# Bunga Rampai Tesis/Disertasi

SPIRIT

Scholarship Program for Strengthening Reforming Institutions

Tema:

## Kehutanan, Komputer, Kesehatan Masyarakat, dan Teknik

Project Coordinating Unit (PCU) SPIRIT
Pusbindiklatren-Bappenas

Kementerian PPN/ Bappenas

## Bunga Rampai Tesis/Disertasi

# TEMA: KEHUTANAN, KOMPUTER, KESEHATAN MASYARAKAT, DAN TEKNIK

## Program Beasiswa SPIRIT

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**Dr. Nur Hygiawati Rahayu, ST, M.Sc, dkk.**

Project Coordinating Unit (PCU)
SPIRIT Pusbindiklatren Bappenas

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**Bunga Rampai Tesis/Disertasi**
**Tema: Kehutanan, Komputer, Kesehatan Masyarakat, Teknik, dan Pertanian**
**Kelompok: Ilmu Alam dan Interdisiplin**


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# KATA PENGANTAR

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Jakarta, November 2017

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# DAFTAR ISI


**KEHUTANAN**

OPSI STRATEGI KEBIJAKAN TENURIAL PENGELOLAAN HUTAN LINDUNG
TENURE POLICY STRATEGIC OPTION ON PROTECTED FOREST MANAGEMENTS
Asis Budiawan .....1

**KESEHATAN MASYARAKAT**

SOCIAL GRADIENTS IN SUBJECTIVE WELL-BEING IN EASTERN INDONESIA: EXPLORING URBAN-RURAL DIFFERENCES
GRADIEN SOSIAL DALAM KESEJAHTERAAN SUBJEKTIF DI KAWASAN TIMUR INDONESIA: MENGEKSPLORASI PERBEDAAN PERKOTAAN-PEDESAAN
Dewi Amila Solikha ..... 15

ANALISIS DISABILITAS TERKAIT FAKTOR-FAKTOR RISIKONYA PADA PENDUDUK INDONESIA USIA PRODUKTIF (BERDASARKAN RISET KESEHATAN DASAR 2013)
DISABILITY ANALYSIS RELATED TO ITS RISK FACTORS ON THE INDONESIAN PRODUCTIVE AGES POPULATION (BASED ON BASIC HEALTH RESEARCH 2013)
Rindra Eriska ..... 27

**KOMPUTER**

PENGEMBANGAN DEPENDENCY IMPACT-BASED ALERT SYSTEM (DIAS) SEBAGAI PENDUKUNG SISTEM PENGAWASAN PADA INFRASTRUKTUR JARINGAN INFORMASI
DEPENDENCY IMPACT-BASED ALERT SYSTEM (DIAS) DEVELOPMENT TO SUPPORT MONITORING SYSTEM IN INFORMATION NETWORK INFRASTRUCTURE
Aji Setiabudi..... 39

ANALISIS MANFAAT PENERAPAN PAPERLESS AUDIT PADA BADAN PENGAWASAN KEUANGAN DAN PEMBANGUNAN
BENEFITS ANALYSIS FOR PAPERLESS AUDIT IMPLEMENTATION AT FINANCIAL AND DEVELOPMENT SUPERVISORY BOARD
Ardi Sulistyo Widodo .....53

PERANCANGAN SISTEM INFORMASI EVALUASI KINERJA APARATUR SIPIL NEGARA (CPSE-IS) DENGAN MENGGUNAKAN UML: STUDI DI BADAN KEPEGAWAIAN NEGARA

DESIGNING CIVIL SERVANT PERFORMANCE EVALUATION INFORMATION SYSTEMS (CPSE-IS) USING UML : A STUDY IN INDONESIA CIVIL SERVICE
Aulia Pradipta..... 65

MODEL REGRESI BERKELOMPOK UNTUK ANALISA DAN PREDIKSI NILAI INVESTASI PENANAMAN MODAL ASING

CLUSTERED REGRESSION MODELS FOR ANALYSIS AND PREDICTION OF FOREIGN DIRECT INVESTMENT INFLOWS
Ika Pratiwi ..... 77

SURVEYOR TANAH DAN PEMIKIRAN SPASIAL: STUDI KASUS DI BADAN PERTANAHAN NASIONAL, INDONESIA

LAND SURVEYORS AND SPATIAL THINKING: A CASE STUDY WITHIN THE NATIONAL LAND AGENCY, INDONESIA
Isa Suryo Ast anto .....87

PREDIKSI KEMUNGKINAN KELULUSAN SISWA PADA KURSUS DARING DENGAN MENGGUNAKAN REGRESI LOGISTIK

PREDICTING STUDENT LIKELIHOOD OF COMPLETION IN EDX MASSIVE OPEN ONLINE COURSE USING LOGISTIC REGRESSION
Moch Ndaru Purnomo Sidi ..... 101

WIRELESS INTRUSION PREVENTION SYSTEM: THE ANALYSIS OF THE EFFECTIVENESS IMPLEMENTATION PRINCIPLES

SISTEM PENCEGAHAN INTRUSI NIRKABEL: ANALISIS PRINSIP-PRINSIP

IMPLEMENTASI YANG EFEKTIF
Sigit Supriyanto .....113

CUTTING SKIN SIMULATION USING UNITY3D ENGINE

SIMULASI PEMBEDAHAN MENGGUNAKAN UNITY3D
Wijaya Kusuma .....123

## PERTANIAN

STRATEGI IMPLEMENTASI PRODUKSI BERSIH PADA AGROINDUSTRI GONDORUKEM

STRATEGY FOR IMPLEMENTATION A CLEANER PRODUCTION IN GUM RESIN AGROINDUSTRY

Dyah Kharismawati .....131

## TEKNIK

PEMBUATAN GEODATABASE UNTUK CADASTRE 3D DI INDONESIA

CREATION OF GEODATABASE FOR 3D CADASTRE IN INDONESIA

Akhmad Misbakhul Munir .....143

PERENCANAAN LINGKUNGAN DAN INFRASTRUKTUR FAKULTAS ILMU SPASIAL UNIVERSITAS GRONINGEN

ENVIRONMENTAL AND INFRASTRUCTURE PLANNING FACULTY OF SPATIAL SCIENCES UNIVERSITY OF GRONINGEN

Aruminingsih ..... 153

SKENARIO UNTUK KEBERLANJUTAN ENERGI DI PULAU JAWA, MADURA, DAN BALI DI INDONESIA PADA TAHUN 2030

SCENARIOS FOR ENERGY SUSTAINABILITY IN JAVA, MADURA, AND BALI ISLANDS IN INDONESIA IN 2030

Muh. Asrofi.....165

SISTEM MANAJEMEN LINGKUNGAN OUTSOURCING: PERSPEKTIF STRATEGIS DAN PRAKTIK TERBAIK ORGANISASI DARI PERUSAHAAN INGGRIS

ENVIRONMENTAL MANAGEMENT SYSTEMS OUTSOURCING: STRATEGIC PERSPECTIVES AND ORGANISATIONAL BEST PRACTICES FROM THE UK COMPANIES

Fery Irawan.....179

MENGEMBANGKAN INDEKS ADMINISTRASI PERTANAHAN UNTUK MENGEVALUASI SISTEM ADMINISTRASI PERTANAHAN

DEVELOPING A LAND ADMINISTRATION INDEX TO EVALUATE LAND ADMINISTRATION SYSTEMS

Ginanjar Drajad Prakoso .....195

PRAKIRAAN HARGA GEDUNG KAMPUS DENGAN MENGGUNAKAN PEMODELAN ANN (ARTIFICIAL NEURAL NETWORK) (STUDI KASUS: GEDUNG UGM)

PREDICTION OF CAMPUS BUILDING PRICES USING ANN (ARTIFICIAL NEURAL NETWORK) MODELING (CASE STUDY: UGM BUILDING)
Handriany Erlianingsih ..... 207

PENGUNGKAPAN LINGKUNGAN PERUSAHAAN PERTAMBANGAN BATUBARA DI INGGRIS DAN INDONESIA

ENVIRONMENTAL DISCLOSURES OF COAL MINING COMPANIES IN THE UK AND INDONESIA
Hardini Lestiani Hernusa ..... 215

FAKTOR PENDUKUNG DAN PENGHAMBAT UNTUK PEMBANGUNAN PIPA AIR MINUM DAN PEMBANGUNAN GORONG-GORONG DI JAKARTA, INDONESIA (1998-2015)

ENABLING AND CONSTRAINING FACTORS FOR PIPED-WATER AND SEWER DEVELOPMENT IN JAKARTA, INDONESIA (1998-2015)
Nur Aisyah Nasution ..... 227

ANALISIS RESIKO DALAM RENCANA PENGAMANAN AIR (RPA) SUMBER (STUDI KASUS DI IPAL DAGO PAKAR, PDAM TIRTAWENING, BANDUNG)

RISK ANALYSIS ON WATER SAFETY PLAN (WSP) SOURCE (CASE STUDY: DAGO PAKAR WTP, PDAM TIRTAWENING, BANDUNG)
Paulina Sri Widarti ..... 241

KORELASI ANTARA KONSUMSI ENERGI DAN PERTUMBUHAN EKONOMI MELIPUTI PERIODE 1990 - 2013 DAN IMPLIKASINYA TERHADAP KEBIJAKAN ENERGI DI INDONESIA

THE CORRELATION BETWEEN ENERGY CONSUMPTION AND ECONOMIC GROWTH COVERING THE PERIOD OF 1990 – 2013 AND ITS IMPLICATIONT TO ENERGY POLICY IN INDONESIA
Ricky M Ramadhan ..... 253

SISTEM INFORMASI GEOGRAFIS BERBASIS INTERNET LAHAN PERTANIAN PANGAN BERKELANJUTAN (LP2B) UNTUK PENGENDALIAN PERTANAHAN

GEOGRAPHIC INFORMATION SYSTEM BASED INTERNET LAND OF SUSTAINABLE FOOD SQUARE (LP2B) FOR LAND CONTROL
Slamet Teguh ..... 255

Bunga Rampai Tesis/Disertasi

# KEHUTANAN

Program Beasiswa SPIRIT

# Opsi Strategi Kebijakan Tenurial Pengelolaan Hutan Lindung

# Tenure Policy Strategic Option on Protected Forest Managements


| | | |
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# ABSTRAK

Kawasan hutan, khususnya hutan lindung berfungsi sebagai perlindungan sistem penyangga kehidupan dalam ekosistem, seperti mengatur tata air dan mencegah banjir. Hutan lindung sebagai sumber daya alam berkarakteristik *common pool resources* (CPRs) karena sumber daya hutan ini memiliki sifat sebagai *public goods* dan *private goods*. Sehingga, pengelolaan kawasan hutan lindung perlu mekanisme pengaturan pengelolaan komprehensif yang melibatkan lintas stakeholder.

Penelitian mengungkapkan arti penting pengelolaan HLSW bagi masyarakat dalam mempertahankan fungsinya sebagai sistem penyangga kehidupan sebagai tematik utama dalam narasi kebijakan. Selain itu, analisis *forest governance* selain dapat mengidentifikasi bagaimana kinerja pengelolaan hutan lindung, juga mampu mengungkapkan kesenjangan antara kebijakan dan implementasi di tingkat tapak. Masalah utama kesenjangan implementasi pengelolaan hutan di tingkat tapak, yakni peranan kelembagaan pengelolaan yang lemah akibat pergeseran komitmen stakeholder dan ketidakpastian tenurial (*tenure insecurity*) pengelolan hutan lindung.

Persoalan kelembagaan berkaitan dengan kurang dapat ditegakkannya kesepakatan bersama atau pun kesepakatan tersebut belum mampu mengatur keselarasan kepentingan antar pihak, akibat pergeseran motivasi dan komitmen yang dinamis. Selain itu, kapasitas pelaksana kebijakan mempengaruhi efektivitas kelembagaan pengelolaan. Inti sari pengelolaan hutan lindung adalah menjaga keseimbangan (*equity*) agar terjaga keberlangsungan fungsi hutan dan memberikan kemanfaatan secara berkeadilan bagi masyarakat. Sedangkan persoalan tenurial akibat ketidakjelasan *overlapping* klaim penguasaan lahan. Sistem penguasaan tenurial yang mantap (*tenure security*) mampu mengantisipasi ketidakpastian (*uncertainty*) sumber daya hutan berkarakteristik CPRs. Selain itu, sistem tenurial yang mantap mampu menjamin para pihak guna memperoleh komitmen (manfaat) yang kredibel secara berkesinambungan. Dengan demikian, alternatif strategi kebijakan tenurial yang bisa diadaptasi oleh pengelola adalah melalui mekanisme pengelolaan tenurial masyarakat sekitar hutan lindung melalui alokasi hak dasar (*bundle of rights*) penguasaan tenurial, tetapi dibatasi penggunaannya sebagai kawasan lindung. Kepastian tenurial (*tenure security*) akan mengurangi ketidakpastian (*uncertainty*) sistem

penguasaan tenurial secara terkendali. Implikasinya mengurangi pengaruh negatif terhadap keseimbangan sistem perlindungan hutan dalam memberikan keadilan sosial bagi masyarakat, sesuai konteks ruang, waktu dan pelaku.

Kata kunci: *tenure security*, *forest governance* CPRs, kelembagaan

# ABSTRACT

Forest areas, especially protected forest served as live support systems protection in ecosystems, such as maintaining the hydrological functions, providing the water supplies and avoids the floods. Protected forests as common pool resources (CPRs) characterized as a public and private goods, has tendency to produced negative externalities. This situations, of course will raise a new problems that challenges, not only the management unit, and even attracted the attention of national and global levels. Managing protected forests required comprehensive management regulatory mechanisms that involves many parties. We argued that the protected forest has highly inherent risks. Therefore, those risks should became the main concerns. This situations should be managed as early detection to avoids and decrease the leverage of forest tenure problems. This situations needed to be fix up to maintain the equity of roles dan fuctions of protected forest in the futures, within to increase the social wellfares.

This study revealed that the importance of management HLSW for society to maintain its function as a life support systems pointed as thematic management policy. This study also revealed that analysis based forest governance frameworks could identify the gap performance of forest managements, also reavealed the disparity of policies implementation at site levels. The main problems is the weakness of management institutions caused by the frictions of stakeholders commitment and the tenure insecurity.

Institutional problems related to lack enforcements of collective choice nor the choice doesn-t-fit to regulate the equity of each interests, caused by the frictions of the comitment and motivation dynamics. Hence, the capacities also influence on how the institutions could works effectivelly. The main objectives of protected forest managements are to keep the equitable of forest fuctions still awake and to provided the sustainability of people benefits. Whereas tenure problems related to the obscurity of overlapping tenure claims. Basically tenure security could anticipated the uncertainty of forest resources which has the CPRs characteristics. Tenure security also gave assurance to conducted the credibel commitments continously. Therefore, tenure policy strategic alternatives which can be adapted through the mechanism of the tenure managements by providing the basic rights (bundle of rights) of tenure claims,

but with limited allotments. Tenure security could reduces and controls the uncertainty of land tenure systems. Implicated to reduces the negavite effects to maintains the equity which provides social justice, adapted to the space, time and actor contexts.

Keywords: tenure security, forest governance, CPRs, institutions

Pengelolaan hutan lindung telah diserahkan ke daerah melalui kebijakan desentralisasi kehutanan. Namun dalam praktiknya, belum mampu menyelesaikan akar masalah kehutanan sesuai dengan yang diharapkan. Permasalahan ini ditandai dengan meningkatnya laju deforestrasi hutan dan kejadian konflik di kawasan hutan (Ekawati et al. 2012; Kartodihardjo et al. 2011). Kondisi ini semakin diperparah dengan skema pengelolaan hutan lindung yang cenderung menjadi costs center karena nilai manfaat hutan lindung yang bersifat *intangible*. Selain itu, sebagai sumber daya yang berkarakteristik CPRs, secara *de facto* hutan lindung cenderung *open access*. Kondisi hutan lindung yang memiliki inherent risks seperti ini dapat mengakibatkan terjadinya potensi konflik tenurial. Fisher et al. (2001) mendefinisikan konflik sebagai hubungan interdepensi individu maupun kelompok yang memiliki atau merasa memiliki tujuan yang tidak sejalan akibat ketidakseimbangan akses sumber daya alam. Potensi konflik terjadi akibat hubungan interdependensi antar pihak, yang akan mempengaruhi preferensi dalam melihat potensi aliran manfaat suatu sumber daya hutan.

Membahas pengelolaan hutan lindung, tidak terlepas dari bagaimana peran pengetahuan dikonstruksikan dalam proses kebijakan dan implementasinya di tingkat tapak. Sebagai bagian pengelolaan, sesungguhnya pemahaman masalah kebijakan adalah mengenai nilai, kepentingan dan kesempatan yang belum tercapai. Yakni, mengenai bagaimana aturan main dibuat dan interaksi para aktor dalam menyikapi potensi aliran manfaat sumber daya hutan. Elemen kunci sistem kebijakan adalah mengurai interaksi antara pelaku, lingkungan, dan narasi secara komprehensif di dalam pengambilan suatu kebijakan (Dunn 1994).

Berkaitan dengan pencapaian *outcomes* kebijakan dalam memberikan keadilan bagi masyarakat, diperlukan usaha bersama untuk mengevaluasi dan memahami persoalan sebenarnya. Kinerja kebijakan (*policy performance*) dapat dilihat sebagai kontribusi guna pencapaian nilai dan manfaat (Dunn 1994). Evaluasi berguna untuk mengurangi potensi risiko dan mengantisipasi ketidakpastian (*uncertainty*) suatu sumber daya hutan. Evaluasi ini diharapkan mampu mendeskripsikan dengan jelas masalah implementasi kebijakan di tingkat tapak dan faktor penyebab utamanya serta mampu memberikan alternatif solusi. Hal ini sesuai pandangan Dunn (1994) bahwa informasi kinerja

kebijakan dapat digunakan untuk meramalkan masa depan kebijakan, bahkan menyusun ulang masalah kebijakan itu sendiri.

Berdasarkan pemaparan rangkaian permasalahan di atas, diperlukan kajian mendalam mengenai permasalahan implementasi pengelolaan hutan lindung di tingkat tapak. Pemerintah daerah perlu melakukan terobosan strategi kebijakan baru, agar tercipta tata kelola hutan lindung yang berkesinambungan dan lebih baik. Terobosan strategi ini dilaksanakan melalui mekanisme identifikasi potensi masalah tenurial yang relevan dengan kondisi dinamika sosial, ekonomi dan karakteristik ekologi hutan lindung.

Bertitik tolak dari permasalahan tersebut, penelitian ini berusaha mengevaluasi implementasi kebijakan, khususnya ditinjau dari aspek tenurial. Selanjutnya, fokus penelitian dirumuskan dalam tiga pertanyaan penelitian.

- Bagaimana keragaan wacana kebijakan daerah tentang pengelolaan hutan lindung?
- Bagaimana kesenjangan implementasi kebijakan daerah?
- Bagaimana formulasi opsi strategi kebijakan tenurial yang sesuai dan tepat dalam pengelolaan hutan lindung?

Tujuan utama penelitian ini adalah mengevaluasi implementasi kebijakan pengelolaan hutan lindung ditinjau dari aspek tenurial. Tujuan utama tersebut dijabarkan ke dalam tiga tujuan pendukung.

- Memahami keragaan wacana kebijakan daerah dalam pengelolaan hutan lindung.
- Mengidentifikasi dan memahami kesenjangan implementasi kebijakan daerah.
- Memformulasikan opsi strategi kebijakan pengelolaan hutan lindung ditinjau dari aspek tenurial.

Penelitian ini menggunakan pendekatan kualitatif, yakni strategi penelitian studi kasus. Menurut Creswell (2010) pendekatan ini berdasarkan pertimbangan tempat peneliti mengumpulkan data lapangan terhadap isu atau masalah yang diteliti bersifat alamiah. Peneliti berusaha mengungkapkan fakta, tanpa mengganggu situasi di lapangan. Selain itu, peneliti menjadi instrumen kunci (researcher as key instrument). Bersifat penafsiran (interpretive) atas yang dilihat, didengar, dan dipahami peneliti terhadap proses dan peristiwa di lapangan berdasarkan konsep tertentu.

## Kendala Kelembagaan Pengelolaan HLSW & DAS Manggar

Kehadiran manajemen pengelolaan hutan (Andersson 2013) adalah untuk mengurangi potensi risiko dan mengantisipasi ketidakpastian karakteristik hutan yang kompleks. Berpijak pada kerangka pencapaian tujuan kelestarian hutan lindung, Kartodihardjo (2013) berpendapat karakteristik hutan yang memiliki berbagai manfaat (tangible dan intangible) harus berimplikasi terhadap perlakuan hak dan kewajiban pada arena yang melampaui batas fisik hutan. Artinya kelembagaan pengelolaan harus memiliki ruang gerak yang mempertimbangkan kondisi karakteristik dan peran masyarakat, selain kapasitas personil pengelola. Dengan demikian, persoalan lain implementasi kebijakan adalah bagaimana kelembagaan mampu melembaga untuk mengurangi potensi risiko di masa mendatang. Implikasinya, pengelola harus melakukan evaluasi dan inovasi guna memperoleh strategi yang optimal. Hal tersebut baru tercapai apabila pengelola memiliki kecukupan pengetahuan dan kapasitas serta mampu mendeskripsikan persoalan serta mencari solusi masalah yang tepat.

Persoalan pengelolaan hutan menurut Kartodihardjo (2013) membutuhkan peranan kelembagaan yang memungkinkan penggunaan aturan, baik formal dan informal. Dengan memperhatikan prasyarat keseimbangan keberadaan dan fungsi mampu terpelihara dengan baik. Harus diakui dalam realitasnya, aturan informal belum tersentuh sama sekali. Bahkan seolah-olah ada asumsi pendekatan hukum merupakan satu-satunya kekuatan paling efektif dalam mengontrol perilaku masyarakat. Namun asumsi ini tidak pernah terbukti di lapangan. Dengan demikian, arti penting kelembagaan yang melembaga menjadi tolok ukur dalam memastikan keberhasilan pencapaian tujuan pengelolaan hutan lindung.

Dalam situasi hutan yang terbatas, menurut Tomich et al. (2004) kunci utama keberhasilan konservasi terletak pada kemampuan membatasi kawasan yang dilindungi melalui kombinasi mekanisme insentif dan penegakan aturan yang disepakati. Ostrom (2013) berpendapat tanpa perhatian yang cukup untuk mempertahankan tata kelola yang kompleks, proses mengatur perilaku dalam melestarikan keragaman hayati akan menghasilkan konsekuensi tragis yang tidak diharapkan. Sekali lagi, hal ini membutuhkan kapasitas mengelola konflik tenurial, termasuk mekanisme pemberian kompensasi masyarakat sekitar hutan.

Maknanya, dalam menjalankan pilihan kebijakan pengelolaan hutan diperlukan kapasitas, pengetahuan dan kemampuan yang mumpuni, termasuk komitmen dukungan politik pimpinan daerah dan pusat secara berkesinambungan. Tentunya dengan tetap memperhatikan berbagai faktor eksternal yang mungkin berada di luar kendali pengelola dan pengambil kebijakan, seperti dinamika sosial, ekonomi dan budaya termasuk dinamika politik nasional.

Kajian tenurial mengungkapkan tiga persoalan kelembagaan pengelolaan HLSW dan DAS Manggar. Pertama, pergeseran komitmen dan dukungan pemangku kepentingan seiring berjalannya pengelolaan hutan lindung. Ditandai dengan berkurangnya dukungan dan atensi yang sebelumnya mendukung pengelolaan hutan lindung. Perubahan dipengaruhi dinamika politik, sosial, interest dan pergeseran motivasi stakeholder. Situasi ini perlu dibangkitkan kembali agar tujuan pengelolaan hutan lindung bersama masyarakat dapat tercapai.

Kedua, kapasitas pengelola belum mampu mengantisipasi tantangan dan hambatan pengelolaan yang dinamis. Saat ini, Badan Pengelola dalam kondisi kurang optimal atau mengalami "kevakuman" untuk mendorong optimasi kinerja unit pelaksana di tingkat tapak. Beban berat pengelolaan terletak di unit pelaksana. Sehingga memerlukan dukungan kuat dari Badan Pengelola, guna menjembatani persoalan di tingkat tapak. Situasi ini menurut Berkes (1996) membutuhkan kelembagaan tingkat tapak yang fleksibel dan dinamis sehingga peluang keberhasilan lebih besar.

Dan ketiga, terkait peningkatan kapasitas dan peranan masyarakat. Masyarakat harus dilihat sebagai subyek yang wajib dilibatkan dalam pengelolaan serta ditingkatkan kapasitasnya. Bukan hanya obyek pengelolaan. Peran masyarakat menjadi penting karena sebagai subyek terdampak langsung kebijakan pengelolaan hutan lindung. Sekali lagi, perlu ditekankan peranan kelembagaan yang mampu menjaga keseimbangan (equity) kemanfaatan ekonomi bagi masyarakat dan keberlanjutan hutan lindung sebagai norma atau aturan yang disepakati bersama. Kesepahaman untuk mempengaruhi atau membatasi perilaku oportunistik. Pelibatan masyarakat dalam pengelolaan harus memperhatikan dan mengakomodir peran dan kepentingan masyarakat setempat.

## Alternatif Strategi Kebijakan Tenurial Pengelolaan HLSW & DAS Manggar

Merujuk pembahasan permasalahan tenurial lahan dan kelembagaan pengelolaan kedua kawasan hutan lindung dalam sub pokok bahasan a dan b sebelumnya, dapat disimpulkan alternatif strategi tenurial pengelolaan hutan lindung. Alternatif tersebut merupakan kompromi penyeimbangan pemenuhan kepastian penguasaan atau kepemilikan lahan dan usaha mempertahankan keberlanjutan fungsi hutan lindung.

Karakteristik tenurial hutan lindung yang dinamis, menurut Clover dan Eriksen (2009) disebabkan oleh kelembagaan pemerintahan yang lemah. Pemerintah seharusnya bertanggung jawab atas kegagalan dalam mengatasi perambahan dan masalah tenurial. Dampak penggunaan wacana normatif dan cara konteks sosial politik yang berinteraksi dengan faktor ekonomi dalam mempengaruhi isu terkait akses, distribusi dan tenure security lahan. Ostrom (2013) memperingatkan tanpa kelembagaan yang efektif dalam membatasi pihak yang bisa memanfaatkan aliran manfaat dan pengaturan manajemen, pada sumber daya CPRs bisa terjadi penggunaan berlebihan. Implikasinya diperlukan integrasi sistem tenurial yang mantap berdasarkan konteks kesejarahan, sosial, ekonomi dan perencanaan tata ruang. Berfungsi memperkuat keberlanjutan pengelolaan hutan lindung sebagai penyangga perlindungan kehidupan.

Memperhatikan persoalan di atas serta merujuk kepada teori property rights (Ostrom dan Schlager 1996) dan teori akses (Ribot dan Peluso 2003) maka pada hutan lindung berkarakteristik CPRs memiliki risiko pengelolaan tinggi. Sehingga, alternatif mekanisme mengelola tenurial masyarakat sekitar hutan lindung adalah melalui pemberian hak dasar (bundle of rights) penguasaan lahan tersebut, tetapi dibatasi pemanfaatannya sesuai dengan konteks ruang dan waktu secara terkendali. Sehingga tujuan pengelolaan yang menjaga keseimbangan kemanfaatan berkeadilan sosial dan keberlanjutan fungsi lindung dapat terpenuhi.

Selanjutnya, kedua tujuan pengelolaan menjadi indikator penyusunan strategi tenurial. Indikator keberlanjutan fungsi lindung disebut dengan istilah "fungsi" kawasan hutan sebagai kawasan lindung. Sedangkan indikator kemanfaatan penguasaan lahan yang berkeadilan sosial disebut sebagai "status"

penguasaan lahan (tenurial) para pihak, terkait bundle of rights yang dimilikinya. Tenure security yang mantap pada indikator "status" akan memberikan kepastian bagi penguasa atau pemilik lahan untuk mengoptimalkan potensi aliran manfaat lahan. Sedangkan keberlanjutan indikator "fungsi" mencerminkan arti penting kelestarian hutan sebagai kawasan lindung. Kedua indikator selanjutnya dikombinasikan dengan bagaimana kesejarahan arena tenurial masing-masing hutan lindung. Menurut Nurrochmat et al. (2014) rekonstruksi kebijakan tenurial kehutanan tidak boleh lagi secara kaku berpijak pada status kawasan hutan, namun yang lebih penting adalah keberlanjutan fungsi hutan.

## Kesimpulan

Arti penting pengelolaan HLSW bagi masyarakat guna mempertahankan fungsinya sebagai sistem penyangga kehidupan kota Balikpapan menjadi tematik utama yang dikemukan Perda No.11 Tahun 2004 tentang Pengelolaan HLSW. Wacana tersebut dibangun dengan menyampaikan informasi yang mendukung pentingnya HLSW bagi masyarakat melalui mekanisme konsultasi publik dan public hearing. Mekanisme tersebut mampu mempengaruhi kognisi masyarakat dalam memandang arti penting keberadaan HLSW. Guna mengarahkan tujuan pengelolaan HLSW, informasi hutan lindung DAS Manggar tidak ditonjolkan dalam pembahasan maupun naskah resmi kebijakan. Meskipun DAS Manggar berperan sebagai penyuplai air baku bagi 80% masyarakat Kota Balikpapan.

Kinerja pengelolaan HLSW & DAS Manggar ditinjau dari forest governance belum berjalan optimal. Masalah utama yang mempengaruhi kesenjangan implementasi pengelolaan di tingkat tapak adalah lemahnya peran kelembagaan pengelolaan dan ketidakpastian tenurial (tenure insecurity).

Persoalan kelembagaan akibat kurang tegaknya kesepakatan bersama atau belum mampu mengatur keselarasan kepentingan antar pihak, dampak pergeseran motivasi dan komitmen stakeholder. Kapasitas pelaksana kebijakan baik pengelola maupun masyarakat terdampak juga turut mempengaruhi efektivitas kelembagaan pengelolaan. Oleh karenanya diperlukan penguatan dan revitalisasi komitmen stakeholder dalam mempertahankan tujuan. Inti sari pengelolaan hutan lindung adalah menjaga keseimbangan (equity) mempertahankan fungsi hutan yang memberikan kemanfaatan secara berkeadilan dan berkelanjutan. Sedang persoalan tenurial timbul akibat

ketidakjelasan overlapping klaim penguasaan lahan, baik antar pemerintah dengan masyarakat maupun antar kelompok masyarakat. Kasus hutan DAS Manggar, penetapan hutan lindung menjadi pemicu utama ketidakjelasan dan ketidakpastian tenurial penguasaan dan klaim lahan masyarakat yang berimplikasi terhadap efektivitas pengelolaan hutan lindung. Sedangkan pada kasus hutan HLSW, overlapping tenurial akibat tidak terakomodasinya kepentingan masyarakat Wain Luar yang subsisten. Walaupun terdapat nilai kearifan lokal (local institutions) masyarakat Wain Dalam yang hidup berdampingan secara harmonis dengan hutan lindung.

Alternatif strategi kebijakan tenurial diberikan melalui mekanisme tenurial masyarakat sekitar dengan memberikan hak dasar (bundle of rights), tetapi dibatasi fungsi penggunaannya. Pemberian kepastian (tenure security) akan mengurangi ketidakpastian (uncertainty) sistem penguasaan tenurial secara lebih terkendali guna mendukung tujuan pengelolaan. Opsi I dapat diadaptasikan pada HLSW, sedang DAS Manggar dapat menggunakan Opsi II. Selain itu, pengelola harus berhati-hati dalam memperhatikan karakteristik tipologi tenurial dan masyarakat sekitar hutan yang tidak statis.

## Bunga Rampai Tesis/Disertasi

# KESEHATAN MASYARAKAT

## Program Beasiswa SPIRIT

# Social Gradients in Subjective Well-being in Eastern Indonesia: Exploring Urban-Rural Differences

# Gradien Sosial dalam Kesejahteraan Subyektif di Kawasan Timur Indonesia: Mengeksplorasi Perbedaan Perkotaan - Pedesaan


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# ABSTRAK

Pengeluaran dan pendidikan per kapita telah dicirikan sebagai indikator kunci untuk posisi sosio-ekonomi (SEP) dan dikaitkan dengan kesejahteraan subjektif (SWB), seperti kesehatan mandiri (*self-rated health* / SRH) dan kebahagiaan.

Proyek ini bertujuan: (1) untuk menyelidiki keberadaan gradien sosial di SWB, independen dari kesenjangan perkotaan-pedesaan, kepercayaan sosial dan partisipasi, dan variabel sosial-demografis dan (2) untuk menguji peran perpecahan urban-rural dalam asosiasi antara SEP dan SWB.

Saya menggunakan data dari Survei Kehidupan Keluarga Indonesia Timur, perwakilan survei besar di Kawasan Timur Indonesia yang dilakukan pada tahun 2012. Variabel dependennya adalah SWB, ditunjukkan oleh SRH yang buruk dan ketidakbahagiaan. Regresi logistik yang dipesan digunakan untuk menilai asosiasi SEP-SWB. Selain itu, saya menilai perbedaan perkotaan-pedesaan dalam asosiasi SEP-SWB. Uji Wald digunakan untuk menentukan keseluruhan efek dari masing-masing prediktor pada SWB.

Ketidakbahagiaan menunjukkan gradien SEP negatif (pengeluaran per kapita dan pendidikan). Namun, ini hanya ditemukan untuk pendidikan sehubungan dengan SRH yang buruk (tidak ada pendidikan OR = 1,96, SD OR = 1,78, SMP OR = 1,40, tinggi OR OR = 1,35). Asosiasi ini tidak bergantung pada efek dari pembaur potensial. Tingkat asosiasi SEP-SWB tampak serupa di antara daerah perkotaan dan pedesaan. Selain pendidikan, kontributor utama SWB lainnya adalah *safety area.*

# ABSTRACT

Per capita expenditure and education have been characterised as key indicators for socio-economic position (SEP) and were associated with subjective well-being (SWB), such as self-rated health (SRH) and happiness.

This project aimed: (1) to investigate the existence of social gradients in SWB, independent of urban-rural divide, social trust and participation, and socio-demographic variables and (2) to examine the role of urban-rural divide in the association between SEP and SWB.

I used the data from the Indonesian Family Life Survey East, a large survey representative of Eastern Indonesia conducted in 2012. The dependent variable was SWB, indicated by poor SRH and unhappiness. Ordered logistic regression was used to assess the SEP-SWB association. Additionally, I assessed the urban-rural differences in the SEP-SWB association. The Wald-test was used to determine the overall effects from each predictor on SWB.

Unhappiness showed a negative SEP gradient (per capita expenditure and education). However, this was only found for education in relation to poor SRH (no education OR=1.96, elementary OR=1.78, junior high OR=1.40, senior high OR=1.35). These associations were independent of the effects from the potential confounders. The degree of the SEP-SWB association appeared to be similar between urban and rural areas. In addition to education, another main contributor to SWB was area safety.

Subjective well-being (SWB) and ill-being have become more central than ever to debates on policy (Diener, 2006). Positive well-being is one of the ultimate goals for adult life. The concept of SWB encompasses a wide range of aspects, including life evaluation, affect, and eudemonia (OECD, 2013a; Dolan & Metcalfe, 2012; Dolan et al., 2011). Happiness and self-rated health (SRH) have been treated as essential variables in measuring SWB.

A number of studies have attempted to assess the importance of SWB on health (Steptoe et al., 2005; Siahpush et al., 2008; Cohen & Pressman, 2006; Diener & Chan, 2011). The focus of most of these studies has also been on the existence of inequality in SWB. Socially disadvantaged people, such as those with low educational attainment, poor economic status and high levels of unemployment, have tended to be less healthy and happy compared to those who are not so disadvantages (Blanchflower & Oswald, 2004; Pierewan & Tampubolon, 2014). Those reflect individual socio-economic position in relation to SWB.

In addition, whether people are urban or rural dwellers has been identified as a significant factor in SWB, and in developing countries this has been observed to have a determining influence on SWB (Easterlin et al., 2011; Knight & Gunatilaka, 2010; Strasser, 2003). Social trust was also found to be significant associated with SWB (Yip et al., 2007) as well as social participation, such as participation in a religious activity or in a rotating savings and credit association SWB, refers to as ROSCA (Alawiyah, 2013; Ferris, 2002).

Many studies related to SWB have been conducted in developed countries, while few have been found in developing countries. However, it has been suggested that a particular culture may have specific effects on people's lives and consequently on their SWB (Diener, 2000; Diener & Tov, 2009). In Indonesia, SWB has been studied using the data that is most representative of western Indonesia (Alawiyah, 2013; Sohn, 2013; Landiyanto et al., 2011). There has previously been few investigations in the eastern part of the country, due to lack of available data and development in almost all sectors, including the health sector.

Since December 2013, however, the Indonesian Family Life Survey (IFLS) East has been publicly available. This survey is the first to have used large-scale data collected from individuals and households residing within

an East Indonesian community. This summer project used the IFLS East data to offer novel findings in the associations between SEP, geographical factors (urban versus rural) and SWB in East Indonesia, as well as social trust and social participation in relation to SWB.

This study uses SWB indicated by poor SRH and unhappiness as the outcomes. Chapter 1 of this dissertation describes the existence of social gradients and urban-rural differences in Eastern Indonesian society. An extensive review of the theory, concept, and current evidence of social gradients, urban-rural differences and other determinants in relation to SWB is presented in Chapter 2. Chapter 3 presents the aims, objectives and hypotheses of this project, while Chapter 4 presents the methods used and discusses the data derived from the IFLS East 2012. Results of testing the hypotheses are shown in

This study found that SEP was significantly and negatively associated with poor SRH and unhappiness after controlling for socio-demographic variables. Evidence was not found for urban and rural differences in the association between SEP and SWB. There were three components of social trust extracted from social trust items, which were area safety, openness, and prejudice.

The association between SEP and SWB remained significant after controlling for urban-rural divide, social trust and participation, other confounding variables. I found social gradients in SWB for education in relation to SRH and happiness; and for per capita expenditure in relation to unhappiness only. Education and area safety were found as the main contributors to SWB, indicated by the highest values in chi-squared Wald-test. The following sections compare the findings with existing literature on the relevant topic.

## Associations Between SEP and SWB

In bivariate association, the odds of the poorest and those with no or lower education were significantly associated with higher odds of being in poor health and unhappiness. Controlling for confounding socio-demographic variables (sex, age and partnership status), to address Hypothesis 1, both SEP measures (per capita expenditure and education) were still negatively and significantly associated with unhappiness. However, only education was significantly associated with SRH after controlling for socio-demographic variables.

I did not find that per capita expenditure was significantly associated with SRH after controlling for socio-demographic variables; this contradicts the previous findings in developed countries which showed that economic status was significantly associated with SRH (Alvarez-Galvez et al., 2013; Shibuya et al., 2002). However, this finding is somewhat similar to the study in Thailand, categorised as a middle-income developing country similar to Indonesia, which showed that income had a weak association with SRH for females and no association for males (Seubsman et al., 2011).

Moreover, the findings in relation to happiness contradicted the Easterlin paradox (Easterlin, 1974), which claimed that happiness would be similar regardless of the economic status of individuals. The study using the original IFLS, which was more representative of West Indonesia, supported this paradox, showing that income was not significantly associated with happiness (Sohn, 2013). One possible explanation for my contradictory finding relates to the poorer economic status in East Indonesia, as compare to that in West Indonesia. Economic status has been said to affect happiness in less affluent societies (Ferrer-i-Carbonell, 2005), and the economic status-SWB association to be stronger for lower income developing countries (Howell & Howell, 2008). This was similar to the previous finding in Turkey, showing that individuals with higher economic status were happier (Selim, 2008).

In terms of education, there was a negative association with poor SRH and unhappiness. This result is similar to the findings in previous studies in (Dubikaytis et al., 2014; Blanchflower & Oswald, 2004; Gerdtham & Johannesson 2001). This implies that education was important for health and happiness as higher education could enable people to be employed (Cuñado & de Gracia, 2012), to have more interpersonal relations (Michalos, 2008), and to have greater involvement in various activities (Chen, 2012).

## The Role of the Urban-Rural Divide in the SEP-SWB Association

The second set of findings, after entering urban-rural divide into the model, showed that the estimates of the association between SEP and SWB was attenuated but remained significant (education for both SRH and happiness, and per capita expenditure for happiness). I suspected that the association between SEP and SWB differed according to urban and rural areas, since urban-rural divide was found to be significantly associated with both SEP and SWB.

Interaction terms were then included to test the presence of urban-rural differences in the SEP-SWB association. This study failed to provide an evidence for a moderating role of urban-rural divide in the SEP-SWB association. This implies that the association between SEP and SWB was unlikely to differ according to area of residence, which addressed Hypothesis 2, but this finding needs to be validated in future studies.

This findings in this study showed that people living in urban areas had lower odds of being in poor health (OR=0.82, 95% CI 0.72-0.94) or unhappiness (OR =0.76, 95% CI 0.65-0.89) than those living in rural areas. This was similar to the findings of previous studies which showed that urban dwellers enjoyed better health and happiness than rural residents (Easterlin et al., 2011; Knight & Gunatilaka, 2010). This may be due to structural disadvantage in rural areas, such as 'higher rates of unemployment' and 'lower educational attainment' (Monnat & Pickett, 2011), limited access to health service provision (Paneli et al, 2006; Strasser, 2003) and lack of doctors and other health professionals (Eberhardt et al., 2001).

Extracting components of social trust and testing independent associations between SEP and SWB, further controlling for social trust components and participation

Three components were identified via PCA among social trust items: area safety, openness, and prejudice. This addressed the third hypothesis. These components were then included in the subsequent multivariate models.

After further entering the components of social trust and social participations, I found that the associations between education and SWB remained statistically significant, independent of the components of social trust, participation in a religious activity and a ROSCA, and socio-demographic variables. However, only certain groups in per capita expenditure were statistically and significantly associated with happiness, but the overall association was significant (p-value for the Wald-test <0.001). These findings addressed Hypothesis 4.

I also found that 'area safety' served as a protective factor from being in poor health and unhappiness, and this was strongly and significantly associated with both SRH and happiness. Meanwhile, openness was weakly associated with SRH, but strongly associated with happiness. However, prejudice was not significantly associated with either SRH or happiness. This is somewhat similar

to previous studies that found social trust was significantly associated with SRH and happiness (Yip et al., 2007; Helliwell & Putnam, 2004). One possible explanation might be that social trust enhances social networks and social support; these factors could lead to improvements in health and well-being (Yip et al., 2007).

In addition, a previous study using the original IFLS showed that social trust was significantly associated with happiness (Sohn, 2013). In this current study, I identified components of social trust that were significantly associated with SRH and happiness.

In terms of social participation, only participation in a ROSCA was associated with happiness. This is somewhat similar to a study conducted by Alawiyah (2013) using the original IFLS, which showed that participation in a ROSCA was significantly related to women's welfare. In contrast, participation in a religious activity was significantly associated with SRH in bivariate association, but this was not the case for happiness.

In addition, participation in religious activity was not statistically and significantly associated with either SRH or happiness in multivariate analyses. This finding differs from previous studies, which had shown positive associations between participation in religious activity and SRH (Hummer et al., 1999) and happiness (Ferris, 2002; Witter et al., 1985). It has been found that the association between participation in a religious activity was stronger for older age (Witter et al., 1985). The finding of the current study could be related to the age of the study sample, who were mostly under 30 years of age.

## Social Gradients in SWB

I found that there were social gradients in the association between one measure of SEP (education) and SWB (SRH and happiness) after controlling for all other variables. These were confirmed by a statistically significant result in a test for trend ($p<0.001$). These findings addressed Hypothesis 5. Previous studies had found that there was a trend toward SRH at all levels of education (Rosero-Bixby & Dow, 2009; Mirowsky, 2008). However, this gradient was not found in relation to happiness (Cuñado & de Gracia, 2012).

## The Main Contributors to SWB

I found that education, the urban-rural divide, area safety, and openness statistically and significantly contributed to both SRH and happiness. Per capita expenditure and participation in a ROSCA significantly contributed to happiness only. In contrast, prejudice and participation in a religious activity did not significant contribute to SWB. In addition, education and area safety were found as the main contributors for both SRH and happiness in Eastern Indonesian residents. These findings addressed Hypothesis 6.

## Strengths and Limitations of This Study

This study benefited from having a high response rate (98 per cent) and few missing cases (less than 10 per cent) in the variables used to analyse social gradients in SWB and to explore urban-rural differences in the SEP-SWB association. Moreover, this sample size provided a power to minimise type II errors. Existing physical disability has been found to be negatively associated with SRH and happiness (Dunn et al., 2009; Cott et al., 1999). Thus, exclusion of individuals with physical disabilities was likely to have decreased the introduction of selection bias. Furthermore, this study accounted for the effects from confounding variables, such as age, sex and partnership status in all models.

This study also benefited from using PCA to extract components, which reduces redundancy and complexity in a study construct (Karamizadech, 2013), specifically concerning social trust in this study. This allowed the components of social trust which contributed to SWB to be identified. However, this finding needs to be interpreted with caution, given the miserable category in post-estimation according to the Kaiser-Meyer-Olkin measure.

The items were selected from the list of social trust items in the IFLS East questionnaires and I only included items which were mostly used in a previous study on well-being using the original IFLS (Alawiyah, 2013).

Despite the strengths of the current study, there were also several limitations. Firstly, the findings were from analyses on cross-sectional data; therefore, the temporal sequence was unclear and could not infer a causal relationship between SEP and SWB. Secondly, the study used three self-reported variables (SRH, happiness, and social trust), which may have introduced

information bias. Responses to self-reported variables were influenced by wording and ordering in the survey questionnaires (Macinko & Starfield, 2001), depending on how respondents interpreted the questions (Krause & Jay, 1994), and on the the context that survey researchers used to address each question (Schwarz, 1999). However, this study used similar wording and ordering in the questionnaire to those of the original IFLS, as well as standardised survey methods. This may have reduced the information bias in the current study.

Thirdly, this study only examined social gradients in SWB using per capita expenditure and education; this was due to the unavailability of data on other SEP indicators such as occupational position. The information related to 'work for pay' was available in this dataset, but I could not use it since this variable closely reflects the similar dimension of SEP to economic status as per capita expenditure. Fourthly, this study was unable to account for other variables such as personality traits which have been found to be associated with SRH and happiness (Butkovic et al., 2012; Lockenhoff et al., 2011). This was not available in the IFLS East.

Finally, recall bias for variables that required accurate recollection, such as per capita expenditure, was possible. This could have resulted in an over- or under-estimation of the amount of money that respondents spent weekly, monthly and annually, but the extent of the bias is unknown. Fortunately, the respondents included in the current study were mostly under 30 years of age. This should have reduced the recall bias that might be operative in this study since young respondents tend to recall information more accurately (Craik, 2000).

## Conclusions

In conclusion, the current study contributes towards filling the gap of Eastern Indonesian studies related to subjective well-being (SWB), and shows support to social gradients in SWB, independently of urban-rural divide, social trust and participation, and other confounders. This study failed to show a moderating role of urban-rural divide in the SEP-SWB association, and this needs to be explored further.

This study also found that education and area safety were the main contributors for SWB (self-rated health and happiness) in East Indonesia, through which SWB can be addressed by wider social determinant of health. This is essential in the formulation of health policies to promote multi-sector partnerships.

# Analisis Disabilitas terkait Faktor-faktor Risikonya pada Penduduk Indonesia Usia Produktif (Berdasarkan Riset Kesehatan Dasar 2013)

# Disability Analysis Related to Risk Factors toward Productive Ages in the Indonesian Population (Based on Basic Health Research 2013)


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# ABSTRAK

Saat ini terjadi peningkatan penduduk usia produktif (15-64 tahun) di negara berkembang khususnya Indonesia. Pada usia produktif terjadi peningkatan angka kejadian disabilitas. Disabilitas didefinisikan sebagai kesulitan atau ketidakmampuan yang dialami seseorang dalam melakukan aktifitas sehari-hari (yang diukur melalui 12 parameter sesuai dengan WHODAS 2.0). Studi empiris telah menemukan banyak faktor risiko yang terkait dengan disabilitas. Tujuan penelitian ini adalah untuk mengetahui pengaruh faktor-faktor risiko disabilitas terhadap kejadian disabilitas pada penduduk Indonesia usia produktif sehingga dapat menentukan prioritas intervensi pelayanan kesehatan yang sebaiknya disediakan. Penelitian ini menggunakan data Riset Kesehatan Dasar 2013 dengan besar sampel 665.546 orang berusia 15-64 tahun dengan studi *cross-sectional*. Pada penelitian ini didapatkan hasil bahwa penduduk Indonesia usia produktif yang mengalami disabilitas ada sebanyak 14.2% dengan risiko mengalami disabilitas meningkat sesuai dengan peningkatan usia. Faktor risiko yang meningkatkan kejadian disabilitas pada usia produktif di Indonesia yaitu : penyakit diabetes mellitus, hipertensi, stroke, tidak melakukan aktivitas fisik, merokok, obesitas, gangguan mental emosional, usia yang semakin tua, jenis kelamin perempuan, dan tidak/belum pernah sekolah. Faktor risiko yang dominan adalah stroke (OR = 5.045, 95% CI 4.045 – 6.292) dan gangguan mental emosional (OR = 8.822, 95% CI 8.348 – 9.323). Penyakit stroke dan gangguan mental emosional menjadi fokus intervensi pengendalian disabilitas pada usia produktif di Indonesia melalui program intervensi berbasis masyarakat.



Kata kunci: disabilitas, usia produktif, WHODAS 2.0, faktor risiko

## ABSTRACT

There is an increased population of productive ages (15-64 years old) in developing countries, especially Indonesia. At the productive age there have been an increase in the incidence of disability. Disability is defined as the difficulty or inability of people conducting daily activities (as measured by the 12 parameters in accordance with WHODAS 2.0). Empirical studies have found many risk factors associated with disability. The purpose of this study was to determine the effect of risk factors on the incidence of disability in the Indonesian population of productive ages so that it can determine the priority of health care interventions that should be provided. This study uses data from Basic Health Research 2013 with the sample 665.546 people from 15-64 years old with a cross-sectional study. In this study showed that the Indonesian population of productive ages who have disabilities have as many as 14.2% with a risk of having a disability increases with increasing age. The risk factors that increase the incidence of disability in productive ages in Indonesia, namely: diabetes mellitus, hypertension, stroke, do not do physical activity, smoking, obesity, mental emotional disorder, increasingly older age, female gender, and do not / have never attended school. The most dominant risk factor are stroke (OR = 5.045, 95% CI 4045-6292) and mental emotional disorder (OR = 8822, 95% CI 8348-9323). Stroke and mental emotional disorder have become the focus of disability control interventions in the productive ages in Indonesia through community-based intervention program.



Keywords: disability, productive age, WHODAS 2.0, risk factor.

