Elimination Method in Determining the Proportion of Aggregate Gradation	431
Bagus Hario Setiadji, Supriyono, and Amelia Kusuma Indriastuti	
Conceptual System Model Dynamic OSH Performance Improvement of Building Construction Projects	441
Feri Harianto, Nadjadji Anwar, I Putu Artama Wiguna, and Erma Suryani	
Experiment the Effect of Providing Monetary Incentives and Safety Patrols on Work Safety Behavior in Construction Project Implementation	449
Feri Harianto, Nadjadji Anwar, I Putu Artama Wiguna, and Erma Suryani	
Development of Activity-Based Safety Plan for Precast Parapet Panel Work in Elevated Construction	459
Pungky Dharma Saputra, Anasya Arsita Laksmi, Nina Purwanti, and Muhammad Hamzah Fansuri	

Game Theory Approach for Risk Allocation in Public Private Partnership 471
 Adhika Nandi Wardhana, Farida Rachmawati, and Erwin Widodo

Analysis of Change Orders Based on the Type of Road Construction 479
 Mega Waty and Hendrik Sulistio

Implementation of Occupational Safety and Health Management Systems During COVID-19 Pandemic on High-Rise Building Construction Projects 489
 Aleksander Martin and Mega Waty

Developing Knowledge Management Strategy to Improve Project Communication in Construction of Coal Mining Infrastructure: A Conceptual Study 497
 Alfandias Seysna Putra, Leni Sagita Riantini, and Mohammad Ichsan

Portable Structure for Post-disaster Temporary Shelter 511
 Bayu Ariaji Wicaksono, Dalhar Susanto, and Emirhadi Suganda

Concrete Damage Risk Rating Examination to Existing Buildings 523
 Henny Wiyanto, Reagen Yocom, and Glen Thenaka

A Literature Review of Life Cycle Costing of Dam Asset Management 533
 Ismi Astuti Anggraini, Ayomi Dita Rarasati, and R. Jachrizal Sumabrata

An Explorative Study to Public Rental Housing’s Tenants Using Importance Performance Analysis 543
 Indira Surya Kumala and Farida Rachmawati

Modeling of Conceptual Framework to Understand Stakeholders’ Awareness in Construction Industry in Thailand Affected by the 3rd Wave of COVID-19 Pandemic 557
 Nattasit Chaisaard and Grit Ngowtanasuwan

A Literature Review on Healthy Buildings Based on Various Perspectives 567
 Louferinio Royanto Amatkasmin, Mohammed Ali Berawi, and Mustika Sari

Analysis of Dominant Influence Factors of the Application of the Incentive Plan Model on the Material Waste 585
 Triongko Agatha Bayuaji and Basuki Anondho

Accuracy of Schedule Performance Calculation with ES Method and EV Method 597
 Cangga Kristiandi and Basuki Anondho

Analysis of Dominant External Factors on Construction Project Overhead Costs	609
Hendi Wijaya and Basuki Anondho	
A Competency Model of Thai Small-Medium Enterprise Contractors for Owner Satisfaction in Construction Projects	619
Grit Ngowtanasuwan	

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Single Tariff System to Provide Incentive for Longer Distance Users and to Keep Efficient Toll Gates Operations



Apta Sampoerna and Leksmono Suryo Putranto 

Abstract Due to limited investment funds, the toll road construction usually should be in stages in several segments. The toll tariff of segments that were operated in the earlier stages may only be determined by the length of the segment in km multiplied by toll tariff per km. After all segments have been operated, we also need to consider additional factors, e.g., an incentive to longer distance users, efficient toll gate operations, and smooth toll gate services. Integrated toll road payment system usually implements open toll payment system with uniform tariff. Logistic vehicles which usually traveled longer distances will be subsidized by vehicles traveling shorter distances. The open toll payment system is usually implemented by payment in the upstream barrier toll gates. It will keep efficient toll gate operations by concentrating all payment equipment and officers in the upstream barrier toll gates. This paper will discuss the single tariff determination of Jakarta Outer Ring Road (JORR) 2 Area 1 connecting Jagorawi-Cinere-Serpong-Kunciran-Cengkareng. There were several factors considered, i.e., road user ability/willingness to pay, breakeven point based on predicted average annual daily traffic, and related regulations. The resulted single tariff was Rp. 20,000.-.

