

Doctoral dissertation review
Opinion about Mr. mgr inż Rajiansyah
for the doctoral dissertation
title

Management of a Communication Network: A Cooperative Game Approach.

This review of the doctoral dissertation, authored by Mr. [Cand. PhD. mgr inż] Rajiansyah, M.Sc. Eng., was commissioned by the Chairman of the Disciplinary Council for Technical Information Technology and Telecommunications, Mr. Prof. Dr. Wojciech Bożejko (Letter No. W4N-KP-SW.4110.8.2026 dated 25.06.2026 r.). The supervisor¹ of this dissertation is Mr. [Prof.] Dr. David M Ramsey, Prof. Uczelni, and the auxiliary supervisor is Mr. dr. inż. Dariusz Gąsior². The doctoral dissertation is written in English³. The dissertation submitted for review was carried out as part of the implementation doctorate program in cooperation with - ⁴.

1. The research problem and its significance

What is the most important issue considered in the dissertation?

Is it scientific in nature?

Does it have any practical significance?

Please refer to my attached Opinion about this thesis!

2. Author's contribution

What is the author's most important contribution to obtaining the results described in the dissertation?

If necessary, the reviewer may distinguish between the contribution claimed by the author of the thesis and the contribution the reviewer considers most important. In this case, the reviewer should provide reasons why the reviewer disagrees with the author's claims (e.g., someone has already proposed the idea, or it is original but incorrect for the reasons described in section 3). We also ask for comments on the practicality of the proposed solutions (it may be that the problem is very practical, but the proposed solution is not). If appropriate, the reviewer may refer to other quality indicators (e.g., quality of the publication, the author's patents, citations, implemented applications, etc.).

Please refer to my attached Opinion about this thesis!

3. Correctness

Are the claims made in the thesis trustworthy? Are the justifications sound? Point out any weaknesses and errors you've noticed. Also, highlight the aspects of validity that are most valuable (elegance of evidence, experimental design, analysis of empirical data, quality of prototype software/hardware, etc.).

Please refer to my attached Opinion about this thesis!

¹ to choose

² if an auxiliary supervisor was appointed

³ optional

⁴ optional

4. Candidate knowledge

Which chapters (or sections within chapters) of the dissertation discuss the existing state of knowledge and thus confirm the candidate's general knowledge in Technical Information Technology and Telecommunications? What areas of these disciplines are covered in these chapters/sections? What is the reviewer's opinion of the quality of these chapters/sections? What is the reviewer's opinion of the bibliography? How complete is the bibliography? Please provide other arguments for or against stating that the candidate has general knowledge in Technical Information Technology and Telecommunications.

Please refer to my attached Opinion about this thesis!

5. Other notes

Other comments, if any, e.g. editorial, linguistic, etc.

Please refer to my attached Opinion about this thesis!

6. Summary

Taking into account the opinions presented in the previous points and the requirements defined by Article 187 of the Act of 20 July 2018 - Law on Higher Education and Science (as amended)⁵ my assessment of the dissertation in terms of three basic criteria is as follows:

A. Does the dissertation contain an original solution to a scientific problem? (select one option by marking X)

☒	☐	☐	☐	☐
<i>Definitely YES</i>	<i>Probably YES</i>	<i>It's hard to say</i>	<i>I don't think so</i>	<i>Definitely NOT</i>

B. After reading the dissertation, do you agree that the candidate has general theoretical knowledge in the discipline of Technical Information Technology and Telecommunications?

☒	☐	☐	☐	☐
<i>Definitely YES</i>	<i>Rather YES</i>	<i>It's hard to say</i>	<i>I don't think so</i>	<i>Definitely NOT</i>

C. Does the candidate have the ability to conduct research independently?

☒	☐	☐	☐	☐
<i>Definitely YES</i>	<i>Rather YES</i>	<i>It's hard to say</i>	<i>I don't think so</i>	<i>Definitely NOT</i>

Moreover, taking into account his coming from Indonesia and making his way in very competitive European academic environment with scientific excellence, **I recommend awarding distinction to the doctoral dissertation** ⁶.