Disabilitas yang terjadi pada orang dewasa usia produktif akan menimbulkan hari produktif yang hilang (hari mengalami kesulitan). Sebuah penelitian menunjukkan bahwa pada karyawan dengan diabetes mellitus mengalami risiko 2 kali lipat untuk absen kantor dibandingkan rekan-rekan kerjanya yang tanpa PTM. Peningkatan risiko absensi karyawan tersebut sebagian besar dikarenakan penyakit non kardiovaskular (Kivimaki et al., 2007). Bersama-sama waktu kerja yang hilang karena mengalami hari sulit dengan alasan kesehatan maka seseorang bisa mengalami kerugian ekonomi.

Meskipun sudah banyak penelitian yang membahas tentang disabilitas, namun belum ada penelitian yang membahas disabilitas dihubungkan dengan faktor-faktor risikonya secara lebih lengkap. Penelitian disabilitas menggunakan data survei kesehatan nasional di Indonesia sebelumnya adalah bukan pada populasi usia produktif saja atau dengan faktor risiko terbatas (Astuti and Budijanto, 2009, Astuti and Budijanto, 2008, Muljati et al., 2014, Pradono et al., 2009). Pada penelitian studi populasi disabilitas sebelumnya, penelitian terbatas menilai prevalensi disabilitas pada PTM saja (Bhattacharya et al., 2008, Vos et al., 2015, Klijs et al., 2011) atau tanpa dikaitkan dengan faktor perilaku kesehatan (Yokota et al., 2015).

Hal-hal tersebut menyebabkan penelitian disabilitas yang ada belum bisa memberi informasi seberapa besar risiko terjadinya disabilitas yang sesuai dengan kondisi saat ini dimana Indonesia mengalami bonus demografi, peningkatan kejadian PTM berhubungan dengan peningkatan faktor risiko akibat perubahan gaya hidup seiring dengan perkembangan dunia yang makin modern serta lingkungan sosiodemografi yang sangat bervariasi di berbagai propinsi di Indonesia (Kementerian Kesehatan, 2015b). Hal ini kemudian mendorong peneliti untuk melakukan analisis disabilitas dengan meng-adjust faktor-faktor risikonya secara lebih lengkap pada penduduk usia produktif dengan menggunakan survei kesehatan nasional. Penelitian ini dapat memberikan data dan kondisi disabilitas penduduk usia produktif untuk memperoleh informasi yang lebih komprehensif tentang karakteristik disabilitas seperti kondisi kesehatan yang berhubungan dengan disabilitas pada usia produktif serta untuk memahami bagaimana intervensi pelayanan kesehatan yang sebaiknya disediakan.

Besarnya proporsi penduduk usia produktif (usia 15 – 64) pada tahun 2010 – 2035 menjadikan tantangan agar usia produktif dapat dijalani dalam kondisi sehat. Penyakit Tidak Menular merupakan penyakit kronis yang

mengancam sejak usia muda dan seringkali menimbulkan disabilitas pada usia produktif. Perilaku kesehatan yang salah dan masalah kesehatan lainnya juga dapat menyebabkan disabilitas pada usia produktif. Disabilitas pada usia produktif merupakan masalah kesehatan yang dapat terjadi karena penyakit yang diderita sejak usia muda dan pola hidup yang dijalani.

Masalah kesehatan pada usia produktif yang dihubungkan dengan disabilitas membutuhkan perawatan jangka panjang termasuk rehabilitasi, serta menimbulkan hari mengalami kesulitan akibat disabilitasnya. Dari sisi ekonomi juga akan membutuhkan beban biaya yang cukup besar, bukan saja bagi individu namun juga terhadap keluarga dan bahkan pemerintah.

Kondisi kesehatan yang dipengaruhi PTM (diabetes mellitus, hipertensi, stroke), faktor perilaku kesehatan (kurangnya aktivitas fisik, merokok), masalah kesehatan lainnya (status gizi/obesitas dan status kesehatan mental emosional) penduduk usia produktif dapat mempengaruhi usia harapan hidup. Untuk meningkatkan kesehatan penduduk usia produktif agar tetap aktif, produktif, mandiri, berkinerja dan sehat maka disabilitas pada usia produktif harus ditiadakan. Disabilitas yang terjadi sejak usia muda tentu akan memberi dampak negatif untuk jangka panjang. Terdapat bukti dari seluruh dunia yang menunjukkan ada hubungan kompleks antara disabilitas dengan kesehatan penduduk.

Permasalahan penduduk usia produktif perlu mendapat perhatian khusus. Oleh karena itu perlu dilakukan analisis yang mendalam tentang disabilitas sebagai informasi penyusunan prioritas intervensi pada pelayanan kesehatan untuk meningkatkan kualitas hidup usia produktif. Hal ini kemudian mendorong peneliti untuk melakukan analisis disabilitas terkait faktor-faktor risikonya pada penduduk usia produktif di Indonesia berdasarkan Riset Kesehatan Dasar Tahun 2013. Penelitian ini dapat memberikan data dan kondisi disabilitas penduduk usia produktif untuk memperoleh informasi yang lebih komprehensif tentang karakteristik disabilitas seperti kondisi kesehatan yang berhubungan dengan disabilitas pada usia produktif serta untuk memahami bagaimana intervensi pelayanan kesehatan yang sebaiknya disediakan.

Berdasarkan latar belakang dan rumusan masalah yang telah diuraikan sebelumnya, maka yang menjadi pertanyaan penelitian dalam penelitian ini adalah bagaimana pengaruh faktor-faktor risiko disabilitas terhadap kejadian

disabilitas pada penduduk Indonesia usia produktif?

Tujuan penelitian ini adlah untuk mengetahui pengaruh faktor-faktor risiko disabilitas terhadap kejadian disabilitas pada penduduk Indonesia usia produktif.

## Analisis Gambaran Disabilitas

Indikator disabilitas menjadi penting dengan makin meningkatnya prevalensi PTM (Kosen and Sidharta, 1998). Disabilitas dapat diukur dengan melihat interaksi antara individu dan lingkungannya (WHO, 2013). Bagi Indonesia konsep ICF untuk penelitian disabilitas belum banyak digunakan. Data disabilitas Indonesia sebagian besar didasarkan pada angka disabilitas fisik dan atau disabilitas kognitif, tidak melihat interaksinya dengan lingkungan dan masyarakat. Menurut WHO (2010), pengukuran disabilitas diperlukan dalam melengkapi diagnosis medis untuk merencanakan pelayanan yang dibutuhkan, perawatan, performa kerja dan integrasi sosial. Pengukuran disabilitas berguna untuk menilai keberhasilan pengobatan dan intervensi yang telah diberikan. Item penilaian WHODAS 2.0 cukup handal dan sensitif untuk mengukur perbedaan yang dibuat oleh intervensi yang diberikan. Hal ini dicapai dengan menilai individu yang sama sebelum dan setelah intervensi (WHO, 2013). Oleh karena itu akan jauh lebih baik jika penggunaan parameter disabilitas ini adalah untuk mengetahui juga sejauh mana keberhasilan pengobatan, intervensi ataupun pengobatan yang telah dilakukan. Kalau saja antara penelitian Riset Kesehatan Dasar tahun 2013 dan yang sebelumnya memakai instrument disabilitas yang sama maka hasilnya akan dapat kita bandingkan. Sehingga kemudian dapat kita lihat apakah terjadi penurunan atau peningkatan derajat disabilitas pada masing-masing PTM/perilaku kesehatan/kondisi kesehatan setelah dilakukannya serangkaian intervensi kesehatan.

## Analisis Hubungan antara PTM dengan Disabilitas

Penyakit Tidak Menular (PTM) merupakan salah satu penyakit yang mengalami pergeseran pola penyakit dimana yang biasanya baru muncul pada usia tua, maka saat ini bisa sudah mulai terjadi sejak usia produktif.

Dari hasil uji bivariat penelitian ini menunjukkan bahwa seseorang yang mempunyai lebih dari satu penyakit PTM meningkatkan risiko mengalami

disabilitas. Hasil uji statistik menunjukkan bahwa individu usia produktif dengan diabetes saja mempunyai risiko 3,067 kali untuk mengalami disabilitas, pada individu dengan diabetes dan hipertensi mempunyai risiko 4,292 kali untuk mengalami disabilitas, dan pada individu dengan diabetes dan stroke mempunyai risiko 14.008 kali. Demikian pula pada seseorang yang menderita stroke. Ketika individu menderita penyakit stroke saja tanpa disertai dengan PTM lainnya, maka individu tersebut berisiko 11,265 kali untuk mengalami disabilitas. Sedangkan jika individu tersebut menderita stroke disertai hipertensi akan meningkatkan risiko menjadi 12,112 kali untuk mengalami disabilitas. Ketika seseorang mempunyai tiga macam PTM dalam dirinya juga akan meningkatkan risiko kejadian disabilitas. Risikonya meningkat menjadi 13,008 kali untuk mengalami disabilitas dibandingkan dengan yang tidak mempunyai tiga macam PTM (diabetes, hipertensi, dan stroke).

Dari hasil penelitian longitudinal di Amerika didapatkan hasil bahwa subyek dengan diabetes dan stroke tapi tanpa kondisi komorbiditas lain memiliki risiko hampir 18 kali lebih tinggi mengalami disabilitas dalam melakukan kegiatan sehari-hari (OR = 18,8; 95% CI 3,3-105,2) dibandingkan dengan subyek tanpa salah satu dari 2 kondisi. Risiko cacat semakin meningkat jika subjek memiliki kondisi komorbiditas (hipertensi, serangan jantung, kanker, patah tulang pinggul, arthritis) (Otiniano et al., 2001 ). Penelitian lain menyebutkan bahwa stroke pada pasien diabetes memiliki pola klinis yang spesifik, disabilitas yang lebih tinggi dan prognosis buruk dalam hal fungsi motorik (Megherbi et al., 2003).

## Analisis Hubungan antara Perilaku Kesehatan dengan Disabilitas

Aktivitas fisik yang dilakukan secara teratur dapat meningkatkan sistem jantung dan pembuluh darah. Peningkatan harian waktu aktivitas fisik dapat mengurangi risiko kejadian disabilitas, bahkan jika intensitas kegiatan aktivitas fisik tidak meningkat (Dunlop et al., 2014). Dari hasil analisis bivariat didapatkan hasil bahwa perilaku tidak menjalankan aktivitas fisik mengalami kejadian disabilitas yang hampir sama pada semua domain. Namun kejadian disabilitas dengan tingkat sangat berat lebih banyak terjadi pada domain mobilitas.

Dari hasil sebuah penelitian di Jerman yang menganalisis 3333 orang didapatkan bahwa aktivitas sedang dan aktivitas tinggi memiliki efek perlindungan terhadap terjadinya disabilitas (OR = 0,80 dan 0,73). Aktivitas fisik yang tinggi mengurangi risiko dan menunda timbulnya kecacatan dalam beberapa tahun, tapi tidak bisa menunjukkan efek pada tingkat keparahan (jumlah keterbatasan) disabilitas (Strobl et al., 2014). Penelitian lain menyimpulkan tingkat aktivitas fisik mempengaruhi risiko disabilitas baik di kalangan perokok dan non-perokok. Di antara mantan perokok dan perokok moderat, aktivitas fisik yang kuat dapat membantu mencegah disabilitas kerja, sementara di kalangan perokok berat aktivitas fisik kemungkinan tidak cukup untuk melawan efek buruk dari intensitas merokok terhadap kemampuan mencegah disabilitas kerja (Lallukka et al., 2014).

## Analisis Hubungan antara Kondisi Kesehatan Lain dengan Disabilitas

Ketika seseorang mempunyai kombinasi antara obesitas, gangguan mental emosional dan tidak menjalankan aktivitas fisik maka akan meningkatkan risiko. menjadi 13,276 kali untuk mengalami disabilitas dibandingkan dengan yang tidak mempunyai obesitas, gangguan mental emosional dan tidak menjalankan aktivitas fisik. Adanya gangguan gangguan kesehatan mental menyebabkan peningkatan beban kondisi kesehatan lainnya termasuk juga penyakit kronis (Linden et al., 2015). Penelitian lain menyimpulkan bahwa Obesitas dikombinasikan dengan kekuatan otot yang rendah (akibat kurangnya aktivitas fisik) meningkatkan risiko penurunan kecepatan berjalan dan mengembangkan disabilitas mobilitas, terutama di kalangan orang-orang <80 tahun (Stenholm et al., 2009).

## Analisis Hubungan antara Sosiodemografi dengan Disabilitas

Hasil uji statistik penelitian ini menunjukkan bahwa terdapat hubungan yang bermakna antara usia dengan kejadian disabilitas. Semakin meningkat usia, risiko untuk mengalami disabilitas semakin tinggi. Individu dengan usia 25 - 34 tahun mempunyai risiko 1,120 kali untuk mengalami disabilitas dibandingkan dengan usia 15 – 24 tahun. Sedangkan individu dengan usia 55 - 64 tahun

mempunyai risiko 2,266 kali untuk mengalami disabilitas dibandingkan dengan usia 15 – 24 tahun.

## Hubungan Jenis Kelamin dengan Disabilitas

Dari 331.249 (49.8%) wanita usia produktif terdapat 16,1% yang mengalami disabilitas. Hasil uji statistik menunjukkan bahwa wanita usia produktif mempunyai risiko 1,304 kali untuk mengalami disabilitas dibandingkan dengan yang laki-laki.

## Hubungan Pendidikan dengan Disabilitas

Hasil uji statistik penelitian ini menunjukkan bahwa terdapat hubungan yang bermakna antara pendidikan dengan kejadian disabilitas. Semakin rendah pendidikan, risiko untuk mengalami disabilitas semakin tinggi. Individu usia produktif dengan pendidikan dasar mempunyai risiko 1,074 kali untuk mengalami disabilitas dibandingkan pendidikan tinggi. Sedangkan individu usia produktif yang tidak/belum sekolah mempunyai risiko 1.506 kali untuk mengalami disabilitas dibandingkan dengan pendidikan tinggi.

## Hubungan Status Perkawinan dengan Disabilitas

Hasil uji statistik penelitian ini menunjukkan bahwa terdapat hubungan yang bermakna antara status perkawinan dengan kejadian disabilitas. Individu usia produktif dengan status menikah mempunyai risiko 1,128 kali untuk mengalami disabilitas dibandingkan yang belum menikah. Status menikah tersebut memberi risiko disabilitas yang paling rendah dibandingkan status perkawinan lainnya.

## Hubungan Pekerjaan dengan Disabilitas

Hasil uji statistik penelitian ini menunjukkan bahwa terdapat hubungan yang bermakna antara pekerjaan dengan kejadian disabilitas. Individu usia produktif yang tidak bekerja mempunyai risiko lebih tinggi untuk mengalami disabilitas dibandingkan yang bekerja. Pekerjaan sektor formal lebih mempunyai efek perlindungan terhadap kejadian disabilitas.

## Hubungan Tempat Tinggal dengan Disabilitas

Dari 323.346 (51,4%) individu usia produktif yang tinggal di pedesaan terdapat 13,9% yang mengalami disabilitas. Hasil uji statistik menunjukkan bahwa tempat tinggal di pedesaan mempunyai risiko yang hampir sama dibandingkan tempat tinggal di perkotaan untuk mengalami disabilitas.

## Analisis Faktor Risiko Disabilitas pada Usia Produktif

Dari pembahasan seluruh faktor risiko disabilitas pada usia produktif dapat diketahui bahwa terdapat faktor yang meningkatkan risiko kejadian disabilitas dan ada faktor yang memberi efek perlindungan terhadap kejadian disabilitas. Faktor risiko yang meningkatkan kejadian disabilitas yaitu : penyakit diabetes mellitus, hipertensi, stroke, tidak melakukan aktivitas fisik, merokok, obesitas, gangguan mental emosional, usia yang semakin tua, jenis kelamin perempuan, tidak/belum pernah sekolah, dan status perkawinan tidak menikah. Sedangkan yang termasuk faktor yang memberi efek perlindungan terhadap kejadian disabilitas yaitu : bekerja dan tempat tinggal di pedesaan. Dari hasil uji statistik kemudian diketahui bahwa terdapat 3 (tiga) variabel yang menjadi variabel confounding pada penelitian ini yaitu pekerjaan utama, status perkawinan dan pendidikan.

Dari seluruh faktor risiko disabilitas pada penelitian ini terdapat dua variabel yang merupakan faktor risiko dominan, yaitu stroke (OR = 5,045, 95% CI 4,045 – 6,292) dan gangguan mental emosional (OR = 8,822, 95% CI 8,348 – 9,323). Jika dibandingkan dengan semua variabel kecuali variabel sosiodemografi (seperti tampak pada Gambar 5.8), penyakit stroke memiliki angka kejadian disabilitas yang paling tinggi di semua domain disabilitas. Dari hasil uji interaksi juga dapat terlihat bahwa terdapat interaksi antara stroke dan gangguan mental emosional. Dengan berbagai alasan tersebut, maka stroke dan gangguan mental emosional akan dijadikan fokus intervensi pengendalian kejadian disabilitas pada usia produktif. Intervensi yang dilakukan pada kedua variabel tersebut diharapkan akan lebih tepat sasaran dan berhasil guna untuk mengurangi atau menghilangkan kejadian disabilitas pada penduduk Indonesia khususnya pada usia produktif.

## Kesimpulan

Penduduk Indonesia usia produktif yang mengalami disabilitas ada sebanyak 14.2% dengan risiko mengalami disabilitas meningkat sesuai dengan peningkatan usia. Faktor risiko yang meningkatkan kejadian disabilitas pada usia produktif di Indonesia yaitu: penyakit diabetes mellitus, hipertensi, stroke, tidak melakukan aktivitas fisik, merokok, obesitas, gangguan mental emosional, usia yang semakin tua, jenis kelamin perempuan, dan tidak/belum pernah sekolah.

Faktor yang memberi efek perlindungan terhadap kejadian disabilitas pada usia produktif di Indonesia yaitu: status bekerja dan tempat tinggal di pedesaan. Penduduk usia produktif yang mempunyai lebih dari satu PTM, perilaku kesehatan yang tidak sehat, dan atau lebih dari satu kondisi kesehatan lainnya meningkatkan risiko mengalami disabilitas dibandingkan dengan yang tanpa kombinasi PTM/perilaku kesehatan/kondisi kesehatan lainnya. Berdasarkan analisis faktor-faktor risiko disabilitas ditemukan bahwa penyakit stroke dan gangguan mental emosional menjadi fokus intervensi pengendalian disabilitas pada usia produktif di Indonesia melalui program intervensi berbasis masyarakat.

# Bunga Rampai Tesis/Disertasi

# KOMPUTER

## Program Beasiswa SPIRIT

# Pengembangan Dependency Impact-Based Alert System (DIAS) sebagai Pendukung Sistem Pengawasan pada Infrastruktur Jaringan Informasi

# Dependency Impact-Based Alert System (DIAS) Development to Support Monitoring System in Information Network Infrastructure


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# ABSTRAK

Tesis ini membahas tentang pengembangan sistem peringatan berbasis dampak dependensi (DIAS), yaitu sistem yang akan menerima informasi tentang suatu insiden keamanan informasi, menganalisisnya, kemudian memberikan peringatan kepada pemilik aset yang bersangkutan. Analisis dampak dikembangkan dari Model Analisis Dampak Dependensi, dengan mendefinisikan *Intra Relation Compound* (IRC) dan *Inter Relation Compound* (ERC). Walaupun begitu, model yang dikembangkan ini tetap menggunakan prinsip relasi antar komponen dalam satu maupun antar aset teknologi informasi. Relasi – relasi antar komponen tersebut didefinisikan terlebih dahulu dalam bentuk matriks dependensi, matriks relasi intra-aset, dan matriks relasi inter-aset. Matriks – matriks tersebut disimpan dan dianalisis di dalam sistem DIAS untuk mengetahui luas dampak. Suatu komponen berdampak luas jika banyak komponen yang bergantung padanya, baik secara langsung maupun tidak langsung. Dua belas skenario dengan berbagai kondisi disusun untuk menguji model analisis. Pengujian dilakukan dengan membandingkan hasil analisis yang dilakukan oleh model awal dengan model yang dikembangkan (IRC & ERC). Hasilnya menunjukkan bahwa IRC mampu menghitung 25% lebih banyak dibandingkan IR, dan ERC 62% lebih banyak dibandingkan ER.



Kata kunci: analisis risiko, DIAS, *dependency impact analysis mod*el, i*nter relation compound, intra relation compound*, sistem peringatan, sistem jaringan informasi

# ABSTRACT

This thesis discusses the development of dependency impact-based alert system, a system that will receive data about a security incident, analyze it, and finally send alert to the owner. The impact analysis is developed from Dependency Impact Analysis Model, by defining Intra Relation Compound (IRC) and Inter Relation Compound (ERC). Nevertheless, this developed model is still using the concept of relation between components within or outside assets of information technology. Those relations are defined by using dependency matrix, intra-asset relation matrix, and inter-relation matrix. Those matrices are stored and analyzed inside DIAS to find out the width of impact. A component may have a wide impact if there are many other components depend on it, directly or indirectly. Twelve scenarios with different conditions are prepared to test the analysis models. System testing is conducted by comparing the analysis result from the original model with the proposed model. The results show that IRC is able to count impacts 25% higher than IR, and ERC 62% higher than ER.



Keywords: risk analysis, DIAS, dependency impact analysis model, inter relation compound, intra relation compound, alert system, information network system

Pada awalnya, sejarah keamanan informasi berasal dari perkembangan keamanan komputer, yang dahulu masih sederhana dengan cukup mengamankan lokasi, perangkat keras, dan perangkat lunak. Pada era perang dunia kedua tersebut, komputer mainframe pertama yang dikembangkan untuk memecah kode keamanan komunikasi musuh, cukup dijaga dari sisi fisiknya saja, misalnya dengan penjagaan militer, kunci, dan kartu akses. Keamanan informasi pada era ini masih menggunakan skema yang sederhana, yaitu dengan pengamanan fisik dan pengklasifikasian dokumen. Sedangkan ancaman paling utama yang dihindari adalah pencurian data (spionase) dan sabotase.

Pada saat perang dingin, komputer mainframe mulai dipasang saling terhubung antar wilayah agar mampu menyelesaikan proses yang lebih rumit. Pada era ini, cikal bakal internet yang dikembangkan oleh ARPA mulai tumbuh, bersamaan dengan potensi penyalahgunaannya. Dan tidak jauh dari masa itu juga, ditemukan microprosessor (akhir tahun 1970), sehingga komputer yang awalnya masih terpusat, mulai terdesentralisasi ke lokasi fisik yang berbeda. Selanjutnya, perkembangan komputer yang terjadi pada tahun 1980 semakin mendorong perkembangan jaringan. Pada masa itu, jaringan tersebut baru bisa digunakan oleh pemerintah, akademisi, dan industri. Namun mulai tahun 1990, internet sudah mulai bisa diakses oleh umum, hampir dari berbagai penjuru dunia, dan dengan berbagai macam penggunaannya.

Pada awalnya, teknologi internet yang dibuat oleh ARPA sudah digunakan sebagai standar de facto, karena belum ada standar yang dikembangkan sendiri oleh industri. Aspek keamanan saat itu masih mendapatkan prioritas yang rendah, sebagai contoh adalah teknologi email yang memiliki kelemahan keamanan, sehingga banyak disalahgunakan. Pada saat internet dan email baru sebatas digunakan oleh ilmuwan komputer, autentikasi dan enkripsi email tampaknya tidak diperlukan. Pengamanan sistem komputer yang awalnya cukup dari segi fisiknya saja, mulai tidak cukup setelah teknologi jaringan digunakan, karena informasi yang tersimpan di dalamnya semakin terpapar terhadap ancaman keamanan yang lebih luas.

Teknologi informasi dan jaringan selalu berkembang dari dulu hingga sekarang. Teknologi tersebut membuat komunikasi informasi lebih efisien, cepat, dan mudah dengan biaya yang rendah. Komunikasi informasi tersebut bisa dilakukan di mana saja dan kapan saja, sekaligus mengurangi penggunaan

kertas. Banyak organisasi menyadari, bahwa dengan mengkombinasikan jaringan lokal dengan internet, akan mampu membuka banyak peluang baru, jika dibandingkan hanya menggunakan jalur *leased line* konvensional.

Dengan menggunakan sistem komputer yang ada di dalam infrastuktur teknologi informasi, informasi digital bisa dibuat, disimpan, dan ataupun direproduksi dengan cara – cara baru. Di sisi lain, infrastruktur tersebut rentan terhadap penyalahgunaan atau perusakan yang berimbas kepada stakeholder. Oleh karena itu, walaupun teknologi informasi mampu memberikan peluang – peluang baru, namun tetap harus dijaga aspek keamanannya, yaitu *confidentiality, integrity*, dan *availability*.

Salah satu contoh kasus penyalahgunaan sistem komputer terjadi pada tahun 1988 oleh Robert Morris. Mahasiswa Universitas Cornell tersebut membuat aplikasi yang mampu menyebar secara tersembunyi dari komputer ke komputer, dengan mengeksploitasi kelemahannya. Worm tersebut menghabiskan memory komputer dan membuat kinerjanya lambat. Usaha untuk menghentikan worm tersebut dilakukan hingga beberapa hari.

Banyak usaha yang telah dilakukan dalam memerangi penyalahgunaan sistem komputer. Diantaranya adalah penggunaan firewall, pembentukan CSIRT, penegakan cyberlaw, implementasi ISMS dan sebagainya.

Saat ini firewall digunakan untuk mengamankan jaringan bervariasi karena bisa digabungkan dengan kemampuan lain. Firewall yang sebelumnya hanya sebatas mengamankan pada layer 3 dan 4 (*network layer* dan *transport layer*), sekarang sudah dilengkapi dengan IPS, SSL *offloading*, content *based filtering*, DNS *filtering*, *mail relay*, dan sebagainya. Firewall tersebut, dan juga halnya dengan perangkat monitoring yang lain, mempunyai fungsi notifikasi saat ada masalah yang muncul.

## Sistem Pengawasan Jaringan Informasi

Seiring dengan infrastruktur teknologi informasi yang bertambah kompleks, banyak aspek yang harus dilindungi dan diawasi operasionalnya. Saat ini, sudah banyak muncul perangkat – perangkat yang mampu melindungi dan mengawasi jaringan informasi. Bahkan sebagian dari perangkat tersebut, mampu mendeteksi masalah sekaligus mengatasinya secara langsung dan

otomatis. Beberapa fungsi perangkat – perangkat tersebut diantaranya:

- mengawasi fungsi operasional perangkat jaringan (*up, down*, *flapping*, *underutilize*),
- mengawasi fungsi operasional layanan jaringan (web, email, dan sebagainya),
- mengawasi dan melindungi dari serangan berbasis jaringan seperti malware, DoS, APT,
- mendeteksi dan mengatasi *vulnerabilities* sistem lewat jaringan,
- mengawasi dan melindungi dari kebocoran data tertentu,
- mengawasi ruang pusat data terhadap kualitas suplai listrik, asap dan kebakaran, kebocoran air, suhu, dan kelembapan, dan
- mengawasi ruang fisik tertentu dengan CCTV.

Banyaknya aspek yang perlu ditangani tersebut, berpotensi menyebabkan organisasi atau perusahaan untuk memakai berbagai macam perangkat pengawasan. Di sisi lain, perangkat – perangkat tersebut biasanya dikonfigurasi untuk mengirimkan notifikasi kepada pihak yang terkait jika muncul masalah pada infrastruktur TI yang diawasi. Notifikasi – notifikasi tersebut bisa berupa email, pager, SMS, IM, audio, dan sebagainya. Ada banyak faktor yang dipertimbangkan untuk memilih jenis notifikasi, diantaranya:

- Banyaknya informasi yang harus dikirim, apakah sedikit atau banyak,
- format informasi yang dikirimkan, apakah cukup teks, atau format lain yang lebih kompleks,
- kecepatan pengiriman, misalnya apakah lebih cepat menggunakan email, SMS, atau *voicecall,*
- dependensi dengan infrastruktur lain, misalnya apakah pengiriman email masih memungkinkan jika terjadi masalah jaringan internet di pusat data,
- kebiasaan pihak yang akan dikirimkan notifikasi, apakah lebih baik lewat email, SMS, atau cara lain,
- banyaknya pihak yang akan dikirimkan notifikasi, misalnya apakah cukup beberapa orang saja, atau satu grup dengan banyak anggota,
- infrastruktur telekomunikasi di daerah yang terkait, misalnya apakah pihak yang menerima notifikasi sering berada di daerah yang tidak ada akses internet.

## Peran Manajemen Risiko

Keamanan informasi bertujuan utama untuk mendukung misi organisasi. Semua organisasi pasti akan terpapar oleh ketidakpastian, yang sebagian diantaranya akan berdampak negatif. Mengelola ketidakpastian tersebut bukanlah tugas yang mudah. Sumber daya yang terbatas, dan lanskap *threats - vulnerabilities* yang selalu berubah, membuat tidak semua risiko yang muncul bisa ditangani. Oleh karena itu, diperlukan alat bantu yang mampu menyatukan pemahaman antara teknisi keamanan dengan pihak manajemen terhadap dampak – dampak potensial pada aset informasi, yang selanjutnya berpengaruh terhadap misi organisasi. Alat bantu atau metodologi tersebut diantaranya NIST, OCTAVE, FRAAP, COBRA, dan Risk Watch.

Hasil *risk assesment* memungkinkan pihak manajemen menentukan apa yang harus dilakukan terhadap risiko – risiko tersebut. Jika sistem yang menentukan besaran risiko tersebut sudah tertata, organisasi akan mampu menentukan prioritas tindakan yang akan diambil. Sistem tersebut akan membantu organisasi agar terfokus pada risiko yang besar dahulu [4]. Disinilah sistem pengawasan jaringan informasi diharapkan bisa membantu dalam hal:

Mendeteksi awal masalah, yang jika dibiarkan akan mengganggu aset informasi yang dimiliki. Contohnya adalah rusaknya satu PSU dari suatu server yang memiliki *redundant* PSU. Dalam jangka pendek, hal itu tidak akan mempengaruhi operasional server. Namun jika tidak ditangani, dan suatu saat PSU yang kedua juga rusak, maka server akan mati.

Mengawasi aset informasi, yang jika terganggu dan dibiarkan akan mengakibatkan kerugian yang lebih besar. Misalnya jika layanan email mati dan tidak segera diatasi, akan mengakibatkan email yang dikirim dari perusahaan lain akan mengalami bounce.

Setiap organisasi mempunyai aset informasi beserta infrastruktur yang digunakan sebagai pendukung sekaligus *business enabler*. Aset – aset tersebut biasanya diberi perlindungan dan diawasi agar terhindar dari gangguan, sekaligus merespon dengan cepat setiap insiden yang muncul. Dalam prakteknya, infrastruktur TIK yang dimiliki organisasi bisa bertambah kompleks karena heterogenitas infrastruktur, dan dependensi antar komponen yang dimilikinya. Salah satu tantangan terhadap kondisi tersebut adalah bagaimana mengirimkan peringatan masalah atas suatu aset dan infrastruktur TIK,

berdasarkan besarnya dampak dan tingkat darurat masalah tersebut. Karena sistem yang baik harus mampu memilah lalu memprioritaskan masalah yang muncul, kemudian diinformasikan kepada pihak yang tepat.

## Pertanyaan Penelitian ini adalah

- Bagaimana cara sistem menerima informasi insiden keamanan dari sistem pengawasan jaringan informasi?
- Bagaimana cara sistem menentukan luasnya dampak insiden tersebut?
- Bagaimana sistem menentukan cara mengirim peringatan beserta pihak yang dituju?

Penelitian ini ditujukan untuk mengembangkan sistem yang mampu menginformasikan masalah yang terjadi di infrastruktur jaringan informasi, berdasarkan luas dampaknya. Manfaat yang bisa diambil dari hasil penelitian ini yaitu, sistem yang mampu menginformasikan insiden yang muncul kepada pihak terkait dengan tepat.

Penelitian ini hanya akan membahas pengembangan sistem pengirim informasi peringatan dini berdasarkan luas dampak dan tingkat daruratnya. Sistem yang menjadi pengawas jaringan informasi tidak akan dikembangkan, dan hanya digunakan sebagai pengumpan data.

## Implementasi dan Pengujian Sistem

Diimplementasikan tiga jenis matriks yang akan digunakan untuk membantu dalam menganalisis dampak dependensi, antara lain:

- matriks dependensi aset, yang digunakan untuk mengatur dependensi antar aset,
- matriks relasi intra aset, yang digunakan untuk mengatur daftar komponen beserta hubungannya di dalam suatu aset, dan
- matriks relasi antar aset, yang digunakan untuk mengatur hubungan komponen antar aset yang berbeda.

Ketiga matriks diatas disimpan sebagai array dan dimasukkan ke dalam server basis data.

## Implementasi Matriks Dependensi Aset

Matriks dependensi aset dimasukkan ke dalam tabel dalam format array multi dimensi [id_asset][id_affected_asset] => value di mana id_affected_asset adalah aset – aset yang mendapatkan dampak karena mempunyai dependensi dengan id_asset. Sedangkan value merupakan nilai yang bisa diacuhkan, karena tidak digunakan. Format tersebut dipakai karena:

- mampu digunakan untuk operasi matriks tanpa bergantung banyak pada basis data,
- mencegah duplikasi array key, dan
- memungkinkan satu aset berdampak pada satu atau lebih aset lain.

Cuplikan matriks dependensi aset pada ilustrasi kasus di jaringan pada Subbab 3.2.2.3, di mana aset DNSE (r_assets.id = 4) yang berdampak pada DNSI (r_assets.id = 8), ditulis dalam bentuk matriks multi dimensi [4][8] => 1. r_assets. id adalah nama tabel dan nama kolom di dalam server basis data.

## Implementasi Matriks Relasi Intra Aset

Matriks relasi intra-aset disimpan pada kolom components pada table r_assets dalam bentuk array multi dimensi, dengan format [component_name][affected_ component_name] => value. Cuplikan matriks relasi intra aset s4 (DNSE) pada Subbab 3.2.2.3, untuk relasi "Ethernet" ke "DNS Service" ditulis menjadi [Ethernet][DNS Service] =>

## Implementasi Matriks Relasi antar Aset

Matriks relasi antar aset diimplementasikan dengan kolom er pada table r_assets dengan menggunakan array multi dimensi berformat [component_ name] [id_affected_asset] [affected_component_ name].=> 1. Jika mengacu pada pada Subbab 3.2.2.3, maka relasi antar aset komponen e1 pada s4 ke s8 bisa dituliskan ke dalam array dengan bentuk [Ethernet] [8][Ethernet] => 1 .

## Implementasi Analisis IRC

Sesuai dengan pseudo-code pada sub bab 3.2.2, analisis dampak terdiri dari IRC dan ERC, di mana analisis ERC juga melibatkan IRC. Algoritma IRC

pada lampiran 2 dituliskan di dalam fungsi yang bernama countCIR dengan parameter $id_asset (nomor aset di dalam basis data) dan $init_comp (nama komponen yang ada di dalam aset tersebut). Kode pemrograman baris 70-77 adalah persiapan sistem dalam mempersiapkan variabel awal yang diperlukan, untuk melanjutkan proses penghitungan CIR. Baris kode 79-80 adalah langkah mempersiapkan edges sekaligus menambah poin IRC.

Selanjutnya, tiap edges diperiksa apakah ada nilai IR yang bisa dihitung. Jika ada, maka nama – nama komponen tersebut akan ditambahkan pada IRC, sekaligus dianggap sebagai edges yang baru. Edges yang baru tersebut akan dianalisis ulang IR-nya, apakah ada poin tambahan yang bisa didapat. Jika tidak ada edges yang baru, maka penghitungan IRC akan dianggap selesai. Proses – proses tersebut dapat dilihat pada baris kode 82-96. Pada proses akhir, $id_asset dan $init_comp dihapus dari IRC, kemudian hasilnya dikirimkan kepada yang memanggil fungsi countCIR, seperti pada baris kode 98.

## Implementasi Analisis ERC

Analisis ERC ditulis menjadi algoritma seperti pada lampiran 3. Baris 45-53 adalah langkah awal untuk mencari relasi antar aset pada komponen utama yang mendapat masalah. Lalu baris kode 54 adalah proses pencarian CIR dan relasi antar aset yang dilakukan berselang – seling dan berulang – ulang. Proses tersebut hanya akan berhenti jika tidak ada lagi relasi antar aset (lihat baris nomor 60).

Relasi antar aset ditampung sementara ke variabel $edges_inter, yang selanjutnya dijadikan dasar untuk mencari IRC pada aset yang terkait. Pencarian IRC tersebut dilakukan menggunakan fungsi countIRC yang sebelumnya sudah dibangun. Selanjutnya, setiap komponen yang ada pada IRC tersebut akan dicari relasi antar aset.

## Uji Analisis IRC dan ERC

Pengujian sistem DIAS dilakukan dengan cara mengkonfigurasi dependensi aset dan relasi komponen, yang kemudian dibuat simulasi.

GUI yang dibangun untuk mengkonfigurasi dependensi antar aset, di mana baris pertama adalah daftar aset yang memberikan dampak kepada aset

– aset pada kolom pertama. Dalam contoh tersebut, terlihat bahwa S5 (DNSE) memberikan dampak kepada S1 (DNSI) dan S2 (Internet).

Konfigurasi matriks relasi inter-relasi akan muncul setelah dilakukan konfigurasi dependensi aset disana akan terdapat konfigurasi matriks intra-relasi pada "DNSE", dan inter-relasi kepada aset "DNSI" dan "Internet". GUI pada sistem DIAS yang dibangun untuk menguji IR, ER, IRC, dan ERC secara serentak. Drop down disediakan agar bisa dipilih komponen mana yang akan disimulasikan sebagai komponen utama yang mendapat masalah. Sedangkan pengaturan dependensi antar aset, dan relasi antar komponen dilakukan pada bagian GUI yang lain, yaitu pada menu "Assets".

Komponen "Ethernet" pada DNSE bermasalah, maka akan berdampak eksternal (ERC) pada nomor aset 4 (komponen "Ethernet IIX"), nomor aset 3 (komponen "Ethernet" dan "DNS Service"), dan nomor aset 2 (komponen "Ethernet WAN"). Selanjutnya, peringatan akan dikirim lewat SMS dan email kepada setiap owner yang terlibat, dengan isi peringatan yang sama. Cara seperti ini ditujukan agar setiap owner yang terlibat, memahami di mana masalah utamanya, dan berdampak ke mana saja.

Secara total, IRC mampu menghitung dampak lebih banyak dibandingkan dengan IR. Kelebihannya dibandingkan dengan model IR, terlihat pada skenario nomor 2 hingga 8, dimana DIAS mampu menghitung (menggunakan IRC) dampak lanjutan dari dampak pertama. Selain itu, DIAS juga mampu menormalisasi penghitungan, dengan tidak menghitung kembali komponen yang sudah dianalisis sebelumnya. Dari gambar yang sama, bisa disimpulkan bahwa IRC menghitung 25% lebih baik dibanding dengan IR.

ERC berhasil menghitung lebih banyak 62% dibandingkan ER, terutama pada skenario nomor 9 hingga 12. Fluktuasi nilai ER terjadi pada skenario 9 dan 10, karena model tersebut tidak mampu menghitung dampak eksternal yang didahului oleh dampak internal.

## Kesimpulan dan Saran

Model analisis IRC dan ERC dikembangkan untuk menghitung dampak internal dan eksternal secara menyeluruh. Dampak internal yang membentuk rantai, di mana dampak pada satu komponen bisa berimbas ke komponen yang lain, harus bisa dianalisis menggunakan model IRC tersebut. Selain itu, dampak

eksternal yang membentuk rantai antar aset, juga harus bisa dianalisis dengan menggunakan ERC.

Berdasarkan skenario pengujian dan data hasil pengujian, bisa disimpulkan bahwa IRC mampu menghitung dampak 25% lebih banyak dibandingkan dengan IR. Sedangkan ERC mampu menghitung dampak 62% lebih banyak dibandingkan dengan ER. Sedikit atau banyaknya dampak yang didapat dari hasil analisis tersebut, sangat bergantung pada bentuk relasi internal maupun eksternal. Terlihat berdasarkan hasil pengujian, bahwa IRC dan ERC kadang menunjukkan hasil yang sama dengan IR dan ER. Sedangkan pada skenario lain, IRC dan ERC menunjukkan hasil yang lebih tinggi dibandingkan model IR dan ER tersebut.

Analisis dampak pada DIAS bisa dikembangkan lebih lanjut dengan memperhitungkan bobot aset, bobot dampak, probabilitas kejadian. Selain itu, bisa dikembangkan penentuan level risiko berdasarkan faktor – faktor yang lebih luas.

# Analisis Manfaat Penerapan Paperless Audit pada Badan Pengawasan Keuangan dan Pembangunan

# Benefits Analysis for Paperless Audit Implementation at Financial and Development Supervisory Board


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# ABSTRAK

Badan Pengawasan Keuangan dan Pembangunan (BPKP) merupakan lembaga pemerintah yang bertugas menjalankan pengawasan intern. Peranan sistem informasi/teknologi informasi (SI/TI) diamanatkan dalam Rencana Strategis BPKP adalah meningkatkan kualitas pengawasan. Peningkatan kualitas pengawasan dilakukan dalam bentuk penerapan *paperless audit* yang berupa *e-office* serta *e-document*. Peran SI/TI belum mendukung sepenuhnya penerapan paperless audit pada proses bisnis audit di BPKP. Permasalahan yang terjadi adalah organisasi kesulitan dalam melakukan proses pelacakan bukti audit, waktu yang diperlukan untuk penyusunan laporan lama, auditor tidak selalu mengisi formulir kendali mutu audit, serta sistem informasi penugasan dan perencanaan tidak bisa berbagi data. Dari *best practice* terkait perbaikan proses bisnis dengan memanfaatkan SI/TI, kajian manfaat yang dilakukan sebelumnya akan membantu menghindari permasalahan yang terjadi dalam perbaikan SI/TI sehingga analisis lebih lanjut terhadap manfaat penerapan paperless audit dilakukan untuk mengetahui apa manfaat penerapan paperless audit terhadap perbaikan proses audit. Untuk melihat lebih lanjut manfaat penerapan paperless audit bagi BPKP, dilakukan analisis manfaat menggunakan *Tools Benefits Dependency Network* serta kategorisasi manfaat menggunakan *Tools Generic IS/IT* Business Value Category. Penelitian ini menghasilkan manfaat yang utama dari penerapan paperless audit bagi BPKP yaitu mempercepat proses bisnis audit serta negara mendapat manfaat peningkatan efisiensi.



Kata kunci: audit tanpa kertas, Kategori Nilai Bisnis IS / IT Generik, Jaringan Ketergantungan Manfaat.

# ABSTRACT

Financial and Development Supervisory Board (FDSB) is a government institution which has a task to handle internal supervision. The role of information systems/information technology (IS/IT) mandated in FDSB Strategic Plan is to improve the quality of supervision in the form paperless audit implementation that conducted by e-office and e-document. Paperless audit implementation on audit business process has not fully supported by IS/IT. The problems are organization hard to tracking audit evidence, the time required for reports preparation is too long, auditors do not always fill out quality control form, and information systems for assignments and planning cannot share data. From best practices related to an improvement of business processes by utilizing IS/IT, benefits analysis that conducted earlier would help avoid problems occurred in IS/IT improvement. Based on this best practices, further analysis is performed to find out what the benefits of paperless audit implementation for the audit process. To see more about that benefits, a benefits analysis using Dependency Benefits Network and categorization of benefits using Generic IS/IT Business Value Category are conducted. This research provides major benefits of paperless audit implementation is accelerated FDSB audit business processes and the state gets the benefit by increasing efficiencies.



Keywords: paperless audit, Generic IS/IT Business Value Category, Benefits Dependency Network.

Peran sistem informasi/teknologi informasi (SI/TI) dalam pelaksanaan pengawasan sangat penting. Peranan SI/TI diamanatkan dalam Rencana Strategis BPKP 2015-2019 untuk meningkatkan kualitas pengawasan dengan memperbaiki proses dan prosedur audit. Perbaikan proses dan prosedur audit dilakukan dengan memanfaatkan SI/TI dalam bentuk penerapan *paperless audit*. Penerapan paperless audit dilakukan dengan menggunakan SI/TI dalam bentuk e-office yang terdiri dari proses review audit dan komunikasi hasil audit, serta e-document yang berupa kertas kerja elektronik.

Audit merupakan proses pengumpulan dan evaluasi bukti mengenai informasi untuk menetapkan dan melaporkan tingkat kesesuaian antara informasi tersebut dengan kriterianya (Arens, Elder, dan Beasley, 2012). Shumate dan Brooks (2001) menyatakan *paperless audit* merupakan istilah yang umum digunakan untuk menggambarkan otomatisasi proses audit yang dilakukan dengan bantuan aplikasi pada komputer dengan penggunaan bukti audit dalam bentuk elektronik. Hal ini sejalan dengan Coderre (2009) yang menyatakan aplikasi komputer dipergunakan untuk melakukan otomatisasi proses audit untuk meningkatkan efektivitas dan efisiensi proses audit. Untuk penggunaan teknologi informasi lebih lanjut pada proses audit, teknologi tidak hanya untuk otomatisasi proses audit akan tetapi dipergunakan untuk melakukan audit secara otomatis dan berintegrasi dengan sistem informasi yang menangani proses bisnis. Audit secara otomatis dilakukan dengan melakukan review secara terus menerus pada setiap transaksi yang terjadi untuk menilai kesesuaiannya dengan kriteria yang telah ditetapkan sebelumnya.

Braun dan Davis (2003) menyatakan aplikasi komputer tersebut dipergunakan untuk membantu dalam menyusun kertas kerja elektronik, mendeteksi penipuan, untuk mendukung tugas-tugas pencarian informasi dan analisis, serta pelaporan hasil audit. Untuk eksternal auditor Ahmi dan Kent (2012) menambahkan penggunaan aplikasi komputer dalam proses audit dipergunakan untuk mengevaluasi risiko fraud, identifikasi entri pada jurnal akuntansi dan penyesuaiannya, mengecek akurasi berkas elektronis, menyimulasikan prosedur pengolahan laporan keuangan, mengurutkan transaksi berdasarkan kriteria yang telah ditentukan, serta untuk mengambil contoh transaksi pada berkas elektronis.

Penelitian Ahmi dan Kent (2012), Braun dan Davis (2003), Coderre (2009), serta Shumate dan Brooks (2001) memberi penjelasan penerapan

paperless audit dilakukan dengan otomatisasi proses audit dengan bantuan aplikasi komputer serta melakukan audit secara otomatis dan berintegrasi dengan sistem informasi yang menangani proses bisnis. Penerapan paperless audit dipergunakan untuk membantu menyusun kertas kerja elektronik, mendeteksi penipuan, mendukung tugas-tugas pencarian informasi dan analisis, pelaporan hasil audit, mengevaluasi risiko fraud, identifikasi entri pada jurnal akuntansi dan penyesuaiannya, mengecek akurasi berkas elektronis, menyimulasikan prosedur pengolahan laporan keuangan, mengurutkan transaksi berdasarkan kriteria yang telah ditentukan, serta untuk mengambil contoh transaksi pada berkas elektronis.

Berbeda dengan penerapan paperless audit hasil penelitian Ahmi dan Kent (2012), Braun dan Davis (2003), Coderre (2009), serta Shumate dan Brooks (2001), penerapan paperless audit di BPKP dilakukan dengan menggunakan SI/TI dalam bentuk e-office untuk review audit dan komunikasi hasil audit, serta e-document untuk menyusun kertas kerja elektronik (BPKP, 2015). Penerapan paperless audit di BPKP tidak dimaksudkan untuk otomatisasi proses audit melainkan untuk membantu perbaikan dari proses prosedur audit yang ada saat ini.

Peranan SI/TI diamanatkan dalam Rencana Strategis BPKP 2015-2019 untuk meningkatkan kualitas pengawasan dengan memperbaiki proses dan prosedur audit. Perbaikan proses dan prosedur audit dilakukan dengan memanfaatkan SI/TI dalam bentuk penerapan paperless audit. Penerapan paperless audit dilakukan dengan menggunakan SI/TI dalam bentuk e-office yang terdiri dari review audit dan komunikasi hasil audit, serta e-document yang berupa kertas kerja elektronik (BPKP, 2015).

SI/TI belum mendukung sepenuhnya penerapan paperless audit pada proses bisnis audit di BPKP. Peran SI/TI baru terdapat pada proses bisnis persiapan audit serta pelaporan hasil audit dan belum berperan pada proses pelaksanaan audit serta pengendalian mutu audit.

Identifikasi masalah dilakukan dengan wawancara Kepala Pusat Informasi Pengawasan (Kapusinfowas) BPKP. Hasil wawancara dengan Kapusinfowas BPKP disebutkan bahwa proses persiapan audit sampai dengan pelaksanaan audit belum didukung sistem informasi untuk melaksanakan audit secara paperless. Proses pelaporan hasil audit masih dalam bentuk ringkasan

dari laporan hasil audit yang direkam secara manual dengan bantuan operator SIMHP.

Identifikasi masalah juga dilakukan dengan pengamatan pada Laporan Bulanan Hasil Pengawasan (LBHP) unit kerja XYZ BPKP. Pengamatan dilakukan pada LBHP yang terbit pada bulan Februari sampai dengan Agustus 2016. Hasil pengamatan pada LBHP unit kerja XYZ BPKP, dari 236 Laporan Hasil Pengawasan (LHP) yang dihasilkan pada tahun 2016, 30% belum terekam dalam aplikasi SIMHP sampai Agustus 2016.

Pengamatan juga dilakukan pada mailing list BPKP yang berisi data monitoring pengunggahan LHP. LHP diunggah ke sistem informasi Document Management System (DMS) setiap semester. Pengamatan dilakukan dari semester 2 tahun 2013 sampai dengan semester 2 tahun 2016. Hasil pengamatan menunjukkan, dari 33 perwakilan BPKP, terdapat 40 % perwakilan yang belum mengunggah LHP ke DMS sesuai dengan waktu yang ditentukan.

Permasalahan yang terjadi pada proses audit disebabkan tidak ada pengembangan SI/TI pada proses pelaksanaan audit dan pengendalian mutu audit. Permasalahan ini juga disebabkan tidak ada dukungan SI/TI untuk pertukaran data PKPT dengan penugasan serta tidak ada dukungan SI/TI untuk memasukkan data LHP secara otomatis ke SIMHP. Berdasarkan permasalahan yang terjadi, pengembangan SI/TI untuk mendukung proses dan prosedur audit akan membantu perbaikan proses bisnis audit di BPKP.

Ward dan Daniel (2012) menyatakan sebelum dilakukan pengembangan SI/TI perlu dilakukan identifikasi yang jelas terhadap manfaat yang dibutuhkan. Setelah dilakukan identifikasi manfaat, dilakukan perencanaan yang rinci untuk merealisasikan manfaat yang telah diidentifikasi. Manfaat yang telah teridentifikasi selalu dimonitor dan direalisasikan dalam proyek pengembangan SI/TI serta dilakukan kuantifikasi sesuai dengan kasus bisnis (Marnewick, 2016). Identifikasi manfaat yang dilakukan sebelum pengembangan SI/TI dapat menghindarkan dari permasalahan yang sering muncul dalam pengembangan SI/TI. Permasalahan itu adalah perencanaan proyek yang tidak matang, kesalahan dalam estimasi sumber daya SI/TI, serta kebutuhan proses bisnis terhadap manfaat SI/TI tidak diidentifikasi secara cermat (Han dan Huang 2007).