Keywords Single tariff · Incentive · Efficient introduction

1 Background

Building additional road segments might be considered as a non-sustainable transport supply program as it might encourage massive development along the road and at the end will create a congested car-dependent corridor. However, we cannot rely on a transport system on public transport provision only. The system is for passenger service. For goods transport (logistics) and for certain passenger

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H. A. Lie et al. (eds.), *Proceedings of the Second International Conference of Construction, Infrastructure, and Materials*, Lecture Notes in Civil Engineering 216, https://doi.org/10.1007/978-981-16-7949-0_29

329

movements (e.g., last-mile and first-mile transport) road transport is essential. Therefore, in a long-term plan of a city transport system, road network completeness, to avoid missing links and bottlenecks (including in toll road sub-systems) is a must.

Infrastructure (including toll road) development should be given priority in developing countries. However, the national budget is usually limited and/or should be distributed proportionally to other sub-sectors. Private-sector funding would be an alternatives source fund but might need time to be invested. Therefore, the toll road construction usually should be in stages in several segments.

The toll tariff of segments that were operated in the earlier stages may only be determined by the length of the segment in km multiplied by toll tariff per km. After all segments have been operated, we also need to consider additional factors, such as an incentive to longer distance users, efficient toll gate operations, and smooth toll gate services.

Integrated toll road payment system usually implements open toll payment system with uniform tariff regardless of the distance. Logistic vehicles which usually traveled longer distances should be provided with an incentive to support national welfare. They will be subsidized by vehicles traveling a shorter distance [1]. An open toll payment system is usually implemented by payment in the upstream barrier toll gates. It will keep efficient toll gate operations by concentrating all payment equipment and officers in the upstream barrier toll gates instead of distributing payment equipment in remote downstream tollgates. However, this may create a long queue in upstream barrier toll gates if no attention was not given to this matter. Nevertheless, the smoothness of toll gate services will not be covered by this paper. This paper will discuss the single tariff determination of Jakarta Outer Ring Road (JORR) 2 Area 1. Total observed length 50.43 km (Fig. 1). The reason to conduct this research was to balance benefits received by road users and toll investors. There were several factors considered, i.e., road user Ability to Pay (ATP), Willingness to Pay (WTP), breakeven point based on predicted Average Annual Daily Traffic (AADT), and related regulations.

1.1 Scopes

To include ATP and WTP analysis, the only group I vehicles (passenger car, jeep, pick-up, small truck, and bus) were observed (comprise of 80–90% of toll road users). ATP and WTP questionnaire items are not relevant to company vehicles which predominantly comprise heavy logistic vehicles (from group II to V). Hypothetically this will not significantly affect the resulted single tariff determination. Moreover, the variability of travel length of private light vehicle users is usually the highest among other toll road users and, therefore, more relevant in the determination of a single tariff.



Fig. 1 JORR 2 Area 1 (circled with green line)

2 Literature Review

2.1 Types of Toll Transaction System

There are three types of toll transaction systems [2], i.e.:

- Open transaction system (single tariff) and the payment conducted in off-ramp (downstream). Please refer to Fig. 2.
- Open transaction system (single tariff) and the payment conducted in on-ramp (upstream). Please refer to Fig. 3.
- Closed transaction system (based on distance) and therefore the vehicle should be identified in the on-ramp (upstream) and payment conducted in off-ramp (downstream) based on identified distance. Please refer to Fig. 4

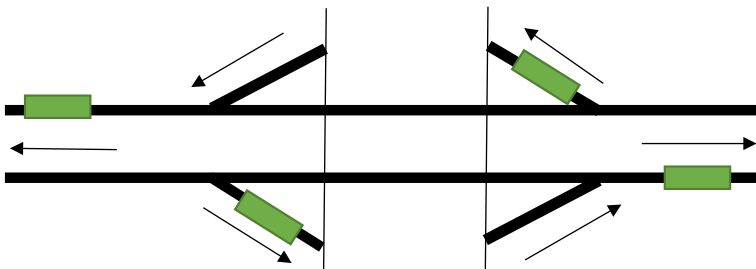


Fig. 2 Open transaction system (off-ramp payment)