Please refer to my attached Opinion about this thesis!

⁵<http://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20190000276>

⁶ optional

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Poznan, July 13, 2026

Opinion about

Mr. mgr inż Rajiansyah

for the doctoral dissertation on:

**“Management of a Communication Network:
A Cooperative Game Approach”**

in the field:

Engineering and Technology

in the discipline:

**Scientific Discipline Council
Information and Communication Technology**

at

Wroclaw University of Science and Technology

**Dear My Excellency,
dear Respected Dean,
dear Respected Chairman of the PhD. Jury,
dear Ladies and Gentlemen, dear Professors,**

this is very remarkable **Doctoral Thesis** towards promotion to the degree in the field *Engineering and Technology* in the discipline *Scientific Discipline Council Information and Communication Technology* at the **Wroclaw University of Science and Technology** in **Wroclaw, Poland**, and I fully support this submission and goal!

Mr. Cand. PhD. mgr inż Rajiansyah is, in my scientific assessment and personal observation, a highly educated young scientist with exceptional intellectual abilities who has developed remarkably in recent years and has the potential to gain international renown.

Mr. Cand. PhD. mgr inż Rajiansyah comes from *Indonesia*, a country with which I have a friendship spanning approximately 34 years - it is like a homeland to me. Not least for this reason, I am all the more able to appreciate and value *Mr. Cand. PhD. mgr inż Rajiansyah*'s scientific, developmental, social and academic achievements.

A significant number of my many lectures in Indonesia - many onsite and several online - also dealt with the methodology and themes of *collaborative game theory* – which *Mr. mgr inż Rajiansyah*'s chose as well. Today's candidate (and hopefully soon-to-be doctor) uses, like me, the fairness measure of the *Shapley value* and considers alternatives such as the *Owen-Shapley (spatial) power index*.

These coincidence make me happy, and I congratulate him for his wise choice and excellent realization of it.

It underlines the relevance and universality of this doctoral thesis and reminds us of the great efforts he had to make to settle in Europe, to assert himself in an extremely competitive environment, and at the same time to serve his people, their future and the future of all peoples of the world – and to do so through cooperation rather than bitter rivalry. This doctoral thesis seems to be extremely truthful.

With his remarkable intellectual abilities, perseverance, and diligence, *Mr. mgr inż Rajiansyah* has become a role model in his home country, his host country and internationally for modern researchers and young scientists who present science and gain worldwide recognition.

This international significance is particularly evident in his own country, with its diverse languages and traditions, which demands an even greater degree of humanity, understanding, respect, and a willingness to adapt and serve all citizens in the broadest sense.

At and from *Wrocław University of Science and Technology*, his performance – together with the one the research group whose member he is – shines brightly. *My main reference persons or collaborators* so far at this scientific school (like *Prof. Dr. David Ramsey*, *Prof. Dr. Rafał Weron* and my coauthors, *Prof. Dr. Rafał Michalski* and *Prof. Dr. Jerzy Grobelny*), worked very hard for the colleagues and the young people. Now, at the occasion of this PhD. process, I have been glad to communicate / collaborate again with his supervisor **Prof. Dr. David Ramsey**, who himself has been supported by his auxiliary supervisor **dr. inż. Dariusz Gąsior**. Their success counts all the more for having made it this far.

To state it clearly and unequivocally: *this academic school – including the doctoral thesis in question – enjoys my complete trust. Over several years, including a personal visit, I have been able to gain a clear understanding of its academic standards, its culture of discussion, and especially the rigor of its research.*

Mr. mgr inż Rajiansyah writes with the authority of a *Mathematician*, which is quite remarkable, since his thesis is situated in Management and Technology.

It is an honor that he also considered my scientific contributions.

This strong and unique, rich (with its in total 202 pages gross) **PhD. Thesis** is well-structured, well and documented, carefully and elegantly written. In a sense, this thesis' ranges from real-world motivation, scientific concepts and methods, clear and helpful diagrams and illustrations, to feedback from the practitioner(s).