Berdasarkan hasil penelitian Han dan Huang (2007), Marnewick (2016), Peppard et al. (2007) serta Ward dan Daniel (2012), identifikasi manfaat penerapan paperless audit sebagai langkah awal pengembangan SI/TI untuk mendukung seluruh proses audit akan membantu BPKP melihat potensi manfaat dari penerapan paperless audit serta menghindari permasalahan yang sering muncul dalam pengembangan SI/TI. Untuk melihat potensi manfaat penerapan ini, diajukan pertanyaan penelitian "Apa manfaat penerapan paperless audit pada seluruh proses bisnis audit yang dilakukan oleh BPKP ?"

Tujuan dari penelitian ini adalah mengetahui manfaat penerapan paperless audit bagi BPKP. Oleh karena BPKP sebagai salah satu Lembaga Pemerintah Non Kementerian (LPNK) di Indonesia, penelitian ini juga ditujukan untuk mengetahui manfaat penerapan paperless audit di BPKP bagi negara Indonesia.

Penelitian ini bisa dikategorikan sebagai exploratory research karena penelitian ini melakukan riset untuk mendapatkan pemahaman yang lebih jelas tentang sesuatu (Wibisono, 2003). Penelitian ini dilakukan untuk mendapat pemahaman yang lebih jelas tentang manfaat penerapan paperless audit di BPKP sebagai bahan pertimbangan bagi pimpinan dalam rencana penerapan paperless audit pada semua proses bisnis audit di BPKP. Penelitian ini juga menggunakan metode case studies research karena memecahkan permasalahan yang terjadi pada suatu organisasi (Sekaran dan Bougie, 2010). Studi kasus yang diteliti berupa analis manfaat penerapan paperless audit pada BPKP.

Penelitian ini menggunakan data primer diperoleh dari hasil wawancara dan data sekunder berasal dari dokumen internal BPKP yang relevan dengan penelitian.

## Pembahasan

Proses bisnis audit terdiri atas proses persiapan audit, proses pelaksanaan audit, serta proses pelaporan hasil audit. Berikut prosedur baku pelaksanaan proses bisnis audit saat ini:

Proses persiapan audit. proses ini berisi proses penentuan tim, penyusunan surat tugas, penyusunan program audit, serta pembagian tugas prosedur audit pada anggota timPelaksanaan audit. Proses pelaksanaan audit

bertujuan untuk pemeriksaan terhadap objek pengawasan sesuai peraturan yang berlaku. Proses pelaporan hasil audit. Proses pelaporan hasil audit dilakukan untuk mengelola hasil audit.

SI/TI belum mendukung sepenuhnya penerapan paperless audit pada proses bisnis audit di BPKP sehingga proses bisnis audit sekarang memiliki beberapa kelemahan, yaitu:

Proses persiapan audit. Pada proses persiapan audit terdapat kelemahan pada sistem informasi penyusunan program kerja dan penugasan tidak bisa berbagi data program kerja dan penugasan secara otomatis. Hal ini disebabkan tidak ada dukungan SI/TI untuk pertukaran antara data program kerja dengan penugasan.

Proses pelaksanaan audit. Pada proses ini terdapat kelemahan yaitu waktu yang dibutuhkan penyusunan Laporan Hasil Pengawasan (LHP) lama karena tidak ada pengembangan SI/TI pada proses pelaksanaan audit. Proses pelaporan hasil audit. Pada proses ini terdapat kelemahan yaitu organisasi kesulitan dalam melakukan proses pelacakan dokumen audit terhadap temuan yang dilaporkan auditor yang disebabkan proses digitalisasi LHP belum terlaksana secara berkelanjutan.

Pengendalian mutu audit. Pada proses ini terdapat kelemahan yaitu auditor bisa mengisi ataupun melewati tahapan formulir kendali mutu audit yang telah ditetapkan organisasi. Hal ini karena pengendalian mutu audit tidak didukung SI/TI.

Kelemahan yang teridentifikasi pada proses bisnis audit di BPKP membutuhkan perbaikan. Perbaikan dilakukan dengan pengembangan SI/TI dalam bentuk penerapan paperless audit yang mendukung proses bisnis audit di BPKP. Penerapan paperless audit dilakukan dengan menggunakan SI/TI dalam bentuk e-office yang terdiri dari proses review audit dan komunikasi hasil audit, serta e-document yang berupa kertas kerja elektronik. Rencana pengembangan paperless audit di BPKP meliputi pengembangan SI/TI untuk mendukung proses bisnis audit yang terdiri atas persiapan audit, pelaksanaan audit, pelaporan hasil audit, serta pengendalian mutu audit.

Pengembangan SI/TI untuk mendukung proses bisnis audit dilakukan dengan memerhatikan peraturan kepala BPKP Nomor PER-1511/K/IP/2011 tentang Standar Format, Substansi, dan Prosedur Penyusunan Laporan Hasil

Pengawasan BPKP Kepada Menteri/Pimpinan Lembaga/Kepala Daerah Dan Presiden. Dalam peraturan kepala tersebut terdapat peraturan yang tetap mempertahankan tanda tangan basah oleh pejabat penanda tangan terhadap dokumen,surat, dan laporan yang disajikan ke pihak luar.

Sebagai langkah awal perbaikan proses bisnis audit, dilakukan identifikasi manfaat serta kemampuan SI/TI BPKP, analisis proses bisnis audit saat ini, serta tujuan utama BPKP.

Analisis dengan menggunakan Tools Benefits Dependency Network menghasilkan identifikasi SI/TI BPKP saat ini yang memberi kemampuan untuk memperbaiki proses bisnis audit sehingga memberikan cara kerja baru dalam menjalankan proses bisnis audit serta manfaat dari penerapan paperless audit di BPKP.

Dari hasil Perbaikan proses bisnis audit BPKP, dihasilkan manfaat yang relevan dan signifikan terhadap BPKP. Manfaat yang telah berhasil diidentifikasi dipetakan ke Generic IS/IT Business Value Category. Manfaat relevan dan signifikan dari penerapan paperless audit akan membantu BPKP untuk mencapai tujuan meningkatkan kualitas pengawasan (BPKP, 2015). Manfaat yang terklasifikasikan ke Generic IS/IT Business Value Category memiliki kemungkinan keterkaitan. Oleh karena itu manfaat yang relevan dan signifikan akan dimodelkan berdasarkan hubungan sebab akibat dengan menggunakan Systematic Diagram.

Pemodelan dilakukan untuk memperoleh manfaat yang utama dalam penerapan paperless audit. Tahapan pemodelan ke dalam Systematic Diagram untuk memperoleh manfaat yang utama adalah sebagai berikut:

Penentuan variabel sebab yang mempengaruhi variabel lain. Variabel ini merupakan manfaat yang relevan dan signifikan.Penentuan variabel tujuan yang menjadi tujuan dari investasi ini. Variabel ini merupakan variabel yang menjadi akibat ataupun dipengaruhi karena variabel lain namun tidak menutup kemungkinan jika variabel ini juga mempengaruhi variabel lain. Berdasarkan Renstra BPKP 2015-2019, tujuan yang akan dicapai adalah meningkatkan kualitas pengawasan. Dari hasil pemodelan hubungan sebab akibat menggunakan Tools Systematic Diagram dihasilkan manfaat yang utama dari penerapan paperless audit bagi BPKP adalah mempercepat proses bisnis audit.

## Kesimpulan

Manfaat yang utama dalam penerapan paperless audit bagi BPKP adalah mempercepat proses bisnis audit sebesar 10,1%. Percepatan proses audit ini dihasilkan dari perbaikan proses bisnis audit saat ini yaitu:

- Percepatan proses persiapan prosedur audit sebesar 0,24%.
- Menghilangkan proses perekaman laporan audit sehingga diperoleh percepatan sebesar 0,028%.
- Percepatan proses review audit dengan melakukan review audit bersamaan dengan proses pelaksanaan audit sehingga memperoleh percepatan sebesar 5,62%.
- Percepatan pada proses penyusunan laporan audit sebesar 4,21%.

Manfaat dari penerapan paperless audit di BPKP bagi negara adalah meningkatkan efisiensi. Peningkatan efisiensi dihasilkan dari pemetaan manfaat mempercepat proses bisnis audit sebagai sebab ke Kerangka Pikir Kesejahteraan Digital sebagai akibat. Dari hasil pemetaan diperoleh manfaat bagi negara meningkatkan efisiensi. Peningkatan efisiensi diperoleh dari kenaikan jumlah permintaan audit yang dapat diselesaikan oleh BPKP tanpa harus meningkatkan anggaran pengawasan intern.

Untuk studi kasus analisis manfaat penerapan paperless audit pada BPKP, penggunaan Tools Benefits Dependency Network mempermudah dalam melakukan analisis manfaat pada SI/TI enabler untuk memenuhi investment objective. Pada penelitian ini, proses analisis manfaat SI/TI enabler dilakukan pada SI/TI yang sudah dimiliki BPKP terlebih dahulu untuk memastikan manfaat SI/TI tersebut benar-benar terealisasi dalam memenuhi investment objective.

## Saran

Penerapan paperless audit di BPKP memberi manfaat yang besar bagi tugas pengawasan BPKP sehingga disarankan untuk melakukan desain arsitektur SI/TI yang mendukung implementasi paperless audit. BPKP belum menerapkan paperless audit sampai dengan saat ini sehingga disarankan untuk mengadakan penelitian yang mengukur kesiapan organisasi maupun auditor dalam penerapan paperless audit serta faktor-faktor yang menjadi penghambat ataupun fasilitatornya.

Penelitian bertemakan benefit management untuk melakukan pengaturan dan optimalisasi SI/TI yang dimiliki organisasi disarankan mempergunakan Tools Benefits Dependency Network. Tools ini membantu melakukan analisis manfaat dari SI/TI yang telah dibelanjakan organisasi tersebut dalam memenuhi tujuan organisasi.

# Designing Civil Servant Performance Evaluation Information Systems (CPSE-IS) Using UML: A Study in Indonesia Civil Service

# Perancangan Sistem Informasi Evaluasi Kinerja Sipil (CPSE-IS) dengan Menggunakan UML: Studi di Badan Kepegawaian Negara


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# ABSTRAK

Latar Belakang. Manajemen kinerja sangat penting untuk mengelola dan mengatur kinerja dan prestasi kerja baik secara individu maupun organisasi. Sistem informasi digunakan untuk mendukung manajemen kinerja dalam organisasi agar memberikan penilaian kinerja staf yang efisien dan efektif. Untuk mendapatkan pemerintahan yang baik, pemerintah Indonesia mereformasi skema birokrasi mereka dan menggunakan sistem manajemen kinerja yang baru. Badan layanan sipil nasional (NCSA) sebagai salah satu lembaga pemerintah di Indonesia yang memiliki tanggung jawab dalam pengelolaan sumber daya manusia perlu memanfaatkan sistem informasi dalam penilaian kinerja staf.

Tujuan. Penelitian ini bertujuan untuk merancang spesifikasi kebutuhan suatu sistem informasi. Sistem informasi digunakan untuk menilai kinerja staf di layanan publik Indonesia. Sistem informasi disebut sistem informasi evaluasi kinerja pegawai negeri sipil (CSPE-IS).

Metode. Penelitian ini menggunakan penelitian sains desain sebagai metodologi utama. Pengumpulan data dikumpulkan dengan menggunakan literatur studi seperti buku, jurnal dan artikel dalam manajemen kinerja dan beberapa peraturan dan kebijakan dalam manajemen kinerja di layanan publik Indonesia. Terlebih lagi, wawancara semi terstruktur juga digunakan untuk memberikan detail mendalam tentang manajemen kinerja di NCSA. Data dianalisis dan dirancang dengan bahasa pemodelan terpadu (UML) seperti use case dan activity diagram.

Hasil. Ada 67 use case yang dirancang sebagai spesifikasi kebutuhan utama dari sistem informasi (IS). Kasus penggunaan adalah fungsi dasar utama dalam IS yang harus disediakan untuk mengembangkan CSPE-IS.

Kesimpulan. Fungsi fungsional IS terutama memenuhi persyaratan pengguna. Pekerjaan masa depan harus dijalankan seperti pengembangan IS dengan pemrograman bahasa yang direkomendasikan dan kerangka kerja yang sesuai serta desain database yang kompatibel

# ABSTRACT

Performance management is essential for managing and organizing the performance and work-achievement in both individually and organization. The information system is used for supporting the performance management in the organization in order to provide efficient and effective of the staff performance assessment. In order to gain good governance, Indonesia government reforms their bureaucratic scheme and employs new performance management system. National civil service agency (NCSA) as one of institution in Indonesia government that has the responsibility in human resource management requires to utilize an information system in staff performance assessment.

The research is for designing the requirement specification of an information system. The Information system is used for assessing staff performance in the Indonesia public service. The information systems is called civil servant performance evaluation information systems (CSPE-IS).

The research employs design science research as the main methodology. The data collection was collected by study literature such as books, journals and articles in performance management and several regulations and policies in the performance management in Indonesia public service. Moreover, the semi structured interview also is used for providing indepth detail about performance management in the NCSA. The data was analysed and designed with unified modeling language (UML) such as use case and activity diagram.

Results. There are 67 use cases are designed as the main requirement specification of the information systems (IS). The use cases are the main basic functionalities in the IS that should be provided in order to develop the CSPE-IS.

Conclusion. The designed functionalities of the IS mainly meet the user requirements. The future works should be executed such as developing the IS with recommended language programming and appropriate framework also compatible database design.

It has been long considered that the performance in the organization, individual or any level in the company should be managed well. In the history of development economics, performance management is an essential aspect in developing company's strength, reducing weakness, enhancing opportunity and preventing threats in the company (De Waal, 2006). Nowadays in the globalization era, gaining success needs much greater performance achievement in all areas such as the quality of goods and services established, the cost at which they are needed, and the speed to finish and build the product and services to the market (Lawler, 1995). Furthermore, De waal (2006) argued that performance management has pivotal role in managing company's strength to gain profit.

The need of increasing the performance is spreading out in every sector including public sector. Government over the world prepare to regenerate and reorganize in the name of performance. Ingraham (2005) examines that "for much of the twentieth century and certainly for the last 25 years, performance has been a siren's song for nations around the world". There is common acknowledgement that performance management will gradually to be substantial and importantly required by government. The rapid pace of developing performance frameworks officially in the many governments around the world indicates that performance management is considered to provide valuable goal for management of public sector. At the same time, Van Dooren, Bouckaert and Halligan (2010) reminded about the vastly concern about how well performance management is working in the real environment and how it needs several improvements.

Information Technology (IT) has important role to support the human resource management (HRM) and enhancing their performance. Soto-Acosta, Martí´nez-Conesa and Colomo-Palacios (2010) said that to improve "productivity and knowledge-intensive products and services", it is essential to get support from IT. More over, Srisa-ard (2005) informed that information systems (IS) also has essential role for providing accuracy of data and information for people who will take some decision making. Today, the high demand of improving performance using an IS lead to increasingly in the difficulty, the complicatedness and also capacity and amount of the information systems, Zachman (1987) suggested to use "logical construct or architecture" for determining and managing all of the components of the systems. The software requirements specification document

acquires adequate and essential requirements for developing the information systems into IT project.

Excellent performance assessment to bring appropriate and substantial performance culture in the organization is important. The performance culture should focus on producing good products and services to the customers. In the government, the customers are publics, private companies and others government. Staff performance assessment requires information systems especially online based to support staff evaluation system in the government area. The assessment system online based should accommodate the needs of organization such as credible system, clarity and accountability, effective and efficient and also trustworthy (Demchak, Friis, La Porte, 2000; La Porte, Demchak, & De Jong, 2002).

The research objective is to design the requirement specification of information systems that is for evaluating the staff performance in the public area. The focus of this research is designing and finding the requirement specification of information systems to evaluate and assess staff performance. Staff in this context is civil servants as they are government apparatus. It will also utilize case study in the Indonesia government to gain better understanding of the real environment in the staff performance assessment in government area especially in te Indonesia government. Furthermore, the research will measure the aspects of staff performance assessment.

This dissertation will not investigate in-depth on human resource management area such as the measurement method and key elements of assessment. The research will be based on regulations, laws and policies in the Indonesia government. This research will have greater contribution on staff performance evaluation especially in the developing civil servant performance evaluation information system by presenting the design of requirement specification information systems.

The case study will held in the National Civil Service Agency (NCSA) of The Republic of Indonesia. NCSA has responsibility to manage the human resource and administration in the Indonesia civil service. They also should evaluate and assess civil servants performance in Indonesia based on

Government Regulation No.46/2011 and NCSA's Chief Regulation No.1/2013, the new performance assessment that is imposed by Indonesia government.

The initial idea to conduct this research is from my own experience. The author have been working in NCSA for 5 years and mainly in development of IS for supporting human resource management. The author realized that the important role of IT in the HRM area to support organization process business especially staff performance assessment needs to be accelerated and improved. As Casado-Lumbreras et.al (2009) mentioned that "IT workers professional practice must be continually revised and improved in order to adapt workers competences' to technical innovations and soft skills to evolving markets".

The primary research tool was using books, journals, articles about the topic of dissertations for getting the general term and introduction relate with the topic and also several laws, regulations and policies in the Indonesia Government relate with the topic of dissertation.

The second research tool for providing empirical research was using semi-structured interviews. The interview is conducted for gaining in-depth information about the topic. The interviewees were asked to evaluate and discuss about the prototype design of the dissertation's topic to get the real requirements. The interview also provides the real description of the performance management and what the employees need in the performance management evaluation in the real environment. The semi-structured interview was conducted in order to maintain and achieve suitable and significant qualitative data and information needed in order to still focus on the dissertation's topic.

Other research tool was using specific case study. The case study is for narrowing the research and gaining in-depth of the quality of the research. The research tools was for providing a design of requirement specification of the Information System (IS) relate with the topic of this dissertation. The data and information for designing of the specification requirement are obtained from the preliminary research on literature review, interviews and several laws, regulations and policies in the Indonesia Government as the primary research tool in this dissertation.

## Global Usecase

The use case has 3 main actors. There are appraisee, assessor and human-resource staff (HR). They represent civil servants in the Indonesia public service and especially in National Civil Service Agency. There are 67 use case with 18 base use case and many of extended, included and specialized use case. The base use case is the functionality of the system that typically essential, whereas the other type of use case is an added-use case based on the base use case and also important. The system at least should have 67 features or functionality required for the user perspective based on the use case diagram. The 67-functionalities are the features in the system that user could do in the system based on their user privilege, and it is not the basic main task and job role of the particular position in the organization. The user who has position in the organization could do their job role and task outside of this use case diagram. The use case diagram only shows the functionlaities in order to performance assessment.

## Global Activity Diagram of Login User

The system could recognize and identify the user based on the username. In the database, the username should relate with staff identifier number (SIN), password and privilege of the user. For instance, user as appraisee who is ordinary staff, will enter their personal page. Whereas, user as assessor will be presented different page. The administrator is given privilege to grant the user's privilege by the director of the organization. The changing that will be made should be permitted by the deputy of the organization.

## Appraisee View

Appraisee is an employee that would be assessed or evaluated. In the case study, National Civil Service Agency (NCSA) of Republic of Indonesia, the appraisee is civil servants in the Indonesia government that would be assessed such as functional staff, structural staff and ordinary staff.

There are 3 kind of civil servants as appraisee in the NCSA that have been mentioned above, such as:

- Structural staff, it is an employee that lead a unit.
- Functional staff, it is an employee that work based on their functionality, their education background, and they should fulfill a credit to get promotion.
- Ordinary staff, it is an employee that is subordinate of the structural staff and work based on structural staff's instruction.

## Human Resource View

The Human Resource (HR) is a unit that manages and maintains human resource issues in the organization. Based on the use case diagram, The HR refers to administration biro in the NCSA as unit that manages the administration of employees and performance evaluation unit as unit that maintains the staff performance of employees in the NCSA. They both will work together with several rules and regulations based on the Indonesia public policies.

The Human-Resource (HR)-view has 2 main base use case, there are manage performance measurement and generate appraisee performance statistics. The 'manage performance measurement' use case mainly is for managing the performance measurement effort. For instance, the HR has privilege to input every unit goals and objectives. After they got the formal letter from the management about the vision, mission, goals and objectives of every unit, they would input it in the system for performance management purpose. They also input the performance grade criteria and performance measurement criteria and indicator, both is used for assessing and evaluating appraisee-performance.

The decision making of reward and punishment are outside the system via directors meeting. The system only supports the information of appraisee performance, historical data of appraisee performance. The HR system would receive data and information from other systems, such as from appraisee, assessor and top-assessor. The result of performance assessment (daily, monthly or annually), the result of appraisee's objection of performance assessment result, and staff attendance record would be received by the HR system for reward and punishment decision making.

## Manage Performance Measurement

Mainly the HR system has feature for managing performance measurement system. In the system they have several feature such as input unit goals and objectives for providing job-activities list of the appraisee, input assessment criteria and indicators also performance grade list for supporting assessor in the assessment effort, and input reward and indiscipline statement after receiving the performance assessment result of the appraisee.

## Input Unit Goals and Objectives

The HR will input the goal and objectives every unit. They are only as entry data staff because the unit goals and objectives are developed by directors meeting. The unit goals and objectives use for providing the appraisee to compose the job-activities plan as it will be used for generating job-activities list for each unit and each job role.

## Input Assessment Criteria and Indicators

The HR also will input the performance assessment criteria and indicators. The criteria and indicators are develop by directors and experts based on organizations objectives and regulations. It is important for providing the criteria and indicator for assessor in assessing and evaluating appraisee performance.

## Input Assessment Performance Grade

The HR will input the performance grade. It is used for giving performance level when assessing the appraisee performance. The performance grade is based on regulation and conducting in the directors meeting.

## Input Reward Statement

The HR will provide the reward system based on appraisee performance assessment result. There are several elements that should be obtained by the HR system to make the decision such as daily achievement, monthly and annual performance result of the appraisee, the judgment statement of the objection, attendance record of the appraisee, the assessor recommendation

and performance statistics. Those factors provide some information to support the decision making. The HR could give several reward such as promotion to the unit that link with appraisee competencies, giving training and workshop for developing skills and knowledge of the appraisee, mutation to the other unit based on appraisee competencies, and giving performances-fee based on appraisee performance assessment result.

## Summary

This chapter concludes the process of the development on the design of specification requirement of Civil Servant Performance Evaluation-Information System (CSPE-IS). The respond of the research questions and some recommendations as future work are also presented.

This dissertation covers a whole process for designing of the specification requirements of CSPE-IS using UML mainly use case and activity diagram. The designed functionalities of the system mainly meet the user requirements. The research identified 3 main actors who use the system with minimum of 67 functionalinities of the system required. The functionalities are based on the use cases. The functionalities that are represented with the use cases are not only the main responsibilities of the employees. The 67-functionalities are the features that user could do in the CSPE-IS (only relate with the performance assessment effort) and are not the main task of each job-role in the organization.

From the performance management perspective in the National Civil Service Agency (NCSA) of Indonesia, there are several issues that require to be provided such as:

Indepth and detail of feedback for the appraisee as the performance assessment based on result-oriented that could not assess the real actions and behavior of the appraisee and could not improve their good culture and good behavior needed. Behavioral assessment in the Indonesia public service still evaluates general appraisee's behavior that could not conclude the whole good behavior for improvement. The manager should provide coaching for the staff as appraisee when the manager delegates some task to the staff for developing their knowledge and skills, and indirectly improving the organization performance.

The target measures such as quantity, quality, time and budget is very useful and have implemented Armstrong and Baron (2005) theory. The basic standard of assessment criteria and indicator should be well-defined. Although those issues are not the main concern in this research, the method of the staff performance evaluation in Indonesia public sector is the main focus for developing the information system and need clearly to be defined for developing better information system that will support the performance assessment.

# Model Regresi Berkelompok untuk Analisa dan Prediksi Nilai Investasi Penanaman Modal Asing

# Clustered Regression Models for Analysis and Prediction of Foreign Direct Investment Inflows


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# ABSTRAK

*Foreign Direct Investment* (FDI) merupakan salah satu komponen ekonomi yang banyak diminati oleh banyak negara sebagai salah satu alternatif arus masuk modal swasta. Komponen tersebut memiliki peran penting dalam mencapai pertumbuhan ekonomi yang pesat, terutama di negara-negara berkembang. Sebenarnya, sebagian besar investasi langsung terjadi di antara negara maju. FDI melibatkan dua pihak, yaitu negara tuan rumah dan negara investasi. pola FDI menguntungkan keduanya. Ada karakteristik khusus dari negara tuan rumah yang sangat penting bagi negara investor saat menentukan  di Negara mana akan melakukan investasi. Oleh karena itu penting untuk menyelidiki faktor-faktor penentu FDI potensial dan hubungannya untuk memprediksi kecenderungan arus masuk FDI ke negara tuan rumah.

Namun ketersediaan seri FDI terbatas untuk masing-masing negara. Oleh karena itu, kami mengusulkan sebuah pendekatan baru dengan menggabungkan metode clustering dengan regresi hutan secara acak atau *Bayesian Model Averaging* (BMA) untuk mengatasi masalah ini. Forest Regression secara acak merupakan pendekatan yang menjanjikan untuk memprediksi deret waktu keuangan namun belum pernah digunakan dalam memprediksi arus masuk FDI. BMA adalah pendekatan lain dalam peramalan ekonomi, yang semakin mendapat perhatian. Dengan menggunakan berbagai karakteristik negara dari berbagai daerah dan faktor penentu FDI yang telah diidentifikasi dalam literatur tentang FDI di negara-negara berkembang dan negara maju di Asia, Afrika, Amerika Latin dan Eropa, analisis dilakukan dalam satu kerangka kerja yang telah dilakukan terpisah antara Negara maju dan berkembang atau oleh daerah.

Pada tahap pertama dari solusi yang diajukan, masing-masing negara dikelompokkan ke dalam kumpulan kelompok yang lebih kecil untuk mengurangi ketidakpastian dan untuk memperbaiki kinerja peramalan dibandingkan dengan memperkirakan model rangkaian waktu individual untuk masing-masing negara secara terpisah. Kemudian untuk masing-masing cluster, forest regretion acak dan BMA memecahkan persamaan regresi yang diusulkan, dimana masing-masing cluster parameter model dibatasi sama untuk mendapatkan estimasi presisi. Untuk mengevaluasi kinerja solusi yang diajukan, prediksi error untuk setiap model dengan dan tanpa clustering akan dibandingkan. Hasilnya menunjukkan adanya perbaikan sebanyak 70,31% dengan solusi yang diajukan.

# ABSTRACT

Foreign Direct Investment (FDI) is one of many economy components that has been found to be attractive to many countries as one alternative of private capital inflow. It has a crucial role in achieving rapid economic growth, especially in developing countries. In fact, most of the direct investment takes place among developed countries. FDI involves two parties, which are the host country and the investing country and FDI benefits both of them. There are particular characteristics of the host country that are crucial for the investing country when determining in which host country they do the investment. It is therefore important to investigate the potential FDI determinants and their relationships to predict the future trend of FDI inflows to the host country.

However the availability of FDI series is limited for each country. Therefore we propose a novel approach by coupling clustering methods with random forest regression or Bayesian Model Averaging (BMA) to tackle these problems. Random forest regression is a promising approach for prediction of financial time series but has never been used in predicting FDI inflows. BMA is another approaches in economic forecasting, which is gaining more attention. Using various characteristics of countries from various regions and the FDI determinants that have been identified in the literature on FDI in both developing and developed countries in Asia, Africa, Latin America and Europe, the analysis is conducted in one framework that has been performed separataly between developed and developing countries or by the region.

In the first stage of the proposed solution, the individual countries are clustered into a smaller sets of clusters to reduce the uncertainty and to improve the forecasting performance compared to estimating the individual time series models for each country separately. Then for each cluster, random forest regression and BMA solve the proposed regression equation, in which each cluster the model parameters are restricted to be the same to gain estimation precision. To evaluate the performance of the proposed solution, the prediction error for each model with and without clustering will be compared. The results show an improvement as much as 70.31% with the proposed solution.

Österholm & Abrego (2008) menyatakan bahwa dalam pertumbuhan ekonomi Colombia, faktor domestik memiliki peran sebanyak 60%. Di antara faktor domestic tersebut, iklim investasi yang diproyeksikan oleh angka investasi Penanaman Modal Asing (PMA) dan kebijakan fiskal memegang peran lebih penting daripada kebijakan moneter. Berdasarkan deskripsi dari World Bank, PMA adalah kegiatan menanam modal untuk melakukan usaha yang dilakukan oleh sebuah perusahaan atau penanam modal dari satu negara ke perusahaan atau penanam modal di negara lain. Sebagai investor, sangat penting untuk memperhatikan karakter negara tujuan investasi sebelum memutuskan untuk berinvestasi di negara tersebut. Demirhan & Masca (2008) menemukan bahwa ukuran pasar, infrastruktur dan keterbukaan perdagangan adalah faktor positif yang signifikan sedangkan inflasi dan besaran pajak adalah faktor negatif yang signifikan untuk PMA di negara yang berkembang. Berdasarkan regional, menurut Mottaleb & Kalirajan (2010), negara-negara berkembang di Asia lebih banyak diminati oleh investor asing dan negara dengan pendapatan menengah ke bawah adalah penerima PMA tertinggi. Lipsey (2001) menganalisa PMA di negara maju dan menyatakan bahwa pendapatan per kapita dan keterbukaan perdagangan memiliki hubungan positif dengan PMA, sedangkan besarnya negara memiliki hubungan negatif dengan PMA.

Berdasarkan hasil analisa dari penelitian sebelumnya, penggunaan model statistik yang akurat sangat penting dalam memprediksi nilai PMA di negara tujuan dan menentukan karakteristik dari negara tujuan investasi yang penting dalam menarik PMA. Prediksi PMA untuk satu negara tertentu telah dilakukan menggunakan model *Autoregressive Integrated Moving Average* (ARIMA) oleh Al-rawashdeh, Nsour, & Salameh (2011) untuk Jordan; Turolla & Margarido (2011) untuk Brazil dan model jaringan syaraf tiruan untuk ekonomi Asia (Pradhan, 2010). Metode lain yang sedang mendapat banyak perhatian di ilmu ekonomi adalah metode Bayesian, khususnya Bayesian model averaging (BMA). Salah satu keuntungan metode Bayesian adalah mempertimbangkan ketidaktentuan parameter dan model, sehingga dapat memodelkan ketidaktentuan di masa depan dengan lebih akurat. BMA mampu menangani permasalahan pemilihan variabel di model regresi linear di ilmu ekonomi yang melibatkan regressor dalam jumlah banyak dan jumlah observasi yang relatif terbatas (Steel, 2011). Dengan mempertimbangkan keuntungan-keuntungan tersebut, metode Bayesian diaplikasikan untuk memprediksi PMA dalam thesis ini.

Metode lain yang menjanjikan dalam memprediksi time series keuangan tetapi belum pernah digunakan untuk memprediksi adalah regresi *random forest*. Metode tersebut adalah metode tanpa parameter dan nonlinear yang lebih fokus pada keakuratan prediksi daripada memodelkan distribusi yang mendasari secara eksplisit. Kelemahan utama dari metode tersebut adalah sulitnya menginterpretasi model, karena diperlakukan sebagai black box. Kumar & Thenmozhi menggunakan teknik random forest untuk memprediksi arah dari pergerakan stock index dan hasil lebih baik daripada menggunakan analisa diskriminan tradisional, model logit dan model jaringan syaraf tiruan.

Dalam thesis ini, kami menginvestigasi prediktor PMA yang penting yang telah diidentifikasi pada penelitian mengenai PMA sebelumnya untuk negara maju dan berkembang di Asia, Africa, Amerika Latin dan Eropa. Beberapa diantaranya adalah GDP, keterbukaan perdagangan, stabilitas ekonomi dan besaran pajak.

Tujuan dari thesis ini adalah untuk membangun dan membandingkan model BMA dan regresi *random forest* dalam memprediksi PMA untuk 58 negara di Asia, Eropa, Afrika dan Amerika Latin dengan menggunakan data dari 15 tahun terakhir sejak tahun 2000 dan khususnya untuk mengeksplor prediktor PMA yang potensial. Dengan keterbatasan jumlah observasi untuk tiap negara, negara-negara yang memiliki pola PMA yang sama dikelompokkan bersama dalam kluster dan dibatasi untuk memiliki koefisien regresi yang sama untuk mencapai ketepatan estimasi. Dan untuk mengevaluasi performa dari model statistik tersebut, kesalahan prediksi dari masing-masing model dengan dan tanpa clustering akan dibandingkan dan dievaluasi berdasarkan *Mean Square Error* (MSE).

## Metode Penelitian

Data dan prediktor PMA digunakan thesis ini diambil dari World Bank dari tahun 2000 - 2014 atas 58 negara yang dipilih secara random. Karakteristik negara tujuan sebagai prediktor PMA yang digunakan dalam thesis ini sebanyak 15, yang terdiri 4 (empat) karakter ekonomi, 3 (tiga) karakter infrastruktur, 5 (lima) karakter politik dan kualitas pemerintahan, tarif pajak, sumber daya manusia, dan logaritma dari GDP dunia (efek krisis ekonomi).

## Metode Analisis

Dengan keterbatasan tersedianya data PMA secara runtut dari waktu ke waktu untuk negara-negara yang dipilih, kami mengusulkan prediksi PMA secara 2 (dua) tahap, yaitu pada tahap pertama, negara-negara yang memiliki tren PMA yang serupa dikelompokkan menjadi kelompok-kelompok lebih kecil menggunakan teknik clustering, kemudian pada tahap kedua, pada tiap kelompok negara kami mengaplikasikan regresi random forest dan BMA untuk melakukan prediksi. Untuk mengevaluasi hasil prediksi, kami akan membandingkan kesalahan prediksi tiap model dengan dan tanpa clustering.

Metode clustering yang baik adalah yang mendapat observasi dengan kemiripan yang besar pada satu kelompok (homogenitas) dan mendapatkan kelompok-kelompok yang berbeda satu sama lain (heterogenitas). Dalam thesis ini, terdapat 2 (dua) metode clustering yang digunakan yaitu Hierarchical Clustering dan Bayesian Hierarchical Clustering. Pada metode clustering secara hirarki, metode pengelompokan yang digunakan adalah aglomerative, dari atas ke bawah, dimulai dari membentuk kelompok sebanyak jumlah observasi, dimana tiap klaster terdiri dari satu observasi, kemudian tentukan 2 (dua) klaster terdekat terus dilanjutkan sampe semua observasi dikelompokkan menjadi satu klaster. Untuk menentukan kedekatan deret waktu, diukur menggunakan teknik Dynamic Time Warping (DTW). Cara penghitungan DTW menggunakan teknik pemrograman dinamis untuk mencari jarak minimum antara dua deret waktu dari semua jalur yang memungkinkan berdasarkan matriks jarak. Dalam menentukan jumlah kelompok yang tepat untuk data ini, kami membandingkan ukuran kualitas clustering dari beberapa index atas beberpa jumlah kelompok yang diusulkan, yaitu CH index, Beale indes, Marriot index dan KL index.

Hampir sama seperti metode clustering dengan hirarki secara tradisional, metode clustering secara bayesian juga menggunakan metode agglomerative, namun dalam penghitungan jarak antara kluster berdasarkan nilai posterior maksimum clustering.

## Hasil Clustering

Hasil pengelompokan negara berdasarkan tren PMA dengan menggunakan clustering secara hirarki dan metode clustering hirarki secara Bayesian menyetujui bahwa dari 58 negara sampel dikelompokkan menjadi 8 kelompok,

namun negara yang termasuk dalam kelompok tersebut berbeda antara kedua metode tersebut.

Hasil pengelompokan menggunakan metode clustering secara hirarki, pada kelompok 1 terdiri dari 14 negara yaitu 7 (tujuh) negara berkembang dan 7 (tujuh) negara maju dari berbagai region. Tren PMA adalah stabil di awal kemudian naik sampai tahun 2007 kemudian menurun. Kelompok 2 terdiri dari 12 negara yaitu 7 (tujuh) negara maju di Eropa, Asia dan lainnya. Sedangkan 5 negara lainnya adalah negara berkembang di Asia, Afrika, dan Amerika Latin. Tren PMA adalah menurun. Ada 4 (empat) negara di kelompok 3 yaitu 2 (dua) negara maju dan 2 (dua) negara berkembang dengan tren PMA cukup stabil selama periode sampel. Pada kelompok 4, terdapat 4 negara berkembang di Asia dan Afrika yang menunjukkan tren PMA yang positif. Kelompok 5 dapat dilihat sebagai kelompok pencilan karena tren PMA yang tidak mudah terlihat, terdiri dari Brazil, Chili dan Singapura. Terdapat 10 negara di kelompok 6 yang didominasi oleh 6 (enam) negara berkembang di Afrika, Asia dan Amerika Latin yang memiliki tren PMA hampir sama dengan kelompok 1. Kelompok 7 terdiri dari 6 negara yang merupakan negara berkembang, memiliki tren naik hingga 2007 kemudian menurun. Kelopok 8 terdiri dari 5 negara maju dengan tren PMA menurun.

Hasil pengelompokan menggunakan metode clustering hirarki secara Bayesian, pada kelompok 1 terdiri dari 9 (sembilan) negara yang didominasi oleh 6 (enam) negara maju di Eropa dengan tren PMA menurun. Kelompok 2 terdiri dari 10 negara yang merupakan gabungan 7 (tujuh) negara maju dan 3 (tiga) negara berkembang. Tren PMA pada kelompok ini menurun tajam diantara tahun 2000-2002 kemudian stabil. Negara di kelompok 3 terdiri dari negara-negara pada metode sebelumnya dan Singapura. Tren PMA pada kelompok ini stabil dan sedikit naik pada akhir periode sampel. Kelompok 4 adalah kelompok terbesar yang terdiri dari 15 negara didominasi oleh negara maju di Eropa dengan tren PMA naik sampai tahun krisis kemudian turun karena faktor krisis ekonomi. Terdapat 9 (sembilan) negara berkembang di Asia, Afrika dan Amerika Latin dengan tren PMA meningkat. Kelompok 6 terdiri dari 3 (tiga) negara berkembang di Afrika dan Portugal namun tidak menunjukkan tren PMA yang sama diantara keempat negara tersebut. Baik pada kelompok 7 atau 8 terdiri dari 3 (tiga) negara berkembang, namun tren pada kelompok 7 menurun sedangkan

pada kelompok 8 menunjukkan tren naik diantara tahun 2000-2008 kemudian menurun sampai tahun 2015.

## Hasil Regresi Random Forest

Regresi random forest digunakan untuk mengestimasikan prediksi PMA terhadap hasil pengelompokan dari metode clustering secara hirarki dan metode clustering hirarki secara Bayesian juga pada keseluruhan data tanpa dikelompokkan terlebih dahulu. Untuk mengetahui performa regresi random forest, nilai MSE pada masing-masing hasil pengelompokan dibandingkan. Berdasarkan nilai MSE, performa regresi random forest terhadap hasil pengelompokan dari metode clustering secara hirarki lebih kecil daripada hasil pengelompokan dari metode clustering hirarki secara Bayesian, yaitu 15,71 dibanding 16,24. Nilai MSE dari regresi random forest terhadap hasil pengelompokan kemudian dibandingkan dengan keseluruhan data tanpa dikelompokkan, yaitu 16,63. Hal ini menunjukkan bahwa prediksi menggunakan metode clustering baik secara hirarki atau hirarki secara bayesian, dapat meningkatkan hasil prediksi sebanyak 5,85%.

## Hasil Bayesian Model Averaging (BMA)

Prediksi menggunakan BMA juga dilakukan terhadap hasil pengelompokan dari metode clustering secara hirarki dan metode clustering hirarki secara Bayesian juga pada keseluruhan data tanpa dikelompokkan terlebih dahulu. Berdasarkan nilai MSE, performa BMA terhadap hasil pengelompokan dari metode clustering secara hirarki lebih kecil daripada hasil pengelompokan dari metode clustering hirarki secara Bayesian, yaitu 16,54 dibanding 16,91. Nilai MSE dari BMA terhadap hasil pengelompokan kemudian dibandingkan dengan keseluruhan data tanpa dikelompokkan, yaitu 28,71. Hal ini menunjukkan bahwa prediksi menggunakan metode clustering baik secara hirarki atau hirarki secara bayesian, dapat meningkatkan hasil prediksi sebanyak 70,31%.

## Kesimpulan dan Saran

Pada thesis ini telah dilakukan kombinasi baru untuk memprediksi PMA. Dimana bila dibandingkan dengan metode sebelumnya, kombinasi baru ini menunjukkan

banyak peningkatan. Khususnya, terhadap data yang dikelompokkan dengan metode clustering terlebih dahulu, menghasilkan prediksi yang lebih baik.

Dari hasil analisa, dapat disimpulan bahwa trend umum PMA pada negara maju adalah menurun, sedangkan pada negara berkembang adalah meningkat; nilai PMA pada periode sebelumnya merupakan prediktor penting pada tiap hasil pengelompokan, sumber daya manusia dan inflasi hanya muncul pada hasil pengelompokan yang didominasi oleh negara berkembang.

Regresi random forest yang dikombinasikan dengan metode clustering secara hirarki adalah model terbaik sedangkan BMA yang digunakan pada keseluruhan data tanpa dikelompokkan adalah model terburuk dalam memprediksi PMA.

# Surveyor Tanah dan Pemikiran Spasial: Studi Kasus di Badan Pertahan Nasional, Indonesia

# Land Surveyors and Spatial Thinking: A Case Study Within the National Land Agency, Indonesia


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# ABSTRAK

Harapan masyarakat dalam pelayanan publik, terutama pada layanan pertanahan, semakin meningkat seiring berjalannya waktu. Badan Pertanahan Nasional (BPN) selaku instansi pemerintah di Indonesia memiliki tanggung jawab untuk memenuhi harapan masyarakat. Salah satu komponen dalam BPN adalah surveyor tanah. Mereka adalah ujung tombak BPN untuk memberikan layanan survei dan pemetaan kepada publik. Pengembangan teknologi survei dan pemetaan merupakan salah satu solusi untuk meningkatkan kemampuan mereka dalam memenuhi kepuasan masyarakat. Namun, surveyor lahan harus memahami pengetahuan dasar yaitu keterampilan dan kebiasaan pikiran, alat representasi dan proses penalaran terhadap masalah struktur, menemukan jawaban dan solusi ekspres seperti yang didefinisikan dalam konsep pemikiran spasial. Kemampuan berpikir secara spasial adalah prasyarat untuk menggunakan dan memahami teknologi geospasial. Oleh karena itu, pemikiran spasial sangat penting bagi surveyor lahan. Penelitian ini bertujuan untuk mengetahui kemampuan berpikir spasial surveyor lahan di BPN. Untuk melakukannya, pertama, kerangka berpikir spasial untuk surveyor lahan di BPN didefinisikan. Langkah ini diperlukan untuk menentukan tugas surveyor lahan dan melakukan kajian literatur tentang konsep pemikiran spasial.

Kedua, Uji Kemampuan Pemikiran Spasial Tanah (LS-STAT) dikembangkan. Ketiga, evaluasi dilakukan untuk memberikan tes yang sesuai. Bagian terakhir adalah menganalisa hasil uji sehubungan dengan latar belakang surveyor lahan profesional. Hasilnya menunjukkan beberapa tugas teknis surveyor lahan berpotensi relevan dengan konsep pemikiran spasial yang mendefinisikan kerangka pemikiran spasial untuk surveyor lahan di BPN. Kerangka ini digunakan sebagai ide dibalik pengembangan LS-STAT. Untuk menghasilkan tes yang sesuai, evaluasi siswa, evaluasi ahli, dan evaluasi peserta uji dilakukan. Mengenai korelasi antara latar belakang profesional surveyor dan hasilnya, peserta yang memiliki latar belakang pendidikan *Diploma I National Land Academy* (DI STPN) meraih nilai tertinggi. Selain itu, peserta yang memiliki pengalaman kerja 1-10 tahun memiliki nilai tertinggi. Hasil tesis ini diharapkan dapat digunakan untuk menganalisis kemampuan surveyor spasial spasial dengan cara yang terukur dan obyektif.



Kata kunci: Pemikiran spasial, kerangka berpikir spasial, LS-STAT, surveyor lahan, Badan Pertanahan Nasional

# ABSTRACT

Expectations of the society in public service, especially in land services, are increasing in time. National Land Agency (NLA) as government institution in Indonesia has a responsibility to fulfill the public expectations. One of the components in NLA is Land surveyors. They are the spearhead of NLA in order to give survey and mapping services to the public. The development of surveying and mapping technology is one of the solutions to increase their capability in order to meet the public satisfaction. However, land surveyors must understand the basic knowledge i.e. skills and habits of mind, tools of representation and process of reasoning to structure problems, find an answer and express solutions as defined in spatial thinking concepts. The ability to think spatially is prerequisite to use and understand the geospatial technologies. Therefore, spatial thinking is of importance for land surveyors. This research has objectives to investigate spatial thinking ability of land surveyors in NLA. To do so, first, a spatial thinking framework for land surveyors in the NLA is defined. This step is needed to specify the tasks of land surveyors and perform a literature review of spatial thinking concepts.

Second, a Land Surveyor Spatial Thinking Ability Test (LS-STAT) is developed. Third, an evaluation is carried out to deliver the appropriate test. The last part is analysing the test results in relation with the land surveyor professional background. The result shows several technical tasks of land surveyors are potentially relevant with spatial thinking concepts that defined the spatial thinking framework for land surveyors in NLA. The framework is used as the idea behind the development of LS-STAT. To generate an appropriate test, student evaluation, expert evaluation, and test participant evaluation are performed. Regarding the correlation between the land surveyor's professional background and the results, the participant having Diploma I National Land Academy (DI STPN) education background achieved the highest score. In addition, participants having 1-10 years working experience have the highest score. This thesis result is expected to be used to analyze land surveyor spatial thinking ability in a measurable and objective way.



Keywords: Spatial thinking, spatial thinking framework, LS-STAT, land surveyors, National Land Agency

Land surveyors are widespread in entire land offices in Indonesia. Land offices are NLA offices on the national level (head office), regional level (province) and sectoral level which are settled in every city or regency (municipality). At the time, NLA has 34 regional land offices and 436 municipality land offices in the whole country. Furthermore, NLA has almost 4000 land surveyors with a diverse educational background, age, and gender.

Land surveyors and spatial thinking are related one another. To perform the task, land surveyors must apply their ability in understanding the spatial concept, especially in geographical space because their task is in the geographical domain. In addition, spatial thinking ability of land surveyors will determine their behaviour in executing their tasks, for instance on how they understand the spatial relationship in the field. According to the Radex theories in a review of spatial ability research explained, spatial thinking ability plays an important role to determine the intelligence as well as the verbal and the numerical cognitive aspect of individuals (Mohler, 2009). By knowing the spatial thinking ability of the land surveyor, it will help NLA to define the right policy for the development of land surveyors. Especially, to avoid land disputes as the results of survey and mapping that might happen from the publication of land certificates in the land registration process.

Expectations of the society in public service, especially in land services, are increasing in time. National Land Agency (NLA) as government institution has a responsibility to fulfill the public expectations. One of the components in NLA is Land surveyors. They are the spearhead of NLA officers in order to give survey and mapping services to the public. Moreover, they have important roles in survey and mapping activities for land registration processes. Land surveyors are intentionally trained persons who have received advanced training in spatial and geospatial science. Nowadays technical development of surveying and mapping has been increased rapidly. Geographical Information Systems (GIS), Remote Sensing (RS), and Global Positioning Systems (GPS) are examples of the tools that can play an important role in survey and mapping activities. In general, it tends to be more computer literate and it makes a land surveyor become easily to handle the problem during field work. However, land surveyors must understand the basic knowledge i.e. skills and habits of mind,

tools of representation and process of reasoning to structure problems, find an answer and express solutions as defined in spatial thinking concepts. The ability to think spatially is prerequisite to use and understand the geospatial technologies in geography (Bednarz & Bednarz, 2008). Therefore, spatial thinking is of importance for land surveyors.

National Research Council (NRC), 2006 has been published a comprehensive report about "Learning to Think Spatially". Spatial thinking is defined as "a collection of cognitive skills comprised of knowing concepts of space, using tools of representation and reasoning processes". In the report, it is also mentioned that spatial thinking is a skill to mentally manipulate objects, forms, positions and relationships in space and time. The term space is related with perception, thinking, memory, and behavior. Spatial thinking consists of many different spaces. Montello (1993) distinguished four major classes of spaces, i.e. figural, vista, environmental and geographical. As many research have shown, spatial thinking is necessary and important in many fields of science and engineering, including physics, chemistry, mathematics, engineering, geosciences and medicine (Russel-Gebbett (1984); Mathewson (1999); Carter, LaRUSSA, and Bodner (1987); Downs and Liben (1991); Pallrand and Seeber (1984)). The importance of spatial thinking is to permit individuals comprehend spatial relationships and make representations in an appropriate way (Bednarz & Bednarz, 2008).

Considering the importance of spatial thinking for land surveyors, there is a need to investigate their spatial thinking ability. Land surveyors might already apply the concepts of spatial thinking during performing their tasks, for example when identifying the geometry of the land parcels. However, spatial thinking ability of land surveyors in NLA has never been examined before. To measure spatial thinking abilities, a variety of tests has been developed. Hegarty, Richardson, Montello, Lovelace, and Subbiah (2002), used self-assessment questionnaires to measure spatial thinking. Other research conducted by Dean and Morris (2003) developed a test to measure spatial abilities of individuals. However, those tests are categorized as psychometric measures and limited to the psychological field (Lee & Bednarz, 2012). A Study performed by Lee and Bednarz (2009) has developed a spatial skills test to examine the effect of GIS

learning on the spatial thinking ability of state university students. Another study that developed a spatial thinking test was conducted by Firdiansyah (2012). He developed a spatial thinking in geographical space test for Geography and non-Geography students. However, all those mentioned tests are not specifically designed for land surveyors.

In this proposed research, land surveyors will be the main target group. To be able to investigate their spatial thinking ability, it is necessary to develop a test which is relevant to land surveyors. Specifically, the spatial thinking ability test for land surveyors in this research will be named as LS-STAT (Land Surveyors Spatial Thinking Ability Test). Their tasks will be defined and linked with specific spatial thinking concepts. These concepts can be used for the development of an appropriate test. However, it is also possible to elaborate from available spatial thinking tests since the test were arranged using valid spatial thinking concepts for instance, Hegarty et al. (2002); Reginald G Golledge, Marsh, and Battersby (2008); Lee and Bednarz (2009).