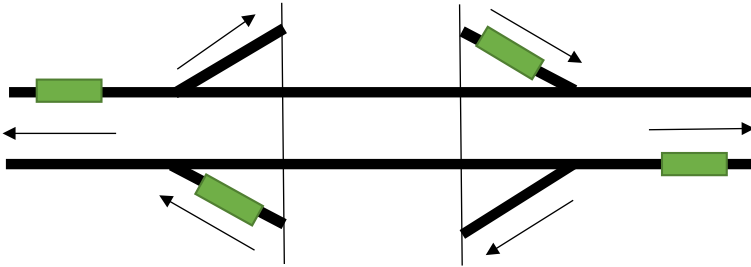


Fig. 3 Open transaction system (on-ramp payment)

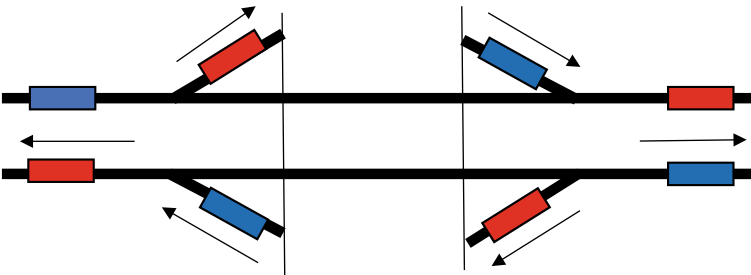


Fig. 4 Closed transaction system

2.2 ATP and WTP

ATP is the ability of someone to pay for the received services based on his/her wealth level. The approach used in ATP analysis is based on transport cost analysis from routine income earned. In other words, ATP is the ability of the public to pay his/her travel costs as stated by Tamin et al. [3]. According to Yulianto et al. [4], there were several factors affecting ATP, i.e., the amount of the income, transport demand, total transport cost, and percentage of income disbursed for transport cost.

WTP is the willingness of service users to pay for the received services. According to Hotmaida [5] and Nugroho et al. [6], several factors were affecting WTP, i.e., offered product, service quality, user utility of the transport services, and transport user behavior.

3 Method of Data Collection and Analysis

3.1 Method of Data Collection

There were two groups of data used in this paper, i.e., secondary data and primary data. The main secondary data was predicted AADT and regulations regarding toll road financing to calculate tariff based on breakeven point. Primary data was collected from group I vehicle users, consist of:

- General data (name, age, gender, educational attainment, and occupation).
- ATP data (monthly travel frequency, average travel time, travel period, monthly income, monthly toll road expenses, and travel purpose)
- WTP data (choice between 10, 20 and 30 min time saving for choice of tariff between twenty thousand rupiahs and thirty thousand rupiahs)

3.2 Method of Data Analysis

Figures 5, 6, and 7 describe the steps taken for determining the single tariff:

4 Profile of Respondents

There were 126 respondents (40 females and 86 males). However, only 122 responded to ATP-related questions and therefore, the ATP/ km data was only calculated from those 122 respondents. Their mean age was about 37 years old