The **6 chapters** of the thesis are as follows:

Chapter 1 - Introduction,

Chapter 2 - Preliminaries,

Chapter 3 - General Model of a Communication Network,

Chapter 4 - A Model with Linear Costs and No Capacity Constraints,

Chapter 5 - A Model with Linear Costs and Capacity Constraints,

Chapter 6 - Conclusions and Future Studies,

including SCIENTIFIC ACHIEVEMENTS and REFERENCES.

The sheer number of illustrations, tables, etc., makes the doctoral thesis a work of art!

The thesis contains no fewer than **172 references**, which document the candidate's extensive reading and are particularly evident in *Chapters 1* and *2*.

Chapter 6 could also have included some forward-looking references, but this does not pose a significant problem. I myself address such potential future directions ("outlook") for the candidate in some more detail in this report, mentioning specific names and areas of focus.

According to my assessment, this **PhD. Thesis** can be called a *Great Work*.

In addition to *structural* and *economic* factors, *real-world communication networks* encounter *capacity* limits. Every transmission link has a finite capacity, thus limiting the amount of data that can be transmitted. If demand exceeds capacity, congestion occurs, leading to reduced performance and poorer service. Capacity constraints significantly impact routing decisions, coalition viability, and profitability. *Network flow* models with *capacity constraints*, such as maximum flow and multi-commodity flow problems, have been extensively studied to address these challenges. However, these models primarily focus on optimal flow distribution and do not consider the cooperative behavior of *multiple providers*.

Recent research is beginning to fill this gap by **combining cooperative game theory** with *resource allocation* and *routing strategies in communication networks*.

Centrality measures, such as *betweenness centrality* and *degree centrality*, have **traditionally** been used to assess the importance of nodes and edges in a network. However, these measures are *purely* structural and do **not** consider *economic* factors such as flows, costs, and revenues. Recent studies underscore the need for economic and game-theoretic centrality measures that better capture real-world network utilization and value creation. Despite growing interest in cooperative network models, some **gaps** remain. Many existing studies are based on simplified assumptions, such as unlimited capacity or a purely structural evaluation of network elements. These assumptions **limit** the applicability of the models to real-world communication systems.

There has been a necessity for a *unified* framework that *integrates* network structure, economic factors, and capacity constraints within the context of a collaborative (or cooperative) game. Recent research also underscored the importance of *integrating cooperative game theory* with advanced *computational techniques* such as *AI* and *network learning* to improve scalability and decision-making.

The motivation for this research stems from these challenges. There has been a clear need for a comprehensive model that captures both the *physical* and *economic* aspects of *communication networks*. Such a model should provide tools to evaluate each provider's contribution, develop *fair allocation* mechanisms, and support *efficient network management*.

This PhD. study aims to address these problems by modeling communication networks as cooperative games in which providers control network edges and form *coalitions to serve communication routes*. By combining *graph theory*, *network flow optimization*, and *collaborative game theory*, this research seeks to deepen our understanding of how network structure influences cooperation, efficiency, and profit sharing.

The results are intended to help improve *decision-making in multi-provider communication networks* and promote the development of *fair and efficient resource allocation* mechanisms.

This doctoral thesis is indeed a strong testament to intellectual and personal strength and is supported by several *very valuable (journal) publications, related to the thesis*, already completed and several more that are certainly to be expected from the candidate (including submitted work):

- Ramsey, D., Gäsior, D., & Rajiansyah, R. (2024). Management of a communications network involving a number of service providers: A cooperative game approach. SSRN Electronic Journal. <https://doi.org/10.2139/ssrn.5202728>.
- Ramsey, D., Gäsior, D., & Rajiansyah, R. (2025). A cooperative game theoretic model of a multi-agent information network based on the Myerson value. *Procedia Computer Science*, 270, 1669–1678. <https://doi.org/10.1016/j.procs.2025.09.287>.
- Gäsior, D., Rajiansyah, R., & Ramsey, D. (2026). Revenue Sharing in a Network via a Centrality Measure Incorporating Capacity Constraints.