To conclude, spatial thinking ability will help land surveyors in the NLA to structure the problems, find solutions, and express findings in performing their tasks. As such, in order to be able to investigate land surveyors spatial thinking ability, it is needed to develop a test (LS-STAT). The outcomes of this research are expected to be used for the evaluation of the land surveyor's spatial thinking ability in NLA. Through extensive evaluations, NLA will be able to monitor land surveyors ability, implement the improvements, and increase their capability in performing their tasks. The overall objective of this research is to investigate spatial thinking ability of land surveyors in NLA. In order to do so, it is important to explore land surveyor tasks in NLA and review spatial thinking concepts which are relevant with land surveyor tasks. In seeking their spatial thinking ability, a test (LS-STAT) needs to be developed. To reach the research objective, several research questions were formulated as mentions as follows;

- Q1: What particular NLA land surveyors tasks can be linked to spatial thinking concepts?
- Q2: What are appropriate tests to analyze spatial thinking abilities of land surveyors?
- Q3: How to generate an applicable spatial thinking ability test for land surveyors?

- Q4: What are the relations between the different professional background of the respondents and the test results?

## Spatial Thinking Frameworks for Land Surveyors in NLA

This sub-chapter will discuss the role of spatial thinking framework regarding the process to investigate the spatial thinking ability of land surveyors in NLA. Spatial thinking framework for land surveyors should taking into account as the main idea behind the developed LS-STAT and whole process in the study of spatial thinking and land surveyors.

Spatial thinking framework is an entry point of the discussion in chapter five. The framework should set up accurately. This consideration is because the framework will decide which terms in the spatial thinking concept have been used to define the LS-STAT. Basically the spatial thinking framework is a reference to understand the context of spatial thinking within the land surveyors in NLA. The framework was constructed by two main components, i.e. spatial thinking concepts and the main tasks of the land surveyors which are relevant with the spatial thinking concepts. This means a selection of the land surveyor's tasks have been taken. Accordingly, the land surveyor tasks on the framework are considered as the technical tasks especially in the scope of GIS.

The comprehension of understanding in each term of the concepts is a crucial point in order to link the tasks to the concepts. Possibility in misinterpretation can make the evaluation process to generate wrong conclusions. The evaluation process is a step where the tasks are analyzed and linked to the spatial thinking concept. The impact is influence to the next process especially when developing the material test. Because the framework used as the main idea behind the development of LS-STAT.

Objectivity to decide which term in the spatial thinking concepts is relevant with the land surveyor's tasks becomes more important. Accuracy and precision also needed to avoid redundancy on the selected terms. The relevancy of land surveyors tasks and spatial thinking concepts must be completely matched. By practicing those approaches the objective conclusion can be delivered.

Accordingly, the framework was designed as simple as possible to make it understandable. Furthermore, the relevancy of the framework was close to the idea of the former spatial thinking concepts. Basically, study about land

surveyors and spatial thinking was quite rare discussed. Mostly studies about spatial thinking were related with students with different levels of education. In other words, the framework might be used for further research especially when discussed about spatial thinking in the context of land surveyors. However, improvement is still open to conduct since the result of expert evaluation mentioned that this research is an introductory study.

## The LS-STAT Evaluation

The topics to discuss in this sub-chapter are related with the criteria to develop reliable test material (LS-STAT), the representation of the participant who involves in the evaluation process, and subjectivity in giving a comment and feedback.

First, the evaluation is needed to produce comprehensive test material. In this research evaluation of the LS-STAT was conducted before and after the test. Student evaluation and expert evaluation was taken before the test. On the other hand participant evaluation was represented as an evaluation after the test. In accordance with Biocca, Harms, and Gregg (2001), in the social research the pilot testing provides preliminary support for the reliability, validity, and sensitivity to measure social presence. Furthermore, Reginald G Golledge et al. (2008) also suggested to do the pilot testing before implementing the real test. Pilot testing on the mentioned literature is associated with student evaluation. In addition, expert evaluation is more relevance with evaluate the appropriateness of the LS-STAT. Thus, participant evaluation was also taken as the follow up of the expert evaluation results. Based on that explanation, the evaluation process was conducted in sequential level. The objective is to improve the quality of the developed LS-STAT. In other words, the LS-STAT was clearly evaluated using guidelines given based on the literature and additional reference. Therefore, the LS-STAT is already fulfilling the criteria to develop a test material.

Second, the respondents of the student evaluation and expert evaluation were randomly chosen. A question about how representative the respondent to evaluate the LS-STAT are might be appeared. The evaluation result is depending

on the capacity of the respondent. In general, it can be assumed that the respondent involved in the evaluation process is a person who has knowledge in the geo-information science field.

Students involved in the evaluation process are 2nd year Master Geo-information Science program at Wageningen University. It is considered that they have more capacity in understanding the concept of geo-information science. That is the main requirement for the respondent to be able to evaluate the LS-STAT. In addition, the student evaluation is more focussing on the layout of the LS-STAT. Therefore, the MGI student is acceptable to involve on the evaluation. On the other hand, experts involved on the evaluation are professionals in the field of geo-information science. The experts are from Alterra Wageningen University with specialities in spatial knowledge systems. Based on that information it is enough argumentation to involve them as expert on the evaluation.

Third, the evaluation was in forms of questionnaire. Therefore the subjectivity in giving a comments and feedback cannot avoid. To reduce the subjectivity in answering the questionnaires were designed into two types, i.e. closed and open questions. In a closed question the respondent only choose the category in rating scale. On the other hand, open questions were designed to obtain more results where the respondents can elaborate their answer.
Subjectivity in giving a comment might be caused by factors that need to control. For example, target group of respondents, length of questionnaires. In this research, target group of respondents was determined carefully along the discussion and supervision process. The questionnaire also designed according to the reference, therefore the content is just straight to the point. Those mentioned steps were concrete actions to reduce the subjectivity. In conclusion, the subjectivity level of the questionnaires was reduced therefore it can be used as a tool for analysis.

According to the feedbacks, is indication that the LS-STAT is need to improve. That particular issue was depicted on the outliers answer. That five out of six statements show a negative opinion. Essentially, research the results will be more comprehensive if all negative issues can be analyzed and

summarized as guidance to conduct better research in the future. Outliers are potential focus to have inquiry. Osborne (2005), describes that keeping the legitimate outliers and do not violating the assumption is a rational choice for the better research in the future. Regarding those outliers results in this thesis research, it might be generated by the limitation during attain the material test. In addition, the result is influenced by capacity of understanding the statement by the participants.

## Self Assessment Results and the LS-STAT Score

Self-assessment is an additional method to analyze the spatial thinking ability of the land surveyors. The self-assessment method is applied using Santa Barbara Sense of Direction scale (SBSOD) where literally can be used to analyze sense of direction of the participants. Sense of direction itself is highly correlated with spatial thinking concepts which are associated with spatial orientation knowledge within environment. The idea to apply this assessment is to introduce the spatial thinking knowledge to the participants since this is the first spatial thinking test for the land surveyors. In addition, the purpose is to observe how their confidence is in accomplishing the test. The assessment results are used to compare with the spatial thinking test results.

In general, the assessment results show intermediate score, between 2 - bad to 4 -good. Thus, it can be assumed that the participants are quite confidence with their spatial knowledge. This is important for the participants as internal validity process. Huitt, Hummel, and Kaeck (1998), explained internal validity is the recognition in experimental research refers to how well and how confidently the variable can conclude the results. This means, SBSOD is assume as variable that can reflect the results of the spatial thinking test. Comparing to the LS-STAT score, the findings is also relevant. Average score of LS-STAT also in intermediate level.

Although the SBSOD self-assessment tool is different than LS-STAT, we can see similar results between those two methods. This might be not a coincidence because between SBSOD and spatial thinking test is composed by spatial knowledge where SBSOD is more related with individual orientation within the environment and spatial thinking test is

more emphasize to the function of GIS. Based on that important finding, SBSOD and LS-STAT can be applied to analyze land surveyor spatial thinking ability.

The explanation about that important finding can be analyzed using Charcharos, Kokla, and Tomai (2016) where described assess spatial thinking ability should in holistic way with combining small-scale spatial abilities (perception, visualization, and orientation) and large-scale spatial abilities (sense of direction, perspective topology, and spatial updating). Based on that description, it can associate that small-scale spatial ability is represented using LS-STAT, and the large-scale spatial ability is represented using SBSOD. To sum up, LS-STAT and SBSOD is combination of small-scale and large-scale spatial abilities that can be used to assess spatial thinking ability of land surveyors.

Question: "What particular NLA land surveyor's tasks can be linked to spatial thinking concepts?"

In general, the tasks can be linked into spatial thinking concepts are categorized as; pre-survey, land measurements, mapping, and calculation. In the category pre-survey the tasks are; identify the parcels location based on land registration maps, ensure the distribution of the benchmark, and assure the adjacent land parcels in surrounding. In the category land measurement the tasks are; determine physical land parcels boundaries in the fields, prepare constructions staking out for drawings, perform the field surveys, and recognize field features relevant to the survey. Moreover, in the category mapping the tasks are; evaluate the spatial relationship, identify boundary conflict based on land registration map, and create land parcels map. In the last category calculation the tasks are; calculate area of the land parcels, and compile GIS data as a report of land measurement. All mentioned tasks are part of the land surveyor's technical tasks which related with GIS. According to the findings, we may conclude that the particular land surveyor's tasks can be linked to the spatial thinking concept is presented on the spatial thinking frameworks for the land surveyors.

**Question: "What are appropriate tests to analyze spatial thinking abilities of land surveyors?"**

The appropriate test to analyze spatial thinking ability of land surveyors is Land Surveyor Spatial Thinking Ability Test (LS-STAT) and Santa Barbara

Sense of Direction Scale (SBSOD). LS-STAT has two type test form, i.e. paper based and field based. LS-STAT and SBSOD is a test combining small-scale spatial abilities (perception, visualization, and orientation) and large-scale spatial abilities **(sense of direction, perspective topology, and spatial updating).**

**Question: "How to generate an applicable spatial thinking ability test?"**

To generate an applicable spatial thinking ability test, considerable methods have been applied. To deliver a comprehensive test, the LS-STAT is evaluated into two steps. Firstly, evaluate before conducting the test through student evaluation and expert evaluation. Secondly, evaluate after the test through participant evaluation. The results of participant's evaluation did not directly improve the LS-STAT but it can be used as guidelines for improvement in the future research. Evaluation is mandatory in order to generate an applicable test. The methods should consider some critical issues evaluation. Multi stages improvement is helps to enhance the LS-STAT relevance and appropriateness.

**Question: "What are the relations between the different professional background of the respondents and the test results?"**

In general, different professional backgrounds of land surveyors show different score results. In this research, we investigated the professional background according to the educational background and the working experience. The educational backgrounds are divided into four categories, i.e. DI STPN, DIV STPN, SMA, and S1 Ilmu Hukum. The results showed that DI STPN has the highest score belong to other group. In addition, statistic analysis using one-way ANOVA and Duncan's test depict the different working experience is significantly different. The result is accordance with the hypothesis where land surveyors with GIS education background will have better performance in spatial thinking ability than non-GIS education background. Scientifically, Hegarty et al. (2010) also stated that geoscientist has better performance in spatial abilities than other scientist.

On the other hand, the working experience category analysis presented that land surveyors with 1-10 years working experience having highest score than 11-20 years, 21-30 years, and >30 years. Moreover, the achievement score of the participants are gradually lower from short experience to long

experience where the lowest score was achieved by land surveyors with >30 years experience.

To conclude, hypothesis regarding the correlation between the land surveyor professional background and the test results are fulfilled in the education background. Meanwhile, the working experience did not meet the hypothesis where the shortest working experience has the highest score.

# Prediksi Kemungkinan Kelulusan Siswa pada Kursus Daring Menggunakan Regresi Logistik

# Predicting Student Likelihood of Completion in edX Massive Open Online Course Using Logistic Regression


| | | |
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# ABSTRAK

Tingkat kelulusan yang rendah adalah isu umum di Massive Open Online Courses (MOOCs). Sejumlah besar siswa mendaftar ke MOOC namun sebagian besar dari mereka tidak pernah menyelesaikan kursus. Bahkan ketika tingkat penyelesaian didasarkan pada pengukuran lain daripada jumlah siswa yang terdaftar, seperti jumlah orang yang mengakses sumber daya atau mencoba masalah pada minggu pertama, tingkat penyelesaian masih lebih rendah dibandingkan dengan tatap muka -MOOC lingkungan. Meskipun hal ini mungkin tidak menjadi masalah karena ada perbedaan lain dalam keberhasilan sebuah MOOC, sebaiknya administrator MOOC memiliki wawasan yang dapat membantu mereka meningkatkan tingkat penyelesaian siswa.

Penelitian ini mencoba membangun model prediktif untuk mengukur kemungkinan siswa tetap aktif dalam minggu depan selama MOX edX. Model ini didasarkan pada pengamatan platform MOO edX, namun juga dapat digunakan pada platform MOOC lainnya asalkan mereka memiliki sarana untuk mengumpulkan data yang sebanding. Data yang dihasilkan secara acak dibangun, meniru pengamatan mingguan pada siswa selama MOX edX. Regresi logistik digunakan untuk mengkalibrasi dan memverifikasi model prediktif. Analisis tentang goodness-of-t, tanda karakteristik karakteristik perilaku siswa, dan akurasi prediksi akan diberikan.

## ABSTRACT

Low completion rate is a common issue in Massive Open Online Courses (MOOCs). Large number of students enrolled into a MOOC but the majority of them never finished the course. Even when the completion rate is based on other measurement than the number enrolled students, such as the number of people who accessed the resources or tried the problem sets on the first week, the completion rate is still lower compared to face-to-face non-MOOC environments. While this may be not be considered a problem since there other definitions of success for a MOOC, it is preferable for MOOC administrators to have an insight that can help them increase students' completion rate.

This research attempts to build a predictive model to measure the likelihood of students remain active in the next week during an edX MOOC. The model is based on observations of edX MOOC platform, but it can also be used on other MOOC platforms provided they have the means to gather comparable data. Randomly generated data is built, emulating weekly observations on students during an edX MOOC. Logistic regression is used to calibrate and verify the predictive model. An analysis of the goodness-of- t, the significance of student behavior characteristics, and the prediction accuracy will be given.

## Introduction

MOOC (Massive Open Online Course) has been growing in popularity since the launch of three major MOOC initiatives in 2012. Coursera1 was launched in January 2012, followed by Udacity2 in March 2012, and edX3 in May 2012. The New York Times later dubbed 2012 as "The Year of MOOC". The initiatives have attracted million of students from around the world to enroll, with Coursera alone claims the number of 4.45 million students by August 2013.

The popularity of MOOC can arguably attributed to its lack of enrollment fee and its open nature in accepting anyone from any academic background. In contrast to MOOC, traditional online courses are usually a part of degree programs which require tuition fee and academic prerequisites. In addition, the large choice of courses offered and the growing support from prominent learning institutions also arguably contribute to the popularity of MOOC.

## edX MOOC

edX is one of the major MOOC platforms, created by MIT and Harvard as a non-profit initiative in May 2012, although the first prototype course was offered by MIT in March 2012. As recent as August 2013, 26 other universities have joined the initiative with a total of 62 courses offered.

This research has a particular interest on edX for several reasons. The first one is the availability of its main software, edx-platform5, as an open source software along with the documentation of its metadata. The second one is the capability of edx platform to record virtually all kinds of student interaction within the platform as the students access the learning resources, do the assessment and participate in forum discussions. With typical high number of enrolled students, this feature has the potential of creating a rich and massive student interaction data which can facilitate data mining and analytic researches. The third one is the recent decision by University of Queensland to join the edX initiative in May 20136, hence the potential availability of data for researchers in the University of Queensland.

## Measurement of MOOC's Success

A recurring issue in MOOC is its low retention rate, as the majority of students who enrolled into a course never earned a certificate. MOOC administrators are

eager to publish the number of students enrolled into their courses, but they seldom publish the number of students who completed the courses. From some published reports and a compilation of anecdotes, we can argue that the average completion rate in MOOCs is less than 10%, although in some courses with short duration (5 to 6 weeks) the completion rates can reach above 20%. Compared to traditional online courses in both long distance and face-to-face learning environments, this figure seems abysmally low. But as some reports on MOOCs show, many enrolled students never went beyond the registration process. The relatively small effort and commitment required in enrolling might has contributed to this. Nevertheless, the potentially serious students who have demonstrated some e orts in their first week in a course are also "leaking out" during the duration of a course.

The number of active students over time in edX's 6.002x (Circuits and Electronics), a prototype course offered by MIT in May 2012. P. F. Mitros, et al. defines active students as those who enrolled before a certain time during the course and accessed the course's learning materials, or participated in the forum discussions after that time. The drop-out rate during 6.002x was constantly high between the beginning of the course and the midterm, but it slowed down after that. The same trend also happened in Duke University's Bioelectricity course offered in September 2012 and in Coursera's MOOCs offered by The University of Edinburgh in January 2013. It can be argued that the "windows shoppers" or those who never bother to check the course content can be disregarded, and attention should be given primarily to those who actually access the course resources. Kizilcec, et al. argued that the number of certificate earners should not be considered as a sole measurement of a MOOC's success, since there are a lot of students who gain something from a course without passing all assessments. Thus, the success of a MOOC should be measured by students' level of persistence within a course, and the number of students who remain active throughout the course duration is a good indicator of it.

Cochran, et al. suggested that if high attrition rate is a problem in an on-line course, more criteria and limitations should be placed during the registration process. Setting higher entry requirement in a MOOC might not be a practical solution, especially if the MOOC administrators want to attract as many students as possible. Nonetheless, the latest iteration of edX's 6.002x

charges a registration fee for students who want to get an official certificate. This may become more common in the near future.

The research tries to understand how a student's likelihood of completing an edX course is affected by his or her interaction within the edX platform. Hopefully the research result will give edX MOOC administrators more insight on what factors make students stay (or not stay) within a course.

## Distribution of Forum Posts

As shown in the previous section, only a few information is available on forum participants in 6.002x. Scaled to the simulated number of enrolled students, there will be 721 of 1,597 certificate earners who post in forum discussions. About 2,326 forum threads and 19,384 forum posts will be created. In total, only 900 students will ever participate in forum discussions. Since the majority of forum participants are certificate earners, it is assumed that an average of 19,384 posts / 14 weeks or 1,385 posts will be created each week, and 900 students post in the forum every week. Thus, 900 "forum post" slots need be randomly distributed each week. The receivers are assumed to be the certified earners and students with a passing cumulative percentage of score in that particular week.

## Distribution of Forum Viewings and Video Viewings

This is as far as the simulated data can be built with confidence of its distribution. There is not enough information to distribute the numbers for variables of "cumulative forum views" and "cumulative video viewings". For these two variables, the data distribution is a work of guess based on the variable "cumulative percentage of score" and randomized parameters.

The values of "forum views" variable were generated by weighted random generator with output from 0 to 5 and probabilities of 10%, 20%, 20%, 20%, 20%, and 10%. This follows the assumption that the number of times students view forum threads in a week is not significantly related to the percentage of cumulative score. If the "forum views" value is smaller than the value of "forum posts" then the value of "forum views" is replaced

with the value of "forum posts", i.e. students who post in forums at least see the same number of threads. The values of "video views" variable were also generated by weighted random generator with output from 0 to 5 and probabilities of 3%, 7%, 10%, 20%, 30%, 30%. This also follows the assumption that the number of times students view videos in a week is not significantly related to the percentage of cumulative score.

## Dependent Variable

The goal of this thesis is to gain understanding on what factors contributes to students retention within an edX course. For this purpose, a model will be created for each weekly time slices during an edX course. Since students' retention depends on their interaction within the edX platform, each model's dependent variable is the probability of students staying within the course in the next week. The outcome value of "0" represents "not active in the next week" and the outcome value of "1" represents "active in the next week".

By creating a model for each week, the design will be able to show the change of significance for each predictors as the course progresses. There is a change in the drop-out rate before and after the midterm. The model design will determine how much this change affect the significant of each predictors.

The model design considers four independent variables as potentially significant indicators of whether a student is going to stay within a course in the next week, or not.

## Cumulative Percentage of Score

As shown in previous chapter, studies by both Breslow, et al. and Barber and Sharkey agree that cumulative assessment score is a good predictor for student success within an online course. In a MOOC, students who score low on the first problem set might conclude that the particular MOOC is going to be too time consuming or too di cult. Conversely, students who pass the first problem set might have a better motivation to continue. Cumulative assessment score is arguably a good indicator of students' performance trajectory.

In the models, cumulative percentage of score is a continuous predictor defined as the ratio of the cumulative assessment score until this week to the

maximum assessment score possible until this week. The variabel's range is between 0 and 1.

## Cumulative Forum Posts and Cumulative Forum Views

The significance of forum participation was contradicted by Barber and Sharkey. However, their finding was conducted on a small population of students and lack of high quality forum posts, compared to typical edX MOOCs as shown by Breslow, et al. As long as active forum discussions can be observed along with good quality forum posts, the number of forum posts and forum views can be considered as a significant predictors to predict students' level of persistence. In the model, cumulative forum views is a discrete predictor defined as the total number of threads viewed until this week, while cumulative forum posts is a discrete predictor defined as total number of posts written until this week.

## Cumulative Video Viewings

According to Breslow, et al., measurement of weekly video viewing can be a good indicator of students engagement and persistence. They also found that the video production quality did not affect students' "experience or satisfaction", i.e. the students focus more on the video content. This finding is in agreement with the findings of Wol, et al. and Ramos and Yunko that page hits or the number of times students access a course resource is a good predictor of students' progress within the course. The model defines cumulative video viewings is a discrete predictor as the number of videos the students view until this week.

## Overall Model Design

For each datasets, variations of this model (model A) will be tested using logistic regression analysis. The first variation includes all predictors, entered at once as as single block. The second variation (model B) only uses cumulative percentage of score as the predictors. This is because the process of generating the simulated datasets relies heavily on this predictor.

## Model A: All Independent Variables

Model A was tested with logistic regression on the 13 datasets with various size ranging from 10,661 records in week 1 to 3,198 records in week 13. The cut-o point of significance is set at 0.05, considering the large number of observations. Almost in every regression result, variable "percentage cumulative of score" is always statistically significant. Variable "cumulative forum posts" is statistically significant in week 3, 4, 5, 6, 7, 8, 9, and 12. Variable "cumulative forum views" is only statistically significant in week 12 and 13, while variable "cumulative video views" is only statistically significant in the last week before the exam. The odds ratio for "percentage cumulative of score" (47.945) is much higher than the other predictors, which indicates that it contributes more significantly to the model.

The distribution of the simulated datasets was fitted into the constraint of the number of weekly active students and test takers. This fitting process depends on the assessment score, and thus it was expected that the predictor "percentage cumulative of score" is always statistically significant in predicting the probability of students being active next week. Regarding cumulative forum posts, the result is unexpected, since the majority of forum posters are certificate earners and thus assumed to be people with passing percentage cumulative of score (>50%). Moreover, the number of posts made each week is only approximated at 900. These conditions potentially lead to quasi-separation. One explanation is that the random distribution used to generate "cumulative forum posts" values violates the constraints mentioned above.

For the variables of cumulative forum views and cumulative video views, they are assumed to have a uniformly-distributed values since both variables do not depend on test taking status and percentage cumulative of score. But this distribution results in almost at line in their probability prediction plots.

The percentage of correct prediction for the model in week 1, week 7 (before the midterm) and week 13 (before the exam) are not different from their null models (i.e. only includes the constant). Although the predictive accuracies look good (72% in week 1, 92% in week 7, and 97% in week 13), these only indicate an over fitting, where the predictions are 100% positive. Values of -2LL (2245.114 in week 1, 1936.742 in week 7, and 747.056 in week 13) and 2 (2245.114 in week 1, 461.746 in week 7, and 142.364 in week 13) indicate poor goodness-of- t with an improvement as the course progress. But this is more caused by the decrease

of the negative outcomes, since the model still makes 100% positive prediction. Thus, model A can't be used to correctly predict the likelihood of students being active in the next week.

## Model B: Percentage Cumulative of Score

Model B consists of one predictor: percentage cumulative of score. This predictor was chosen since the distribution of assessment scores in the simulated dataset is arguably resembles the actual data. Logistic regression was performed on model B using datasets of week 1 to week 13. In all these regressions, the predictor "percentage cumulative of score" is always statistically significant for the model. Its odds ratio is always much higher than the odds ratio of the constant, which indicates that "percentage cumulative of score" contributes significantly into the model.

However, model B's predictive accuracies are not different from the accuracy of their null hypothesis. In fact, model B has similar accuracy values with model A (e.g. 72% in week 1, 92% in week 7, and 97% in week 13). This indicates the model is no better than the null model. The similarity in values also indicates that the predictor "percentage cumulative of score" is too significant that once it enters the model, the other predictors are rendered statistically insignificant (case of model A).

The values of -2LL (9255.607 in week 1, 1944.968 in week 7, and 754.734 in week and 2 (2242.771 in week 1, 453.519 in week 7, and 134.686 in week 13) are large, indicating that the model is a poor t. As the course progresses the fitness of the model improves, but that is because the population of negative outcome decreases while the model prediction is still an over fitting 100% postive.

The fitted probability plot fails to reach below the cut-o probability point of 0.5. This is caused by many students with low cumulative assessment scores that decided to continue their study. If these group of students are removed from the dataset, the plot graph will look like a logistic curve, and the model will be able to predict negative outcome.

Fitting the simulated data to the predicted numbers of active students resulted in models that always predict positive outcomes ("active in the next week"). Both model A and B include the percentage cumulative of score and

both model fail to predict the likelihood of the students being active in the next week. Both models are poor- ts with large -2LL and 2 values.

The models can only give a better t, after a modification to the dataset. This involves removing low cumulative scoring students from the list of students that will be active in the next week. For example, after removing students with grades below 30% of the marks, the model fitness improved. The graph looks like logistic curve and the models can predict both positive and negative outcomes. But this means the violation of the constraint number of the supposedly active students in the next week.

## Conclusion

While this research has given some insight on how student interaction within an edX MOOC affects his retention within the course and has identified factors that contribute to students' completion of the course, it has not been able to answer the research question on how to predict the likelihood of students being active in the next week of the course.

The research has found that ordinary logistic regression is unable to make pre-diction for rare events. The contraints applied to the simulated data has resulted in datasets where the negative outcomes are rare in proportion to the positive out-comes. When this datasets are fed into the models, logistic regression process can not predict negative outcomes since the cut-o point is always above 0.5.

While the research only uses simulated data, this situation arguably also happens in an actual dataset from an edX course, where the drop-out rate for test takers and active students are also constant between 9% and 12%. This means that there are more students continuing their study than those who are dropping out (i.e. the rare events are students dropping out).

# Wireless Intrusion Prevention System: The Analysis of the Effectiveness Implementation Principles

# Sistem Pencegahan Intrusi Nirkabel: Analisis Prinsip-prinsip Implementasi yang Efektif


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Internet telah menjadi 'norma' bagi kehidupan manusia dan dapat membawa informasi dan komunikasi dengan cara yang lebih cepat, modern dan dinamis. Berbagai macam fasilitas dan konsep yang ditawarkan oleh internet, membuat perbedaan besar bagi kehidupan masyarakat di seluruh dunia. Selain itu, internet telah menjadi kebutuhan terutama bagi bisnis dan organisasi seperti konsep e-bisnis, e-commerce dan e-banking. Konsep-konsep tersebut berkontribusi pada berbagai variasi layanan konsumen, termasuk efisiensi waktu, pelayanan yang cepat, ketepatan dan keamanan, yang menjadi alasan mengapa orang-orang menyukai layanan tersebut sehingga terus tumbuh.

Internet merupakan sebuah sistem yang terdiri dari berbagai macam jaringan, yang dapat menghubungkan antara satu komputer ke komputer lain (Bonaventure 2011). Namun, karena evolusi akses internet terus berkembang pesat, saat ini tidak hanya komputer, tetapi perangkat lain seperti notebook, tablet, ponsel, dan gadget canggih lainnya dapat dengan mudah terhubung ke internet. Kemudian, ada pilihan alternatif bagi perangkat tersebut untuk terhubung ke internet selain menggunakan kabel jaringan yang disebut dengan teknologi nirkabel atau wireless. Adanya koneksi nirkabel identik dengan kisaran komunikasi radio yang relatif singkat yang bisa menggantikan koneksi kabel konvensional, dimana Wireless Fidelity (Wi-Fi) atau Standar IEEE 802.11 termasuk ke dalam kategori ini (Cooklev 2004).

Perkembangan teknologi memiliki dampak positif dan negatif, termasuk kemudahan akses. Karena hampir semua informasi dapat diakses dengan mudah, koneksi standar 802.11 juga dibayangi oleh isu keamanannya itu sendiri. Kondisi ini menyebabkan jaringan komputer menjadi lebih rentan terhadap ancaman intrusi (Axelsson 2000). Penyusup atau dikenal sebagai Hacker, adalah orang yang mendapatkan akses tidak sah ke dalam sistem jaringan untuk tujuan keuntungan, kriminalitas, atau bahkan untuk sekadar kesenangan belaka (Oriyano and Gregg 2013). Dengan menggunakan teknik-teknik yang canggih, para penyusup sering berhasil dalam mengeksploitasi kerentanan dalam infrastruktur dan informasi penting yang dalam hal ini organisasi telah gagal dalam mengamankannya.

Keamanan jaringan merupakan sistem pelindung untuk menjaga dari akses yang tidak sah, modifikasi, atau perubahan informasi (James et al. 2000). Oleh karena itu, melindungi dan mengamankan infrastruktur jaringan sangat penting. Hal ini juga membutuhkan kontrol akses yang melibatkan otorisasi

akses dan pemantauan karena dapat menjadi sasaran mudah bagi penyusup jika sistem pencegahan tersebut lemah. Meskipun beberapa teknologi keamanan jaringan yang ada sebelumnya dapat memenuhi sebagian tantangan ini, namun untuk teknologi nirkabel masih tetap memerlukan sistem keamanan yang tepat untuk mencegah akses yang tidak sah ke dalam jaringan Local Area Network (LAN) dan terhadap aset informasi lainnya.

Implementasi yang tepat untuk sistem keamanan jaringan dari infrastruktur modern masih terus diperdebatkan saat ini. Jelas, sistem keamanan preferensi harus diterapkan sesuai dengan semua kebutuhan keamanan, kompatibilitasnya terhadap lingkungan dan menggunakan anggaran yang efisien. Beberapa pendekatan berbasis model telah dikembangkan dan diterapkan pada sistem keamanan Wireless LAN terkait. Namun, setiap organisasi memiliki persyaratan keamanan yang unik serta penggunaan teknologi dan arsitektur yang berbeda. Pelaksanaan yang efektif dari sistem keamanan terhadap ancaman di infrastruktur LAN nirkabel sangat penting untuk diuraikan. Dengan demikian prinsip-prinsip implementasi yang efektif akan dibahas dalam penelitian ini.

## Metode Penelitian

Penelitian ini didasarkan pada pendekatan kualitatif yang menurut Taylor et al. (2015), mendefinisikan metodologi kualitatif sebagai prosedur penelitian yang menyajikan deskripsi data dalam bentuk tulisan atau lisan oleh orang-orang dan pengamatan terhadap perilaku. Penelitian kualitatif adalah metode untuk mendapatkan kebenaran dan diklasifikasikan sebagai penelitian ilmiah dibangun di atas teori-teori yang telah dikembangkan dari penelitian berdasarkan bukti empiris.

Penelitian ini bertujuan untuk mengetahui prinsip-prinsip efektivitas sistem keamanan nirkabel mengenai beberapa faktor dan kriteria yang mempengaruhi dalam implementasinya. Penelitian ini akan mempelajari prosedur dan masalah yang ada, khususnya penulis mencoba untuk menggambarkan, menganalisis dan menginterpretasikan kondisi yang ada. Studi kualitatif ini tidak hanya akan menampilkan data tetapi akan berusaha untuk memahami hubungan antara berbagai faktor dan kriteria termasuk sudut pandang dan proses yang sedang berlangsung.

Secara umum data yang digunakan adalah data kualitatif, tetapi beberapa merupakan data kuantitatif. Sedangkan, sumber data tersebut dibagi menjadi dua jenis, yaitu sumber data primer dan sumber data sekunder. Sumber data primer diperoleh dari diskusi dengan beberapa kerabat penulis tentang pelaksanaan subjek terkait dan produk melalui percakapan online atau menggunakan media komunikasi lainnya. Sumber data sekunder berasal dari dokumen sumber yang telah ada, yang kemudian digunakan untuk memperluas ulasan data. Sumber data tersebut diperoleh dalam bentuk buku, literatur akademis, arsip, dan online artikel yang berkaitan dengan fokus penelitian.

Namun, karena faktor informasi yang sangat terbatas, akan sulit mengumpulkan data primer dari vendor langsung, dikarenakan para vendor sengaja menjaga keamanan informasi tersebut untuk tidak di publikasikan kepada masyarakat umum. Utamanya, agar tidak digunakan oleh pihak tertentu untuk mencari kelemahan dari sistem pertahanan tersebut.

Oleh karena itu, sampel yang digunakan adalah data hasil penelitian yang telah ada sebelumnya, dipilih dengan cermat agar relevan dengan penelitian ini. Namun, alasan penulis juga mencoba menyajikan sampel agar lebih mudah dalam identifikasi dan cukup mewakili dari arsitektur yang ada. Data analisis dibuat dalam bentuk tabel dan narasi dengan tujuan menyederhanakan menjadi bentuk yang lebih mudah dibaca dan ditafsirkan. Kemudian data tersebut dihimpun dan dimanfaatkan sehingga dapat digunakan untuk menjawab pertanyaan-pertanyaan yang diajukan dalam penelitian ini.

Terakhir, penelitian ini menggunakan analisis induktif, di mana penulis mencoba untuk merumuskan pernyataan atau abstraksi teoritis yang lebih umum. Analisis akan didasarkan pada pengetahuan empiris atau pengalaman yang diperoleh dari pengamatan secara tidak langsung dan dari studi pustaka untuk kemudian mengkompilasinya dan menarik kesimpulan.

Hasil dan Pembahasan Penelitian

Sistem deteksi dan pencegahan intrusi atau Intrusion Detection and Prevention System (IDS/IPS) telah ada selama lebih dari satu dekade terakhir. Awalnya, Platform Intrusion Detection System (IDS) bertugas memantau dan memberikan suatu metode peringatan akan terjadinya serangan yang terdeteksi pada jaringan sehingga tindakan lebih lanjut dapat diambil untuk menghentikan serangan tersebut. Kemudian dengan peningkatan evolusi platform Intrusion

Prevention System (IPS) yang signifikan, termasuk kemampuan untuk mendeteksi ancaman dan mengambil tindakan untuk menghentikan ancaman tersebut secara otomatis. Sistem keamanan jaringan tersebut secara efektif bekerja dalam infrastruktur jaringan tradisional, namun ada beberapa faktor yang menyebabkan kebutuhan spesifik dari pemantauan jaringan dan deteksi intrusi pada infrastruktur Wireless LAN.

## Mengapa Sistem Pencegahan Intrusi Nirkabel

Meskipun tidak sepenuhnya menggantikan jaringan tradisional, teknologi WLAN telah digunakan di berbagai tempat umum dan perkantoran untuk memudahkan koneksi pengguna ke internet (Zhang and Guizani 2011). Namun, seperti teknologi lainnya, kemudahan penggunaan ini memiliki masalah keamanan serius (Wrightson 2012). Terutama untuk organisasi besar dengan banyak karyawan yang dianggap rentan terhadap pelanggaran keamanan. Oleh karena itu diperlukan pendekatan pencegahan teknis untuk mengurangi masalah keamanan, seperti Hongyu et al. (2004) menyoroti bahwa WLAN harus dilengkapi dengan sistem keamanan untuk menyediakan solusi perlindungan untuk deteksi dan respon terhadap ancaman potensial. Salah satu faktor perbedaan utama antara jaringan tradisional dan nirkabel yaitu komponen yang di monitor. Beberapa komponen yang terkandung dalam jaringan nirkabel tidak ada dalam jaringan kabel seperti kekuatan sinyal, gangguan, jarak, dan interval sinyal.

## Komponen, Arsitektur dan Teknik Analisis pada Sistem Pencegahan Intrusi Nirkabel

Sistem Pencegahan Intrusi Nirkabel dapat berupa sistem terdiri alat sensor keamanan atau perangkat lunak keamanan yang terintegrasi yang mampu mengamati jaringan Wireless LAN. Menurut Timofte (2008), suatu Sistem Pencegahan Intrusi Nirkabel biasanya terdiri dari empat komponen. Yang pertama adalah sensor Wireless, berfungsi untuk mendeteksi dan menganalisa aktivitas jaringan nirkabel. Kemudian yang kedua adalah Server Manajemen, yang menganalisis informasi yang diterima dari sensor. Ketiga adalah Server Database, menyimpan informasi kegiatan dari sensor dan manajemen server pengolahan, dan yang terakhir adalah Konsol antar muka, terminal antarmuka untuk pengguna dan administrator.

Jenis dan tipe dari sensor merupakan hal yang paling mendasar ketika mengimplementasikan solusi Sistem Pencegahan Intrusi Nirkabel. Terminologi jenis sensor di atas terkait dengan metode penyebaran sensor-sensor itu sendiri, sehingga melalui pendekatan ini, WIPS diklasifikasikan.

Empat metodologi dalam WIPS untuk menganalisis intrusi, termasuk: berbasis Signature, berbasis Anomali, Analisis Protokol dan Analisis Spektrum. Kebanyakan sistem pencegahan intrusi nirkabel mengadopsi beberapa metodologi deteksi dalam satu sistem, baik secara terpisah atau terintegrasi sehingga proses deteksi lebih akurat dan fleksibel.

Firewall tidak dapat mencegah intrusi yang telah diluncurkan dari perangkat WLAN internal di dalam perimeter (Vartak et al. 2007). Dengan demikian, solusi teknis yang secara aktif dan otomatis mencegah intrusi dalam perimeter jaringan nirkabel terus dikembangkan. Sementara itu menurut Vartak et al. (2007), ada 3 (tiga) teknik pencegahan umum di WIPS yaitu RF Jamming, Switch port blocking, dan Pencegahan berbasis Over The Air (OTA).

## Prinsip-prinsip Implementasi Sistem Pencegahan Intrusi Nirkabel

Setiap organisasi memiliki penyebaran WLAN yang berbeda, termasuk skema, arsitektur, pemanfaatan, akomodasi dan masih banyak hal lainnya. Akibatnya, berbagai skema jaringan akan efektif jika preferensi teknologi WIPS, opsi penyebaran, dan faktor bentuk dipilih secara tepat. Arsitektur WLAN IPS harus direncanakan dengan hati-hati, serta mempertimbangkan berbagai tingkat ancaman, dan jenis aset yang akan dilindungi sesuai dengan kebutuhan organisasi.

Berdasarkan beberapa literatur dan penelitian dari Iheagwara et al. (2006), TechTarget (2009), Coleman et al. (2010), and Kyostila (2014), ada 7 faktor penyebaran, termasuk: Biaya Hardware, Coverage Area, Dampak Kinerja WLAN, Fungsi, Attention Span, Integrasi dan Pemisahan tugas. Sementara itu, setiap organisasi memiliki kriteria persyaratan yang unik seperti perbedaan teknologi WLAN dan arsitektur yang digunakan. Oleh karena itu, evaluasi independen harus dilakukan oleh masing-masing organisasi.

Selanjutnya, jenis arsitektur keamanan yang dipilih akan optimal jika sesuai dengan kriteria persyaratan. Berdasarkan beberapa literatur oleh

Coleman et al. (2010), Hulme (2015) and Scarfone (2015), penulis menguraikan beberapa evaluasi terhadap 8 (delapan) kriteria: Penemuan Serangan, Pertahanan Serangan, Manajemen Perangkat, Kinerja Sistem Pencegahan, Kepatuhan Kebijakan, Forensik Data, Biaya Implementasi, dan Ukuran Organisasi. Termasuk juga analisis beberapa sampel produk dari pihak ketiga untuk membandingkan di setiap kriteria pelaksanaan WIPS. Sensor tersebut adalah Cisco Adaptive Wireless IPS, AirTight WIPS, Fluke Networks AirMagnet Enterprise, Aruba RFProtect, Zebra Technologies AirDefense, and HP Mobility Security IDS/IPS (Scarfone 2015).

Namun kriteria tersebut tidak menjadi tolak ukur yang komprehensif, dan setiap elemen tidak wajib sebagai dasar pemberian evaluasi perencanaan pelaksanaan WIPS bagi organisasi. Namun, kriteria-kriteria tersebut diharapkan dapat membantu dalam proses evaluasi yang dilakukan oleh organisasi. Ringkasan kriteria dan hasil penelitian berikut dapat digunakan dalam referensi untuk perencanaan dalam implementasi WIPS yang efektif, yaitu:

Sebagian besar organisasi yang telah menerapkan ISO 27001 membutuhkan IDS/IPS sebagai kepatuhan keamanan karena telah dinyatakan dalam kontrol yang organisasi harus penuhi. Namun bagi organisasi yang belum melaksanakan kebijakan tersebut, sangat direkomendasikan untuk mempelajari "best practice" pada ISO/IEC 27039:2015 sebagai pedoman bagi pelaksanaan WIPS.

Ada lebih banyak faktor dan kriteria untuk dipertimbangkan ketika mengevaluasi persiapan pelaksanaan WIPS. Beberapa kriteria, seperti harga dan kinerja bervariasi untuk setiap organisasi dan tergantung pada arsitektur WIPS yang dipilih seperti sensor WIPS khusus atau Access Point dengan built-in WIPS. Karakteristik infrastruktur WLAN dan penyebaran model WIPS yang ada seperti berbasis hardware, berbasis virtual, layanan berbasis cloud, harus ditentukan secara tepat agar efektif.

Sebagian besar produk WIPS yang ada adalah komersial, jadi pada dasarnya organisasi harus membeli sistem atau lisensi yang harganya cukup mahal. Dalam rangka menyeimbangkan biaya terhadap resiko, kebanyakan produk sensor terintegrasi memiliki kemampuan untuk penggunaan fitur pemantauan penuh waktu. Sensor tersebut secara standar biasanya dikonfigurasi menjadi scanner paruh waktu, tetapi dapat dikonversi untuk beroperasi dalam modus pemantauan penuh waktu.

Untuk sebuah organisasi dengan anggaran yang ketat, opsi ini akan menjadi pilihan yang sangat dianjurkan. Selain itu, ada Sistem Pencegahan Intrusi Nirkabel open source berbasis software disebut OpenWIPS-ng yang menawarkan keamanan di lingkungan jaringan nirkabel yang dapat digunakan dengan cara yang sama secara gratis. Namun, fitur OpenWIPS-ng tidak sekaya yang komersial.

Terkait dengan arsitektur jaringan campuran, beberapa produk WIPS menawarkan perlindungan lengkap yang menggabungkan deteksi ancaman dengan pencegahan nirkabel proaktif dan kolaborasi keamanan jaringan kabel. Dengan demikian, pilihan ini akan efektif bagi organisasi dengan infrastruktur LAN campuran.

Dalam penyebaran teknis, baik menggunakan arsitektur terpusat atau desentralisasi, kedua skenario tergantung pada bagaimana luas dan kompleks infrastruktur WLAN dalam organisasi selain mempertimbangkan faktor skalabilitas dan ketersediaan tinggi. Sekali lagi, mengikuti aturan rasio praktis yaitu empat atau lima Access Point untuk setiap sensor WIPS. Selain itu, akan efektif apabila menempatkan sensor di sekeliling bangunan. Alasannya adalah bahwa hal tersebut akan meningkatkan efektivitas triangulasi dan akan mengantisipasi kemungkinan penyusup dari luar gedung.

## Kesimpulan dan Saran

Analisis ini memberikan gambaran dari prinsip-prinsip pelaksanaan WIPS. Dalam pertimbangan yang diusulkan, ada beberapa kekuatan dan keterbatasan masing-masing arsitektur penyebaran yang ada. Namun, praktik terbaik untuk efektivitas penyebaran bisa disesuaikan dengan kebutuhan dan kemampuan organisasi, termasuk memenuhi fitur keamanan dan kompatibel dengan lingkungan jaringan LAN.

Ada potensi untuk memperkuat implementasi WIPS dengan melakukan analisis faktor-faktor dan kriteria. Penulis percaya prinsip-prinsip ini dapat meningkatkan efektifitas dan efisiensi pelaksanaan WIPS. Praktek terbaik ini merupakan kombinasi dari analisis strategis dan teknis di mana merupakan langkah awal untuk menerapkan analisis kinerja untuk abstraksi selanjutnya dalam implementasi Sistem Pencegahan Intrusi Nirkabel.

Kesimpulannya, hasil analisis prinsip-prinsip ini dapat diterapkan untuk merencanakan suatu kegiatan atau menjadi bahan penelitian untuk membantu pelaksanaan WIPS saat ini. Demikian pula, informasi yang disajikan kemudian bisa menjadi perpustakaan atau referensi untuk studi lanjut. Hasil penelitian ini dapat dikombinasikan dengan metode analisis lainnya seperti kinerja dan biaya. Keterbatasan penelitian ini adalah ketidakmampuan untuk mendapatkan data primer pada produk WIPS yang ada, pengumpulan data melalui observasi dan komunikasi langsung dengan pihak ketiga merupakan langkah yang tepat. Selanjutnya, prinsip-prinsip ini harus divalidasi sebelum implementasinya sehingga pendekatan ini dapat diandalkan.

# Cutting Skin Simulation Using Unity3D Engine

# Simulasi Pembedahan dengan Mesin Unity3D


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## ABSTRACT

The advance of information technology, especially in computer graphics, has made it possible to create a fantastic high quality 3D graphics visualisation. Computer graphics has been used in many fields in human life. People utilizes it to enhance their daily activity such as in entertainment and serious jobs. To produce a 3D computer graphics product, we need a set of tools which are including hardware and software. Personal Computer (PC), Scanner, and 3D printer are the example of the hardware. On the other hand, Operating system, 3D Application Programming Interface (API), 3D engine, and 3D Modelling software are the example for the software needed to create 3D computer graphics product. Surgical simulation is one of the products that utilizes the computer graphics technology to create the simulation that helps surgical training and simulation. There are two main ways to do simulation in surgical simulation: using real object and using computer graphics as the object. Using real object can be done by providing cadaver so the surgeons or the trainees can work with it. It could also be combined with computer graphics where the object is coming from 3D printed object. However, the printed object can only to be used once in the simulation. To make the object can be used over and over again, the object should be created and manipulated directly on the computer. Hence, the object will be reused easily. There are a lot of 3D engine to create 3D graphics simulation. Almost all of the engines support two main 3D API in computer graphics: Microsoft DirectX and OpenGL. Unity3D is one of the engines that supports those two APIs and available for free. There is a weakness in this methods. The realism and the accuracy of the simulation are depending on how well the 3D object simulates the actual object in surgery.

# ABSTRAK

Kemajuan teknologi informasi, terutama dalam grafis komputer, telah memungkinkan untuk menciptakan visualisasi grafis 3D berkualitas tinggi yang fantastis. Grafik komputer telah digunakan di berbagai bidang dalam kehidupan manusia. Orang memanfaatkannya untuk meningkatkan aktivitas keseharian mereka seperti hiburan dan pekerjaan serius. Untuk menghasilkan produk grafis komputer 3D, kita membutuhkan seperangkat alat yang termasuk perangkat keras dan perangkat lunak. Printer, Personal Computer (PC), Scanner, dan 3D adalah contoh perangkat keras. Di sisi lain, sistem operasi, 3D *Application Programming Interface* (API), 3D engine, dan software 3D Modeling adalah contoh untuk perangkat lunak yang dibutuhkan untuk membuat produk grafis komputer 3D. Simulasi bedah merupakan salah satu produk yang memanfaatkan teknologi grafis komputer untuk menciptakan simulasi yang membantu latihan bedah dan simulasi. Ada dua cara utama untuk melakukan simulasi dalam simulasi bedah: menggunakan benda nyata dan menggunakan grafis komputer sebagai objeknya. Menggunakan benda nyata dapat dilakukan dengan menyediakan mayat sehingga ahli bedah atau trainee dapat bekerja dengannya. Dapat juga dikombinasikan dengan grafis komputer dimana objeknya berasal dari objek cetak 3D. Namun, benda cetakan hanya bisa digunakan sekali dalam simulasi. Untuk membuat objek dapat digunakan berulang-ulang, objek harus dibuat dan dimanipulasi langsung pada komputer. Makas, objek akan mudah digunakan kembali. Ada banyak mesin 3D untuk membuat simulasi grafis 3D. Hampir semua mesin mendukung dua API 3D utama dalam grafis komputer: Microsoft DirectX dan OpenGL. Unity3D adalah salah satu mesin yang mendukung kedua API dan tersedia secara gratis. Ada kelemahan dalam metode ini. Realisme dan keakuratan simulasi bergantung pada seberapa baik objek 3D mensimulasikan objek sebenarnya dalam operasi.

## Introduction

Surgical simulation is a simulation to help surgical training education or preoperative surgery planning. At an earlier stage, there are some methods to do a surgical training or surgical simulation such as do the surgical operation on animal, cadaver, or patient. There are some obstacles for each of them. Practice using animal is cheaper than a cadaver, but the animal has a lot of different things with a human body. Using cadaver gives an advantage because of the similarity of the structure of the body between the cadaver and human body. However, there is still a problem. The properties of soft tissues in the cadaver is different with the real life soft tissues of the human. Furthermore, it is quite expensive to do surgical training using cadaver. Meanwhile, practicing surgical operation on the real human patient is very dangerous for novice surgeon. It will be very risky to involve them in real surgery. The best way is to allow the novice surgeon to observe the actual operation which is doing by the expert and let them assist in a small task. The responsibility of surgeon operating for the novice surgeon can gradually increase over time until they are ready to be fully involved in the surgeon operating on a patient. Unfortunately, this will take a long time. That is why the surgical simulation is introduced to overcome all these problems.

## Surgical Simulation

Surgical simulation is a simulation to make an imitation of the real surgeon operating on the patient including all aspect of the surgery condition such as the part of the body of the patient and the tools which are being used in the surgery. To imitate the part of the patient's body which is to be operated by the surgeon, there are several methods to produce the 3D object using computer graphics such as CT Scan, Magnet Resonance (MRI), and nuclear scanner (SPECT). These three imaging methodologies are using radiology technic. The computer is generating the 3D object from the images which are taken from those methods. Digital geometry processing is used to produce a three-dimensional image of the inside of the object from a large series of two-dimensional radiographic images taken around a single axis of rotation (Herman, G.T 2009).

Kenji YOKOTA, Takaaki MATSUMOTO, Yoshie MURAKAMI, Kaori ANDO, and Masashi AKIYAMA from Department of Dermatology of Nagoya University

Graduate School of Medicine reported their success on preoperative surgical simulation and planning. They said 3-D modelling and printing have rarely been reported in the field of skin surgery. They were using Zed View 3-D preoperative imaging software (LEXI, Kanagawa, Japan), the Geomagic Freeform touch-sensitive digital modelling system (SYSTEMCREATE, Osaka, Japan) and the ProJet 660Pro 3-D printer (3D Systems, Rock Hill, SC, USA). They created the 3D computer object using CT images and print the 3D object using the 3D printer. There are two cases of malignant skin tumours in their surgical simulation and planning. The simulation is done in front of the patient and the surgeons which are involving in the surgery. The first case is a 77-year-old woman who had a recurrent lesion of malignant melanoma (MM) on the right cheek (Figure 1). The second case is a 77-year-old woman who had a recurrent lesion of malignant melanoma (MM) on the right cheek (Figure 1).