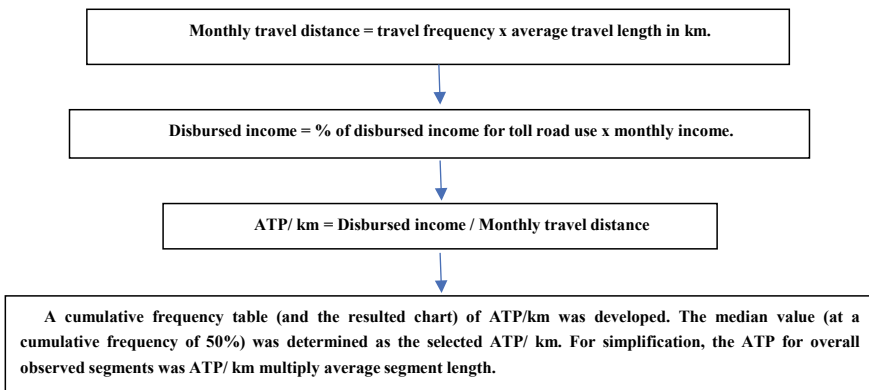


Fig. 5 Determination of ATP

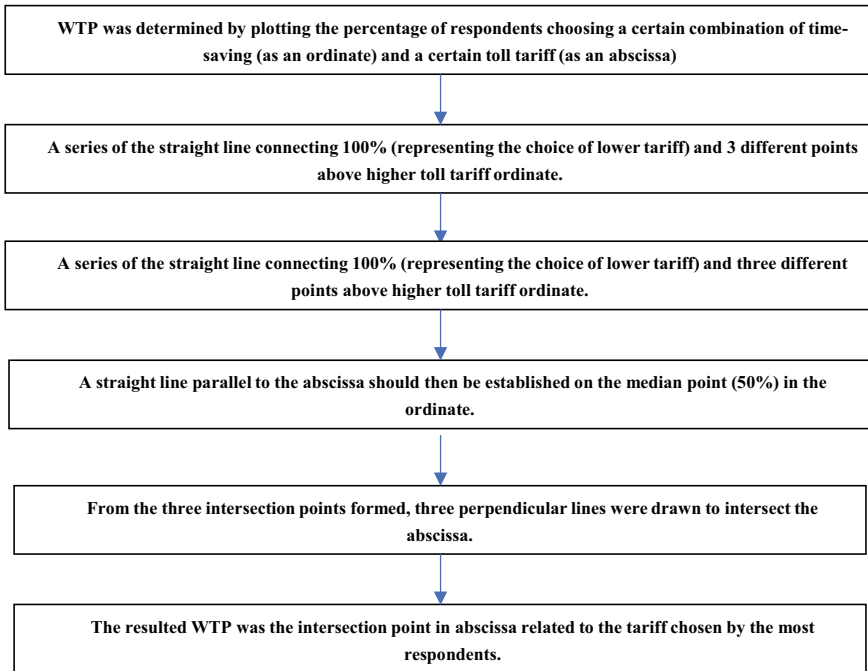


Fig. 6 Determination of WTP

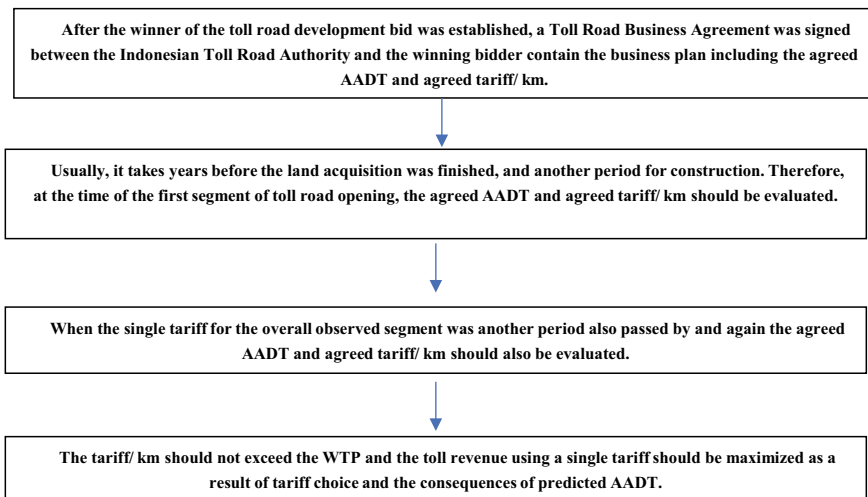


Fig. 7 Adjustment of selected single tariff

(standard deviation of 12) and ranged between 19 and 64 years old. Most of them (about 55%) earned less than 10 million rupiahs (USD 696 as 22 May 2021 exchange rate) monthly, about 33% earned above 10 million rupiahs up to 20 million rupiahs (USD 1392) monthly, about 8% earned above 20 million rupiahs up to 30 million rupiahs (USD 2088) monthly, and less than 5% earned above 30 million rupiahs monthly. About 31% of them spend less than 1 million rupiahs (USD 70) on toll roads monthly, about 27% spend more than 1 million rupiahs up to 3 million rupiahs (USD 209) monthly and most of them (about 42%) spend more than 3 million rupiahs monthly. The monthly travel frequency of most of them (54%) was more than seven times while the rest travel less. Travel time on the toll of most of them (about 63%) spends 30 to 60 min while the rest travel with a less or longer period. Most of the respondents travel on toll roads during morning and afternoon peak hours. Most of them (66%) travel on the toll road for work/ business purposes and the rest for various non-work purposes.