There are also a number of publications and presentations in other formats. I am quite certain that in the coming months and years the number of premium publications by today's candidate and prospective doctor will increase dramatically, also with the advice or guidance of his supervisors.

Like any other PhD. thesis, this one could not be all-encompassing and completely exhaustive. A reviewer must understand this, which I naturally do. This is all the more true for a PhD. thesis like this one, which is pioneering in some parts and thematically comprehensive in others. As a reviewer, one can and must also make the same - very slight - allowances for the technical perfection of the work.

Personally, I am impressed by him as an up-and-coming scientist! I admire his ability to think structurally while simultaneously keeping very concrete and future-oriented applications in mind – one could also call it modeling, an approach to game theory, data mining/data handling, analytics, systems/model theory from industrial engineering and mathematics – which even incorporates the “environment” and “human factors” (in a broader sense), a more *comprehensive* and *modern* picture than the *traditional* paradigm.

In *managerial and scientific* contexts, the effects of human factors are not always easy to prove or measure, for example in sensitivity analyses - such as “weak forces” - but in reality they are often, albeit secretly, “strong forces” and can contain powerful competitive advantages.

Given the nature of us Humans, and of our *Companies and Groups, Economies and Societies*, these “Human Factors” can be considered being among the “hardest” factors. In fact, I think that this is a great advantage also for his future in **teaching – educating** students up to highest levels in profession and personality, in Indonesia, in Asia and in any other countries and parts of the world.

Mr. Cand. PhD. mgr inż Rajiansyah has been able to get valuable paper acceptances and published in premium journals. In fact, since I served as Program Committee member, *EURO Conference Advisor*, etc., I can speak about a High Level and a Diversity of his research directions. He and his coauthors have understood deep subjects, and in contents and technically they mastered them in written representation.

Furthermore, I would like to underline *Mr. Cand. PhD. mgr inż Rajiansyah*'s eagerness to always improve and learn! What is more, he seems to possess a fundamentally **pleasant and kind personality**, deeply rooted in his family, his home country in Indonesia and his home region in *East Kalimantan (Borneo Island)*, and committed to them and to humanity, not least through scientific and “operational” research.

He was and is part of the excellent research group of *Prof. Dr. David Ramsey* and is therefore a candidate for the doctoral degree (Cand. PhD.) *mgr inż Rajiansyah*. He has combined the best aspects of the *Optimization, Operational Research and Economics* traditions of *Wrocław University of Science and Technology* – itself being one of the top universities in Poland - which already maintained close relationships with its various famous *Engineering and Technology* faculties, with the outstanding and modern engineering and high-tech research of *Wrocław University of Science and Technology*, especially under the direction, co-direction and guidance of *Prof. Dr. David Ramsey* with his many advanced projects.

Among the remarkable **properties** of *Mr. Cand. PhD. mgr inż Rajiansyah* as I feel and perceive, there could be mentioned:

- interest in “qualitative” and “quantitative” sciences, statistics, data mining, uncertainty handling, modern “human” sciences, game theory, multi-criteria decision making, and their development,

- ability to work in applications,
- loyalty and reliability,
- ability to work hard,
- high intelligence and scientific skillfulness,
- ability to write excellent books (like the thesis) and papers,
- ability to lecture and present scientific work in front of an international audience,
- ability to work in a team,
- international experience,
- interest in different cultures, willingness to develop professional skills in science and organization (I trust),
- overcoming of obstacles and hardships in life,
- leadership skills (I trust).

Cand. PhD. mgr inž Rajiansyah's and his - *Prof. Dr. David Ramsey's* team's - work can be characterized as follows:

- Excellent scientific foundations and knowledgeability, especially, in Optimization and Operational Research, Analysis and Calculus, Game Theory, elements of Discrete Mathematics, Probability Theory and Statistics, Heuristics and Complexity Theory, Machine Learning and Artificial Intelligence;
- Openmindedness and communication skills, communicativeness and curiosity in modern applications in a wider range of areas, from natural and "human" sciences to modern management;
- Readiness to serve well and carry over responsibility at all levels of academia, and at the international platform;
- Excellence in hospitality of welcoming guests;
- Willingness and decidedness to prepare papers and to publish them in formats of all kinds, in journals of all levels, especially, in top-ranked journals;
- Contributions to better understanding and friendship between the nations.