## Main Objective of the Research

There are several methods to produce 3D computer graphics which will be used in surgical simulation. The best way may be from radiology scanner regarding this approach is using the real object as the reference to create 3D computer graphics. For real case such as the example mentioned above, this method gives an accurate result according to the real surgery which will be held. On the other hand, for training purpose any 3D software such as 3D Studio Max, Maya 3D, Blender etc., can generate a realistic 3D model. The models can be printed using 3D Printer to create the object which will be used in the simulation. The printed 3D object is relatively able to simulate the human body which is going to be operated in surgery. This research is intended to create 3D skin object in computer graphics to be used in the surgical training simulation. The 3D object is not going to be printed on the 3D printer, but the 3D object is going to be manipulated directly in the application. To achieve this objective, the 3D skin object is not created by 3D software creation such as 3D Max, Blender, Maya 3D etc. The application needs full control of the 3D skin object. Creating this object manually by using script will allow controlling the vertices of the object and how the triangles of the object are formed from the vertices.

Microsoft DirectX and Open GL are the most popular of 3D Application Programming Interface (API) in computer graphics. However, to build 3D object

from scratch using these 3D API is a relatively complicated task. To ease the creating 3D object model which is able to be manipulated at runtime, several 3D game engines have been investigated to search the engine that offers the features that this research needed and the easiness to use the engine. The 3d game engines are intended to use a static model and premade animated object (e.g. animated human model). Hence, this research is also aimed to find the possibility to use the 3D engine for creating a deformable 3D object which will be utilized in the surgical training simulation. If the engine can be used to create the deformable 3D skin object, it will be useful because the application developers can avoid the complexity of the Microsoft DirectX or Open GL API and will have more focus on the functions of their software.

In chapter 2 of this research discusses about computer graphics in generally and its history. The vector is briefly discussed in the section regarding the importance of the understanding of the vector in computer graphics. The chapter also discusses about the Microsoft DirectX and OpenGL since these 3D graphics Application 4

Programming Interface (API) are the main players in the industries. The last discussion in the chapter is discussing about 3D Graphics Engine that gives the ease of utilizing Microsoft DirectX or OpenGL without the complexity of low level of the API. The discussion is about the methodology and algorithm to create a deformable 3D skin and manipulate it using Unity3D 3 engine. The last chapter is a conclusion of the research.

## Conclusion

Surgical simulation using computer graphics could become an important thing in the future. It is a medical training or planning tool with efficient cost. The simulation can be repeated again and again without creating or buying a new set of the simulation tool. We can use Unity3D without any fee. Once we have created the 3D object, the simulation can use it forever. Even the 3D object could be better in term of realism of the object in the future due to some update of the simulation application. However, the accuracy of the simulation to simulate the real operation still need to be improved. The complexity of the properties of the object that being simulated such as the elasticity and its behaviour is too complex. Managing each element that forms the 3D object in the simulation is

the important thing. These works are including the way how to get the data of each element and how to manipulate it such as adding, deleting and moving the element. There are a lot of research to be done to create a realistic surgical simulation.

Bunga Rampai Tesis/Disertasi

# PERTANIAN

Program Beasiswa SPIRIT

# Strategi Implementasi Produksi Bersih pada Agroindustri Gondorukem

# Strategy for Implementation a Cleaner Production in Gum Resin Agroindustry


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# ABSTRAK

Produksi bersih merupakan strategi manajemen lingkungan terintegrasi yang mengurangi terbentuknya limbah dari sumber penghasilnya, sebagai salah satu alternatif yang digunakan untuk mengatasi terbentuknya limbah yang sekaligus menjadi cara mendapatkan efisiensi produksi. Strategi produksi bersih merupakan metode preventif yang diharapkan dapat memberikan manfaat perbaikan proses bagi industri yang terlibat. Penelitian ini dilakukan dengan mengambil studi kasus di Pabrik Gondorukem dan Terpentin di daerah Nagreg. Dalam penelitian ini digunakan pendekatan MET matriks (*material cycle*, e*nergy uses and toxixity emission matrix*) untuk mendapatkan informasi bahan dan energi yang masuk maupun yang dikeluarkan dari setiap tahapan proses yang didukung dengan analisis neraca massa dan neraca energi.

Pengembangan matriks informasi tahapan proses digunakan untuk mengidentifikasikan titik kritis yang merupakan masalah utama penghasil limbah pada masing-masing tahapan proses dan menunjukan efisiensi produksi pada saat ini. Alternatif opsi produksi bersih untuk masing-masing masalah pada titik kritis diperingkatkan dengan metode AHP untuk mendapatkan prioritas opsi yang memberikan penurunan limbah paling tinggi. Kriteria yang digunakan adalah kriteria kelayakan produksi bersih yaitu teknis, ekonomi dan lingkungan. Faktor teknis menjadi prioritas dalam pemilihan opsi produksi bersih yang dapat dilaksanakan dengan bobot 0,49, yang artinya kesesuaian opsi produksi bersih yang direkomendasikan dengan kondisi pabrik dan sumberdayanya merupakan faktor utama dalam penentuan prioritas opsi. Skor AHP tertinggi dari opsi produksi bersih yang direkomendasikan adalah pengaturan jadwal pengiriman getah dengan bobot skor 0,216 yang diikuti dengan sosialisasi standar mutu getah dan pengawalan getah, berarti bahwa opsi pengaturan jadwal pengiriman dan sosialisasi standar mutu serta pengawalan getah memberikan konstribusi penurunan limbah dan peningkatan efisiensi produksi yang paling besar.

Kata kunci: Produksi bersih, Gondorukem, Matriks material, energi dan toksisitas, Proses hirarki analitik

# ABSTRACT

Cleaner production is an integrated environmental management strategy that leads to prevention of the formation of waste from source, as an alternative used to overcome the information of waste source as well as a way to get production efficiency. As a preventive method, cleaner production strategy is expected to provide improved benefits for industrial related processes. This research was carried out by taking a case study in the Turpentine and Gum Resin Factory that was located in Nagreg. This study used MET matrix (material cycle, energy uses and toxixity emition matrix) approach to obtain information about material and energy going, and the energy emitted from each stage of the process that was supported by the analysis of mass balance and energy balance.

The development of information stage process matrix was able to identify critical point which was the main problem of waste production in each stage and demonstrate the efficiency of the production at this time. Cleaner production alternatif for each problem at critical point was ranked with AHP to get priority option that provides waste reduction and increased the highest efficiency of technical, economic and environmental criteria. The highest value of the factor was 0.49 for technical factor, which was conformity of the alternative cleaner production with the conditions of the factory. The highest value of cleaner production alternative was 0.216 for scheduling the delivery of sap, followed by the training for quality standar in the amount of 0.155, that means alternative scheduling the delivery of sap and training for quality standar provides the highest waste reduction and increased the highest efficiency.



Keywords: cleaner production, gum rosin, material, energy and toxixity matrix, analytical hierarki process

## Latar Belakang

Indonesia merupakan negara produsen gondorukem ketiga terbesar di dunia dengan konstribusi mencapai 8 % dari total produksi gondorukem dunia. Produksi gondorukem terbesar adalah China dengan produksi sampai 80 % dari total produksi dunia atau mencapai 500-850 ribu ton/tahun, diikuti Brazil dengan produksi gondorukem mencapai 80 ribu ton/tahun. Volume produksi gondorukem Indonesia yang diperdagangkan mencapai 60 ribu ton yang terdiri atas 80 % untuk pasar ekspor dan 20 % untuk memenuhi kebutuhan industri di dalam negeri (Fachrodji et al., 2009).

Konstribusi pendapatan kelompok industri non kayu termasuk gondorukem mencapai 42,3 % dari total pendapatan Perum Perhutani tahun 2011, yakni sebesar Rp1.178,9 miliar (Laporan tahunan Perum Perhutani 2011). Namun kapasitas industri gondorukem yang ada saat ini, khususnya yang dimiliki perhutani belum dapat dimanfaatkan secara optimum akibat kurangnya bahan baku. Selain itu, mutu getah yang diterima pabrik berada pada grade bawah sehingga berdampak pada perlakuan lebih untuk mengekstrak gondorukem dari getah. Untuk mengatasi permasalahan di atas, perlu dilakukan efisiensi produksi dengan tujuan meminimumkan biaya produksi sehingga keuntungan dapat meningkat meskipun penerimaan tetap (Artiyanto, 2006). Pengkajian produksi bersih pada industri olahan getah pinus yang menghasilkan gondorukem dapat menjadi salah satu metode untuk mencapai efisiensi produksi dengan perbaikan proses produksi yang meminimalkan limbah dari sumber penghasilnya.

Produksi bersih merupakan suatu strategi pengelolaan lingkungan yang sifatnya mengarah pada pencegahan dan terpadu agar dapat diterapkan pada seluruh siklus produksi. Strategi produksi bersih ini berawal dari pemikiran bahwa upaya untuk melindungi lingkungan perlu menyatukan dua kepentingan, yakni kepentingan lingkungan dan kepentingan bisnis. Dengan demikian, titik berat manajemen bergeser ke arah pengembangan teknologi dan proses produksi yang mencegah terjadinya limbah, tidak hanya mengolah limbah yang telah terbentuk (Indrasti dan Fauzi, 2009).

Pengkajian produksi bersih bersifat proaktif sehingga dapat dijadikan alat bantu yang baik untuk perbaikan berkelanjutan. Perbaikan berkelanjutan tersebut dalam introduksinya ke Sistem Manajemen Lingkungan akan membawa percepatan yang terarah dan terukur, baik dengan indikator fisik

maupun ekonomi (Hasibuan, 2005). Produksi bersih juga merupakan proses berkelanjutan untuk menuju disain lingkungan (ecodesign), yaitu pendekatan desain produk dengan memperhitungkan dampak lingkungan dari produk (Knight dan Jenkins, 2008). Dasar proses desain lingkungan adalah analisis yang komprehensif terhadap situasi yang terjadi. Pemahaman situasi riil dari sudut pandang lingkungan digunakan untuk mengembangkan strategi dan pengukuran yang spesifik (Wimmer et al., 2004). Fokus desain dan produksi yang ramah lingkungan adalah pada proses produksi bersih, pengurangan penggunaan material, energi dan bahan beracun, upaya daur ulang dan penggunaan kembali komponen dan produk yang telah selesai digunakan.

Penelitian ini diharapkan dapat memberikan masukan strategi implementasi produksi bersih yang dapat diterapkan pada agroindustri gondorukem sehingga diperoleh perbaikan proses yang mengarah pada efisiensi proses produksi dan penurunan limbah yang dihasilkan.

Produksi bersih merupakan suatu strategi yang digunakan untuk mengatasi terbentuknya limbah dari sumbernya. Sebagai metode preventif, strategi produksi bersih diharapkan dapat memberikan manfaat perbaikan kinerja bagi industri yang bersangkutan. Kapasitas produksi agroindustri gondorukem yang belum berjalan optimal merupakan sebuah tantangan untuk mengetahui kinerja industri yang telah dicapai dan bagian mana yang diperlukan perbaikan. Oleh karena itu diperlukan pengkajian produksi bersih pada agroindustri gondorukem untuk mendapatkan bagian mana yang memerlukan perbaikan dan metode perbaikan yang paling diterima. Selain itu produksi bersih merupakan gambaran menyeluruh seluruh tahapan proses produksi sehingga dapat diidentifikasi permasalahan dari segi limbah dan emisi yang dihasilkan untuk merumuskan rekomendasi perbaikan untuk kinerja industri.

Tujuan penelitian ini adalah menyusun strategi produksi bersih untuk meningkatkan kinerja agroindustri gondorukem, dengan tujuan spesifik sebagai berikut:

Menganalisis opsi produksi bersih yang dapat dilaksanakan pada proses produksi pabrik pengolahan getah pinus menjadi gondorukem. Menentukan prioritas opsi produksi bersih dengan menggunakan proses hierarki analitik.

Menyusun strategi implementasi produksi bersih pada industri gondorukem.

Hasil penelitian ini diharapkan dapat memberikan masukan pada industri terkait strategi implementasi produksi bersih yang dapat diterapkan pada proses produksi untuk mendapatkan perbaikan kinerja proses produksi dengan minimalisasi limbah dan emisi dari sumber pembentuknya.

## Penerimaan dan Pengujian

Permasalahan pada tahapan ini adalah ceceran getah pinus di lokasi penerimaan akibat bongkar muat dari truk dan kegiatan penimbangan. Pada periode tutupan terjadi penumpukan truk yang bongkar muatan di lokasi penerimaan sehingga menimbulkan antrian panjang dan ceceran pada sepanjang jalur masuk pabrik ke tempat penerimaan. Selain itu pengiriman yang terakumulasi pada periode tertentu mengakibatkan bak penampung penuh dan sebagian ditempatkan di ruang terbuka yang menyebabkan penurunan mutu getah. Permasalahan lain adalah fungsi pengujian kurang efektif akibat letak laboratorium pengujian getah yang jauh dari lokasi penerimaan, sehingga hasil pengujian laboratorium tidak dipakai sebagai dasar penuangan getah berdasar jenis mutunya.

## Pengenceran

Permasalahan pada tahap pengenceran adalah keterbatasan jumlah tangki melter sehingga produksi harus berhenti saat dilakukan pengambilan limbah padat yang berada di dasar tangki secara manual, serta tidak adanya talang ukur untuk mengetahui secara pasti jumlah getah yang masuk ke tangki untuk diolah.

## Pencucian

Permasalahan pada tahapan ini adalah keterbatasan kapasitas tangki pencucian sehingga hanya dapat menampung larutan getah dari satu kali proses pengenceran, akibatnya pengendapan yang dilakukan kurang optimal.

## Pengendapan

Tahapan keempat adalah pengendapan yang berfungsi menyaring kotoran yang masih tersisa. Pengendapan dilakukan pada tangki penampung dengan

kapasitas 7000 l. Tangki penampung ini berfungsi menampung larutan getah dari tangki pencucian yang selanjutnya akan dikirim ke tangki pemasak, sekaligus sebagai ukuran jumlah larutan getah yang akan dimasak. Tangki penampung juga berfungsi untuk menampung getah yang terbuang pada proses blowdown, yaitu dengan ditarik masuk dari kolam limbah ke dalam tangki penampung, kemudian diendapkan beberapa saat untuk memisahkan getah dari air dan kotoran.

## Pemasakan

Tahapan kelima adalah pemasakan. Proses pemasakan larutan getah menjadi gondorukem dan terpentin pada dasarnya prinsipnya menggunakan metode destilasi uap yaitu pemisahan berdasarkan titik didih. Metode distilasi uap adalah metode penyulingan cairan yang tidak saling campur dengan air yaitu dengan menghembuskan uap panas ke dalamnya. Pengontrolan dilakukan pada kaca pengamat untuk mencegah terbawanya larutan getah ke tangki kondensor dan melakukan peludangan (canning) atau pengemasan tangki gondorukem.

## Pengolahan Limbah

Permasalahan utama penghasil limbah tersebut merupakan permasalahan yang spesifik pada pabrik yang bersangkutan, kemudian dilakukan perbandingan berdasar literatur dan wawancara dengan pihak manajemen terkait hubungan permasalahan tersebut dengan pabrik gondorukem yang lain, sehingga diperoleh permasalahan yang dapat terjadi pada pabrik gondorukem lain dengan kondisi serupa. Proses pengolahan pada pabrik gondorukem pada dasarnya adalah sama yaitu dimulai dari penerimaan dan pengujian, dilanjutkan dengan pengenceran getah dan pencucian, kemudian dilakukan pengendapan sebelum dimasak dalam tangki pemasakan.

## Penentuan Prioritas Opsi Produksi Bersih

Opsi produksi bersih yang telah diperoleh kemudian disusun menjadi suatu alternatif dalam struktur hirarki dengan faktor yang digunakan adalah 3 kriteria kelayakan produksi bersih, yaitu aspek teknis, aspek ekonomi dan aspek lingkungan.

Kondisi teknis yang mempengaruhi penentuan prioritas adalah kapasitas produksi pabrik, luas pabrik, peralatan yang tersedia, lingkungan kerja, topografi lokasi yang berbukit serta sumber daya manusia yang tersedia. Kondisi industri gondorukem yang sedang berkembang dan investasi peralatan yang bernilai tinggi juga menjadi pertimbangan.

## Strategi Implementasi Produksi Bersih

Hasil penelitian menghasilkan beberapa opsi strategi produksi bersih terpilih. Strategi yang menjadi prioritas yaitu pengaturan jadwal pengiriman. Selain itu strategi lain yang memiliki tingkat kepentingan dan hasil evaluasi kelayakannya dapat memberikan pengaruh terhadap peningkatan kinerja proses yaitu sosialisasi mutu getah dan pengawalan getah. Strategi implementasi yang dapat dilakukan berdasar opsi prioritas yaitu:

## Pengaturan Jadwal pengiriman

Pengaturan jadwal pengiriman yang dilakukan harus mempertimbangkan kemampuan produksi dan kemampuan pengiriman dari masing-masing penghasil getah yang lingkupnya berada di luar pabrik yaitu KPH sehingga jadwal pengiriman dapat memberikan manfaat pada seluruh industri gondorukem. Insentif untuk program pemetaan penghasil getah diperlukan guna mendukung model penjadwalan yang tepat.

## Sosialisasi Mutu Getah dan Pengawalan Getah

Kurangnya pengetahuan dan kesadaran akan pentingnya faktor mutu bahan baku dalam industri gondorukem menjadi salah satu alasan dilakukannya sosialisasi yang menyeluruh pada industri gondorukem. Perlu adanya insentif harga getah berbasis mutu sehingga manfaat ekonomis getah pinus bermutu baik dapat berdampak pada lini terbawah yaitu tenaga penyadap sampai dengan pabrik pengolahan.

## Sosialisasi dan Pemasangan Rambu Keselamatan Kerja.

Pengawasan, pengendalian dan perlindungan keselamatan dan kesehatan kerja dilakukan dengan cara meminimalisasi potensi bahaya dengan menjaga

sistem pengawasan, perawatan kesiapan lingkungan, dan tata cara pelaksanaan kerja karyawan, memakai atau mempergunakan alat pelindung diri di lokasi kerja yang berpotensi menimbulkan kecelakaan dan penyakit akibat kerja, serta memastikan bahwa sistem manajemen keselamatan dan kesehatan kerja dipatuhi dan dilaksanakan sesuai kebijakan dan prosedur serta instruksi kerja yang telah ditetapkan. Sistem keselamatan kerja harus diketahui semua stakeholder sehingga dilakukan sosialisasi dan juga pemasangan rambu di lokasi pabrik.

## Rekomendasi Strategi Implementasi Produksi Bersih

Berdasarkan prioritas alternatif produksi bersih yang diperoleh dapat disimpulkan bahwa aspek lingkungan belum menjadi perhatian utama dalam penanganan masalah limbah. Aspek utama yang menjadi sumber perhatian dalam menangani masalah limbah adalah faktor teknis dari sisi bahan baku, yaitu alternatif pengaturan jadwal pengiriman dan pengawalan mutu dan pengiriman getah. Faktor bahan baku melibatkan pihak eksternal pabrik yaitu KPH sebagai penghasil bahan baku getah pinus dan Perhutani sebagai pembuat kebijakan, sehingga rekomendasi strategi untuk mendukung implementasi produksi bersih pada agroindustri gondorukem adalah sebagai berikut:

Perlu adanya perbaikan sistem insentif harga yang didasarkan pada mutu getah pinus. Penentuan harga getah pinus sebaiknya berdasar mutu riil getah sehingga mulai dari penyadap di hutan pinus sampai dengan penerima getah pada pabrik memberikan perlakuan yang baik pada getah untuk memperoleh harga yang lebih tinggi.

Perlu adanya sosialisasi manfaat ekonomis mutu getah pinus, bahwa getah pinus bermutu baik menurunkan biaya produksi sehingga meningkatkan keuntungan pabrik yang pada akhirnya berdampak pada nominal bagi hasil yang diterima KPH dari pabrik.

Perlu adanya insentif teknologi pemetaan TPG sehingga diperoleh data kemampuan produksi yang akurat untuk merumuskan kebijakan pengaturan pengiriman getah yang menguntungkan bagi penghasil getah maupun pabrik pengolah. Kebijakan yang dirumuskan dengan pengaturan jadwal pengiriman dari TPG, pengumpulan pada TPG induk, maupun mekanisme pengiriman ke

pabrik diharapkan dapat menghilangkan akumulasi bahan baku pada suatu periode dan kekosongan pada periode lain sehingga kapasitas produksi harian dapat tercapai.

Meningkatkan kesadaran akan good manufacturing practices di lingkungan pabrik dengan memberikan SOP yang jelas baik pada aspek operasional maupun kesehatan dan keselamatan kerja, melakukan sosialisasi SOP pada semua lini pada pabrik dan memastikan SOP yang telah disusun dilaksanakan dengan baik. Kebijakan kesehatan dan keselamatan kerja dengan adanya divisi khusus yang menangani masalah k3 serta sistem prestasi dan hukuman dapat dijadikan alternatif untuk memupuk kesadaran pekerja terhadap pentingnya aspek keselamatan dan kesehatan kerja.

Mendorong agroindustri gondorukem untuk mengadopsi sistem manajemen lingkungan yang terintegrasi dengan produksi bersih.

## Kesimpulan

Hasil identifikasi terhadap proses produksi pada pabrik gondorukem menghasilkan kelemahan yang perlu mendapat perbaikan untuk meningkatkan kinerja industri gondorukem. Melalui analisis neraca massa dan met matriks diperoleh tahapan kritis dan permasalahan utama yang menyebabkan terbentuknya limbah. Secara umum kelemahan yang ada pada semua tahapan proses sehingga menghasilkan limbah yaitu mutu getah yang masuk rendah dan pengolahannya belum efisien, keterbatasan peralatan dan tangki proses, serta kurangnya kesadaran akan kesehatan dan keselamatan kerja di lingkungan pabrik.

Metode pengambilan keputusan AHP pada 10 opsi produksi bersih yang direkomendasikan memperkuat permasalahan mutu getah sebagai prioritas utama dalam implementasi produksi bersih pada industri gondorukem. Prioritas opsi produksi bersih dengan bobot 0,216 adalah pengaturan jadwal pengiriman getah, diikuti dengan pelatihan standar mutu getah dan pengawalan mutu dengan bobot 0,155, yang artinya opsi tersebut memberikan penurunan limbah yang terbesar sehingga berdampak pada efisiensi proses produksi gondorukem.

Pencegahan kehilangan bahan baku yang diperoleh dengan penerapan opsi pengaturan jadwal pengiriman sebesar Rp7.910,-/ton gondorukem, sedangkan aspek lingkungan berupa minimalisasi limbah getah sebesar 2,65 kg/ton gondorukem. Perlakuan yang diberikan pada getah merupakan strategi prioritas untuk peningkatan kinerja industri gondorukem sehingga akan berdampak pada peningkatan kinerja lingkungan pada industri gondorukem.

Bunga Rampai Tesis/Disertasi

# TEKNIK

Program Beasiswa SPIRIT

# Pembuatan Geodatabase untuk Cadastre 3D di Indonesia

# Creation Of Geodatabase for 3D Cadastre in Indonesia


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# ABSTRAK

Modernisasi dan pembangunan perkotaan telah mengubah cara orang memanfaatkan tanah mereka. Faktor-faktor tersebut (dan faktor pendukung lainnya, seperti kekayaan atau masalah keuangan lainnya) telah mendorong orang untuk memanfaatkan sumber daya lahan untuk memenuhi kebutuhan mereka. Dalam beberapa dekade terakhir, telah terjadi peningkatan usaha atau kecenderungan pengembangan vertikal (misalnya tipe apartemen perumahan) sebagai solusi untuk sumber daya lahan yang terbatas. Akibatnya, sistem peta 2D, yang tidak bisa mewakili situasi 3D ini dengan benar, nampak tidak memadai.

Badan Pertanahan Nasional (BPN) Republik Indonesia adalah lembaga yang didirikan untuk mengelola penggunaan dan pendaftaran kepemilikan tanah di Indonesia. BPN, saat ini, menggunakan sistem pendaftaran 2D. Namun, BPN juga mendaftarkan kepemilikan unit apartemen (masing-masing flat akan dicatat sebagai satu kesatuan dan satu set hak). Proyek ini bertujuan untuk mengadaptasi metode praktis yang bisa digunakan di Indonesia untuk merekam dan memvisualisasikan unit apartemen dalam pendekatan hibrida untuk mempertahankan kadaster 3D.

Geodatabase untuk kadaster 3D, dalam konteks Indonesia, dibuat dengan menggunakan ArcGIS setelah mempertimbangkan persyaratan pendaftaran tanah Indonesia berdasarkan peraturan perundang-undangan di Indonesia. Model 3D untuk apartemen dibuat menggunakan Google SketchUp Makes dan kemudian modelnya diintegrasikan ke dalam geodatabase. Namun, untuk alasan praktis dan untuk menghindari kompleksitas kadaster 3D, ada beberapa keterbatasan dan asumsi yang dibuat dalam proyek ini. Meskipun geodatabase yang diusulkan oleh proyek ini tampaknya layak dan sesuai untuk diadopsi, BPN juga harus mempertimbangkan pendekatan lain dalam kadaster 3D dan membandingkan semua pendekatan 3D yang ada untuk menemukan metode yang paling praktis. Masalah User dan Usability dapat dipertimbangkan saat memilih metode terbaik untuk diadopsi.

# ABSTRACT

Modernization and urban development have changed the way people utilize their land. Those factors (and other supportive factors, such as wealth or other financial matters) have been encouraging people to exploit land resources to meet their needs. In recent decades, there has been an increasing effort or trend towards vertical development (e.g. the apartment type of housing) as a solution for the limited land resources. Consequently, 2D map systems, which cannot represent this 3D-situation properly, seem inadequate.

The National Land Agency (NLA) of the Republic of Indonesia is an institution established to manage the use and register the ownership of the land in Indonesia. The NLA, currently, is using a 2D registration system. However, the NLA also registers the ownership of apartment units (each flat will be recorded as a single entity and a single set of rights). This project aimed to adapt a practical method to be used in Indonesia to record and visualize apartment units in a hybrid approach to maintaining the 3D cadastre.

A geodatabase for 3D cadastre, in the Indonesian context, was created using ArcGIS after considering requirements of Indonesian land registration based on law and regulation in Indonesia. 3D models for apartments were created using Google SketchUp Makes and then the models were integrated into the geodatabase. However, for practicable reasons and to avoid complexity in the 3D cadastre, there were some limitations and assumptions made in this project. Although the geodatabase proposed by this project seems to be feasible and suitable to be adopted, the NLA should also consider other approaches in 3D cadastre and compare all available 3D approaches to find which the most practical method is. User and Usability issuescan be considered when choosing the best method to be adopted.

Modernization and urban development have changed the way people utilize their land. Those factors (and other supportive factors, such as wealth or other financial matters) have been encouraging people to exploit land resources to meet their needs. On the other hand, limited land forces people to exploit land vertically. Therefore, in recent decades, there has been an increasing effort or trend towards such vertical development (e.g. the apartment type of housing). Consequently, 2D map systems, which cannot represent this 3D situation properly (e.g. the conventional cadastral map only represents parcels boundaries on the surface), seem inadequate.

The government of the Republic of Indonesia is using Law number 5 year 1960 (Presiden Republik Indonesia, 1960), that is the Basic Agrarian Law (BAL), as a legal framework to perform cadastral tasks (land administration and land registration). The BAL was enacted as an implementation of the 1945 Constitution of the Republic Indonesia article 33 which implied that earth (land), water and natural resources are controlled by the State and must be utilized for the welfare of Indonesian citizens (Majelis Permusyawaratan Rakyat, 1945). The National Land Agency (NLA) of the Republic of Indonesia is an institution established to manage the use and register the ownership of the land in Indonesia. The NLA, currently, is using a 2D registration system. This means that the NLA only deals with land registration horizontally; in other words, in the map, a parcel is defined by the boundary of the surface of the land under consideration. However, the NLA also registers the ownership of apartment units (each flat will be recorded as a single entity and a single set of rights).

Furthermore, Indonesian Law number 20 year 2011 (Presiden Republik Indonesia, 2011), on Strata Title for Apartment, is used as the legal framework for apartment registration. According to the law, the NLA issues a certificate of apartment ownership (SHMSRS – sertipikat hak milik atas satuan rumah susun) that is linked to the right to build the apartment complex on the land parcel. In other words, the NLA registers the parcel in which the apartment building is located and also registers each apartment unit by linking additional documents for the apartment unit. Stoter (2004) defined this method as 'A 2D cadastre with 3D tags'. This method is very simple and practical; however, there is no spatial data for each apartment unit so all units in one complex will be linked to the

same parcel. This does not make sense for visualization purpose. Therefore, Stoter (2004) also proposed two other approaches for 3D cadastre, namely a full 3D approach and a hybrid approach.

To quote Stoter (2004, p. 222) "In a full 3D cadastre, rights are no longer established on parcels, but on well-defined, surveyed volumes". This method needs a new legal framework to register these volumetric rights because, and, as stated by van der Molen (2003), cadastres will not run properly without "appropriate legal frameworks and transparent public administrative structures" (institutional parameters). In other words, the development of the technology should go together with the development of institutional conditions. Many research and development projects have discussed topics related to 3D technology, e.g. 3D applications, 3D data collection, 3D data sets and 3D DBMS & GIS/CAD software (Lemmen and van Oosterom, 2003) that have become important tools making it possible to create 3D cadastre systems. Some papers are focusing on technical aspects, such as Ellul and Haklay (2006) and Spirou-Sioula, Ioannidis and Potsiou (2013); others address the legal aspects of 3D cadastre (including institutional issues), namely Ho et al. (2013) and van der Molen (2003). Van Oosterom (2013) stated that, during the last decade, "the domain of 3D cadastres has clearly matured in both research and practice".

However, considering the current legal framework in Indonesia, the full 3D approach is not suitable. The main reason is because, currently, land registration in Indonesia only refers to land surfaces (Presiden Republik Indonesia, 1960). According to that law, land rights only apply to land surfaces with additional rights to exploit the land (not only the surface) for other beneficiaries as stated on the legal document. For example, when someone is given a right to build on land, he or she is allowed to dig the land for building foundation purposes as required. Nonetheless, if he or she discovers natural resources (oil, coal etc.), he or she is not allowed to take benefits from the resources because it is not in accordance with the building requirements. The other reason is related to the technical aspect of the land registration in Indonesia. There are approximately 85.8 million parcels in Indonesia and only about half of those parcels have been registered, according to Supandji (2013) who estimated about twenty years are required to register all parcels. It will take even longer to meet the agenda if Indonesia is also converting its 2D cadastral mapping into a 3D mapping system.

For those reasons, it makes sense for Indonesia not to use the full 3D approach for its land registration but consider a third approach, the hybrid approach. This kind of 3D cadastre approach is achieved by modelling or recording a 3D situation and linking it to the current map. This is similar to the 3D tags approach, but the apartment unit will be recorded as single record or model, not only as additional documents of the parcel. Spirou-Sioula, Ioannidis and Potsiou (2013) presented three alternative ways to make a transition from the existing 2D cadastral system to a 3D hybrid model using SDBMS, 3D GIS and CAD applications. They believed that a 3D hybrid model is more appropriate and realistic in the short term context because employing a full 3D model needs the amendment of the existing legal frameworks (e.g. a new law to define 3D properties and rights). In addition, they emphasised the advantages of such representation methods and interoperability with current software over more complex efforts to create a 3D model. Hence, the hybrid approach seems to be suitable within the Indonesian context.

This project, therefore, is attempting to create a geodatabase for 3D cadastre, in the Indonesian context, based on the approach advocated by Spirou-Sioula, Ioannidis and Potsiou (2013) by creating apartment models and integrating them into a geodatabase, thus using a hybrid approach. ArcGIS and Google SketchUp Makes will be employed to achieve the objective. ArcGIS is powerful software for maintaining any spatial data, especially storing and managing data in a single geodatabase. By managing GIS data in a (file) geodatabase, it is easier to maintain the data, and also it makes it possible to optimize storage capacity because ArcGIS can implement data compression and has other advantages (Childs, 2009). In addition, there is also a great possibility that the data will be migrated to other GIS software packages (i.e. interoperability). ArcGIS supports the use of such 3D modeling, but Google SketchUp Makes is chosen to create the models for several reasons. The first reason is the ability to instantly create a realistic and accurate model, i.e. it has a wide range of tools to make detailed models from its huge library. The second reason, and the main reason, is the possibility or capability of integrating the data into a geodatabase in ArcGIS.

This project's two aims are to adapt a practical method to be used in Indonesia to record and visualize apartment units in a hybrid approach to maintaining the 3D cadastre.

## Scanned Drawing Issue

Six files of scanned engineering drawings of a multi-storey building were used as digitizing guidance to create apartment models in this project. The drawings consist of one basement and five floors that vary in the number of rooms and design. As a case study in the project, an apartment is represented by a room with synthetic/dummy data for the attributes required for the Apartments feature class as indicated in the geodatabase design.

Since there are six different files of drawings, each drawing needed to be registered based on one reference drawing (in this project, the basement drawing is used as reference) so all drawings are relatively matched, in term of position, with each other. However, the poor quality of the architectural blueprint is clearly seen from those drawings (which are about 30 years old) because there are such inconsistent forms of drawing of the same object, for example pillars (see Figure 18). This make it difficult to identify very accurate control points for the registration since some control points need to be the common objects of the drawings. In this project, the accuracy issue is not really of concern and becomes almost a limitation for this project. In fact, this project was intended to propose a practical way to adopt a 3D cadastre in the context of the current situation of land registration in Indonesia.

Furthermore, one drawing is damaged because some parts of the image are distorted as seen in Figure 19. For this situation, the models on those parts were created by deriving or interpolating the image from another drawing of the respective location. The assumptions were taken that each floor has the same outer wall of the building and should be drawn in

Although accuracy is not a concern in this project, the registration of the drawings is still considered to have very low RMS error value as indication of the transformation's accuracy. Figure 21 shows the screenshot of the Link Table of the registration for the fourth floor's drawing. It can be seen that those four control points bring RMS error value of 1.72999 x 10-12 using Projective Transformation. RMS error is defined as a value of the total error computed from the difference between control points used for transformation (ESRI, 2014). Zero is the perfect value for RMS error meaning that the control points of the target

image are perfectly matched to the reference image. Table 8 shows RMS error values of the drawings.

## Models Issue

3D models of apartments were created based on the scanned drawings of the building, therefore, the models' accuracies are related to the accuracy of the drawings. As discussed in the previous section, this project was not concerned with a very accurate result of the models because the main intention was to propose a very practical way of adopting 3D cadastre for land registration in Indonesia. In the current situation, the main concern is to make a 3D visualization of apartments and to integrate the models into a geodatabase. In other words, instead of only attaching attribute data or documents of apartments in the current cadastral system, 3D models can also be integrated to give a better visualization and to complement the spatial data of the current system.

Google SketchUp Makes offers possibilities for creating realistic and accurate 3D models by providing a wide range of tools and libraries for modeling. There are many models created and shared online from the many SketchUp users around the world and these can be accessed at https://3dwarehouse.sketchup.com/. Figure 22 is one example of a model created using a drawing as guidance including its interior. In this project, however, models are not created that way. Instead of creating models formed by walls, interiors etc., each apartment is represented by the "room" itself. In other words, the models created in this project were not very "realistic" or detailed because it needs more time to create such detailed models and it was expected that time allocation for the project would not be sufficient for that purpose. On the one hand, it is good to use detailed models for apartment representation; on the other hand, this project was intended to propose a practical way, including a simple and quick way to create model. Indeed, the National Land Agency

(NLA) as the institution in charge of performing land registration in Indonesia is not dealing with sophisticated 3D models for apartments. The NLA is concerned with the apartment "boundary" that is represented by its room.

## Conclusions

To conclude, it can be stated that all objectives of this project (designing geodatabase, creating models, importing models into the geodatabase and ArcGIS customization) have been achieved as discussed in the Chapter 3; however, some issues (such as limitations and assumptions made in this project) should be noted as indicated in the Chapter 4. Generally, the limitations on the project were needed for practical reasons and to avoid the complexity of the 3D cadastre proposed, so the method of this project is doable by operators or officers of the National Land Agency (NLA). Designing the geodatabase and customizing ArcGIS are done only at the early steps, and if this approach is accepted by the NLA, to be implemented, the geodatabase can be replicated in all land offices in Indonesia. The NLA staff members, therefore, will execute other steps related to model creation as discussed in Section 3.2 to 3.4.

The hybrid approach presented in this project seems to be feasible and suitable for adoption by the NLA. However, before deciding to implement the geodatabase suggested in this project, the NLA should also consider other approaches or research in 3D cadastre and compare all available 3D approaches to identify which is the most practical method. The NLA should encourage more staff members to study or do research in 3D the cadastre topic. User and Usability issues can be considered when choosing the best method to be adopted.

# Perencanaan Lingkungan dan Infrastruktur Fakultas Ilmu Spasial Universitas Groningen

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# ABSTRACT

Post-disaster recovery is an effort to rehabilitate the affected community by providing a safer environment. In certain area, the recovery often deals with relocation and resettlement if the source of danger cannot be removed. In order to pursue a quick recovery in relocation and resettlement, a top-down planning approach with hierarchal structure is generally applied. In the midst of the complex problem of conducting resettlement and providing a safer environment for community, this top-down planning is modified or even complemented with different planning approaches to address the dynamics of the situation. Furthermore, the aim of this research is to understand the planning process during the post-disaster recovery and to acknowledge the difficulties that top-down planning is confronted when dealing with resettlement project. This paper captures the most affected area of densely populated in Sleman Regency in Indonesia that face a volcanic eruption as the study case. The paper uses the method of qualitative research through the selection of secondary data, primary data, and in-depth interview to give a comprehensive picture of the case. This thesis concludes that the top-down planning adapts to the complex situation by applying a community-based approach to allow more flexible coordination among stakeholders and active participation in the community. Hence, the strengths and weaknesses of the implementation of top-down planning with community-based program are expected to be lessons-learned for further post-disaster planning policy.

# ABSTRAK

Pemulihan pasca bencana merupakan upaya untuk merehabilitasi masyarakat yang terkena bencana dengan menyediakan lingkungan yang lebih aman. Di daerah tertentu, pemulihan sering berkaitan dengan relokasi dan pemukiman kembali jika sumber bahaya tidak dapat dilepas. Untuk mengejar pemulihan cepat dalam relokasi dan pemukiman kembali, pendekatan perencanaan top-down dengan struktur hirarki umumnya diterapkan. Di tengah masalah kompleks dalam melakukan pemukiman kembali dan menyediakan lingkungan yang lebih aman bagi masyarakat, perencanaan top-down ini dimodifikasi atau bahkan dilengkapi dengan pendekatan perencanaan yang berbeda untuk mengatasi dinamika situasi. Selanjutnya, tujuan dari penelitian ini adalah untuk memahami proses perencanaan selama pemulihan pascabencana dan untuk mengetahui kesulitan yang dihadapi oleh perencanaan dari atas ke bawah saat berhadapan dengan proyek pemukiman kembali. Makalah ini menangkap daerah yang paling terkena dampak terpadat di Kabupaten Sleman di Indonesia yang menghadapi letusan gunung berapi sebagai studi kasus. Makalah ini menggunakan metode penelitian kualitatif melalui pemilihan data sekunder, data primer, dan wawancara mendalam untuk memberikan gambaran menyeluruh mengenai kasus tersebut. Tesis ini menyimpulkan bahwa perencanaan top-down menyesuaikan dengan situasi yang kompleks dengan menerapkan pendekatan berbasis masyarakat untuk memungkinkan koordinasi yang lebih fleksibel antara para pemangku kepentingan dan partisipasi aktif di masyarakat. Oleh karena itu, kekuatan dan kelemahan pelaksanaan perencanaan top-down dengan program berbasis masyarakat diharapkan dapat dipelajari secara pelajaran untuk kebijakan perencanaan pasca-bencana lebih lanjut.

Disasters have devastating impacts to people's life and environment, thus immediate response is required to recover them to their normal condition. According to the definition of Center for Research on the Epidemiology of Disasters (CRED, 2007), "Disaster is a situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering". Therefore, disaster which are occurring in an increasing frequency in the world with devastating impact (Shaw, 2006 in Karunasena, et. al., 2010) have stimulates several planning approaches from the national and international level to overcome the impacts. In attempt to achieve immediate response and recovery, planning approaches are selected and examined by planners and policy-maker. One of the approaches to manage a quick response in effective way is top-down planning approach. Subsequently, planning processes in post-disaster situation can be regarded as functional rational rather than as communicative rational (De Roo, 2001). He further elaborates traditionally this situation is solved by using a functionality reasoning, which means not much more than top- down policy urging a central government giving directives to local authorities. Functional rationality is concerned with means and efficiency – it is seek to meet ends in the most effective and efficient way (Allmendinger, 2002). Hummel and Ahlers (2007) also argue that the centralized management and support is vital to effective and efficient reconstruction, emergency funding can be appropriated and distributed to areas affected by the disaster, and myriad agencies are coordinated to move reconstruction forward. This reflects the top down-planning is still generally applied in post-disaster recovery; since it is believed the functional rational behind this planning approach support functional yet quick recovery.

Along with its functionality, top-down planning also receives criticism on its limitation on dealing with complex problem that usually occur in post-disaster recovery. Allmendinger (2009) argues the functional rationality behind the top-down planning is akin to command rather than collaboration. While the fuzzy nature of planning in the complex situation requires collaborative act of actor-consulting to address differences (Roo & Porter, 2012), top-down planning gives little space for different actors involved in the planning process. Healey (1997) supports the idea that communicative rationality takes as an

ethical commitment to enabling all stakeholders to have a voice, which then offers a way of mobilising for change through collective efforts. In the contrary, the public and leaders often clamor to re-build quickly yet better than before, by using the common practice of command and directives from centralized government (Comfort, 2005 in Ingram et. al., 2006). This idea is generally framed with a phrase of 'build back better'. It means recreate or rebuild the community or environment with better condition than before. The doubt still remains on whether it is feasible for top-down planning to unlock the phrase 'build back better' into realization due to the complex characteristic of post-disaster recovery. Khasalamwa (2009) argues that despite the engaging mantra 'build back better', the disaster response in some cases have not lived up to expectations. In many cases this phrase is difficult to be brought into reality, particularly when a top-down planning is used in the process. For instance, the government's top-down policy of reservoir resettlement in Yangtze River (China) resulted in rural-urban migrants being marginalized as a community. Instead of becoming better, the quality of the resettlement in new area is degraded (Heming, Waley, & Rees, 2001). The criticism is basically derived from the perspective that top-down planning approach with its command and hierarchal characteristics has limited function to deal with complex issue (e.g. post-disaster recovery).

Post-disaster recovery in resettlement project is complex issue since several different issues emerge altogether. Post-disaster recovery is not just a single issue of rebuilding houses and buildings, but often it also consists of several different issues of relocating and rehabilitating community. The act of relocating residents from the hazard zone in resettlement project happens when the danger cannot be removed. Disaster caused by volcanic eruption is one of the situations where the possible option for recovery is by moving people to safer environment. Chan (1995) in Whiteford and Tobin (2004) explains to protect populations from hazards, relocating population is one of the most common practices. Nevertheless, the difficult part for planner is to make sure the quick recovery and collaborative act are both embraced in the post-disaster planning.

Thus, this research reviews the practice of post-disaster planning and its strategy to live up the expectation of 'build back better'. The aim

of this research is to understand the planning process during the post-disaster recovery and to acknowledge the challenges that top-down planning is confronted when dealing with resettlement project. Case study of community-based resettlement in Sleman Regency, Yogyakarta, Indonesia is selected to demonstrate the practice of top-down planning in recovery process. Further, the paper seeks some lessons-learned extracted from the case study. Therefore, the following research questions are defined to address the planning process and the confronted challenges during the post-disaster recovery.

- How and why is top-down planning process implemented typically in resettlement projects during post-disaster recovery?
- How community-based approach influences top-down planning used in the resettlement project, specifically in the case of Rekompak program in the Sleman Regency, Yogyakarta, Indonesia?
- Are there key factors in the Sleman's resettlement planning process which can be a lessons-learned for further post-disaster planning policy, specifically for Indonesia's context?

Those empirical questions are addressed by a theoretical approach based on theories as the followings:

- The concept of post disaster recovery in disaster management cycle.
- The concept of top down planning.
- The concept of community-based approach.

As mentioned in the previous explanation, this paper aims to provide insight on the approach of top-down planning in post-disaster recovery in effort to provide safer environment for the community. On addressing the research questions, the set of objectives are stated in the following lines: Identify the government's approach in conducting the resettlement project in Sleman Regency.

Identify the practice of community-based resettlement from the case study and how it affects the line of coordination in top-down planning. Identify the role of stakeholders and how they influence the recovery process. Identify the strengths and weaknesses of the post-disaster planning based on the case study.

Hereafter, these objectives guide the flow of discussion from understanding the concept and theoretical background, then to put it into the context by the illustration of the case study. It is hoped that the output of this study can be an additional reference for all stakeholders from practitioner, government officials, academics, to NGO's on the implementation of planning policy in post-disaster situation and how it affects the execution of project.

Mount Merapi (2,968 amsl) is located in the provinces of Central Java and Yogyakarta in Indonesia. It is the most active stratovolcano in this archipelago country; it erupts more than 80 times between Year 1672 to 2010 (Bappenas & BNPB, 2011). On average, it erupts once in just every 4 years. In its ordinary patten, Mount Merapi activity starts from lava development, followed by dome collapse to create pyroclastic flow (Kusumayudha, 2012). More than 200,000 people live in the disaster-prone are of Merapi (Statistic Bureau, 2008 in Bappenas & BNPB, 2011) with acquaintance towards Merapi's ordinary pattern. Kusumayudha (2012) says in most villages there are community association that well-trained on volcanic hazard mitigation. Villagers have commonly known to live their daily life harmoniously with the nature of Merapi. It has been providing valuable natural resources for people's life. It has been among Indonesia greatest givers of life and prosperity for some of the earth materials, energy and fertile soils (Murphy, 2010). Merapi's volcanic ash contains fine material which play important role in feeding the soil (Suriadikarta, et. al., 2011). Consequently, villagers benefit the abundance crops yield to gain profit and income.

## Conclusion

The theoretical concept of top-down planning and community-based approach are discussed earlier in the second chapter of the thesis. Further, the conceptual model of this thesis elaborates that power-related and functionality characterizes top-down planning, and participatory characterizes community-based approach. These post-disaster planning approaches connect to the dependent and complex characteristics of resettlement. In the study case, the general situation of resettlement project in Sleman's case can be characterized by the top-down driven initiatives, limited resources of villagers, strong communal bond, enthusiastic community participation, multi-stakeholders

involvement, lengthy implementation, The characteristics of Sleman's case proven to be more complicated since the profile of local community impose the characteristic of the resettlement project. This leads to the adaptive post-disaster planning towards the distinct characteristic of resettlement in Sleman.

From the research result and analysis of the findings, top-down planning adapts to the complex situation of recovery by involving community-based approach into the post-disaster planning. Though, it is manifested in form of community participation in the final planning process. The master plan and the disaster-prone area are already established before community enters the 'arena' of planning. The unique thing on Sleman's case is community does sharing responsibility and authority in genuine participation (see e.g Anstein's ladder of citizen participation, 1969; Selener's type of participation, 1997) in resettlement plan, although they are still exhausted in the transition phase (see the concept of post-disaster management cycle). The fact that the participation resembles partnership type implies that community also holds control provided that they are doing continuously cooperation with Rekompak and government. The transition phase is not also bringing difficulty to villagers, government also face a difficult situation in regard with some of NGO's works in the transition phase. The chaotic situation after the disaster left some confusion on what things should be done and what things should be prohibited. Eventually, the post-disaster planning is not just limited to address complexity and dependency of resettlement project, but it also address the connectivity among actors. Refers to the case study, the connectivity among actors has become an important factor to the accomplishment of post-disaster planning. Even in the case of disaster recovery, actors whom acquire the most linkages to other stakeholders possess larger access to influence the planning process. Furthermore, the excerpt of top- down planning process, influence of community-based approach, and key factors in the Sleman's resettlement planning process are presented in the next sections.

## Top-down Planning Process

From point of view of recovery process, specifically in resettlement project, the top- down planning practice has rather dominant role. The establishment of master plan of Action Plan for Rehabilitation and Reconstruction after Merapi's

Eruption, map of disaster-prone area of Merapi eruption, and Rekompak program for resettlement project, affirm the practice of top-down planning in the recovery process of Sleman, Yogyakarta. Aside from the functionality and power-related factors, as the theoretical concept suggests, the practice of top-down planning also indicates a distance or gap factor. The so-called master plan is considered as product of scientific and analytical techniques, where only the experts and decision-makers are part of its establishment. It does emphasize on functional rationality as the behind logics. But digging deeper to the case, the top-down planning process is also induced by a gap between government and community. Often it position community as the receiver of end-product of policy. The hierarchal structure of government takes part on creating the distance between government and community. The synoptic profile in the hierarchal structure depicts a one-line organization that makes the government seem quite unreachable. However, as the paradigms shifted on disaster management to become more preventive, multilateral, decentralization, disaster risk management, common responsibilities (as shown prior in Figure 4.2), government is indeed need a 'hub' to link better with community. In this situation, Rekompak program has become a suitable hub to connect them to community and local actors in the resettlement project.

The sets of guidelines, regulation, and directives mark the top-down planning process in Sleman's case. Soon after the disaster occurred, work team consists of line ministries are formed to handle the recovery. National Board for Disaster Management is appointed to be the leading agency for post-disaster recovery process. Along with other governmental institution, this team formulates the necessary steps to be taken for the establishment of recovery plan. The systematic yet functional organization made a clear guideline – which then becomes the strength of this post-disaster planning, The foremost critique for the top-down planning process is the lengthy procedure and obstructed reciprocal interaction during the execution of resettlement project.

## The Influence of Community-based Approach

In the midst of the complex problem of resettlement project after the disaster, the top- down planning is complemented with different planning approaches to address the dynamics of the situation in Sleman's case. Community-based

approach is then applied to address the complex problem of multi-aspect of recovery. As discussed in Chapter 5, the recovery covers from physical, social to economical recovery. The multi-aspect recovery may not solely answered by direct guidelines from central government. In the case of Sleman, it needs negotiation and discourse along the planning process to deal with multi-aspect recovery. Therefore, the community-based approach stimulates a more dynamic interaction in the coordination line. It modifies the rigid line of coordination to be more flexible, thus creating more connection between actors. Moreover, it also supports community participation in the planning process. These modifications of the way of doing planning recovery are resulted from the influence of community-based approach towards top-down planning practice. It has been the strong points of this post-disaster planning. A huge expectation would be the fact that afterwards, community can see and experience the effect of their involvement. Not merely just involve in the planning process, but whether they can actually benefit from their involvement in the resettlement plan.