5 Results

5.1 ATP Analysis

Figure 8 shows that the 50-percentile of ATP was Rp. 2,800.-/ km. Therefore the ATP of each segment was Rp. 39,732.- (Jagorawi-Cinere), Rp. 28,392.- (Cinere-Serpong), Rp. 31,920.- (Serpong-Kunciran) and Rp. 39,732.- (Kunciran-Cengkareng) respectively. To simplify the overall ATP determination, an average of ATP of overall JORR 2 Area 1 weighted by each segment length was established as representative ATP, i.e., Rp. 36,102.-

5.2 WTP Analysis

Table 1 shows the number and percentage of respondents choosing each pair of time-saving and toll tariff. The lowest choice tariff (Rp. 20,000.-) was assumed to be chosen by 100% of the respondent while the percentage higher choice of tariff (Rp. 30,000.-) was calculated by dividing the number of respondents choosing it divided by the total respondent choosing the particular time-saving.

Figure 9 shows the WTP for all segments in the observed JORR 2 Area 1.

The determination of WTP at three different time-savings was by selecting the value chosen by most respondents. In this case, it was Rp. 29,000.- for a time-saving of 30 min.

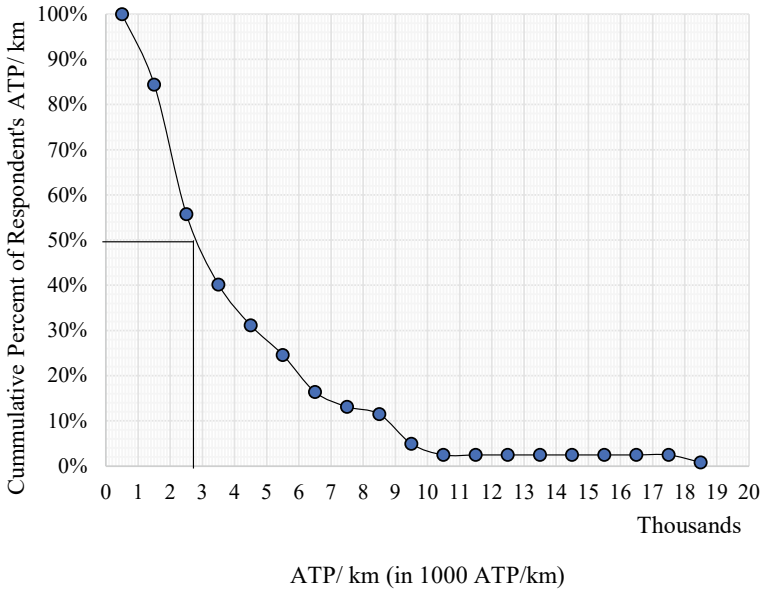


Fig. 8 50-percentile of ATP, i.e. Rp. 2,800.-/ km

Table 1 Number and percentage of respondents choosing certain pair of time-saving and toll-tariff

Ruas	Percentage of respondent (%)			Number of respondents			
	10 min	20 min	30 min	10 min	20 min	30 min	
<i>JORR 2 Area 1 (50.43 km)</i>							
Tariff	20,000	100.0	100.0	100.0	93	140	162
Tariff	30,000	34.4	39.3	44.4	32	55	72

5.3 Single Tariff Adjustment

After the Toll Road Business Agreement was signed between the Indonesian Toll Road Authority and the winning bidder, a business plan containing an agreed AADT and an agreed toll tariff was established. Table 2 shows the agreed figures in this stage, let's call it stage 1.

Stage 2 was adjusted business plan after the opening of the first segment, as shown in Table 3.

At stage 3, the adjustment was conducted using a trial and error process to maximize re-venue whilst keeping the tariff below the WTP as can be seen in Tables 4, 5, 6, and 7. The AADT in Tables 5, 6, and 7 was adjusted inversely to the