The recovery attempt based on 'build back better' vision has been widely accepted in disaster management. It is not a new concept to be implemented in disaster recovery and it is not a special treatment for Sleman's recovery. Since Sleman's recovery vision is relatively similar with many disaster recoveries, are there any distinguishing key factors in the Sleman's resettlement planning process as a lessons-learned? In regard with this key factor, many respondents identify the accommodating planning policy in Sleman's resettlement planning process has open the accessibility for community to participate on determining their own resettlement. Regional Disaster Management Board of Sleman Regency (2014) highlights the importance of participatory activity along the planning process on achieving a good resettlement project. The participatory activity is enabled to take place by the accommodating planning policy. It doesn't put top-down planning as the single planning approach, but use another planning approach to fill the weakness of top-down planning practice in addressing the complexity of problems. This key factor of accommodating planning policy has causal effects which determining the further implementation in the resettlement projects. Breaking down to the details, these are the distinctive implementation of Sleman's resettlement planning process which can be a lessons-learned for further post- disaster planning policy, specifically for Indonesia's context:

- The Rekompak has positioned not just a program for recovery but also becomes an effective knot for all the stakeholders to be connected, then to involve and contribute to the project.
- The structure of coordination of planning and budgeting is organized by the top- down planning approaches that adapts to the complexity by applying a community- based scheme and cross-scale interaction for recovery process.
- The government establish an integrated master plan specifically for rehabilitation and reconstruction program by involving experts and related authorities in early planning process. The integrated master plan comprises: Action Plan as for Rehabilitation and Reconstruction after Merapi's Eruption as the regulatory guideline for all stakeholders, Map of disaster-prone area of Merapi's eruption as spatial guideline on developing resettlement, Rekompak program to facilitate the recovery process by committed to these general guidelines.
- Community-based resettlement could be implemented by the clear role of each technocrat, officials, villagers, and NGO's, whereas the most possible.
- The shared-responsibility is essentially translated as shared-power or shared- authority in the context of Sleman's case. The sense of community's ownership is build through sharing the power to determine and manage the relocation, site-plan and resettlement by themselves.

# Skenario untuk Keberlanjutan Energi di Pulau Jawa, Madura, dan Bali di Indonesia pada Tahun 2030

# Scenarios for Energy Sustainability In Java, Madura, and Bali Islands in Indonesia in 2030


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# ABSTRAK

Jawa, Madura dan Bali (Jamali) merupakan daerah terpadat di Indonesia. Wilayah seluas 8% dari luas Indonesia, tapi memiliki kontribusi ekonomi sebesar 58% dari total aktifitas perekonomian Indonesia di tahun 2010. Hal ini menyebabkan kebutuhan energi di Jamali jauh lebih besar dibanding daerah lain di Indonesia, sehingga pemerintah harus memastikan bahwa keberlanjutan suplai energi ke wilayah ini tetap terjaga.

Konsumsi energi di Jamali mencapai 2791 PJ di 2011 atau 52% dari total konsumsi energi Indonesia. Hal ini mengindikasikan bahwa Jamali mempunyai peran yang sangat penting di Indonesia. Energi dari fosil mempunyai proporsi yang sangat tinggi sebesar 82%, dimana minyak bumi mempunyai porsi terbesar sebesar 42%. Energi terbarukan mencapai 13%, sebagian besar disumbangkan dari biofuel, biomasa, geothermal dan tenaga air.

Untuk memperkirakan konsumsi energi di tahun 2030, riset ini menggunakan software The Long range Energy Alternatives Planning System (LEAP) yang dikembangkan oleh Stockholm Environment Institute. Software ini telah secara luas digunakan sebagai sarana untuk menganalisa kebijakan energi dan mitigasi perubahan iklim. Sebagai tahun dasar, digunakan data pada tahun 2011, dan berikut adalah beberapa asumsi yang digunakan untuk tahun 2011 dan 2030: (1) pendapatan perkapita akan naik dari 2500 menjadi 7500 USD/kapita; (2) populasi akan meningkat dari 140 menjadi 168 juta; (3) jumlah rumah tangga akan naik dari 35 juta menjadi 45 juta; (4) PDB akan naik dari 350 menjadi 1260 miliar USD.

Skenario dalam riset ini adalah: business as usual (BAU), mitigation, renewable dan green. Setiap skenario mempunyai karakteristik tersendiri dengan asumsi yang digunakan. Konsumsi energi di tahun 2030 yang terbesar akan ada di skenario BAU dengan 9726 PJ dan terendah pada skenario green dengan 6663 PJ. Jamali akan masih sangat tergantung kepada bahan bakar fossil terutama minyak bumi. Biofuel bisa digunakan sebagai alternatif untuk mengurangi penggunaan minyak bumi ini, namun akan mempunyai beberapa kendala terkait dengan isu emisi gas rumah kaca dan deforestation. Energy intensity di Jamali akan turun dari 7.9 MJ/USD di tahun 2011 kan menjadi 5,3 – 7.7 MJ/USD pada tahun 2030. Nilai ini masih jauh lebih besar daripada energy intensity Indonesia yang sebesar 4,3 MJ/USD. Sementara itu energi per kapita

akan mengalami peningkatan dari 19.7 GJ/kapita di tahun 2011 menjadi 40-48 GJ/kapita pada tahun 2030. Beberapa permasalahan yang akan dihadapi pada tahun 2030 antara lain adalah: isu lingkungan, tingginya intensitas energi, subsidi energi, resistansi pada PLTN dan pembangunan infrastruktur yang akan membutuhkan investasi yang sangat besar.

# ABSTRACT

Jawa, Madura and Bali (Jamali) are the most populated regions of Indonesia, in which around 60% of the entire population live. Its contribution to the Indonesian economy was approximately 58% in 2010. However, Jamali area is only about 8% of total Indonesia area. So the energy demand in Jamali is much higher than in other regions of the country, which may cause problems to also ensure the sustainability of (future) energy supply to this area. Energy consumption in Jamali system in 2011 was 2791 PJ. It reached 52% of total energy consumption of Indonesia in 2011. Fossil fuel still have high proportion in energy mix, about 82%, especially oil with 42% share of total energy consumption. Renewable energy reach 13%, mainly come from biofuel, biomass, geothermal and hydro.

To estimate the energy consumption of Jamali in 2030, the software of LEAP (The Long range Energy Alternatives Planning System) is used, which is a widely-used software tool for energy policy analysis and climate change mitigation assessment, developed at the Stockholm Environment Institute. The basic year used is 2011 and some assumptions about the period 2011 - 2030 are used: (1) Income per capita will increase from 2500 to 7500 USD/capita; (2) Population will increase from 140.5 million to 168 million in 2030; (3) household number will increase from 35 million to 45 million in 2030; (4) GDP will increase from 350 billion dollars to 1260 billion dollars.

Various scenarios were developed to analyze energy consumption until 2030 in Jamali: (1) business as usual (BAU), (2) mitigation, (3) renewable and (4) green. In the mitigation scenario large emphasis is given to energy conservation and efficiency improvements. In the renewable scenario and the green scenario the emphasis is on the use of renewable energy sources. The highest energy consumption in 2030 is projected by the BAU scenario with 9726 PJ and the lowest energy consumption is projected by in the green scenario with 6663 PJ. In all scenarios Jamali will still depend highly on fossil energy sources, especially oil. Biofuel can be an alternative fuel to replace oil although there will be constraints especially on greenhouse gas emission and deforestation. Energy intensity in Jamali was 7.9 MJ/USD in 2011 and it will decrease to 7.1 MJ/USD in 2030 according to the scenarios. This is higher than rest of Indonesia 4.3 MJ/USD. Energy per capita will increase from 19.7 GJ/capita to 40-48 GJ/capita. Important constraints are derived by the scenario analysis for future

energy supply of Jamali: fossil reserves depletion, environmental issues on biofuel development, high energy intensity, energy subsidy policy that will burden national budget, resistance on nuclear power plant planning and need huge investment to develop infrastructure.

## General Situation in Jawa, Madura and Bali (Jamali)

Jawa, Madura and Bali (Jamali) are the most populated regions of Indonesia, in which around 60% of the entire population live. These regions have a trend to increase in their populations, from 121.4 million in 2000 to 136.6 million in 2010, while Jamali area is only about 8% of total Indonesia area (BPS, 2014). This trend also happens in the economic sector, Jawa has a very dominant economic role in the Indonesian economy, contributing approximately 58% of the Indonesian economy in 2010 (MEMR, 2012). Hence, these situations have led to an energy demand in Jamali that is higher than in other regions of the country.

High economic activities lead to a high demand of facilities to support. However, Jamali has limited natural resources with which to support their needs. In the Jamali area, petroleum reserves is located in West Java and East Java total 178.8 billion liters (1.52 billion barrels), or about 20 percent of the total reserves owned by Indonesia (MEMR, 2014). The gas reserve in Jamali area is about 226.5 million cubic meter (8.6 TSCF), or around the 5.4% of the total gas reserves in Indonesia (MEMR, 2014). This will cause problems in infrastructure development to bring the resources in remote area to Jamali area. Additionally, it will increase the jealousy of people resources origin who feels it was their right to have benefits of energy resources. Decentralization policy that gives more power to local governments will exacerbate the constraint of natural resources utilization issues, especially in permit issues.

Some other resources which can be exploited as energy sources are hydro, geothermal, wind and solar. Some of hydro and geothermal sources are already exploited, but wind and solar are still remain in low amount of utilization. Sustainable development is defined by the Brundtland commission as development meeting the needs of the present without compromising the ability of future generations to meet their own needs (United Nations, 1987). Various bilateral and multilateral agencies started adopting sustainability criteria in their development models after the publication. According to the World energy Council (WEC, 2013) there are 3 dimension of energy sustainability. They are: 1) energy security: the ability of energy providers to meet current and future demand; 2) energy equity: the accessibility and affordability of energy supply across the population, and; 3) environmental sustainability: the achievement of supply and demand-side energy efficiencies and the development of energy

supply from renewable and other low-carbon sources.

Another method of assessing the sustainability was developed by Mainali et.al. (2014). It assesses energy sustainability in rural area in developing countries. The dimensions involved in the method are social, economic, technical and environmental dimensions and each dimension containing some indicators to evaluate the ability to sustain.

Indonesia has a wide variety of energy resources. Its economy was based on export of non-renewable resources for more than four decades, when in 2004 the country became a net oil importer. This means that domestic oil demand cannot be met by relying only on domestic production. Due to data from MEMR (2013) that the oil consumption is 35.8 % of the final energy, then this becomes one of the sectors that are vulnerable to experiencing shortage. Although coal and natural gas reserves still reliable for many years ahead, but the fact that Indonesia is an archipelago and a source of energy away from the consumer, it will need a huge investment to distribute and meet the energy needs of all population.

In Indonesia, fossil fuels remain the main energy source. Levels of development and deployment of efficient and low-carbon and carbon-free energy technologies is slower than expected to fulfill sustained energy demand growth.

## Scenarios for Energy System in Jamali

The increase in energy requirements will result in trade-off between supply, environment, price and infrastructure for supply and distribution of energy. This research will analyze several scenarios of fulfilment of energy demand using some assumption used in Indonesia Energy Outlook 2010 (MEMR, 2010). The outlook is a planning document on energy needs in Indonesia until 2025 and made by MEMR.

## Business as Usual (BAU) Scenario

In the calculation of energy supply, this scenario includes all projects that are already planned or being built and assumed will be completed according to schedule. It is assumed that in case energy demand exceeds the supply, it can be imported from outside Jamali. All infrastructure planning do not reach 2030.

In this scenario it is assumed that growth in demand will be constant, based on previous trend, from 2022 until 2030.

Presidential Regulation No. 5/2006 about National Energy Policy expect to create domestic energy supply security by considering that energy supply will support sustainable development. The assumptions used in this scenario are:

- For house hold: consumption growth of electricity is 7%, gas 11% and wood -5%.
- Industry sectors will have 5% consumption growth.
- Transportation sector will have 8% consumption growth.
- Commercial sector will have 5.6% consumption growth.
- Other sectors will have 5.6% consumption growth.
- For electricity generation, still rely on coal and gas power plant.
- For electricity transmission and distribution, losses are considered to be 7.5% in 2030.

In 2018, a transmission line from Sumatra to Jawa will add electricity supply in to Jawa. The power plant is located in Sumatra and categorized as mine mouth power plant.

## Mitigation Scenario

In this scenario, besides improving energy efficiency, it will emphasize the use of new and renewable energy sources to replace some part of conventional fossil fuels. Some assumptions used in this scenario are:

- There is an efficiency program of energy in household sector.
- consumption growth of electricity is 7%, gas 10% and wood -5Industry sectors will have 4.4% consumption growth.
- The development of the transport sector, which is assumed to include: more Mass Rapid Transportation (MRT) using electricity as power source will be built, more vehicles using compressed natural gas (CNG), vehicle with conventional fuel will increase the efficiency. Transportation sector will have 7.3% consumption growth.
- Commercial sector will have 4,3% consumption growth.
- Other sectors will have 5.3% consumption growth

- For electricity generation, still rely on coal and gas power plant. Nuclear power plant will produce electricity in 2027 with 1000 MW capacity
- For electricity transmission and distribution, losses are considered to be 7.5% in 2030.
- In 2018, a transmission line from Sumatra to Jawa will add electricity supply in to Jawa.
- Renewable energy will be boosted in utilization after 2021: geothermal will increase average 7% per year (10% in 2025) and power plant from solid waste will increase average 10% per year. Solar panel will increase estimated 30% per year due to high utilization as lighting on toll road and a new solar panel factory in Karawang.
- Wind power will increase 15% per year.

## Renewable Scenario

The scenario is combine of renewable energy increment, efficiency in machine and appliance and also new energy usage. In this scenario, government make regulation to boost energy renewable energy capacity and make efficiency certification for home appliances.

- For house hold: consumption growth of electricity is 6%, gas 8% and wood -5%.
- More efficient machinery used in industrial sector and then reduce the energy consumption.
- Industry sectors will have 3.5% consumption growth.
- For transportation sector, electricity will used more by increasing number of and also some route extension of train and subway Biofuel will be mixed up to 20% in conventional fuel and some type of vehicle will use biofuel as their fuel. Transportation sector will have 7.2% consumption growth.
- Commercial sector will have 4,2% consumption growth.
- Other sectors will have 5.1% consumption growth
- For electricity generation, still rely on coal and gas power plant. Nuclear power plant will produce electricity in 2027 with 1000 MW capacity.
- Diesel still used as reserve generator and biodiesel will replace 50% of its diesel oil consumption.

- For electricity transmission and distribution, losses are considered to be 7.5% in 2030.
- In 2018, a transmission line from Sumatra to Jawa will add electricity supply in to Jawa.
- The power plant is located in Sumatra and categorized as mine mouth power plant
- Renewable energy will be boosted in utilization after 2021: the hydro will reach 5.5 GW in 2030.
- Geothermal will be maximally exploited. Almost every big city will have power generator using municipal waste as source of energy and will reach 461 MW in 2030.

## Green Scenario

This scenario will produce more renewable energy than any scenarios above.

- For house hold: consumption growth of electricity is 5%, gas 8% and wood -5%.
- Industry sectors will have 3.1% consumption growth.
- Palm oil will be produced and consumed in transportation sector. Transportation sector will have 7% consumption growth.
- Commercial sector will have 4% consumption growth.
- Other sectors will have 5% consumption growth.
- For electricity generation, although still rely on coal, but new technology on geothermal will boost geothermal exploitation. Nuclear power plant will produce electricity in 2027 with 1000 MW capacity
- For electricity transmission and distribution, losses are considered to be 7.5% in 2030.
- In 2018, a transmission line from Sumatra to Jawa will add electricity supply in to Jawa.
- Renewable energy will be boosted in utilization and it will reach almost 30% of total energy consumption. Renewable energy mostly come from biofuel, palm oil. Almost every big city will utilize municipal waste as source for electricity and estimated reach 1.5 GW capacity in 2030.

- Solar panels will be massively produced and mostly used in home scale. It will reach 17 GW in 2030. Wind turbine will massively be built along south coast of Java and Bali Island. It will reach 433 MW in 2030.

## Conclusions on Energy Issues

Fossil consumption is higher for the BAU scenario compared to other scenarios. BAU consume 8.7 EJ, renewable scenario consumes 7 EJ and green scenario only consumes 4.6 EJ. This makes the green scenario the best scenario in term of the least of fossil fuel consumption.

Due to the using more efficient and more renewable energy compared to BAU, the mitigation, renewable and green scenario will emit less CO2, therefore it has better point in CO2 emission. In renewable and green scenario, nuclear involved in energy supply since 2027 which make a better energy mix in Jamali. However, the nuclear power plant also will create resistance, especially from people around the planned nuclear power plant. Nuclear power plant will cause better in energy mix but become constraints in social acceptance. In mitigation, renewable and green scenario, there are some programs from government to make increase energy efficiency and obligation in biofuel mix. It will need cost and extra effort to implement the program and also time for social adaptation and acceptance.

In term of climate change issues, BAU scenario will act as base line for GHG emission reduction. The mitigation scenario will reduce CO2 emission which is good for climate change issues. In renewable scenario palm oil plantation is main contribution in renewable energy. However, palm oil plantation expansion beside good for energy mix, but also create issues in peatland and deforestation. Peat land used for plantation will cause GHG emission increment and deforestation will cause extinctions and decrease populations, decreased availability of resources, decreased income earning potential , increased environmental risk (decreased resilience) and spread of diseases from animals to people (Bappenas, 2010).

Some of the constraints above may occur when the scenarios are implemented in Jamali. The measures are simply to accommodate some of the weaknesses in the manufacturing scenarios and the consequences thereof.

However, some of the detailed constraints and measures still need more in-depth study to be more suitable in field.

Besides having advantages in number of various renewable energy resources, Indonesia also has many challenges. The main challenges are on the exploitation and utilization of energy resources available. With the depletion of resources, the area of services and the increasing demand of modern energy will be putting pressure on all stakeholders to work together for a more sustainable energy supply.

From the above discussion, it appears that the demand and consumption of energy in Jamali and Indonesia will increase. This demand should be met, because it is very important for the survival and growth of the national economy. Based on the resources owned, infrastructure capacity and result of simulation, it can be concluded that Jamali could not meet their energy needs if only rely on existing local resources. The resources should be imported or transported from outside area and it makes Jamali highly dependent on the continuity of supply from outside the area. Thus, the facility will be needed to accommodate the resources from outside to Jamali are: gas pipeline network, oil pipelines, refinery and storage facility.

## Conclusions

These conclusions are made to answer the research questions mentioned in the previous chapter. Some conclusions from the research above are:
Energy consumption in Jamali in 2011 was 2791 PJ

- Some factors affect the energy consumption in Jamali are: population, infrastructure, energy consumption per capita and supply availability.

From the scenarios simulated, the most realistic is the renewables scenario because the resource of biofuel can fulfill the need of biofuel and still give space for society to change to the renewable fuel.

The challenge will be faced in 2030 are:

- Oil and gas will probably depleted.
- Jamali will need resources from outside Jamali area, especially biofuel.
- Jamali need increasing the production of renewable energy.

- Maintain the low level of energy intensity and energy consumption per capita.
- Environmental issues, especially regarding GHG emission.

# Sistem Manajemen Lingkungan Outsourcing: Perspektif Strategis dan Praktik Terbaik Organisasi dari Perusahaan Inggris

# Environmental Management Systems Outsourcing: Strategic Perspectives and Organisational Best Practices from the UK Companies


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# ABSTRAK

Tujuan dari penelitian ini adalah untuk mengusulkan kerangka kerja praktis bagaimana strategi outsourcing dapat diterapkan pada implementasi dan pemeliharaan sistem manajemen lingkungan (EMS) sehingga jika ditempatkan dalam konteks strategi perusahaan, pencapaian tujuan perusahaan keunggulan kompetitif dan peningkatan kinerja lingkungan yang luas dapat direalisasikan.

Dengan mengumpulkan data dari organisasi dalam berbagai ukuran dan sektor industri, perspektif dari praktisi bisnis diintegrasikan dengan kerangka konseptual model keputusan outsourcing untuk memberikan kerangka praktis yang menguraikan tujuan, manfaat, risiko dan praktik terbaik outsourcing dalam pengelolaan EMSs. daerah. Survei online dilakukan dengan dukungan dari Blackmore Quality Management Services Limited dan Kamar Dagang dan Industri Hertfordshire khusus untuk organisasi yang lebih kecil. Wawancara melalui telepon dilakukan untuk mendapatkan lebih banyak wawasan dimana hasilnya digunakan untuk memudahkan interpretasi hubungan antara variabel dalam survei.

Perspektif strategis EMSs outsourcing dipertimbangkan. Dari analisis tersebut, tiga tingkat kepentingan dalam adopsi EMS termasuk wajib, strategi bisnis dan kesadaran lingkungan; dan tiga strategi outsourcing termasuk mengakses sumber daya komplementer, fokus pada bisnis inti dan kualitas dan keandalan EMS diidentifikasi. Faktor gabungan digunakan untuk menentukan tujuan outsourcing dan memetakan potensi kegiatan yang dioutsourcing. Penelitian ini juga menguraikan risiko yang cukup besar dan merekomendasikan praktik terbaik untuk outsourcing EMS yang efektif.

Telah dicatat bahwa dalam hal ukuran organisasi hambatan pelaksanaan EMS yang diakibatkan oleh keuntungan dan pengemudi yang tidak mencukupi dan biaya sertifikasi yang tinggi tidak direalisasikan secara eksklusif oleh organisasi kecil dan menengah dengan kurang dari 200 karyawan dan omset bisnis kurang dari £ 5,75 juta. Terkait dengan variasi di antara sektor bisnis, organisasi dalam sektor publik dan sektor jasa cenderung menyadari kurangnya dukungan manajemen karena tidak adanya dampak nyata terhadap lingkungan. Di sisi lain, bisnis dalam industri proses atau produk dimana EMS dapat secara langsung berkontribusi terhadap kegiatan operasional mereka dan sertifikasi mereka lebih sering diamanatkan oleh para pemangku kepentingan yang

mengajukan tantangan untuk melangkah lebih jauh dalam menghargai adopsi EMS.

Kata kunci: Sistem manajemen lingkungan, ISO 14001, strategic outsourcing, strategic management.

# ABSTRACT

The purpose of this research is to propose a practical framework of how the outsourcing strategy can be applied to the area of environmental management systems (EMSs) implementation and maintenance so that if it is placed in the context of corporate strategy, the attainment of the company's competitive advantage and broad environmental performance improvements can be realised.

By collecting data from organisations within different sizes and sectors of industry, perspectives from business practitioners were integrated with the conceptual framework of outsourcing decision model in order to provide a practical framework outlining the objectives, benefits, risks and best practices of outsourcing in the EMSs management area. An online survey was undertaken with the support of Blackmore Quality Management Services Limited and the Hertfordshire Chamber of Commerce and Industry specific to smaller organisations. Telephone interviews were conducted to gain more insights where the results were used to facilitate the interpretation of the relationship between variables in the survey.

The strategic perspective of EMSs outsourcing is considered. From the analysis, three levels of importance in the EMS adoption including mandatory, business strategy and environmental awareness; and three outsourcing strategies including accessing complementary resources, focus on core business and quality and reliability of an EMS were identified. The combined factors were used to define outsourcing objectives and map the potential outsourced activities. This research also outlines considerable risks and recommended best practices for an effective EMSs outsourcing.

It was noted that in terms of organisation sizes EMS implementation barriers resulting from insufficient benefits and drivers and high certification costs were not exclusively realised by small and medium-sized organisations with less than 200 employees and business turnover less than £5.75 million. Associating with the variations among business sectors, organisations within public and service sectors tended to realise the lack of management support due to the absence of noticeable impacts on the environment. On the other hand, businesses within process or product industries in which EMSs can directly contribute to their operational activities and their certification is more

often mandated by stakeholders pose challenges to step further in appreciating the EMS adoption.

Keywords: Environmental management systems, ISO 14001, strategic outsourcing, strategic management.

With the increase in overhead costs and the ever increasing environmental legislation, the application of outsourcing practices in the area of environmental management particularly in implementing and maintaining Environmental Management Systems (EMSs) has gained positive responses among business practitioners (Blackmore, 2012). However, there have been insufficient literatures and rare researches discussing about the necessity and objectives of EMSs outsourcing from the perspective of strategic management. The absence of practical framework in any particular business area could increase the potential risks of unexpected problems and failure in achieving the desired benefits resulting from the misapplication of the concept by practitioners (McIvor, 2005). The purpose of this research is twofold. Firstly, it aims to explore the theoretical foundation on which EMSs have roles in corporate strategies and outsourcing strategy has been employed to achieve organisational competitive advantage. It will serve as a conceptual model of how organisations should decide to outsource their EMS management. Secondly, it aims to investigate the relevance of the proposed conceptual model to the actual business perspectives. By serving these purposes, it is expected that a practical framework and recommended best practices in EMSs outsourcing can be disseminated. Thus, this project will be undertaken to answer the following main questions:

- What are the objectives and benefits of EMSs outsourcing?
- What are the major factors that contribute to risks in EMSs outsourcing? How do these risks can be minimized?
- What are the best practices for EMSs outsourcing?

## Is There any Variation Across Different Sizes and Sectors of Organisation?

Based on the literature review, it is hypothesised that accessing complementary resources from the outsourcing partner including technical skills, expertise, support and guidance in order to obtain efficiency by saving time and overhead costs should be an important issue in EMSs outsourcing.

An online questionnaire using a "Survey monkey" format was mainly used besides telephone interviewing. The first method was chosen because of its convenience for respondents and easiness to follow-up. Telephone interviewing

was used to complement the survey and considered easier to arrange than face-to-face interviewing. The survey and interviews were undertaken with the support of Blackmore Quality Management Services Limited (Blackmores). The Hertfordshire Chamber of Commerce and Industry also provided support for collecting data especially from smaller organisations. The survey was carried out towards three categories of organisations which include organisations that do not have an EMS in place, EMS-certified organisations that insource their EMS management and those that outsource it. Implementation barriers, obstacles in EMSs insourcing and reasons, risks and best practices for EMSs outsourcing were the main topics asked to the respective categories of the respondents. Importantly, relevant aspects of strategic outsourcing such as strategic capability, core competence and competitive advantage, outsourcing benefits and insufficient driver issue were also addressed.

It should be clarified in advance that the term of "outsourcing" in general relates to the act of transferring any works, a business function, products or service activities to external party that in this report is termed as "the outsourcing partner" (Power, Desouza & Bonifazi, 2006). Specific to EMSs outsourcing, environmental management activities as the object of outsourcing are termed as "the outsourced works or activities". "The outsourcing organisation" is the organisation that outsources its environmental works or activities. Similarly "the insourcing organisation" is the organisation that keeps in-house its environmental management activities.

## Objectives and Benefits of EMSs Outsourcing

In order to set a specific context of the EMSs outsourcing, the basic premise that organisations in general find barriers and obstacles in the EMS implementation or maintenance due to restricted resources available within them should be firstly examined. Presumably then, organisations deciding to outsource those activities have been driven by the same issue and perceive benefits resulting from it. In this regard the data gathered from the survey as well as the interviews will be presented and discussed in the context of understanding the objectives and benefits of EMSs outsourcing.

## Resouce Barriers Perceived by the EMS Uncertified Organisations

At the start of this research, the working hypothesis was that the majority of organisations that do not have an EMS in place perceive implementation barriers resulted from insufficient benefits and drivers or one of four resource constraints: associated costs of certification, lack of support and guidance, time and knowledge or specialist for implementation.

Observing in this research insufficient benefits and drivers seemed a little more important than lack of time and associated costs of certification. Comparatively there seemed less support for lack knowledge and support and guidance. However, the respondents' perception appeared split between highly relevant on the one extreme and definitely not relevant on the other. Overall the spread of issues seemed quite even and hardly conclusive for different respondents.

Regarding the objectives of EMSs outsourcing, the implication of this finding is twofold. The first is the need to identify the importance of an EMS so that EMSs outsourcing can provide relevant drivers and benefits for those that have been impeded by such an issue. The second is that the EMSs outsourcing should help to reduce the implementation time, contribute to lower the associated costs of certification, such as by lowering the overhead costs in the implementation process, provide support and guidance, and provide knowledge and specialist that can lead to higher quality of EMSs.

Briefly from the graph different points seemed interesting to note, such as the lack of tie into innovation, not much support for staff morale, and surprisingly limited support for reduction of regulatory costs. However, the high variation indicated by the standard deviation values still confirms the split perception between the respondents. This appeared that each of the respondents has a unique perception towards the importance of an EMS. Results from the interviews and comments from the survey will be explored to gain more insights about how organisations perceived the importance of an EMS.

It can be observed that there were some reasons mostly highlighted in adopting an EMS. The first relates to the requirement of stakeholders including customers or clients, investors and regulators. Moreover, some businesses

in certain business sectors, such as chemical industry and oil and gas sector found the importance of an EMS as they faced tight regulations or it is required to maintain an EMS in the industry. According to Orsato (2009), there are two environmental strategies that organisations can adopt in order to achieve a competitive advantage by differentiating their processes, products or services: beyond compliance leadership and eco-branding. Thus, most of them seemed to apply the former strategy and organisations such as KK, LL and ZZ seemed to apply the latter.

The other reason mostly noted in the respondents' comments was connected to the commitment and responsibilities they wanted to demonstrate to their stakeholders or public in general. Connecting these results to the objectives of the EMSs outsourcing, different organisations might have different views about the importance of an EMS due to different reasons in maintaining a certification. Three broad reasons have been described according to the interviews and comments from the survey.

These may also help to explain why promoting innovations for environmental products and reduction of regulatory costs gained less support in the survey. The first aspect may relate to only specific organisations whose business in trading 'green' products or manufacturing design as is the case with the organisations KK and LL, while the second is only relevant for specific sectors that were directly driven by regulations, such as chemical industry and oil and gas sector, as in the case of organisations NN and TT. Therefore it is not surprising that these aspects gained less support compared to namely continual environmental improvements and waste minimisation which seem relevant to more sectors of business.

Before the research began it was hypothesised that the majority of organisations that have an EMS but do not outsource in the implementation process perceive obstacles associating with either aspect of the following additional resources: time, knowledge and skills, support and guidance and overhead costs.

This research prove that time constraint, legal compliance and access to legislative updates relatively had more support than the others. However,

overall it seemed to confirm the prior conclusion related to the barriers in the EMS implementation that the spread of issues were hardly conclusive for different respondents. It can be said that in general different organisations found different issues associating with the obstacles in managing their in-house EMS. Relating to this, the objectives of an EMS outsourcing should be able firstly to acknowledge the relevant issues encountered by the implementing organisations. Then, it should be able to provide necessary resources, such as knowledge of specific regulations, updated environmental legislation or additional human capital to reduce their burden and time in the implementation process.

## Reasons for the EMSs Outsourcing as Perceived by the Outsourcing Organisations

Lastly relating to the objectives of the EMSs outsourcing, it was hypothesised in the beginning of the research that the majority of organisations that outsource their environmental management activities have reasons to access complementary capabilities from external sources ~~ti~~me, skills and knowledge, support and guidance and the opportunity to lower overhead costs ~~an~~d gain benefits that allow them to achieve a competitive advantage.

Nevertheless, the diverse opinion between the respondents as shown by the standard deviation values could not be ignored. Given the mean value approximately five with three for the standard deviation it meant the values varied from two which means "possibly not relevant" to eight which means "definitely relevant". This also seemed consistent with the previous conclusions relating to barriers to certification and obstacles of the EMS insourcing.

However, although there might be less outsourcing organisations that had been driven by such issues, certain organisations might perceive them differently. The first clearly confirmed the need of specific knowledge or technical skills that the organisation did not have. Interestingly, the last statement confirmed the relevance of both the lack of technical skills and focus on core business by stating that the organisation was not expert in that field. Furthermore, the company also stated that although it might be self.

Relating to the organisational capability, 84% of the outsourcing organisations surprisingly stated that they were actually capable to perform the EMS management activities internally. However for 50% of them, outsourcing an EMS management was perceived more efficient economically, while 44% considered outsourcing necessary for specific activities and 28% believed that it can ensure excellent quality. Only 14% of the outsourcing organisations that did not have the capability which 9% confirmed that they might be capable in the future and 6% felt that without outsourcing an EMS could be hardly implemented.

However secondly, some other points seemed to emphasise a different perspective. The case that a wide variety of organisations adopted an EMS not only to respond the regulatory, customers, clients or investors requirement but also to employ it as a business strategy or express an environmental awareness seemed interesting to note. Then most of the outsourcing organisations (86%) admitted that they actually had the capability to perform the EMS management internally, yet decided to outsource because considered it either more efficient economically, necessary for particular activities or ensuring excellent quality. Together with the respondents' perception that focus on core business was a relatively considerable reason, these seemed to emphasise the relevance of strategic outsourcing as illustrated in the conceptual model of an EMS outsourcing decision.

## Risks and Best Practices in the EMSs Outsourcing

Recalling the theoretical framework, Perunovic and Pedersen (2007) suggest that the outsourcing process can be devided into the following stages: the preparation which is intended to answer the questions of whether, what, when or where to outsource, the second stage which relates to the outsourcing partner selection and the third stage which enquires how to manage transition and relationship with the outsourcing partner. Along these stages, some possible risks were identified. This research confirms that inappropriate selection of the outsourcing partner relatively had more support than the other risk variables—more than 70% regarded it as "definitely" and "highly relevant" and no respondent perceived as "possibly"

and "definitely relevant". Comparatively the other three risk variables—hidden costs, unexpected transition and improper decision for establishing outsourced works seemed equally important in a sense that more than 40% regarded them as "definitely" and "highly relevant" and less than 10% perceived as "possibly" and "definitely not relevant". Some comments from the interviews are outlined as best practices to better anticipate these risks.

This seemed to confirm a suggestion made by Woofter (2013) that the determining factors in the success of environmental management outsourcing are not mere technical expertise, but understanding client's business process and objectives with anticipated risks and planned arrangements are among critical factors. Such a continued relationship with the outsourcing partner as had been described is also an important part of transition management as explained by Power, Desouza and Bonifazi (2006). It is suggested that during this transition stage all emergent issues should be addressed up front rather than letting them escalate.

This case arguably provided an example of how improper decision in determining outsourcing works would affect at any stage of the outsourcing process in this case the final stage of certification. Conceptually, Power, Desouza and Bonifazi (2006) suggest that the decision of whether an activity should be outsourced or kept internally as part of strategic assessment should be made clear in the preparation stage or earlier before the works commence.

It is further explained that for effective outsourcing, the objectives set in the context of organisational strategy must be evaluated in advance (Power, Desouza and Bonifazi, 2006). This connects to the previous discussion about the objectives of EMSs outsourcing. Firstly, it is worth considering whether an EMS serves a tool for mandatory requirement, business strategy or demonstrating environmental awareness. Secondly it relates to the strategic importance of outsourcing for the implementing organisation, whether outsourcing serves as a strategy to access complementary resources—technical skills, knowledge, expertise, support and guidance that are not available partially or fully in-house; to perform a more efficient practice economically or to ensure excellent quality.

Managing trust and monitoring results, quality and reliability of an EMS relatively had more support than the other listed best practices. However, it seemed that overall variables were perceived fairly important as their mean, median and mode values showed between six and eight which indicate "probably" and "definitely relevant" respectively.

The two most considerable practices described earlier had more than 60% responses perceiving as "highly" and "definitely relevant". They were followed by easiness to contact and regular meetings whose responses more than 50% regarding as "definitely relevant" or higher. Informal communication and providing additional resources seemed to have a little less support with total responses that regarded it as "definitely" and "highly relevant" were around 40%. In order to better understand these points, some comments from the interviews are outlined.

## Considerable Risks and Recommended Best Practices

As part of the outsourcing plan, risks associating with market vulnerability as said by Quinn and Hilmer (1994) are an influencing factor together with the potential for competitive advantage in the outsourcing decision. Responses from the survey placed inappropriate selection of the outsourcing partner at the top of the identified risks with the average score of eight on a scale from zero to ten. The "definitely relevant" degree of this factor was explained by the respondents that the success of outsourcing process will depend on finding the right company that "listen to us", "devised a structured programme in which we could achieve our goals" (CC: quality and environmental manager, 2013) and "suit your needs…not to make a system that suits their programme" (BB: standards, health and safety manager, 2013). This insight is also suggested by Woofter (2013) that understanding client's business process and objectives, not merely technical expertise, are among the determining factors. Thus, the results suggest that EMSs outsourcing needs a certain degree of customisation that Williamson (1987) and McIvor (2005) describe it as the degree of "asset specificity". Mahnke (2001) states that the high degree of asset specificity will increase the potential of market failure or market vulnerability.

On the side of identified best practices, responses from the survey placed managing trust at the top with the average score of 7.13 on the same scale of the risk factors. Comments from the interviews suggested that "a good long-term business relationship" (AA: quality manager, 2013) and "build-up of trust" with one single outsourcing partner (BB: standards, health and safety manager, 2013) were considered important. McIvor (2005, p.80) describes this form of relationship as "a close long-term strategic collaborative relationship" or "close collaboration".

Close collaboration is recommended when the outsourced activities are critical to competitive advantage and pose a considerable degree of market vulnerability (McIvor, 2005). Hence, such a mutually advantageous relationship is recommended for an organisation that decides to undertake an EMS outsourcing, as it is also expected to provide potential benefits that are unavailable to its competitors.

In order to develop this relationship and build trust with the outsourcing partner, it has been shown that establishing effective media for communication is needed. Regular meetings, visits, contact through email, phone and passing documents, providing consultancy days and induction forms were among media of communication that were suggested. In order to assure the development of this relationship, McIvor (2005) suggests the outsourcing organisation to make a considerable resource commitment. Based on the EMSs outsourcing decision model described in the literature review, outsourced works or activities that pose the market vulnerability risk should be equipped with an adequate degree of hierarchical control. A formal mechanism such as review meetings exemplified in a respondent's comment is also considered necessary to monitor results, quality and reliability of an EMS as set in the contract and the outsourcing objectives.

Another important risk factor indicated by Power, Desouza and Bonifazi (2006) relates to the outsourcing transition management. In this regard the survey result placed unexpected transition and hidden costs the next after inappropriate selection of outsourcing partner with the average score of 6.87 and 6.61 respectively on a scale from zero to ten. A comment of the interviews confirmed the importance of clarifying all costs up front so

that possible disagreement can be avoided and the spirit of partnership with the outsourcing partner can be maintained. Power, Desouza and Bonifazi (2006) generalise that during the transition stage it is important to address all emergent issues up rather than letting them escalate.

# Mengembangkan Indeks Administrasi Pertanahan untuk Mengevaluasi Sistem Administrasi Pertanahan

# Developing a Land Administration Index to Evaluate Land Administration Systems


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# ABSTRAK

Sejak tahun 1996, telah terjadi kemajuan yang signifikan dalam mengembangkan kerangka kerja evaluasi kinerja dan tolok ukur untuk masing-masing aspek Sistem Administrasi Pertanahan. Meskipun telah ada upaya yang dilakukan untuk mengembangkan metode penilaian kualitatif, namun hanya sedikit pekerjaan di bidang penilaian kuantitas kinerja Land Administration. Makalah ini bertujuan untuk membangun landasan bagi Indeks Kinerja Pertanahan Administrasi Kuantitatif.

## ABSTRACT

Since 1996, there has been significant progress in developing performance evaluation frameworks and benchmarks for individual Land Administration System aspects. While there have been efforts made to develop qualitative assessment methods, there have been little work in the field of quantities assessment of Land Administration performance. This paper seeks to establish a foundation for a quantitative Land Administration Performance Index.

## Introduction

Land is the ultimate resource, for no life or economic activity can be sustained without it (Rajabifard, et al., 2013). In order to manage this resource, land administration systems have been continuously developed and used to generate economic output, assist in fair asset valuation, and determine taxation. Ontological and epistemological interpretations of land are not static and all effective Land Administration Systems will adjust in order to meet the needs of people: Western European land administration systems developed methods to facilitate the trade and sale of land as a commodity to meet the desires of a burgeoning bourgeois social class; residential shortages post WWII prompted land administrations to accommodate the concept of subdivisions; the modern information age has forced land administrators to innovate in the realm of land information accessibility and transparency (Ting & Williamson, 1998).

The last 50 years has seen the dominance of globalisation as well as the birth of social equality and sustainability movements. As there is an ever increasing scarcity of land and land resources (Vidal, 2012), land administration systems must achieve good governance in order to guarantee economic, social, and environmental stability and sustainability. The recently developed Land Management Paradigm (shown in Figure 2) provides a holistic approach that encourages land administrators to approach the process of land administration through integrated design: good governance has to ensure all socio-economic, technological and political factors are taken into consideration when implementing and adjusting land-related policy.

In order to achieve good governance, we must ask a key question: how does a land administrator measure good governance? While a general conscientious of benchmarks has been reached amongst academics, there has been relatively little progress in the development of a quantitative or qualitative assessment index. The aim of this paper is two-fold: (1) to propose a method of indexing a land administration system and (2) to highlight the merits of an index.

These objectives were achieved by adopting a positivist approach. The literature review served as the basis of our Land Administration Performance Index and helped determine what our indicators and benchmarks should consist of and how to create an index out of these inputs.

Existing land administration benchmarks are to be identified, scrutinized and adopted in this process as they provided the basis of our index. After the

appropriate benchmarks were identified, the land administration index was created by adopting taxonomy method and determining the mathematical method of an index. These mathematic methods included the determining how to normalization data, selecting proper aggregation types and proper weighting each criteria. This required a Monte-Carlo Simulation to conduct some basic sensitivity analysis.

With the foundation of the land administration index developed, we consulted four individuals from the Indonesian land administration system (National Land Agency) on providing their opinion as well as detailed quantitative land data. This allowed us to show how the Land Administration Performance Index is able to achieve.

## Good Governance in Land Administration

The three main pillars of "sustainable development" (economic, environmental and social) are what defines the concept of good governance (Williamson, 2009). Properly operating Land Administration Systems are expected to take an integrated design approach where all socio-political, technological and political factors and actors are consulted when governing. These factors dictate a jurisdiction's country context, which in turn influences how (often mutually exclusive) public and private interests choose to perceive and manage land resources.

Taking what country context is into consideration, we can boil the definition of good governance down to the following logical statement: good governance will be achieved IF AND ONLY IF public and private needs are met AND these needs are protected by a fairly applied and transparent legal system. These requirements for good governance have been distilled into eight separate aspects by Tony Burns, et al (2008) with the major focus being placed on accurate information, equal and fair application of rule of law on all aspects of land tenure, use and development. These aspects are ultimately jurisdiction agnostic and can be used as a generalised template for a Land Administration Performance Index.

This notion of good governance characteristics being most jurisdiction agnostic has also been alluded to by Ian Williamson, et al (2008), where he argues that corruption in fee collection and taxation and unevenness of

legal application are one of the most common failings of poorly performing land administration systems. Regardless of any land administration system, achieving good governance will require clear and efficient land-related services and regulations as well as fair application of land law.

## Qualitative Indicators of Effectiveness the Systems

This initial framework can provide us with a suitable idea of what a generic Land Administration Performance Index should look like. For the purposes of our Land Administration Performance Index, our aim is to assess all elements listed in Figure 3 via quantitative means as quantitative data allows for easier identification of strengths and weaknesses as well as future trends resulting from changes in the country context, technological infrastructure and land policy (Australian Bureau of Statistics, 2013).

Indeed, Dorman Chimhamhiwa (2006) specially notes the benefits of quantitative benchmarking methods as it allows multiple jurisdictions to use similar benchmarking methods, which ultimately allows performance comparisons between land administration systems. The overall goal is not to "name and shame" poorly performing land administration systems but rather highlight strong performers so that they can serve as models to improve the performance of land administration systems with similar country contexts.

## Developing Indicators and Indices

In finance and economics, indices have become invaluable barometers. Even if the mathematics are often poorly understood, their ability to quantify and aggregate a wide range of performance variables into an easily understood quantity over long discrete periods of time has encouraged their use within the commodities, finance and economics industries (Rauterberg & Verstein, 2013). Despite the world's dependence on indices, from the Australia Securities Exchange to a nation's Consumer Price Index, little research had been put into analyzing their purpose, inherent risks, and methods of regulating and limiting the probability of such risks occurring (Rauterberg & Verstein, 2013):

In light of their importance, the scholarly neglect of financial indices is remarkable. As one observer has remarked: "Only a handful of economists, and

no other academics, have ever looked in any detail at Libor". "Critical thinking about other indices fares no better. Academics and regulators have largely ignored the indispensable role indices play in markets, failing to articulate why financial indices have grown so quickly in importance, how they function, and the risks they face.

To avoid many of these pitfalls, the recommended initial step when developing an index is to adopt the proposed taxonomic method in "Index Theory: The Law, Promise, and Failure of Financial Indices". While we will identify and detail general risks to the Land Administration Performance Index, the scope of the project will not cover remedies to said risks as this is very much country dependent.

However, this will not create the core of any index: the indicators. In order to do so, we evaluate multiple different economic indices in order to determine the mathematical anatomy of an index. This review of existing economic indices will serve as the theoretical basis of for the indicators and benchmarks that make up Land Administration Performance Index.

## Taxonomic Method of Creating Indices

It does not need to be said that indices are essential to modern economies as they provide us with the information required to make informed decisions. One only has to look at the $360 trillion dollars that is indexed to the London Interbank Offered Rate, serving as the index that dictates the interest rates that all lending banks base their values off (Carsella, 2009). As indices such as Libor are so embedded and essential to the global economy, the immense ramifications of interest rate manipulation during the global financial crisis prompted an overwhelming governance response:

Like any institutionalized system, the benefits is produces are compromised if good governance is not achieved (Burns & Dalrymple, 2008). Even if a Land Administration System is significantly different from a financial banking system, the requirements to achieve good governance are not any different: a legitimacy of processes and intuitions, accountability of index providers and involved actors, purpose of index achieves intended effectiveness, earnest participation and transparency from all actors, and no discrimination

against any actor, information, or method are essential (Burns & Dalrymple, 2008).

In many cases, index malpractice and index malproduction are very serious and common risks as it is often beneficial for actors to exploit the system for financial or political gain. These issues must be avoided should any implementation of a Land Administration Performance Index provide any credible and positive benefit to any land administration system. The taxonomic method proposed attempts to break down the complex nature of indices into 8 different criteria to assist in the creation of safeguards and regulation strategies (Rauterberg & Verstein, 2013):

The taxonomic method, the criteria shown in Table 2, allows the index creation process to be methodical and, therefore, minimize the creation of unforeseen risks, biases, and contradictions. It is here where issues that hinder good governance – manipulation, underproduction, malproduction - can be identified and prevent the creation of weak governance practices. While the proposed Land Administration Performance Index cannot stop corruption within institutional and regulatory forces, this taxonomic method provides a whole host of benefits to those governments (and land administrators) who wish to improve their management of land resources:

The index can provide information regarding land administration system performance within local, regional, national, and global contexts across a period of time, thus identifying if land and land information policy is truly effective or not.

Regions with similar country contexts can be identified via the index and thus similar improvement strategies and policy can conceivably be created much more timely and at a much lower cost.

Stagnation and decrease in index score can identify issues with the land administration system, allowing regulators and institutional forces to quickly identify and remedy risks.

## Mathematics of Indices

As noted in the sections above, indices are invaluable tools that can measure aspects that make up good governance, decrease time and cost to create

strategies for regions with similar contexts, and promptly identify land administration systems that are suffering from onsets of weak governance practices. For this to occur, index providers must be aware that indices consist of many incommensurable goods that are mathematically manipulated to achieve a balance of accuracy, tradability, and consistency (Burns & Dalrymple, 2008). The type and purpose of the index should dictate how accurate, tradable, and consistent the index has to be, which ultimately dictates the selection criteria, selection period, and the index's mathematics.

We only have to look at stock exchanges to illustrate this point: the selection period for stock exchanges are never too short, as it would frequently eject businesses with volatile market capitalizations, nor too long, as the index would then be recording the performance of moribund businesses. The end result would be an index that is inaccurate and inconsistent (if the selection period is too long) or not tradable (if the selection period is too short). Thus it is essential to be cogent of the biases and purpose of choosing specific selection criteria, selection period, and mathematical model. This section in particular will discuss the mathematics of indices.

## Existing Indices

A key issue discovered during the literature review process was that the methodology of product and byproduct indices is often opaque in order to protect the product from competitors and competing indices (Rauterberg & Verstein, 2013). Due to the lack of information regarding the process of index creation, the basic mathematical theory and method of the Land Administration Performance Index was derived from existing economic indices – in this case, the Consumer Price Index and Human Development Index – through the process of inference.

The Consumer Price Index is a frequently used tool to gauge the purchasing power of consumers based on the power of the nation's currency, household incomes and the cost of certain essential (eg. staple grains and petrol) and luxury goods (eg. gold). What the Consumer Price Index has in common with the Human Development Index are that both have a method of normalizing the selection criteria, a weight constant, and a method of aggregating the normalized selection criteria. The section below will discuss the type of aggregation then method of normalization.

## Types of Aggregation

There are many methods of aggregation and each has their own inherent strengths and weaknesses. The Human Development Index, as argued by Martin Ravallioni (2010), utilises geometric mean in order to reward consistently good performance in each of the human development indicators. As the purpose of a land administration system is to promote equitable and sustainable social, economic, and environmental land use (Rajabifard, et al., 2013), it is within reason to look into methodologies that are biased against land administration systems that have wide gaps between strengths and weaknesses as it suggests extremely weak governance in certain sectors.

For the purpose of most economic indices, the three major types of aggregation are the following (University of New South Wales, 2008). The variable n represents the number of individual elements, indicators in this case, being implemented:

- Linear, which is expressed in the form
- Geometric, which is expressed in the form
- Harmonic, which is expressed in the form

Their differences can be easily shown via empirical means. It is clear here that linear aggregation does not consider consistency of results, harmonic severely punishes uneven performance, and geometric punishes uneven performance but also appears to recognise strong individual results. As good governance requires consistent performance in all aspects of a land administration system, we see geometric aggregation is the most suitable for the purposes of the Land Administration Performance Index as it highlights key weaknesses as well as key strengths.

## Method of Data Normalization – Feature Scaling

Land Administration Systems utilise a large number of indicators that make the process of aggregation difficult for two reasons: (1) scale type is frequently different for each indicator and (2) scale size is inconsistent. To solve this problem, we have to normalize the outputs in order to aggregate them (Abdi, 2010).

But which method of normalization is most suitable for this index? If we

are to assume that all indicators carry the same weight, normalizing via norm and standard deviation is not suitable as it will impact tradability of the index: the norm and standard deviation will vary every selection period and thus make it impossible to actually determine trends in performance. Should all land administration systems drop in performance simultaneously, so will the norm and standard deviation and thus the index may erroneously suggest that performance has not deteriorated.

Additionally, Chapter 7 of Data Preparation for Data Mining and the video provided by Stanford University claims that many methods of dealing with "out of range" outlier data require the elimination of data points, thus reducing the confidence of the data set, or arbitrary ranges, which will introduce significant bias into the data. To quote Data Preparation for Data Mining:

Imagine (as really happened) using such a tool for building a model of mortgage applicants. The training sample had applicants with salaries up to, say, $100,000. When the model was run, this method ignored all applicants with salaries greater than $100,000.

## Weighting Indicators

In order to generate an accurate result using the Land Administration Performance Index, benchmarks and indicators should be appropriately weighted as it is erroneous to say that all indicators are theoretically worth the same as one another. Dorman Chimhamhiwa (2006) has argued that the country context will dictate the overall weight emphasis that certain benchmarks should have (eg. formal land tenure).

Taking into consideration the research put forward by Daniel Steudler et al. (2004), Dorman Chimhamhiwa (2006) and Tony Burns et al (2006), this weighting emphasis will dictate socio-political differences as all developed indicators and benchmarks are mostly identical outside of the amount of emphasis placed onto them.

## Conclusion

This research has developed a working Land Administration Performance Index concept developed from existing accepted quantitative benchmarks for

evaluating land administration systems. Quantitative approaches like this are more effective at providing both descriptive and inferential statistics, which allow land administrations to quickly identify not only key weaknesses but also key strengths. With the identification of strengths and weaknesses, a land administrator can quickly evaluate and examine existing policy to help provide the overall performance of the land administration system and therefore achieve good governance sooner.

# Prakiraan Harga Gedung Kampus dengan Menggunakan Pemodelan ANN (Artificial Neural Network) (Studi Kasus: Gedung UGM)

# Prediction of Campus Building Prices Using ANN (Artificial Neural Network) Modeling (Case Study: UGM Building)


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# ABSTRAK

Prakiraan biaya merupakan gambaran dan prakiraan nilai yang dibutuhkan demi keberlangsungan pelaksanaan proyek di masa yang akan datang. Prakiraan ini merupakan masukan fundamental untuk proses pengambilan kebijakan awal suatu proyek. Prakiraan pada tahap konseptual dan tahap perencanaan pada umumnya memiliki tingkat akurasi yang rendah. Oleh karena itu keakuratan dalam prakiraan biaya bergantung kepada informasi terbaru dalam bidang konstruksi yang didapat, di samping pemilihan jenis prakiraan biaya yang dipergunakan.

Data gedung kampus yang digunakan sebanyak 17 sampel yang dibangun antara tahun 1990 – 2015. Tujuh parameter digunakan sebagai data input dalam memprakirakan harga gedung kampus dengan metode Artificial Neural Network (ANN) yaitu volume pondasi, luas bangunan, tinggi bangunan, jumlah tingkat bangunan, volume basement, bentang kolom rata-rata, dan nilai Indeks Harga Perdagangan Besar (IHPB) konstruksi/bahan bangunan dari Badan Pusat Statistik. Output target pada tahap perencanaan dan pada tahap konseptual adalah harga kontrak gedung kampus. Gedung kampus berlokasi di Yogyakarta, dibangun dengan struktur rangka atap baja dan memiliki kategori finishing grade yang tidak sederhana. Dicoba sebanyak tujuh kondisi pada tahap perencanaan dan sebanyak dua kondisi pada tahap konseptual untuk memprakirakan harga kontrak gedung kampus.

Dari simulasi ANN diperoleh satu persamaan empiris terbaik untuk prakiraan harga kontrak gedung kampus pada tahap perencanaan dengan struktur ANN terbaik 7-9-1 (7 variabel input, 1 hidden layer dengan 9 neuron dan 1 output) Prosentase error/MMRE maksimal yang dihasilkan adalah sebesar 2,95%. Kemudian diperoleh satu rumus empiris terbaik untuk prakiraan harga kontrak gedung kampus pada tahap konseptual dengan struktur ANN terbaik 6-9-1 (6 variabel input, 1 hidden layer dengan 9 neuron dan 1 output) Prosentase error/MMRE maksimal yang dihasilkan adalah sebesar 6,40%. Persamaan empiris yang dihasilkan dapat digunakan untuk memprakirakan harga kontrak gedung kampus di masa yang akan datang.

Kata kunci: Prakiraan biaya, gedung kampus, Artificial Neural Network

# ABSTRACT

The cost estimation was an overview and a forecast values needed for sustainability of the project in the future. This estimate was the fundamental input for the initial policy-making process of a project. Estimated cost in the conceptual and the planning phase were generally had a low accuracy. Therefore, the accuracy of the cost estimates rely on the latest information which obtained from the construction, in addition to the choice of cost estimates were used.

The campus buildings data were used as many of 17 samples which built between 1990 - 2015. Seven parameters were used as input data in estimating the price of campus building with Artificial Neural Network (ANN) method was the volume of the foundation, area of the building, the height of building, number of floors, volume of basement, the average of span column, and the value of Wholesale Price Index (WPI) construction/building materials from the central board of statistic. Output targets for the conceptual and planning phase was the contract price of campus buildings. the campus building was located in Yogyakarta, built with a steel roof truss structure and include not simple of finishing grade categories. This research had tried as many of seven condition on the planning phase and as many of two conditions at the conceptual phase to estimate the contract price of campus buildings.

The ANN simulation had result one best empirical equation to estimate the contract price of campus building at the planning phase with ANN structure 7-9- 1(7 input variables, 9 nodes in the hidden layer, 1 output) as the best model. About 2,95% maximal percentage had resulting by this model. Then one best empirical equations to estimate the contract price of campus building at the conceptual phase was found with 6-9-1 (( 6 input variables, 9 nodes in the hidden layer, 1 output) ANN structure and result about 6,40% as the maximal percentage. The result of empirical equation can be used to estimate the contract price of campus building in the future.



Keywords: cost estimation, campus building, Artificial Neural Network

## Pendahuluan

Salah satu alokasi dana pendidikan dari APBN adalah digunakan untuk pembangunan gedung kampus baru guna memfasilitasi dan menanggulangi semakin bertambahnya mahasiswa akibat minat dan kesadaran masyarakat akan pendidikan tinggi yang semakin meningkat.

Berbagai metode untuk membantu perhitungan prakiraan biaya telah diperkenalkan, salah satunya metode regresi linier. Namun fakta mengatakan bahwa kesalahan pada perhitungan prakiraan biaya tahap awal belum berkurang (Sodikov, 2005). Hal ini dikarenakan selain detail proyek yang belum terdefinisi secara jelas, juga karena faktor-faktor kualitatif yang dapat memengaruhi persamaan, sehingga keakurasian belum tercapai. Keakurasian dalam prakiraan biaya bergantung kepada informasi terbaru.

Salah satu faktor yang dirasa memengaruhi harga prakiraan biaya suatu gedung adalah nilai Indeks Harga Perdagangan Besar/IHPB konstruksi/bahan bangunan. IHPB konstruksi/bahan bangunan tersebut dapat menggambarkan tingkat harga bahan bangunan yang merupakan salah satu komponen dari biaya pembangunan suatu gedung.

Minimnya data, keterbatasan waktu dan kekurangan sumber daya yang paham mengenai perhitungan prakiraan harga konstruksi merupakan masalah utama. Oleh karena itu perlu dilakukan peninjauan pada faktor yang memiliki korelasi erat terhadap biaya pembangunan gedung kampus selain faktor IHPB yang khususnya tersedia pada tahap persiapan, sehingga dapat tercipta suatu metode perhitungan prakiraan biaya menggunakan metode ANN yang lebih akurat.

Tujuan penelitian ini adalah untuk meneliti faktor apa saja yang berpengaruh terhadap biaya pembangunan gedung kampus dan bagaimana mendapatkan rumus empiris yang dapat memprakirakan harga pembangunan gedung kampus dengan menggunakan metode ANN.

Data yang digunakan untuk penelitian ini adalah data pembangunan gedung kampus Universitas Gadjah Mada Yogyakarta dari tahun 1990 sampai dengan tahun 2015. Data tersebut terdiri dari data awal yang akan dijadikan parameter dalam pemodelan ANN yaitu antara lain lokasi, Tipe pondasi, volume pondasi, luas tapak pondasi, luas bangunan, tinggi bangunan, floor to floor,

jumlah tingkat bangunan, struktur atap, bentang kolom rata-rata,bentang kolom terpanjang, volume basement, IHPB pada tahun pembangunan, finishing grade serta biaya yang terdiri dari biaya kontrak (biaya kontrak tanpa PPN 10%).

## Analisis

Setelah beberapa percobaan, ANN Struktur 5-9-1 (5- variabel input, 9-neuron pada lapisan tersembunyi, 1- output) ditemukan menjadi model terbaik untuk memprakirakan nilai IHPB dimasa yang akan datang. Perhitungan prakiraan harga gedung kampus dimasa yang akan datang dengan menggunakan nilai IHPB prediksi dari rumus ini akan menghasilkan nilai error yang kecil bila dibandingkan dengan rumus lainnya.

Kemudian untuk tahap konseptual, setelah beberapa percobaan kondisi dan variabel sebagai langkah pertama sebelum mencari prakiraan harga gedung kampus dilakukan pencarian terhadap volume pondasi terlebih dahulu dengan metode ANN sebelum hasil dari volume pondasi yang diperoleh kemudian akan dimasukkan kedalam salah satu variabel guna mencari prakiraan haraga gedung kampus tahap konseptual. Rumus mencari volume pondasi terbaik dihasilkan oleh struktur ANN 4-9-1 (4- variabel input, 9-neuron pada lapisan tersembunyi, 1-output). 4 variabel input yang dimasukkan guna menghasilkan volume pondasi adalah : luas bangunan, tinggi bangunan, jumlah tingkat bangunan dan volume basement. Hasil MMRE maksimal yang dihasilkan adalah sebesar 0,005%. Gambar 4.5 menunjukkan struktur ANN 4-9-1 untuk volume pondasi pada tahap konseptual.

Hasil volume pondasi dari rumus tersebut kemudian diikut sertakan dalam mencari rumus empiris yang dapat memprakirakan harga kontrak gedung kampus pada tahap konseptual. Setelah beberapa percobaan dan kondisi, diperoleh model struktur ANN terbaik untuk memprakirakan harga kontrak gedung kampus pada tahap konseptual adalah 6-9-1 (6- variabel input, 9-neuron pada lapisan tersembunyi, 1- output). 6 variabel input yang dimasukkan tediri dari : volume pondasi, luas bangunan, tinggi bangunan, jumlah tingkat bangunan, volume basement, dan nilai IHPB bahan bangunan/ konstruksi. Hasil MMRE maksimal yang dihasilkan adalah sebesar 6,3989%. Gambar 4.7 menunjukkan struktur ANN 6-9-1 untuk harga kontrak gedung

kampus pada tahap konseptual. Gambar 4.8 menyajikan garis regresi untuk struktur 6-9-1 tahap konseptual. Dimana hasil R yang diperoleh menunjukkan nilai 0,9994.

Setelah beberapa percobaan kondisi dan perubahan mix and match variabel, ANN Struktur 7-9-1 (7- variabel input, 9-neuron pada lapisan tersembunyi, 1- output) ditemukan menjadi model terbaik untuk memprakirakan harga pekerjaan struktur gedung kampus. Dimana 7 variabel input yang dimasukkan tediri dari : volume pondasi, luas bangunan, tinggi bangunan, jumlah tingkat bangunan, volume basement, bentang kolom rata-rata dan nilai IHPB bahan bangunan/konstruksi. Hasil MMRE maksimal yang dihasilkan adalah sebesar 4,5135%.

Sedangkan untuik harga pekerjaan struktur, setelah beberapa percobaan kondisi dan perubahan mix and match variabel, ANN Struktur 7-9-1 (7- variabel input, 9-neuron pada lapisan tersembunyi, 1- output) ditemukan menjadi model terbaik untuk memprakirakan harga pekerjaan arsitektur gedung kampus. Dimana 7 variabel input yang dimasukkan tediri dari : volume pondasi, luas bangunan, tinggi bangunan, jumlah tingkat bangunan, volume basement, bentang kolom rata-rata dan nilai IHPB bahan bangunan/konstruksi. Hasil MMRE maksimal yang dihasilkan adalah sebesar 5,4194%. Gambar 4.11 menunjukkan struktur ANN 7-9-1 untuk harga pekerjaan arsitektur gedung kampus.

## Kesimpulan

Faktor yang ikut memengaruhi besarnya nilai prakiraan harga bangunan selain nilai IHPB (berdasarkan hasil porsentase dan validasi terbaik yang dapat dihasilkan oleh metode ANN) adalah volume pondasi, luas bangunan, tinggi bangunan, jumlah tingkat, volume basement, dan bentang kolom rata-rata.

Rumus empiris terbaik dari ANN yang dapat memprakirakan biaya pembangunan gedung kampus pada tahap perencanaan untuk anggaran biaya proyek/ABP dihasilkan oleh konfigurasi ANN 7-9-1 ((7 variabel input, 1 hidden layer dengan 9 neuron dan 1 output). Rumus empiric yang dihasilkan memenuhi persamaan;

Prosentase error/MMRE maksimal yang dihasilkan adalah sebesar 2,9482%. Rumus ini dapat digunakan untuk estimasi harga gedung kampus dengan jumlah lantai maksimal sebanyak 6 lantai/tingkat. Selain itu nilai IHPB yang digunakan dalam variabel input menggunakan nilai IHPB dengan tahun dasar/referensi 1993. Apabila diperoleh nilai IHPB pada tahun dasar berbeda dari tahun 1993, maka dikonversi terlebih dahulu ke tahun dasar 1993.

# Pengungkapan Lingkungan Perusahaan Pertambangan Batubara di Britania Raya dan Indonesia

# Environmental Disclosures of Coal Mining Companies in the UK and Indonesia


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# ABSTRAK

Pengungkapan lingkungan telah menjadi area penelitian yang menarik. Mengingat semakin banyaknya perhatian masyarakat terhadap dampak lingkungan yang signifikan yang disebabkan oleh industri ekstraktif atau perusahaan pertambangan batubara pada khususnya. Untuk merespon tekanan publik, perusahaan perlu secara proaktif mengungkapkan informasi lingkungannya melalui Corporate Environmental Disclosure (CED). Studi ini menyelidiki dan mengeksplorasi praktik pengungkapan lingkungan terkini yang diterbitkan oleh perusahaan pertambangan batubara di Indonesia dan Inggris (Inggris). Penelitian ini mengkaji pengungkapan lingkungan perusahaan pertambangan Inggris dan Inggris dari dua sumber: (1) hasil analisis kandungan CED dalam laporan tahunan perusahaan pertambangan batubara terpilih untuk tahun 2008 - 2012; dan (2) konteks kebijakan dan tata kelola lingkungan Inggris dan Indonesia dan bagaimana kebijakan ini dapat mempengaruhi praktik CED di kedua negara. Penelitian dilakukan terhadap sampel terpilih perusahaan besar yang tercatat di Bursa Efek Indonesia (BEI) atau London Stock Exchange (LSE) di bawah sektor pertambangan batubara. Indonesia dan Inggris telah dengan sengaja memilih untuk menjadi objek penelitian ini karena kedua negara mengadopsi pendekatan wajib terhadap kebijakan dan tata kelola lingkungan yang berkaitan dengan pengungkapan lingkungan dan memiliki tingkat perkembangan yang berbeda. Kombinasi pendekatan analisis konten mekanis dan interpretatif telah diterapkan sebagai metode penelitian untuk menganalisis pengungkapan lingkungan sampel terpilih dalam penelitian ini.



Kata kunci: Pengungkapan lingkungan perusahaan, pendekatan wajib, analisis isi

# ABSTRACT

Environmental disclosure has become an attractive area of research. Considering a growing public attention on the significant environmental impacts caused by extractive industry or coal mining companies in particular. To respond the public pressures, the company needs to proactively disclose its environmental information through Corporate Environmental Disclosure (CED). This study investigates and explores the current practices of environmental disclosure that published by coal mining companies in Indonesia and the United Kingdom (UK). This research examines the UK and Indonesian coal mining companies' environmental disclosures from two sources: (1) the analysis result of CED content in annual report of selected coal mining companies for the years 2008 – 2012; and (2) the UK and Indonesian environmental policy and governance contexts and how these policies might influence CED practices in both countries. The study is conducted on the selected sample of large companies that listed on the Indonesia Stock Exchange (IDX) or the London Stock Exchange (LSE) under the coal mining sector. Indonesia and the UK have deliberately chosen to be the object of this study since both countries adopt the mandatory approach on the environmental policy and governance related to the environmental disclosures and have different level of development. The combination of mechanical and interpretative approach of content analysis has been applied as a research method for analyzing the environmental disclosures of selected sample in this study.



Key words: Corporate environmental disclosure, mandatory approach, content analysis

Indonesia is well known of its abundant natural resources such as oil, gas and minerals as well as the richness and diversity of its forest and marine resources (Resosudarmo, 2005). Indonesia's rain forests, the third tropical forests in the world after Brazil and Congo, account for over 50 per cent of the tropical forest in the Southeast Asian Region (Barbier, 1998). With the abundant mineral resources, the coal becomes the most promising commodity in Indonesia (Prasodjo, 2011).

The exploitation of Indonesia's mineral resources intensified greatly since the mid-1960s when President Soeharto realizes the potential development of mineral resources by inviting the foreign companies to invest and actively involve in mineral extraction by large-scale operations in Indonesia (Resosudarmo, 2005). The enactment of Law no. 1 of 1967 on foreign investment and Law no. 11 of 1967 on mining activities provide a clear procedure for foreign investments in Indonesia (especially in extractive industry) by inferring that all lands within the Republic of Indonesia can be used for mining (Resosudarmo, 2005). By 2007, Indonesia was in seventh position of the world's largest coal producers by contributing 4.2% of the global total coal production (Rusdianasari et al, 2013).

Besides petroleum oil and natural gas, coal is one type of fossil fuels that also considered as the main energy source in the world. Coal is formed from an abundant fossil resource that mostly contain carbon with an energy content ranges from 5,000 to 15,000 Btu/pound (IEA, 2010). The global coal demand in 2010 has grown up to 400% or almost doubled since 1980 (IEA, 2010). The increasing world's coal consumption is driven by the dramatic development in the Asia Region, especially in China. China's coal consumption account for 73% of total coal consumption in Asia and almost 50% in the world in 2010 (IEA, 2010). Together with China, India also takes into account as the largest coal consumers in the world with total coal consumption in both countries almost four-fifths of the global total coal demand (Jones, 2010).

Despite its small contribution relatively 8% of total Asian coal production in 2010, the Indonesian coal production keeps growing rapidly (IEA, 2010). Another reason why Indonesia needs to maintain its coal production level is strongly related to the contribution of the mining revenues approximately 4-5% of the total Indonesian GDP (Maryati et al, 2012; PwC, 2012). The coal can be

recovered from the earth either by surface mining that favorable than deep mining because it less expensive and usually occurs on the mining site with the flat land condition (IEA, 2010). From another point of safety and health hazards, the deep mining technique also considered to be more dangerous because it requires to dig shafts and tunnels in order to reach the coal seam (IEA, 2010). At present, most of the coal mines in Indonesia is using surface mining or open-pit mining than the underground mining (Maryati et al, 201; Ramazan & Dimitrakopoulos, 2012).

However, the open-pit mining was criticized on its potential significant environmental damages due to the removal of top soil and the vegetation upon it and the burial of waste disposal beneath the mining sites (Cooke & Johnson, 2002). The surface mining might lead to several significant environmental and social issues such as Acid Rock Drainage (ARD), acidification of rivers and streams, land degradation, soil erosion, noise, dust, poisonous gases, air pollution, thermal pollution, groundwater pollution and the health issues of local communities (Dudka and Adriano, 1997; Erwiza, 1999; Maryati et al, 2012; McMahon and Subdibjo, 2000; Zachary, 1994). The challenge for the mining industry to actualize the success of the reclamation process for sustainable post mining phase (Erwiza, 1999; Maryati et al, 2012; McMahon and Subdibjo, 2000).

The Indonesian government is urged to be more concerned for the post mining phase (Erwiza, 1999). The significant environmental issue that often occurred during this phase is the large sediment ponds (Erwiza, 1999). There are thousands irregular shaped holes with 50-200 meters deep in black dark water found in East Kalimantan and South Kalimantan (center of mining activities in Kalimantan Island) that often mistakenly seen as a giant lake (Greenpeace Indonesia, 2012; Ministry of Environment, 2003). These lakes are suspected to be filled by mine wastes (Greenpeace Indonesia, 2012). Mine wastes are solid and liquid materials that found at or near mine sites often contain high concentrations of poisonous compounds that can affect the surrounding ecosystems and community (Hudson et al, 2011). Not only the illegal mining companies, but also other licensed mining companies in Indonesia have neglected their commitment to conduct land reclamation after the mining activities ends (Ministry of Environment, 2003).

Although the UK also used open-cut mining techniques that similar to Indonesia, the post mining site condition was found significantly different in Indonesia. One of coal mining companies in the UK, UK Coal has been the leading example in the land reclamation and reforestation of its mined site. The company viewed the restoration process as an integral part of surface mining operations. The restoration of post mined site mostly emphasis on two areas, adding the value back to the surrounding community and restoring the mined site back to its former use and shape (UK Coal a, 2013). The Hicks Lodge site is one example of mined site which owned by UK Coal that has been restored and become part of the National Forest. The company rehabilitates this site by planting total 125,000 trees and providing the network of bridleways, footpaths and cycle paths (UK Coal b, 2013).

The exploitation of natural resources such as coal has not been without any problems (Resosudarmo, 2005). With the magnitude impact caused by mining activities, public attention to the extractive industry has become progressively higher. Conflicts between local communities and the large coal mining companies usually emerged due to the initial public perception that views the company as egoism and irresponsible individuals that intended to exploit the local natural resources without any intention to give value back or benefited the communities (Resosudarmo, 2005). Moreover, various stakeholders, range from non-governmental activist groups, employees to the communities, agreed that the mining industry is one of the most criticized industry in term of its environmental impacts (RepRisk, 2012).

Related to the communities and other stakeholders negative sentiments, the coal mining company needs to proactively respond them by disclosing its significant environmental issues through new public relations strategy (Bakan, 2005). Basically, the companies were urged to be transparent to the public in its activities that affected the surrounding community and environment (Beck et al, 2010; Guthrie & Farneti, 2008; Jenkins and Yakovleva, 2006; Lamberton, 2005). This disclosure is known as the corporate environmental disclosure that could be seen as an important commercial medium for the company to raise its image to the society (Spence, 2007). The term of 'environmental disclosure' as defined by the United Nations Commission of Transnational Corporations' Intergovernmental Working Group of Experts on International Standards of

Accounting and Reporting (UNISAR) is information that made by a company and available for the public through any of the key channels or mediums as company's interaction to its physical environment (Gray, 1990).

In terms of corporate environmental disclosure's media, most of the previous studies analyze the data that derived from annual reports or other stand-alone sustainability report (see for example, Beck et al, 2010; Campell, 2003; Cowan & Gadenne, 2005; Patten & Crampton, 2004; Wilmshurst & Frost, 2000). Since the environmental disclosure evolved, publishing it through the corporate website become a common practice. Thus analyzing the environmental disclosure from the website could also be valuable for the study (Adams & Frost, 2006; Freedman & Jaggi, 2005; Herbst, 2000; Patten & Crampton, 2004).

In the previous section, the difference of post mining condition between Indonesia and the UK was presented. It certainly raises the question whether or not the causes behind the difference was related to the mandatory approaches that adopted in environmental policy and governance in both countries. The UK is a developed country with its powerful economic forces, voluntary and mandatory based environmental regulation and its multinational corporation which operating in all over the world (Holland & Boon Foo, 2003). In the other hand, Indonesia is considered to be an appropriate representative of the emerging countries with its good economic growth which survived during severe financial crisis in 1998, mandatory based environmental policy and its poor post mining condition as stated before (Blackman et al, 2013; Ministry of Environment, 2003). Therefore, the UK and Indonesia were chosen as the research object that will be analyzed and compared further in this study.

The motivation of this study relates to the increasing public's concern on the significant environmental impacts caused by the coal mining companies. The current research agenda in this study attempts to achieve several predetermined main objectives. The first objective is to examine the current practices of coal mining companies' environmental disclosures in Indonesia and the UK within the time frame 2008-2012. The second objective is to analyze and identify the trend in category and sub-category on the selected sample of environmental disclosures. The corporate environmental disclosures will be examined using a combined mechanical and interpretative approach of content analysis that developed by Beck et al (2010) and known as Consolidated

Narrative Interrogation or CONI. Finally, the analysis result in this study will be linked to the result of previous studies on the environmental disclosure area.

The research question of this study is framed as follows:

- To what extent do the coal mining companies in Indonesia and the UK disclose their environmental impacts (within the level of information) in annual reports or stand-alone sustainability reports?
- Based on previous studies, there is an area that has not been researched yet, thus this research is going to be focused on environmental disclosure within the annual report on the environmentally sensitive industry which is a coal mining company in range time of the last five years (2008-2012) to analyze the trend. A sample of the coal mining companies that listed on the Indonesia Stock Exchange (IDX) or London Stock Exchange (LSE) are selected from the coal mining sector in Indonesia and the UK. To address the research question, the coal mining industry is chosen as the research object in this study. The justification to choose this particular industry because it is considered to be the environmentally sensitive industry that tends to get greater attention from its stakeholders related to environmental activities (Deegan and Gordon, 1996).

## The Sample of Coal Mining Companies in the UK

The UK is chosen as the object for this study because it has similar mining technique with Indonesia, open-pit mining but with relatively less impact to the environment. The UK is known as the strongest performers in Environmental Performance Index (EPI) 2012 by Yale University and Columbia University with rank 9th of 132 countries in the world with index 68.82. The UK also considered to be an appropriate representative of the developed countries. As described in the last chapter, the selected sample in this study is the coal mining companies listed in London Stock Exchange (LSE) under the coal mining sub-sector. There are 15 companies listed on LSE under the coal mining sub-sector. Of these 15 coal mining companies, 5 large companies were selected as the sample in this study. The analysis on environmental disclosures of each sample of the UK coal mining companies will be presented below.

## Bisichi Mining PLC

Bisichi Mining PLC (BISI) is a mining company incorporated in the UK with coal operational activities in the Black Wattle Colliery, South Africa (Bisichi Mining, 2012). The company is listed on the LSE since 14 March 1948 with ticker code BISI (LSE, 2012). Information about the amount of coal reserves in a mining site owned by the BISI is not available. Total production for the year 2012 is 1.87 million metric tonnes of coal and was increasing compared to the total production of 2011 is 1.45 million metric tonnes (Bisichi Mining, 2012). During 2008-2012, the BISI has published annual report each year (not yet published sustainability report) with total pages of the report ranging from 62-76 pages (average 69 pages) with minimum information on environmental management (detail shown in analysis below).

For the Bisichi Mining sample, the data of environmental disclosures were retrieved from annual reports published within time period 2008-2012. The environmental disclosure in all the years appears to stable without a significant gap between them. The total environmental disclosures in this period of time were poor within the range from 20 to 32 sentences (average 26 sentences). Some of the categories (i.e. Material, Biodiversity and Land) have no information disclosed during this period and the rest of the categories have just a little amount of information such as Environmental Pollution and Waste, as it was 4 disclosures in 2008 and was declining into 2 disclosures in 2009-2012. The category of General Environmental Disclosure dominates the total of environmental disclosures in the Bisichi Mining annual reports within the period 2008-2012 by 50% (with 73 disclosures of 146 total disclosures).

## Churchill Mining PLC

Churchill Mining PLC (Churcill) has been listed on the LSE since April 2005 with ticker code CHL (LSE, 2012). The Churchill is a mining company incorporated in the UK that begin exploration of the thermal coal deposit in the East Kutai Regency of Kalimantan, Indonesia or known as the East Kutai Coal Project (EKCP) (Churchill Mining, 2012). At present, the Churchill has litigation issue following the negative ruling from the East Kutai Regency that has decided to revoke the EKCP licenses (Churchill Mining, 2012). Churchill's appeal of this

decision to both the Administrative High Court in Jakarta and the Supreme Court of Indonesia but it was unsuccessful (Churchill Mining, 2012).

The environmental disclosures in all the years appears to stable but there was slightly declined in 2009. The total environmental disclosures in this period of time were poor with total environmental disclosures about 224 disclosures that dominated by category General Environmental Disclosure (as shown in Table 4.3 below). Some of the categories (i.e. Environmental Pollution and Waste, Materials, Water and Other) have no information disclosed during this period. It indicates that the Company solely focus on its operational activities compared to the environmental responsibility. The company has the highest disclosure on 2008 followed by 2012 (as shown in Fig. 4.3). The category of General Environmental Disclosure dominates the total of environmental disclosures in the Churchill Mining annual reports within the period 2008-2012 by 57% (with 127 disclosures of 224 total disclosures).

## Analysis the Average Environmental Disclosure in the UK and Indonesia

The company with the least environmental disclosure throughout the period 2008-2012 is the GCM Resources PLC with total disclosure 67 sentences. On the other hand, the company with the most environmental disclosure is the PT Bukit Asam (Persero) Tbk with total disclosure 1,375 sentences. The average Indonesian environmental disclosure can be seen in Fig 4.21 below. It has been noted that the average total pages of the report of the UK company sample is ranging 59-140 pages, compared to the Indonesian company sample with range 108-418 pages. The average the UK environmental disclosure can be seen in Fig 4.22. Moreover, the more pages within the report, the more disclosure or information can be shared with the public. Although, the effectiveness and efficiency of the text need to be further considered.

Related to the category of environmental disclosure, it was identified that the most disclosed category is General Environmental Disclosure (as this category also dominated on the report of Bisichi Mining, Churchill Mining, New World Resources, Adaro Energy, Bayan Resources, Bukit Asam, Bumi Resources, and Indo Tambangraya Megah) and followed by category Sustainability. The least disclosed category is Materials and Water that almost all companies

have no disclosure of them (such as Bisichi Mining, Churchill Mining, New World Resources, Coalfield Resources, Adaro Energy, Bayan Resources, Indo Tambangraya Megah).

## Conclusions

In the application of content analysis in this study, there are two coal mining companies that has published its stand-alone sustainability report, one company from the UK, New World Resources PLC (reporting year 2010, 2011, 2012) and one company from Indonesia, PT. Adaro Energy Tbk (reporting year 2008, 2010, 2011). The Indonesian Law 40/2007 and the Companies Act of 2006 in the UK have not required the company to publish its environmental information in one stand-alone report as the sustainability report (Barbu et al, 2011; Purnomo & Widianingsih, 2012). Both regulations only required the company to disclose key environmental performance indicators as additional information in the annual reports and the business reviews section in particular (Barbu et al, 2011; Purnomo & Widianingsih, 2012). Therefore, these sustainability reports were published by both companies (NWR and Adaro) in voluntary basis.

There are studies that concluded the company's size plays an important role in its environmental disclosure and the large companies is more likely to provide better voluntary reporting to the public (Deegan and Gordon, 1996; Itkonen, 2003; Waddock & Graves, 1997). However, the analysis result in this study indicates the opposite. Of the 10 coal mining companies, there are two companies that have published the sustainability report which represent only 20% of total coal mining companies sample in this study. It indicates the UK government and Indonesian government need to encourage the companies (particularly the listed company) to volunteer and actively disclose their environmental information on the stand-alone sustainability report.

# Faktor Pendukung dan Penghambat untuk Pipa Air Minum dan Pembangunan Gorong-Gorong di Jakarta, Indonesia (1998-2015)

# Enabling and Constraining Factors for Piped-Water and Sewer Development in Jakarta, Indonesia (1998-2015)


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# ABSTRACT

The lack of access to safe drinking water sources and proper sanitation (wastewater) facilities is one of the major issues in infrastructure development and public health in developing countries, including Indonesia. DKI Jakarta, the capital city of Indonesia also can not meet the access of safe drinking water and proper sanitation facilities for the entire population, especially through piping system. Access to piped water sources in Jakarta only increased from 10% in 1975 to 48% by 2015. Access to sewerage systems can only serve 2% of Jakarta's population. Access to sewerage systems has been stagnant since 1989. Through interviews with drinking water and sanitation development and document review and multilevel perspective (MLP) applications, the authors analyzed the supporting and inhibiting factors of safe drinking water supply and proper sanitation in Jakarta. The authors found that the slow development of drinking water and sanitation in Jakarta / Indonesia is caused by the cognitive, regulatory, and actor or actors aspects in the water and sanitation development regime that have not changed significantly to compensate for changes in the political and economic system in Indonesia 1998 (reform era). Through case studies and MLP implementation, the authors conclude that decentralization has no significant effect on the performance of water and sanitation development.

# ABSTRAK

Minimnya akses terhadap sumber air minum aman dan fasilitas sanitasi (air limbah) layak merupakan salah satu permasalahan utama dalam pembangunan infrastruktur dan kesehatan masyarakat di negara berkembang, termasuk Indonesia. DKI Jakarta, ibukota negara Indonesia juga belum dapat memenuhi akses air minum aman dan fasilitas sanitasi layak bagi seluruh penduduk, terutama melalui sistem perpipaan. Akses terhadap sumber air minum perpipaan di Jakarta hanya meningkat dari 10% pada tahun 1975 menjadi 48% pada tahun 2015. Akses terhadap fasilitas pengolahan air limbah terpusat (sewerage system) hanya dapat melayani 2% penduduk Jakarta. Akses terhadap sewerage system ini stagnan sejak tahun 1989. Melalui interview dengan pelaku pembangunan air minum dan sanitasi serta telaah dokumen dan dengan aplikasi multilevel perspective (MLP), penulis menganalisa faktor pendukung dan penghambat penyediaan air minum aman dan sanitasi layak di Jakarta. Penulis menemukan bahwa lambatnya pembangunan air minum dan sanitasi di Jakarta/Indonesia disebabkan oleh aspek kognitif, regulasi, dan norma aktor atau pelaku di regime pembangunan air minum dan sanitasi yang belum mengalami perubahan yang signifikan untuk mengimbangi perubahan sistem politik dan ekonomi di Indonesia yang terjadi sejak 1998 (era reformasi). Melalui studi kasus dan penerapan MLP, penulis menyimpulkan bahwa desentralisasi tidak berpengaruh secara signifikan terhadap kinerja pembangunan air minum dan sanitasi.

## Introduction

Water and sanitation are fundamental to life and are important basic human needs. Jakarta, the capital city of Indonesia has experienced substantial economic growth since the-1990s. However, its piped water and sewer coverage has been much slower to improve. There are many households, both poor and rich, that do not have access to piped water or a sewer network. Piped-water and sewer coverage in Jakarta are much lower than in other large Indonesian cities, such as Surabaya, Medan and Banjarmasin as well as in other Southeast Asian countries.

Inadequate access to water supply and sanitation has challenged the development of Jakarta since the mid-1970s. Attempts to ameliorate this condition have been implemented, but results were unsuccessful. Today, of the 10 million people living in Jakarta, only 48% have access to piped water and less than 2% are connected to a sewer network. The estimated economic impact resulting from lack of water and sewerage access is Rupiah (Rp.)16.2 trillion (US$1.4 billion) per year, which was approximately 1.3% of Jakarta-s- gross domestic product (GDP) in 2012. This amount is the equivalent to approximately Rp.1.7 million (US$139) per person per year, which is three times more than the cost for the rest of the country (Water and Sanitation Program [WSP], n.d.).

To understand why slow progress of piped-water and sewer development has occurred in Jakarta as well as respond to the lack of literature describing such development in this city, this article aims to explain and analyze the dynamic of piped-water and sewer development in Jakarta from 1998 until 2015 using the multilevel perspective (MLP) framework, using Geels–MLP work as a model (2005, 2006). To explain the slow improvement of piped-water and sewer development in Jakarta and to analyze the factors that enabled and constrained its development from 1998 (when Indonesia embarked for a new phase called Reformation era) to 2015, three different levels of analyses were used: landscape, regime, and niche (Geels 2005, 2006). In this paper, author will describe condition at landscape level and enabling and disabling factor for water and sanitation development in Jakarta at regime level.

## Landscape Level (Politic, Economic, Social, and Health Condition)

An important landscape development was the collapse of the centralization era when President Soeharto resigned on May 21, 1998. New constitutions on decentralization i.e. Law No.22/1999 and Law No.25/1999 were enacted and marked the rise of decentralization or the Reform Era. One of the immediate impacts of the Reform Era was an increased demand for freedom of expression and speech. Popular issues for reform were brought and generated primarily by the media combined with demand from communities (Jones, 2012). However, water and sanitation issues are still not top priorities for national and local governments as well as for communities. Governance performance improved during the Reform Era. From 1996 to 2014, all governance performance indicators had increased except for the regulatory quality indicator (World Bank, n.d.). Unfortunately, the improvement in the governance system did not bring many changes in water and sanitation development.

Administrative power to manage water and sanitation service was changed after the implementation of decentralization. In the decentralization era, the central government does not have direct control over water and sanitation provision. After reform began in 1998, water and sanitation were among the responsibilities transferred from the central to the local government. According to law and regulations, the central government was excluded from implementing water supply and sanitation projects, except for regional or national strategic water and sanitation infrastructure projects. However, in practice, the central governments still plays a major role in planning, executing, and financing water supply and sanitation projects. Almost 80% of total urban water and sanitation expenditure comes from the central government budget, with – much of it coming through Ministry of Public Works (Presidential Regulation No.7/2005; No.5/2010, and No.2/2015). The central government still invests more than local governments by constructing and rehabilitating water supply and sanitation infrastructure in urban and rural areas. However, in the city of Jakarta this is not the case, it has the highest fiscal capacity in Indonesia. Its GDP is about 17% of Indonesia's GDP.

While decentralization provides faster response and more appropriate policies, there were some disadvantages for social and health development. In the centralization era, central government provided 80% of the total public budget on health (Thabrany, 2008). The central government health expenditure in the decentralization era has been stagnant at levels below US$4-6 per capita per year, with health services standards dependent on the amount of money allocated by local governments (Bappenas, 2016; Thabrany, 2008). Furthermore, inadequate infrastructure remains a major impediment to poverty reduction in Indonesia where infrastructure investment fell from an average of US$400 million in the 1990s to under US$45million in 2005. Another way to look at the changes in investment is that infrastructure investment was about 5-6% of GDP before 1997, 1-2% in 2000, and 3.4% in the mid-2000s (Ehrhardt et al., n.d.).

## Regime Level

The growth of piped-water and sewer in Jakarta cannot keep up with the population growth per capita income. The number of piped-water connections increased from approximately 560,000 in 2000 to 820,000 in 2015 (piped-water coverage increase from 34% in 2000 to 40% in 2015) while the number of sewer networks increased slightly from 954 to 1,852 during the same period (sewer coverage increase from 0.05% in 2000 to 2% in 2015). By 2015 about 40% of Jakarta's population (or approximately 4.1 million people) has a piped-water connection but less than 2% are connected to sewers (or approximately 0.21 million people). However, in terms of households with improved access to water and sanitation, the numbers are much higher in recent times. In 2014, approximately 93.7% households have access to an improved water source and there were 88.5% households with access to improved sanitation facilities (BPS Jakarta, 2015).

## Enabling Factors for Water and Sanitation Development at Regime Level

An important achievement in the water sector in Reform era was the substitution of Law No.11/1974 with Law No.4/2004 on Water Resources which marked the

water resources management reform. This law introduced a more integrated and comprehensive policy framework in managing water and was prepared by the government with the assistance from the the World Bank. In the previous Law (Law No.11/1974), water resource management was heavily controlled by the government and water use was not distributed equally among sectors. The Law No.4/2004 is the only national law pertaining to wastewater policy. Despite this achievement, the law was overruled by Indonesia's Constitutional Court in February 2015, as it was deemed that the law allowed the private sector to monopolize water resources. The Court has reinstated the previous regulation, Law No.11/1974 as the controlling legislation until a new law is adopted.

## Constraining Factors for Water and Sanitation Development at Regime Level

The Government of Indonesia increased its national-level interest in water and sanitation in 2000 along with the government's commitment to the Millennium Development Goals (MDGs). The increased interest had a considerable impact on refocusing public investment on water and sanitation provision once they began lagging behind. Figure 1 shows that there has been increased investment per capita for water and sanitation since 2005. While an improvement, this investment is still small compared to the magnitude of water and sanitation problems in Indonesia. The estimated investment to achieve 100% urban water supply access is US$11.7 billion per year (based on the projection in 2012) and to achieve 100% urban sanitation access is US$11.2billion (based on the projection in 2015) (World Bank, Ministry of Public Works, and Water Partnership Program, 2012; Bappenas, 2014).

Jakarta already had a water supply operator (Perusahaan Daerah Pengolahan Air Minum Jaya - PAM Jaya) and a wastewater supply operator (Perusahaan Daerah Pengolahan Air Limbah Jaya - PDPAL Jaya). The water regime in Jakarta was dominated by PAM Jaya and its private partners and the sewer regime was dominated by PDPAL Jaya. Central government shifted its attention to other cities and districts of Indonesia due to the high fiscal capacity of Jakarta. The central government diverted its attention from Jakarta because other big cities in Indonesia such as Medan and Surabaya also faced similar urban problems (high population growth, poor raw water quality, etc) and had

proven that they could solve their water and sanitation problems without heavy reliance on central government initiatives (interview, government official).

The Government of Jakarta did not pay much attention to water and sanitation because the regulatory function for water supply and sanitation development was only managed by the Section Head or by a lower working unit under Dinas Pekerjaan Umum. The unit was dissolved in 2008 based on Regional Regulation No.10/2008 on Regional Organization. From 2008 water and sanitation provision in Jakarta had been managed under Badan Pengelolaan Lingkungan Hidup Daerah (Jakarta Environmental Management Agency). However, this agency had also heavily focused their attention on regulating groundwater extraction particularly after the Government of Indonesia issued Government Regulation No.43/2008 on Groundwater. The BPLHD had also been increased their attention on groundwater particularly on deep well extraction as a source of revenue for the local government.

The responsibility of managing sanitation facilities was transferred from Dinas Pekerjaan Umum to BPLH when Dinas Perkerjaan Umum was abolished in 2008. However, because BPLHD is essentially a regulatory department, it did not have the ability to construct and manage sanitation facilities (JICA, 2012). The result was that allocating budget funds to water supply and sanitation in Jakarta was a low priority. PAM Jaya and PDPAL Jaya were treated like other public corporations run on a self-paying basis and did not get money from Jakarta's budget. Jakarta paid more attention and allocated much more funds to managing flood control and traffic and transportation construction. It is possible that the city government's prioritization of drainage and transportation sectors aligned with household-s-preferences when communities paid more attention to flooding and traffic jam issues. The working unit for water and sanitation was reactivated in 2014 under Dinas Tata Air. The agency is currently adjusting and preparing activities to improve water resources in Jakarta for the water and sanitation sector.

Among water supply, wastewater, solid waste management, and drainage issues, public and governmental agencies in Jakarta paid more attention to solid waste management and drainage issues. Of 40-50 community complaints reported to Jakarta-s-local parliament every year, none were related to water and sanitation between the periods of 2000-2013. The public demanded better

solid waste and cleanliness management but not improved water and sanitation services (BPS Jakarta, 2000-2013). Furthermore, the campaigns and promotions that did relate to water and sanitation that frequently drew community attention were solid waste and cleanliness (61.5%); water supply (3.2%); drainage (1.8%); and wastewater (1.5%). The remaining 32% of the communities did not know what topic they were interested in (Pokja Sanitasi, 2012).

Although the majority of communities did not understand the importance of sanitation, a 2014 study by USAID-IUWASH in Pademangan Barat, North Jakarta showed that after sanitation campaigns, the proportion of households who said they did not need septic tank desludging decrease from 57% to 4% (IUWASH, 2015). This study implied that community education can increase demand for sanitation. However, governments have not paid much attention to conducting community campaigns or implementing water and sanitation demand studies. Furthermore, those who demanded better water and sanitation services were usually poor (interview, government official and non-government). One representative from INGO stated that "[While] actually, there is demand from the community, this demand is low and is not a top priority listed in community consultations on development planning (Musrenbangdes). Furthermore, those who may want to demand better water and sanitation are usually voiceless [the poor community]".

Media interest in covering water and sanitation was also low. Of the 1.644 news articles related to the water and sanitation sector in 2013-2014, only 6% were related to wastewater. Forty-two percent were related to water scarcity, 38% to solid waste management, and 15% to drainage issues (personal documentation from Sekretariat Pokja AMPL, 2014). In summary, there is a general lack of household demand for better water and sanitation services in Jakarta.

## Corruption in the Preparation of PPP in Water Supply in Jakarta

There is corruption behind decision-making to implement Public Private Partnership (PPP) in water supply in Jakarta. The process to prepare the PPP agreement was tedious, with negotiations between the two private investors (PALYJA and Aetra) taking over a year to settle. During negotiation preparations, PAM Jaya and its partner (consulting firms) asked for guidance from the former

Governor of Jakarta, Ali Sadikin (1966-1977), who is well-known in Indonesia as the best governor of Jakarta. PAM Jaya asked the Governor to advise President Soeharto to cancel the plan to privatize Jakarta's water supply. According to a representative from non-government, the Governor declared that "if there is any part of President Soeharto's policy that we should agree with, this part is it" (interview, non-government). The plan to privatize water supply in Jakarta was endorsed by Ali Sadikin as it would both improve and accelerate water supply provision in the city, especially considering the limited capacity of PAM Jaya (interview, non-government).

## The Conflict with the Implementation of PPP in Water Supply in Jakarta

In June 1997, two 25-years cooperative agreements were awarded for the provision of water services in Jakarta with PAM Jaya acting as the first party and Lyonnaise des Eaux (later known as PALYJA) and Thames Water International (later known as TPJ) as the second parties. Total investment of PALYJA and TPJ set in this contract was US$250million and US$225million respectively (Sukarma, 2003). Initially, an investment schedule was not part of the target set in the contract, as it was planned to be negotiated every 5 years.

Since the collapse of President Soeharto's regime, there has been no political support for the PPP in Jakarta to move forward. Tedious discussions have taken place between the central government and Jakarta government on which party should issue Badan Regulator Penyediaan Air Minum (BRPAM) regulations. BRPAM has not been able to strongly influence concessionaire parties due to insufficient authority. BRPAM was established based only on a Governor Decree and its operating fund comes from private parties and PAM Jaya (interview, non-government). Since 2001, there have been several times when BRPAM has been off-duty thus leaving no party to actsas a mediator for PAM Jaya and its private partners. "BRPAM is now temporarily in-active [in December 2015-January 2016] since the Governor Decree to elect a new member of BRPAM for the period of 2016-2018 has been delayed by the Jakarta government" (interview, non-government). It was decided that the BRPAM will be established under Governor Decree No.95/2001 (interview, non-government).

## The Absence of Water Tariff Adjustment

There are persistent issues in the implementation of PPP in Jakarta. These problems existed before the PPP. First, the problem on water tariff adjustment. Because of the severe economic crisis in 1998, the Governor of Jakarta was unwilling to adjust the water tariff for inflation. Many times the Governor of Jakarta was unwilling to increase the tariff due to political reason and due to the dissatisfaction with the private operators—performance. The Governors of Jakarta, Fauzi Bowo (2007-2012) and Basuki Tjahaja Purnama (2014-to date) have opposed tariff adjustments since there was social resistance and complaints from communities with poor water services from private operators (interview, non-government).

## Conclusion and Recommendation

The case study in this project examined the dynamics of piped-water and sewer development between 1998 and 2015 in Jakarta, Indonesia. This case study presented findings from interviews and documentation approaches, followed by interpretation using a MLP framework. The findings contribute to the growing discourse regarding the slow progress of piped-water and sewer development in Jakarta, where piped-water coverage has only increased 10% to 48% from 1975 to 2015. During this period, the development of sewer network has been stagnant, providing access to less than 2% of Jakarta's population.

This study has shown the changes and even improvements in the economy, politics, and health in Jakarta can be achieved without much progress in water and sanitation. Although Indonesia has initiated a decentralisation and privatisation reform which reduces the power of the central government and gives more authority to local government and private actors, local governments and the public have failed to make water and sanitation an important aspect of development. A main finding of this research, which is based on qualitative methodology, is that decentralization does not substantially increase government and public responsiveness to water and sanitation issues. The change of water supply management from public (PAM Jaya) to public-private partnership (PALYJA and Aetra) in Jakarta also did not bring about substantial improvements in providing piped-water access.

The key point of the MLP is to observe where the dynamics within landscape and regime become linked. However, in the case of Jakarta, there have only been limited interactions between landscape and regime levels in Jakarta. The lack of interactions between these two levels has prevented the expansion of piped-water and sewer systems in Jakarta. There is some co-evolution in landscape events but not in regime actors. The insider regime actor (i.e. the government) has overall been resistant to changes, with limited innovations implemented to solve water and sanitation problems. Furthermore, there have been inadequate interactions between inside and outside actors. Our findings show that the Jakarta piped-water and sewer systems have not been substantially influenced by technological innovations or by environments outside the technology sector, such as macro-politics, macro-economics, and societal behaviour. Thus, current policy makers should pay more attention and learn from the country's history of the authoritarian bureaucrats, corruption, and weak legislative systems. Awareness of past fallacies and weaknesses can help law makers avoid similar pitfalls during the process of implementing water and sanitation project in a decentralized system.

The MLP is a fruitful starting point allowing for the identification of interrelated of dynamics within piped-water and sewer systems in Jakarta. However, the study of multi regime dynamics (ground water, bottled/refilled water, piped water, sewer and on-site sanitation) needs more emphasis. The slow progress of piped-water and sewer has two major implications for Indonesia and other developing countries that aim to improve their systems. First, to accelerate the achievement of universal access to drinking-water and sanitation, strong leadership from the government in planning and implementing infrastructure is essential. The government needs to create a dynamic between landscape and regime. The government ought to seek out more opportunities for innovation and adaptation to local conditions. Second, the government should promote integration between cultural behaviour and water and sanitation development. The historical, political, economic, and cultural contexts are decisive in water and sanitation development pathways. What worked in developed countries may not work in developing countries due to the differences of historical, social, and cultural conditions.