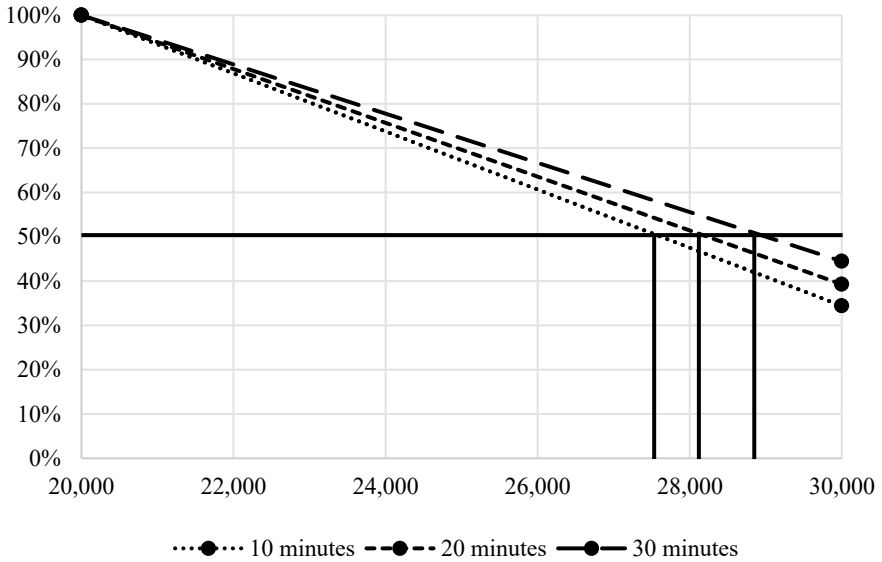


Fig. 9 WTP for all segments in the observed JORR 2 Area 1

Table 2 Toll road business plan at stage 1

AADT	Toll tariff in Rupiah	Toll revenue in Rupiah
42,084	22,000	333,305,280,000
52,911	17,500	333,339,300,000
62,843	17,500	395,390,910,000
44,314	19,500	311,084,280,000
Total revenue in Rupiah		1,373,639,760,000

Table 3 Toll road business plan at stage 2

AADT	Toll tariff in Rupiah	Toll revenue in Rupiah
26,697	22,000	211,440,240,000
31,977	17,500	201,455,100,000
24,732	17,500	155,811,600,000
41,313	19,500	290,017,260,000
Total revenue in Rupiah		858,724,200,000

toll tariff on trial. The trial in this stage stop at Table 7 as the total revenue has reached its maximum value in Table 6. Therefore, the resulting single tariff was Rp. 20,000.-. The value was acceptable as it was still under the WTP (Rp. 29,000.-).

Table 4 Toll road business plan at stage 3-trial 1

AADT	Toll tariff in Rupiah	Toll revenue in Rupiah
29,540	15,000	159,516,000,000
35,383	15,000	191,068,200,000
27,366	15,000	147,776,400,000
45,713	15,000	246,850,200,000
Total revenue in Rupiah		745,210,800,000

Table 5 Toll road business plan at stage 3-trial 2

AADT	Toll tariff in Rupiah	Toll revenue in Rupiah
25,490	17,500	160,587,000,000
30,531	17,500	192,345,300,000
23,614	17,500	148,768,200,000
39,445	17,500	248,503,500,000
Total revenue in Rupiah		750,204,000,000

Table 6 Toll road business plan at stage 3-trial 3

AADT	Toll tariff in Rupiah	Toll revenue in Rupiah
22,379	20,000	161,128,800,000
26,805	20,000	192,996,000,000
20,731	20,000	149,263,200,000
34,631	20,000	249,343,200,000
Total revenue in Rupiah		752,731,200,000

Table 7 Toll road business plan at stage 3-trial 4

AADT	Toll tariff in Rupiah	Toll revenue in Rupiah
19,715	22,500	159,691,500,000
23,615	22,500	191,281,500,000
18,265	22,500	147,946,500,000
30,510	22,500	247,131,000,000
Total revenue in Rupiah		746,050,500,000

6 Conclusions and Recommendations

Based on the analysis in this paper, several conclusions can be made as follow:

1. The ATP/ km for JORR 2 Area 1 was Rp. 2,800.-/ km.
2. The overall ATP for JORR 2 Area 1 was Rp. 36,102.-.
3. The WTP for JORR 2 Area 1 was Rp. 29,000.-.
4. After conducting three stages of tariff adjustment, the resulting single tariff was Rp. 20,000.- which was still less than WTP and therefore can be applied.

The recommended toll transaction system is an open transaction system with on-ramp payment to avoid the provision of transaction equipment in remote gates from the upstream barrier gate. Therefore, the toll gate operation will be more efficient.

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