# Analisis Risiko dalam Rencana Pengamanan Air (RPA) Sumber (Studi Kasus di IPAL Dago Pakar, PDAM Tirtawening, Bandung)

# Risk Analysis on Water Safety Plan (WSP) Source (Case Study: Dago Pakar WTP, PDAM Tirtawening, Bandung)


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# ABSTRAK

Instalasi Pengolahan Air (IPA) Dago Pakar, PDAM Tirtawening menggunakan sumber air baku dari Sungai Cikapundung (melalui intake Bantarawi), dimana kondisi sungai tersebut sekarang banyak mengalami penurunan baik dari segi kualitas maupun kuantitas. Sungai Cikapundung telah tercemar oleh limbah peternakan dan domestik, terutama yang berasal dari wilayah Hulu Sungai Cikapundung. Kondisi tersebut menyebabkan bertambahnya beban pengolahan IPA, sehingga menyebabkan bertambahnya biaya produksi yang dikeluarkan oleh IPA Dago Pakar. Beban IPA bertambah karena bertambahnya penggunaan koagulan (PAC) dengan jenis PAC yang berbeda harga pembeliannya. Oleh karena itu, perlu dilakukan studi penelitian tentang penilaian resiko pada unit pengolahan akibat dari perubahan kualitas (kekeruhan, BOD, warna, pH, DO dan TOC) dan kuantitas sumber air baku. Adapun metode yang digunakan adalah pendekatan metode analisis resiko ekologi. Hasil identifikasi menunjukkan adanya korelasi yang kuat antara kekeruhan akibat limbah peternakan sapi dan kejadian hujan terhadap pemakaian jumlah koagulan bubuk (kg), koefisien korelasi Spearman sebesar 0,795 dan 0,766 dengan nilai signifikansi sebesar 0,000 ($p<0,05$). Nilai total resiko tergolong memiliki resiko tinggi yaitu sebesar 6,48 % dari harga jual air atau sebesar Rp287,36/m3 kapasitas produksi. Hasil peramalan dengan program Crystal Ball dengan memakai tools analisa skenario menggunakan data persentil 1 – 10 %, diperoleh hasil untuk data persentil 1 % diperoleh nilai total resiko Rp250,79/m3 kapasitas produksi atau 5,65 % dari harga jual air (resiko tinggi) dan pada data persentil 10 % diperoleh nilai total resiko Rp266,33/m3 kapasitas produksi atau 6 % dari harga jual air (resiko sangat tinggi).

Kata kunci: analisis resiko ekologi, Rencana Pengamanan Air Minum (RPAM), IPA Dago Pakar, analisa skenario, program Crystal Ball

# ABSTRACT

Dago Pakar Water Treatment Plant (WTP), PDAM Tirtawening use raw water sources from Cikapundung River (through Bantarawi intake), where the condition of the river now much decreased in terms of both quality and quantity. Cikapundung river are polluted by livestock waste, and domestic, especially those from the Upper River region of Cikapundung river. These conditions lead to increased processing load on WTP, thus resulting in increased production costs incurred by Dago Pakar WTP. WTP load increases due to increasing the use of coagulants (PAC) with different types of PAC and purchase price. Therefore, it is necessary to research on risk assessment study on the processing units as a result of changes in quality (turbidity, BOD, color, pH, DO and TOC) and quantity of raw water source. The approach of ecological risk analysis method is use for this study. The result of the identification shows a strong correlation between the turbidity of livestock waste and rain events with the use of powder coagulant (kg). The Spearman correlation coefficient are 0.795 and 0.766 with significance value are 0.000 ($p < 0.05$) respectively. The total risk value is classified as high risk. The total risk value is 6.48% of the average of the water selling price or Rp287.36/m3 production capacity. The results of the Crystal Ball program forecasting using scenario analysis with 1 – 10 % percentile data show that total risk value for the 1 % percentile is 5.65% of the average of the water selling price (high risk) or Rp250.79/m3 production capacity and for the 10 % percentile is 6% of the average of the water selling price (very high risk) or at Rp266.33/m3 production capacity.



Keywords: ecological risk analysis, Water Safety Plan (WSP), Dago Pakar WTP, scenario analysis, Crystal Ball program

## Latar Belakang

Pelayanan suplai air bersih/air minum sangat penting bagi penduduk. Terlebih suplai air bersih/air minum yang terjamin kualitas, kuantitas, kontinuitas dan keterjangkauannya. Hal ini sesuai dengan target MDG's air minum 2015 yaitu pemenuhan pelayanan air minum sebesar 68,87 persen proporsi penduduk Indonesia terlayani air minum secara memadai. Berdasarkan keterangan Direktur Pengembangan Air Minum (PAM), Direktorat Jenderal (Ditjen) Cipta Karya, Kementerian Pekerjaan Umum (PU) menjelaskan bahwa pada akhir tahun 2012 cakupan layanan air minum sudah mencapai 58,05 persen, kemudian target capaian pada tahun 2013 sebesar 61,83 persen, tahun 2014 sebesar 65,61 persen, dan diharapkan pada akhir 2015 dapat dicapai sebesar 68,87 persen sesuai target MDG's (Ditpam PU, 2014).

Fakta yang terjadi di Indonesia adalah masih belum terpenuhinya pelayanan kualitas air minum serta masih rendahnya cakupan dan tingkat pelayanan air minum. Kondisi saat ini, kualitas air yang didistribusikan PDAM hingga sampai ke pelanggan tidak/belum memenuhi kualitas standar air minum atau masih dalam batas kualitas air bersih. Selain itu juga, tingkat kebocoran air yang masih tinggi dari distribusi perpipaan menyebabkan kuantitas pelayanan air berkurang. Penurunan kualitas dan kuantitas sumber air baku diakibatkan oleh penurunan kualitas lingkungan di beberapa aliran sungai sebagai akibat polusi air seperti pada Sungai Cikapundung, serta rendahnya keperdulian dan kesadaran masyarakat yang berkaitan dengan rendahnya pengetahuan dan kesadaran masyarakat tentang perilaku hidup bersih dan sehat. Pembuangan limbah ternak di wilayah Kabupaten Bandung Barat ke sungai, pembuangan limbah cair dan air limbah domestik dan pengelolaan sampah yang kurang baik merupakan sumber masalah utama di Sungai Cikapundung (Prasetyo, 2012). Kondisi ini menjadi alasan Daerah Aliran Sungai (DAS) Cikapundung dipilih sebagai salah satu lokasi uji coba untuk Program Rencana Pengamanan Air Minum (RPAM) atau (Water Safety Plans/WSPs). Uji coba ini dilakukan secara komprehensif baik pada komponen sumber, komponen operator baik yang dikelola oleh PDAM maupun masyarakat, serta komponen konsumen. RPAM merupakan salah satu program yang diinisiasi oleh Pokja AMPL Nasional. RPAM dapat menentukan risiko apa saja yang perlu diprioritaskan dan cara pengelolaannya.

Konsep RPAM/WSPs merupakan metode baru yang diprakarsai oleh World Health Organization (WHO) Tahun 2008 untuk mengevaluasi dan mengelola faktor resiko dalam sistem distribusi air minum dari sumber ke konsumen (Bartram dkk., 2009). Konsep ini banyak diadopsi oleh negara ASEAN seperti Singapura, Filipina, Laos dan Vietnam. Di Indonesia, konsep RPAM telah diadopsi dengan berbagai basis penerapan yaitu RPAM berbasis pada sumber, operator, komunitas dan konsumen (Condrorini, 2012). RPAM merupakan langkah preventif dalam pengelolaan air. RPAM ini diharapkan dapat memberikan dampak nyata bagi masyarakat, seperti perbaikan kualitas air sungai yang berdampak meningkatnya kesehatan masyarakat. RPAM telah dilakukan uji coba pelaksanaan di PDAM Bandarmasih, Kalimantan Selatan yang tertuang dalam manual RPAM Bandarmasih (PDAM Bandarmasih, 2012). Dalam penelitian ini akan menganalisa mengenai RPAM sumber pada IPA Dago Pakar, PDAM Tirtawening yang menggunakan sumber air baku dari Sungai Cikapundung.

PDAM Tirtawening merupakan perusahaan yang menangani distribusi air minum di kawasan Kota Bandung. PDAM ini mempunyai kapasitas produksi 2.509 l/dtk yang melayani ± 74,20 % penduduk Kota Bandung yaitu sebanyak 1.789.836 jiwa pada Tahun 2011. Sedangkan target nasional pelayanan air minum untuk kota besar sebesar 80 %. PDAM Tirtawening mempunyai beberapa IPA dengan beberapa sumber air baku, diantaranya IPA Dago Pakar yang menggunakan sumber air baku dari sungai Cikapundung sebesar ± 600 l/dtk (PDAM Tirtawening, 2013a).

Kondisi Sungai Cikapundung saat ini mempunyai tingkat kekeruhan dan kandungan materi organik yang tinggi. Tingginya kandungan materi organik berasal dari limpasan air hujan dan pembuangan limbah peternakan sapi yang berasal dari hulu DAS Cikapundung. Limbah cair peternakan sapi memiliki konsentrasi TDS dan TSS mencapai 2.000 dan 3.000 ppm (Hidayatullah, dkk., 2005). Berdasarkan data operasi IPA Dago Pakar, kekeruhan air baku dapat mencapai 5.980 NTU pada Bulan Februari 2013 (IPA Dago Pakar, 2013). Kandungan materi organik baik terlarut maupun tersuspensi akan menambah beban operasi IPA.

Selain terjadinya penurunan kualitas, Sungai Cikapundung juga mengalami pengurangan debit yang akan menyebabkan konsentrasi zat

pencemar meningkat pada saat musim kemarau. Pengurangan debit Sungai Cikapundung juga akan mengurangi debit yang dapat diambil oleh IPA Dago Pakar. Produksi akan diturunkan hingga lebih dari 50% di IPA Dago Pakar apabila kekeruhan sudah sangat tinggi di musim hujan yang mengakibatkan beban di unit operasi sedimentasi dan filter terlalu tinggi. Data debit IPA Dago Pakar menunjukkan pengurangan debit produksi hingga 500 l/dtk pada saat kekeruhan tinggi tersebut. Berdasarkan data operasi IPA Dago Pakar sepanjang Tahun 2012, diperkirakan kehilangan debit produksi akibat kekeruhan tersebut sekitar 16.000 m3 (IPA Dago Pakar, 2013).

Berdasarkan data Waspola, Kota Bandung menunjukkan adanya pencemaran limbah organik pada air Sungai Cikapundung dilihat dari nilai BOD dan COD yang melebihi baku mutu dan jumlah E. Coli yang tinggi di air sungai (Waspola, 2012). Kenaikan nilai-nilai BOD dan COD dan penurunan DO dari hulu ke hilir mengindikasikan bahwa semakin ke hilir beban pencemaran tersebut semakin bertambah. Adanya materi organik yang tinggi dalam air baku dan setelah dilakukan pengolahan ternyata kandungan materi organik masih tinggi dapat menimbulkan disinfection by-products (DBPs) yang bersifat karsinogen di air produksi di dalam air olahan di unit proses klorinasi.

Dengan sumber air baku yang berasal dari sumber yang tercemar, resiko pada beban unit pengolahan perlu diidentifikasi, sehingga dapat meminimalisir potensi resiko yang ada. Oleh karena itu, pada penelitian ini akan dilakukan analisa resiko dari Rencana Pengamanan Air Minum (RPAM) berbasis sumber dari IPA Dago Pakar, PDAM Tirtawening, sehingga dapat menjamin kualitas, kuantitas, kontinyuitas, dan keterjangkauan pelayanan PDAM Tirtawening.

Kualitas dan kuantitas air Sungai Cikapundung sebagai sumber air baku PDAM Tirtawening di IPA Dago Pakar sudah tercemar dibandingkan dengan baku mutu kelas III menurut PP 82 Tahun 2001, sedangkan sebagai air baku air minum harus sesuai baku mutu kelas I (Badiamurti dan Muntalif, 2010). Dengan kondisi sumber air baku yang tercemar tersebut menyebabkan potensi resiko pada beban pengelolaan dan pengolahan di PDAM semakin besar. Oleh karena itu, diperlukan suatu konsep manajemen tentang Rencana Pengamanan Air Minum (RPAM) sumber yang berbasis resiko dengan mengadopsi tahapan dari metode analisis risiko untuk sistem ekologis yang dikenal dengan Analisa Resiko Ekologi/ Ecological Risk Assessment (ERA) (U.S.EPA, 1998). Dalam penelitian ini,

analisis resiko akan difokuskan pada parameter penurunan kualitas air sungai Cikapundung akibat penurunan debit air baku, sampah, kekeruhan, dan materi organik.

Maksud dari penelitian ini adalah untuk menganalisa dan memperkirakan total nilai resiko pada unit pengolahan IPA dengan pendekatan metode analisis resiko ekologi (ERA) akibat perubahan kuantitas dan kualitas sumber air baku yang digunakan. Tujuan dari penelitian ini antara lain :

- Mengidentifikasi kandungan materi organik pada sumber air baku, unit pengolahan dan efluen air produksi akibat perubahan kualitas dan kuantitas sumber air baku.
- Menghitung total nilai resiko pada unit pengolahan akibat dari perubahan kualitas dan kuantitas sumber air baku.

## Tahap Manajemen Resiko (Risk Management)

Dalam tahap ini, deskripsi resiko sebagai hasil dari tahap karakterisasi resiko, digunakan sebagai bahan untuk membuat keputusan oleh manajemen yang berkaitan dengan pengelolaan lingkungan. Besarnya nilai resiko yang diakibatkan oleh perubahan kualitas dan kuantitas air baku Sungai Cikapundung pada pengolahan air bersih oleh IPA Dago Pakar menyebabkan PDAM Tirtawening harus menerapkan manajemen resiko sebagai bentuk pengendalian resiko.

## Tahap Rencanakan (Plan)

PDAM Tirtawening membuat peraturan atau kebijakan tentang rencana pengamanan air minum (RPAM) yang berisi tentang visi, misi, dan tujuan dari program RPAM yang akan dilaksanakan. Hal ini dilakukan untuk memenuhi harapan pelanggan, menjaga kesehatan masyarakat dan tetap menjaga kelestarian lingkungan; Membentuk Tim Penyusun RPAM dan mendiskusikan kepada manajemen puncak dan staf PDAM untuk membuat komitmen bersama yang berisi poin – poin sebagai berikut (PDAM Bandarmasih, 2012): Komitmen Internal, antara lain: Menjaga kualitas dan kuantitas ketersediaan air baku; Komitmen dalam proses produksi dan distribusi. Komitmen Eksternal, antara lain: Menjalankan dan melaksanakan visi & misi PDAM Tirtawening; Menjaga

kelestarian lingkungan wilayah tangkapan air; Komitmen untuk mendukung pelaksanaan PP 16 tahun 2005 tentang Pengembangan Sistem Penyediaan Air Minum; Melakukan standarisasi kualitas air; Mendukung secara penuh program RPAM; Mendukung program MDGs; Bersama Dinas/Instansi terkait menyiapkan rencana induk dan program kerja jangka menengah dan tahunan pengendalian pencemaran air dan peningkatan kualitas air.

## Tahap Laksanakan (Do)

Tahap pelaksanaan dari manajemen resiko yang telah dituangkan dalam kebijakan adalah meliputi (PDAM Bandarmasih, 2012):

Lakukan identifikasi kejadian bahaya dan potensi resikonya, meliputi :

- Resiko terhadap K1 adalah tidak terpenuhinya kualitas air minum hasil produksi atau yang didistribusikan/dikonsumsi oleh pelanggan sesuai dengan standar air minum Indonesia berdasarkan Peraturan Menteri Kesehatan No. 492/Menkes/Per./IV/2010 tentang Persyaratan Kualitas Air Minum;
- Resiko terhadap K2 adalah kurangnya pasokan air minum dari operator ke pelangggan air minum yaitu minimal 60 liter/orang/hari;
- Resiko terhadap K3 adalah terputusnya/tidak kontinyu-nya aliran air ke pelanggan dan/atau kurangnya tekanan air minum di daerah pelayanan (minimal 1,5 bar atau 15 meter);
- Resiko terhadap K4 adalah tidak terjangkaunya harga air minum bagi masyarakat. Tarif air minum memenuhi prinsip keterjangkauan apabila pengeluaran rumah tangga untuk memenuhi Standar Kebutuhan Pokok Air Minum tidak melampaui 4% dari pendapatan masyarakat pelanggan.

Lakukan tindakan pengendalian resiko dan susun daftar prioritas, antara lain :

- Koordinasi dengan lembaga pemerintah yang bertanggung jawab terhadap penanganan kawasan hulu dan badan sungai;
- Sosialisasi dengan masyarakat pinggiran sungai dan stakeholder penanganan sungai (BWS, SDA, LH). Perlu direncanakan satu diskusi/ lokakarya penanganan air baku;
- Pemasangan automatic motorised finescreen;

- Pre-klorinasi;
- Penggunaan alternatif koagulan yang lebih kuat terutama untuk mengatasi permasalahan perubahan kualitas air baku yang terjadi secara tiba-tiba, dan lain sebagainya.

## Periksa (Check)

Periksa (Check) merupakan tahap untuk memantau dan mengukur proses terhadap kebijakan lingkungan, tujuan, sasaran, persyaratan peraturan perundang-undangan dan ketentuan lain yang diikuti organsasi serta melaporkan hasilnya (SNI-19-14001-2005). Berdasarkan daftar kejadian bahaya dan tindak pengendalian, lakukan validasi atau pengecekan terhadap pelaksanaan tindakan pengendalian tersebut, antara lain:

- Kajian lokakarya dan sosialisasi;
- Spesifikasi barscreen dan finescreen dari supplier;
- Spesifikasi CCTV dari supplier;
- Uji pencampuran lumpur dengan air baku;
- Pengukuran kekeruhan setelah pencampuran dan uji jar test;
- Kajian K3 di tempat kerja;
- Kajian SOP dan IK;
- Berkurangnya kejadian bahaya dan resikonya;
- Kajian Program-Program Pendukung (Supporting Programs) untuk RPAM;

Berdasarkan rencana induk, melakukan pemantauan dan pengendalian kualitas air yang melibatkan berbagai instansi terkait. Pemantauan dilakukan secara periodik (baik kualitas air sungai maupun buangan limbah cair yang dominan) dan melaksanakan pengujian laboratorium serta evaluasi terhadap hasil uji tersebut. Rekomendasi diberikan kepada Pemerintah Daerah (Gubernur maupun BLH) dalam upaya pengendalian pencemaran air, penegakan aturan dan peningkatan kualitas air sungai; dan lain sebagainya.

## Tindakan (Act)

Tindakan (Act) adalah melaksanakan tindakan untuk meningkatkan kinerja sistem manajemen lingkungan secara berkelanjutan (SNI - 19-14001-2005). Permintaan tindakan korektif terhadap perbedaan yang signifikan antara

hasil aktual dan terencana. Menganalisis perbedaan untuk menentukan akar penyebabnya. Menentukan di mana untuk menerapkan perubahan yang akan mencakup perbaikan proses atau produk. Lakukan rencana dan tindakan perbaikan berdasarkan hasil pengecekan dari daftar kejadian bahaya dan tindakan pengendalian yang telah dilakukan, antara lain:

Bersama dinas/instansi terkait menyusun penetapan garis sempadan dan rencana peruntukan lahan daerah sempadan sungai sesuai dengan Rencana detail Tata Ruang Daerah dalam rangka pengamatan fungsi sungai;

- Melaksanakan lokakarya/seminar tentang perlunya pengamanan sumber air baku;
- Memonitor dan evaluasi terhadap perkembangan sosial ekonomi masyarakat, serta tingkat kesadaran masyarakat dalam ikut berperan serta dalam pengelolaan DAS;
- Pengembangan berbagai bentuk insentif (rangsangan) baik insentif langsung maupun tidak langsung, dalam bentuk bantuan teknis, pinjaman, yang dapat memacu peningkatan produksi biogas dan usaha konservasi tanah dan air;
- Pemasangan automatic motorised fine screen untuk perbaikan sistem intake dalam rangka mengurangi sampah yang masuk;
- Pemasangan papan peringatan untuk pengamanan dan pencegahan kerusakan bar screen pada seluruh intake air baku;
- Pemasangan CCTV untuk pengamanan intake air baku; dan lain sebagainya.

## Kesimpulan

Pendekatan metode analisis resiko ekologis (Ecological Risk Assessment) yang digunakan untuk menganalisa dan memperkirakan total nilai resiko pada unit pengolahan IPA Dago Pakar akibat perubahan kuantitas dan kualitas sumber air baku Sungai Cikapundung diperoleh sumber atau penyebab resiko (stressor) adalah kejadian kekeruhan akibat pembuangan limbah organik di wilayah Hulu Sungai Cikapundung, kejadian kekeruhan akibat hujan dan kehilangan air karena penurunan debit sungai dan pembersihan filter.

Hasil identifikasi kandungan materi organik pada sumber air baku, unit pengolahan dan efluen air produksi akibat perubahan kualitas dan kuantitas

sumber air baku, diperoleh hasil korelasi yang kuat antara kekeruhan yang dihasilkan dari limbah peternakan sapi dan kejadian hujan terhadap pemakaian jumlah koagulan bubuk (kg) dengan koefisien korelasi Spearman (Spearman Rank Correlation) sebesar 0,795 dan 0,766 dengan nilai signifkansi sebesar 0,000 ($p<0,05$).

Nilai total resiko pada unit pengolahan akibat dari perubahan kualitas dan kuantitas sumber air baku tergolong memiliki resiko sangat tinggi yaitu sebesar sebesar 6,48 % dari harga jual air atau Rp287,36/m3 kapasitas produksi. Hal ini akan mempengaruhi peningkatan biaya produksi air di IPA Dago Pakar, karena peningkatan jumlah koagulan yang digunakan. Hasil peramalan dengan program Crystal Ball dengan memakai analisa skenario menggunakan data persentil 1 – 10 %, diperoleh hasil pada data persentil 1 % diperoleh nilai total resiko Rp250,79/m3 kapasitas produksi atau 5,65 % dari harga jual air (resiko tinggi) dan pada data persentil 10 % diperoleh nilai total resiko Rp266,33/m3 kapasitas produksi atau 6 % dari harga jual air (resiko sangat tinggi).

# Korelasi antara Konsumsi Energi dan Pertumbuhan Ekonomi Meliputi Periode 1990 - 2013 dan Implikasinya terhadap Kebijakan Energi di Indonesia

# The Correlation between Energy Consumption and Economic Growth Covering the Period of 1990 – 2013 and Its Implication to Energy Policy in Indonesia


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# ABSTRAK

Energi dan ekonomi saling terkait erat. Meskipun hubungan yang agak samar antara konsumsi energi dan pertumbuhan ekonomi, yang pertama memainkan peran penting dalam hal ini. Fenomena pemanasan global dan permintaan pengurangan Emisi Gas Rumah Kaca saat ini memberikan ilustrasi yang bagus untuk ini. Setiap tindakan pada konsumsi energi untuk mengurangi emisi akan berdampak pada pertumbuhan ekonomi.

Makalah ini mengkaji hubungan antara konsumsi energi menurut sektor (industri, rumah tangga, sektor komersial, transportasi dan sektor lainnya) dan pertumbuhan ekonomi (Produk Domestik Bruto / PDB) di Indonesia yang mencakup periode 1990- 2013. Hasil menunjukkan bahwa konsumsi energi memiliki efek positif. pada pembangunan ekonomi dan sebaliknya.

Makalah ini menganalisis masalah energi di Indonesia melalui trilemma energi dan pemenuhan solusi energi dari manajemen energi (efisiensi dan konservasi), penggunaan energi terbarukan dan reformasi pasar energi (listrik).

Temuan makalah ini memiliki implikasi yang signifikan untuk menyesuaikan keputusan kebijakan pengembangan energi di Indonesia pada tingkat nasional atau internasional. Makalah ini juga memberikan beberapa saran tentang bagaimana memperbaiki sektor ekonomi dan lingkungan negara yang bersangkutan.

# ABSTRACT

Energy and economy are intimately intertwined. Despite the rather vague relationship between energy consumption and economic growth, the former plays a crucial role in the latter. The current phenomenon of global warming and demand of Greenhouse Gas Emissions reduction provides a good illustration for this. Any measures on energy consumption to reduce emission will impact economic growth.

This paper examines the correlation between energy consumption by sectors (industry, households, commercial, transportation and other sectors) and economic growth (Gross Domestic Product/GDP) in Indonesia covering the period of 1990– 2013. Results indicate energy consumption has a positive effect on economic development and vice versa.

This paper analyses energy problems in Indonesia through energy trilemma and fulfilment to energy solutions from energy management (efficiency and conservation), use of renewable energy and energy market reform (electricity).

Findings of this paper have a significant implication for adjusting energy development policy decisions in Indonesia at national or international level. The paper also provides some suggestions on how to improve the economic and environmental sectors of the country in question.

Energy is a necessity for the Indonesian economy, both for consumption and for production activities of various sectors of the economy. As a natural resource, energy should be utilized as much as possible for the prosperity of society and its management should be based on the principle of sustainable development. From the aspect of the provision, Indonesia is a country rich with renewable and non-renewable energy resources. However, exploration and utilization of energy resources has thus far been largely focused on the nonrenewables while renewable sources are relatively not much exploited. This condition significantly diminishes supply of nonrenewable resources especially crude oil (Elinur, et al., 2010). On the other hand, the needs of the oil, gas, coal and electricity have increased along with the growth of the national economy, which is characterized, among others, with the development in each sector, such as industrial, household, commercial, transportation and others, and the increase in the number of population.

Indonesia is becoming an important country in terms of economic development. Indonesia is a country that contains enormous economic potential. Indonesia has abundant natural resources and quality human resources. Despite numerous shortcomings in infrastructure, corruption, and politics, Indonesia is the Southeast Asia's largest economy. In the age of globalization and amidst the debt crisis of the world's central forge Europe, the economic growth of Indonesia is one that is still stable among other developed and developing countries. As a developing country whose national economy is increasing, energy consumption is a major part of the country's development.

Energy and all of its aspects will perpetually be an inevitable challenge for any country. The handling of its availability cannot be left solely to the market mechanism. Government policy plays a crucial role in managing exploitation of energy sources and optimizing its supply and demand. By doing this, any energy sources can be used to strengthen the energy security of the country and to support a rapid growth of its economy (Hanan, Nugroho, 2011).

There is a general belief and agreement that energy availability and consumption play a key role in the process of economic development. Energy use has been associated with population growth and the expansion of urban centers. Energy use is a key to industrialization and the development of industrial and infrastructural facilities. Roads and transportation networks are among the

most energy intensive of these facilities. While some ambiguity has remained regarding the direction of causation - whether from energy to economy or from economy to energy – the importance of the energy-economy interaction is well recognized. Energy use is a necessary input to economic growth and is also a function of growth.

Energy has been defined as both a consumer good and an intermediate good (Pierce, 1986). As a consumer good, at the early stages of economic growth, it is possible that consumers will demand and consume more energy as soon as they can acquire the means to do so. It is also possible that the income elasticity of energy demand could become low. This concept can be tested with the intensity of use technique. As an intermediate good, the demand for energy is a derived demand.

Energy consumption has also been deemed as substantial for technological advancement. Machines, for instance, as an integral part of economic development processes, require energy inputs to operate. Energy is, therefore, a cause or a symptom of economic growth. The amount of energy use is, however, contingent upon availability and price of energy. Thereby, wise and efficient use of energy should become concern of policy makers and managers.

The above intimate link between economic growth and energy consumption calls for promotion of sustainable development through an effective energy and environmental policy. Inefficient consumption of energy leads to global warming and climate change, which will affect economic growth. It will be shown that energy policies will influence Indonesian economic conditions or vice versa.

Based on the above explanation, it is of immediate interest to review the correlation between energy consumption and economic growth in the context of Indonesia. Thus, the proposed title is "the correlation of energy consumption and economic growth in Indonesia covering the period 1990 – 2013 and its implication to energy policy".

Based on the background of the problems outlined above, it can be argued that need for energy is increasing both in the industrial, household, commercial, transportation and others. Thus, utilization of energy sources in an efficient manner is crucial. One potential endavour on the part of the government is energy conservation. Increasing energy consumption will indirectly increase economic growth through the resulting output. The relationship occurs

otherwise; however, that economic growth will have an impact on energy consumption, for the increase of energy is one of the important inputs in the production process.

Based on the background above, the problems in this thesis can be formulated as follows:

- What are the problems of energy in Indonesia?
- What are the problems of economy in Indonesia?

## The Implications to Energy Policy

The energy trilemma with energy security, which refers to the long lasting availability of energy sources; environment sustainability, where all processes of energy sources exploration, production, distribution and consumption are managed to be safe for the environment; and energy affordability, which provides equal and affordable access of energy for all impact. Indonesia government has made the trilemma energy balanced. Policy is the one of the crucial keys for energy balance because it can make stakeholders of energy cognizant of reward and punishment.

## Energy Sustainability (Environment)

Two sectors, energy and forestry, play crucial roles in our efforts to combat global climate change. In the energy sector, it is specifically the burning of fossil fuels that leads to the emission of global warming causing carbon dioxide. Meanwhile, forests serve as sinks for the carbon dioxide produced in the larger the forest, the more carbon emissions it can absorb.

As a member of the global community, what the government of Indonesia has done in the forestry sector plays a significant role in helping mitigate global climate change. Promoting the REDD (Reducing Emission from Deforestation and Degradation) scheme is one way Indonesia can help. Indonesia's consumption of energy is not as large as that of China or India. Carbon dioxide emissions produced by Indonesia's energy sector are much smaller than those that result from the culling of our forests, especially during forest fire season. However, this does not mean that the energy sector in Indonesia need not participate in endeavors to combat climate change.

Reduction of carbon dioxide emissions from the energy sector could be implemented by adding clean energy sources to our current energy portfolio (supply side) or by making sure that people consume energy more efficiently (demand side). The first approach could include developing nuclear power plants or renewable energy sources (particularly geothermal) or by shifting our consumption of fossil fuels from the dirtier sources (coal) to the cleaner ones (natural gas). As exhibited above, in 2020 Indonesia aims to achieve 26 % emission reduction from greenhouse gases. Systematic and tactful endeavors on the part of the government are therefore in dire need to make it happen.

Indonesia is categorized as a country with high wasteful energy use, and this will become a contributing factor towards the greenhouse effect. Besides being wasteful, the national energy use is still rely (55%) on energy sources based on fossil fuel (oil, coal, and gas) which at the end also resulted in the emission of greenhouse effect. If this condition is addressed properly, there would be two big losses experienced nationally in a long term period, namely scarcity of energy and gas production and production of greenhouse effect which will cause climate change.

Climate change results from energy consumption in people's daily activities. Policy intervention in such sectors as transportation, industry, and household is therefore called for in order to minimize the impact of climate change. Coordination across these sectors is unsurprisingly a difficult task to do.

## Energy Security (Supply of Energy)

Energy security is of paramount importance to a nation. Resilience of energy is the core of the energy in Indonesia. As exhibited in the table below, Indonesia has a great many potential energy resources to develop. The big gap between resources and production shows that energy utilization is rather limited in Indonesia.

The ratio electrification in Indonesia is still 80.4 %, meaning that power blackouts are commonplace in many cities, including provincial capitals. Oil based fuels (gasoline, diesel, and kerosene) are widely available, but not in thousands of scattered small islands, mountainous, and isolated areas. Many areas in the country unavoidably experience seasonal supply disruptions.

Nuclear is one of the potential answers to enhance the security of supply energy in Indonesia, but the decision of nuclear power plant lies in the politicians' hand albeit the long term plan of nuclear development that has been in place. Very unfortunately, Fukushima nuclear disaster, though, has made many countries anxious about the perceived danger of a nuclear power plant. What is more, Indonesia is notoriously known for having plenty of disasters like earthquakes, floods, and tsunami, posing even higher risks to sustainability of any nuclear power plan.

Indonesia needs infrastructure with clean, renewable technology to further energy sustainability development. PT. PLN is developing power plants and currently in need of clean technology with super critical 1,000 MW in Java.

Indonesia has a program to accelerate the power system, i.e. building the 10,000 MW fast track phase 1 with coal and phase II with mostly hydro and renewable energy (geothermal). Indonesia's geothermal potential is the world's largest about( 29,164 MW). It is clean, non-exportable, close to major electricity consumers, and the cost of building the power plants is not that expensive. Unfortunately, Indonesia has so far developed only about 1,341 MW, constrained largely by a poor, pricing policy, weak bureaucracy, and inadequate incentives. The plan to build large-scale hydroelectric plants seems unrealistic, mainly due to the geographical mismatch and expensive social environmental costs. Aside from a large area, a hydroelectric plant requires, the geographical condition of Indonesia is not suitable with many large mountains and relocation of residents will be very difficult owing to expensive land acquisition.

Regarding acceptability, the government of Indonesia still has to accept low quality fuels, unreliable electricity services and high-level pollution related to energy production, transmission, and consumption. All those indicators suggest Indonesia is far from achieving a good energy security standard. Other indicators usually applied in detecting energy security are ratio of energy imports, ratio of oil imports (how much comes solely from the Middle East), and the share of low carbon or renewable energy in the country's energy mix.

On energy security and resilience, Energy Law No. 30/2007 only mentions (in Articles 5 and 6) that the government are obliged to provide energy buffer reserves and to take any necessary measures in case of an energy crisis (shortage/lack of supply) or energy emergency (supply disruption due to damage to the energy infrastructure/means).

Indonesia may pay heed to wider energy security by analyzing along the energy supply chain from efforts to make primary energy available, to transformation of primary energy into the final form, and the ways to consume energy.

So far, energy resources (coal, as an extreme instance) have been overexploited with a strong paradigm to serve exports first rather than "domestics first", signifying that Indonesia prefers to secure other countries' energy security rather than their own. For instance, while the government, especially at local levels, easily awards mining licenses without paying heed to sustainability, the exploitation of energy has been done in a non-sustainable way for the sake of making short-term money from exports rather than without regard to long-term energy security. Oil dominates our energy consumption portfolio, while domestic production is less than consumption, meaning our energy cost is vulnerable to oil price hikes.

In the transformation sector (from primary energy to the final form), government of Indonesia has a situation, i.e. insufficient, inefficient, and deteriorating energy infrastructure. Our oil refineries' capacity (about 1 million barrels per day, or bpd) is much less than our consumption of 1.3 to 1.4 million bpd. Meanwhile, most of the refineries are also aging. Oil storage and distribution networks are not extensive enough to cover all parts of our archipelago.

Domestic gas infrastructure (transmission, distribution) is far from sufficient. Even in Java, the biggest island in Indonesia, government have not built interconnected gas transmission network, not to mention an LNG receiving terminal or natural gas storage plant. Coal infrastructure (terminal, transport system, etc.) is also not adequate. As for electricity, people face shortages in power generation (ageing thus need repowering), deteriorating condition of the JAMALI (Java-Madura-Bali) interconnection, transmission bottlenecks, saturated distribution networks, and high losses.

The endpoint of the energy supply chain is the consumption system. Here, our ways of consuming energy (e.g. in transportation and industries) are not efficient enough, making the energy neither longer usable nor available for a wider range of consumers. Our ways of consuming energy, indicated by soaring-energy consumption per GDP, are making our energy security worse, thus need changing.

## Conclusions

This research empirically examines the direction of causality between energy consumption and GDP taking Indonesia as a case study. The results of the analysis show that total energy consumption affects GDP to some extent. This therefore supports the conclusion that there is a relationship between energy consumption and economic growth. Moreover, the results indicate that the effect of energy conservation policies to help stem global warning might have a greater detrimental effect on the economic growth of Indonesia. In aggregate, there is a causality that runs from energy consumption to GDP. These results therefore suggest that Indonesia should be brought into future energy policies such as climate change and energy management, which can be achieved through increase in energy substitute such as wind, solar, geothermal, etc but not through reduction in energy consumption as this might be detrimental to overall economic growth.

Based on the discussions in the previous chapter, it can be concluded that (In terms of the relationship of energy consumption and economic growth):

- In the industrial sector, there is a relationship between economic growth and energy consumption, meaning the ever-increasing economic growth tends to be followed by an increase in energy consumption in this sector;
- In the household sector, there is a relationship between economic growth and energy consumption, which means that the increase in economic growth in the household sector is likely to be followed by an increase in energy consumption in this sector;
- In the commercial sector, there is a relationship between energy consumption and economic growth, which means that an increase in energy consumption in the commercial sector is likely to be followed by an increase in economic growth;
- In the transport sector, there is a relationship between energy consumption and economic growth, which means that an increase in energy consumption in the transport sector is likely to be followed by an increase in economic growth.
- In the other sectors (sectors other than industry, households, commercial and transportation), energy consumption has no effect on GDP. This is because in this sector use of energy is insignificant.

On the whole sector, energy consumption influences GDP, which means that an increase in energy consumption in this whole sector is likely to be followed by an increase in economic growth.

In general, the challenges of energy development in Indonesia are as follows:

The high subsidies for petroleum. Since 2000, Indonesia has shifted from a reliable oil exporter into a net importer of oil. Sustainable petroleum subsidies and increasingly rising production costs make Indonesia unable to meet its own energy needs. These subsidies maintain oil prices to remain low. This consequently encourages a high petroleum consumption, which in turn will result in Greenhouse Gas emissions as a result of burning fossil fuels.

Lack of incentives for renewable energy. Although Indonesia is rich in renewable energy sources such as biogas, geothermal, wind and solar, electricity production using renewable has yet to show any significant improvement. It is caused by a lack of policy support and incentives to the stakeholders who are interested in developing renewable energy.

It takes a high initial investment for renewable energy. Some renewable energy such as solar power plants, geothermal and wind require high initial capital, so that the development of solar power plants, geothermal and wind is difficult to implement if not accompanied by policies and political support.

Cheap electricity price offered by PLN (a state-owned electricity corporation) to costumers. This leads to big investment on the part of the government (state budget) in developing electricity in Indonesia. The electricity market in Indonesia consequently is unproductive and uncompetitive.

With the emission reduction target of 26% in 2020, the Indonesia government launched a national mitigation action plan in the field of energy related GHG groups namely: promoting energy saving movement, the development of alternative energy and renewable energy, as well as the transfer to low-emission transport modes. Achieving such targets will require big efforts.

# Sistem Informasi Geografis Berbasis Internet Lahan Pertanian Pangan Berkelanjutan (LP2B) untuk Pengendalian Pertanahan

# Geographic Information System Internet Based Land of Sustainable Food Square (LP2B) for Land Control


| | | |
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## Pendahuluan

Pertumbuhan penduduk yang tinggi berpotensi mengakibatkan timbulnya berbagai permasalahan diantaranya kerawanan pangan dan perkembangan ekonomi yang menuntut kebutuhan lahan untuk permukiman, industri, infrastruktur dan jasa (Aisyah, 2012). Konversi tanah pertanian menjadi nonpertanian terjadi karena adanya peningkatan kebutuhan penggunaan tanah untuk permukiman, jasa-jasa pendukung kehidupan manusia, industri dan lain sebagainya.

Untuk mengatasi terjadinya perubahan penggunaan tanah pertanian sawah ke nonsawah, pemerintah telah berupaya melindungi lahan pertanian subur dengan menerbitkan UU No. 26 Tahun 2007, UU No. 41 Tahun 2009 dan PP Nomor 25 Tahun 2012 yang bertujuan untuk menetapkan, melindungi dan menyebarluaskan informasi lahan pertanian pangan berkelanjutan (LP2B). Kompleksitas perlindungan lahan pertanian pangan berkelanjutan ditunjukkan oleh banyaknya data dan pihak yang terlibat memerlukan dukungan sistem atau aplikasi yang dapat membantu mempermudah pengelolaan data lahan pertanian pangan berkelanjutan. Sistem tersebut dapat dibangun dengan mengorganisasikan data dan informasi geospasial yang dimiliki berbagai instansi pemerintah dalam sebuah sistem informasi geografis berbasis internet (webGIS) sehingga dapat diakses oleh pihak lain. Agar webGIS dapat mendukung perlindungan lahan pertanian pangan berkelanjutan, kebutuhan webGIS harus didefinisikan dengan mempertimbangkan regulasi/peraturan maupun kebutuhan pengguna.

Melalui proses desain yang dilakukan dalam penelitian ini, diharapkan diperoleh desain dan purwarupa webGIS yang mampu mengakomodasi sebagian kebutuhan pengguna dalam pengendalian pertanahan di tingkat kabupaten/kota, baik kebutuhan terkait aktivitas maupun informasi yang disediakan melalui webGIS tersebut. Purwarupa yang dibangun dalam penelitian ini difokuskan pada purwarupa untuk mendukung pencarian lokasi lahan pertanian pangan berkelanjutan, analisis spasial untuk kesesuaian kawasan lahan pertanian pangan

berkelanjutan terhadap izin perubahan penggunaan tanah dan penyebarluasan data dan informasi geospasial mengenai lahan pertanian pangan berkelanjutan.

## Penelitian tentang SIG

Penelitian tentang SIG perlindungan lahan pertanian sawah sudah banyak dilakukan, akan tetapi masih sebatas penyajian informasi berbasis SIG dekstop dan belum menambahkan fungsi analisis bagi penggunanya. Salah satunya yang dilakukan Prajitno (2008) meneliti tentang sistem informasi geografis sawah lestari di Kabupaten Klaten Provinsi Jawa Tengah. Data yang digunakan merupakan gabungan data primer berupa foto langsung di lapangan dan data sekunder yang diolah menggunakan Arcview yang menghasil model visualisasi informatif persebaran sawah lestari berbasis SIG desktop. Informasi yang disajikan berupa keterangan kesesuaian lahan, sistem irigasi, dan produktivitas lahan.

SIG basis internet telah digunakan dalam penyajian data sawah di daerah di Indonesia. Suhadak (2010) mengembangkan sistem informasi geografis lahan pertanian Kabupaten Banyuwangi berbasis web. Data yang digunakan dalam penyusunan basis data adalah data persebaran sawah dengan klasifikasinya yang disusun dalam PostgreSQL dan MS4W sebagai modul yang digunakan untuk membuat fungsi dan kelas serta Mapserver agar dapat dijalankan pada PHP/Mapscript. Mufidah (2011) membangun sistem informasi geografis (SIG) pemetaan lahan pertanian di wilayah Mojokerto. SIG tersebut berfungsi untuk menampilkan data penyebaran hasil produksi pertanian, jenis tanah (geologi), curah hujan dan tinggi permukaan dari laut dengan menggunakan visual mapping. SIG tersebut dibangun dengan menggunakan Mapserver dan webGIS dengan tujuan masyarakat mampu mengakses informasi pemetaan lahan pertanian di wilayah Mojokerto.

Barus dkk (2012) melakukan penelitian tentang model pemetaan sawah dan perlindungan lahan pertanian pangan dengan penginderaan jauh dan sistem informasi geografis. Data persebaran lahan pertanian pangan

berkelanjutan diidentifikasi dan dipetakan melalui ekstraksi citra satelit resolusi tinggi dan diintegrasikan dengan data lainnya melalui pemanfaatan aplikasi SIG secara desktop. Hasil akhir penelitian berupa rekomendasi penetapan lahan pertanian pangan berkelanjutan di Kabupaten Garut dan Bogor.

Keempat penelitian diatas masih mengangkat tema lahan pertanian secara umum belum terfokus pada lahan pertanian pangan berkelanjutan (LP2B) dan masih bersifat penyajian data. Metode yang akan digunakan dalam penelitian ini adalah dengan membangun webGIS menggunakan ArcGIS Server dan ArcGIS Viewer for Flex yang mampu menyajikan data sekaligus menyediakan tool analisis spasial untuk tujuan pengendalian pertanahan.

## Kebutuhan SIG LP2B untuk Pengendalian Pertanahan

Kebutuhan webGIS LP2B untuk pengendalian pertanahan telah diidentifikasi melalui teknik mempelajari dokumentasi dan wawancara. Hasil identifikasi disajikan dengan mengelompokkan berdasarkan metode dan sumber eksplorasi. Temuan dari setiap kelompok kemudian diolah menjadi sebuah rumusan kebutuhan sebagai hasil akuisisi data kebutuhan informasi, aktivitas, dan interaksi dalam webGIS LP2B untuk pengendalian pertanahan.

Berdasarkan peraturan perundangan sebagai sumber identifikasi kebutuhan, diperoleh sejumlah petunjuk mengenai aktivitas, data dan informasi yang berkaitan dengan aspek geospasial dalam pengendalian pertanahan untuk perlindungan kawasan LP2B di Kabupaten Sleman. Seluruh aktivitas serta data dan informasi yang ditemukan dalam peraturan perundangan disajikan sebagai matrik sehingga mempermudah merumuskan kebutuhan webGIS LP2B untuk mendukung pengendalian pertanahan khususnya LP2B.

## Desain SIG LP2B untuk Pengendalian Pertanahan

Kebutuhan aktivitas yang ditetapkan dengan mempelajari dokumen peraturan perundangan dan wawancara sebanyak lima aktivitas. Akan tetapi, dari lima aktivitas tersebut akan dipilih dengan menyesuaikan fokus tujuan dan cakupan pembuatan purwarupa aplikasi ini. Aktivitas tersebut

merupakan aktivitas yang mendukung dalam pencarian informasi, analisis spasial LP2B terdampak perubahan penggunaan tanah serta pelaporan dugaan pelanggaran pemanfatan LP2B. Ketiga aktivitas terpilih tersebut antara lain:

- mengetahui lokasi Lahan Pertanian Pangan Berkelanjutan (LP2B);
- mengetahui kesesuaian rencana perubahan penggunaan tanah terhadap kawasan LP2B dan sempadan irigasi/sungai;
- mengetahui lokasi dugaan pelanggaran pemanfaatan tanah yang berstatus LP2B.

Desain konseptual yang dibuat untuk ketiga aktivitas tersebut menghasilkan skenario aktivitas, informasi, dan interaksi. Skenario aktivitas menyajikan kegiatan yang menjadi tujuan aplikasi. Skenario informasi menyajikan apa saja yang disajikan dalam aplikasi. Skenario interaksi menyajikan tindakan apa saja yang dilakukan antara pengguna dan aplikasi. Tabel 4 menyajikan contoh desain konseptual pencarian lokasi bidang tanah LP2B menggunakan metode desain berdasarkan skenario.

## Purwarupa SIG Berbasis Internet LP2B untuk Pengendalian Pertanahan

Fungsi pencarian dalam aplikasi webGIS LP2B ini dapat membantu masyarakat pemilik lahan mengetahui apakah tanahnya masuk atau tidak dalam kawasan LP2B. Pengguna dapat melakukan pencarian dengan mengetikkan kata kunci berupa Nomor Identifikasi Bidang (NIB) yang tertera pada sertipikat tanahnya ke dalam kolom pencarian kemudian tekan tombol "Enter" pada keyboard. Hasil pencarian akan langsung ditampilkan pada drop down kolom pencarian (Gambar 1a) dan jika diklik akan ditampilkan berupa tampilan extent bidang tanah LP2B beserta atribut NIB-nya (Gambar 1b). Informasi rinci tentang bidang tersebut dapat diketahui dengan mengkliknya sehingga akan muncul data atributnya pada jendela pop-up, sehingga akan muncul informasi mengenai letak bidang tanah, NIB, luas dan status kepemilikan tanah.

Purwarupa aplikasi ini menyediakan instrumen analisis spasial kepada pengguna untuk mengidentifikasi kesesuaian perubahan penggunaan tanah pertanian terhadap kawasan LP2B. Kawasan LP2B merupakan kawasan pertanian yang tidak dapat dialihfungsikan ke non pertanian selain untuk kepentingan umum dan karena bencana alam. Izin perubahan penggunaan tanah (IPPT) sendiri adalah izin peruntukan penggunaan tanah yang wajib dimiliki orang pribadi yang akan mengubah peruntukan tanah pertanian menjadi non pertanian guna pembangunan rumah tempat tinggal pribadi/perseorangan, dengan ukuran seluas-luasnya 5.000 m2. Salah satu syarat permohonan IPPT menurut Perda Kabupaten Sleman nomor 19 tahun 2001 tentang IPPT adalah denah letak lokasi yang dimohon. Purwarupa aplikasi ini dapat membantu pengguna dalam memetakan lokasi yang dimohon beserta kesesuaiannya terhadap kawasan LP2B.

Tiap orang yang berhak atas tanah yang ditetapkan sebagai lahan pertanian pangan berkelanjutan memiliki wajib memanfaatkan tanah sesuai peruntukan, dilarang mengalihfungsikan dan mencegah kerusakan irigasi. Jika ada masyarakat yang mengalihfungsikan lahan yang sudah ditetapkan sebagai lahan pertanian pangan berkelanjutan akan dikenakan ancaman pidana dan administrasi. Purwarupa aplikasi ini dapat digunakan oleh masyarakat dan pemerintah desa dalam mengidentifikasi dugaan pelanggaran pemanfaatan LP2B. Identifikasi tersebut dapat melalui penentuan lokasi pelanggaran dengan mencari titik koordinat di lapangan dengan menggunakan GPS atau perangkat lainnya.

Purwarupa yang telah dirancang kemudian dilakukan pengujian kegunaan kepada pengguna. Tujuan melakukan tes penilaian pada purwarupa aplikasi webGIS LP2B ini adalah untuk menentukan efektifitas, kepuasan dan efisiensi aplikasi (Aditya dkk, 2011). Sejalan dengan hal tersebut, pengujian ini juga untuk menentukan kegunaan dari purwarupa dalam mendukung analisis kesesuaian izin perubahan penggunaan tanah terhadap kawasan LP2B, pencarian lokasi LP2B dan instrumen pendukung untuk melaporkan dugaan pelanggaran pemanfaatan LP2B.

Berdasarkan data observasi yang telah dicatat semua responden mampu menyelesaikan tugas (tasks) berdasarkan skenario yang telah ditentukan melalui browser internet. Responden dari pengembang terdiri dari unit kerja seperti bagian perizinan, perencana, hukum/legal serta pemasaran. Pengguna juga merasa puas terhadap tampilan, tool analisis dan kegunaan dalam mendukung pekerjaan pengguna.

## Kesimpulan

Informasi yang perlu disajikan dalam webGIS LP2B untuk pengendalian pertanahan di Kabupaten Sleman terdiri atas data dasar fisik alamiah, data dasar fisik buatan, data dasar kondisi sumber daya manusia dan sosial ekonomi, data status pemilikan dan/atau penguasaan tanah, data luas dan lokasi lahan dan data jenis komoditas pangan pokok.

Aktivitas yang dilakukan dalam purwarupa aplikasi adalah pencarian bidang tanah yang masuk dalam kawasan LP2B, analisis kesesuaian izin perubahan penggunaan tanah terhadap kawasan LP2B dan pelaporan dugaan pelanggaran pemanfaatan LP2B.

Purwarupa webGIS LP2B berdasarkan desain dibangun menggunakan perangkat lunak ArcGIS Server dan ArcGIS Viewer for Flex, difasilitasi dengan fungsi pencarian, penggambar dan analisis buffer yang dapat dimanfaatkan pengguna untuk pencarian informasi lokasi bidang tanah LP2B dan analisis kesesuaian perubahan penggunaan tanah terhadap kawasan LP2B.

Purwarupa webGIS LP2B untuk pengendalian pertanahan sangat efektif, efisien dan memberikan kepuasan kepada pengguna dalam usaha pengendalian perubahan penggunaan tanah LP2B dan perencanaan lokasi perumahan.

## Saran

Purwarupa webGIS yang dihasilkan dalam penelitian ini dibangun menggunakan perangkat lunak berlisensi yang memerlukan dukungan dana yang besar, sehingga perlu dikembangkan agar aplikasi ini dapat diimplementasikan pada aplikasi berbasis open source. Pemanfaatan data untuk analisis pengendalian pertanahan pada webGIS LP2B ini hanya sebagian dari seluruh data yang ada, sehingga dapat dilakukan penetian lebih lanjut untuk tema kajian lainnya.

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