The candidate, especially with his dear advisor and auxiliary advisor, and their coworkers, have gained a remarkable recognition. They have provided respect, encouragement, impulses and help to me, to Europe, to Asia, and the entire world. This has become apparent also in their fruitful contributions in research, application and friendship.

This promotion achievement witnesses about this exquisite progress! I understand that there have been (and should be further) research directions in Uncertainty Modelling and Handling, Complexity Theory, Operational Research and Optimization (*OR*), AI, etc., related to which they got a good publication success of papers that have the promise of giving an **Impact** in the future.

Crucial to the high quality, especially of this PhD. thesis itself and that of its author, is

1. its permeation with the goal of developing a truly functional and effective decision support system,
2. its (already) largely achieved (universal) goal, and
3. its ability to inspire, initiate and launch future research on and improvements to every aspect of the decision support system (including complexity, usability, interactivity, and gamification elements) within the scientific community.

Cand. PhD. mgr inž Rajiansyah - with his advisor and the other colleagues - have indeed excellent contacts now to the community of *OR* scholars, optimizers, natural scientists, and engineers. I encourage her to further activate and use these contacts in future, e.g., in the *OR* community of **EURO** and **IFORS**. The candidate may have many future chances to attend *EURO* and *IFORS* conferences. The 2026 *IFORS* conference took place in Vienna, Austria.

The next 2027 and 2028 *EURO* conferences will be in Athens, Austria, and Munich, Germany. The next 2029 *IFORS* conference will be in Calgary, Canada.

Of course, there is no force here.

Moreover, I suggest his / their team to take into account *in the Future*,

- The application of further/other mathematical methods, which represent a key technology;
- The work of recent years on the development and application of new data mining, statistics, machine learning, deep learning, *OR* and *AI* methods such as CMARS, RCMARS, RMARS, CGPLM, RCGPLM, etc., which are very helpful in almost all areas of academic and everyday life;
- Recent work on information theory, rumor spread, the link between financial/economic dynamics and human factors (especially regarding demand in production planning), time series / hidden Markov models and regime switching, and regulatory networks.

Research and lectures were carried out here by authors such as: *Ayşe Özmen, Fatma Yerlikaya, Alper Cevik, İnci Batmaz, Pakize Taylan, Erik Kropat, Gülser Köksal, Semih Kuter, Betül Kalaycı, Emel Savku, Magdalena Graczyk-Kucharska, Vilda Purutcuoglu, Zeynep Alparslan Gök, İsmail Özcan, Selma Gütmén, Erfan Babaee, Alreza Goli, Selma (Christina) Belen and Burcu Gürbüz.*

For the candidate – soon to be a PhD. – and his supervisor, future visits to the *SING* conferences on game theory could also be of great interest, as could possible collaborations with the game-theoretical school of *Prof. Dr. S. Zeynep Alparslan Gök* (my former student), with its branches in Turkey and Spain (and Poland).

The above statements praise and honor **Poland** in a pleasing way, alongside the nations of Europe and the world – the member societies of *EURO* and *IFORS* – and **Indonesia** with its great history and human resources, remarkable potential in science and operations research, engineering and technology – and all their common areas of life and their common future.

Naturally, all this **praise** also presents significant **challenges**, regarding his country of **Indonesia**, such as the following:

Firstly, Indonesia is a very young, multi-ethnic and multi-cultural nation – giving due weight to all these aspects is a major undertaking.

Secondly, Indonesia requires efficient administration and a diversified economy so that decisions are implemented, aid reaches those in need, and everyone has an opportunity.

Thirdly, this is especially true regarding the anticipated consequences of climate change, which poses a particular threat to the vast nation of Indonesia, whether due to deforestation, monocultures, increasing mass tourism, or rising sea levels.

Our candidate's highly qualified and sound knowledge and training, combined with his awareness and sensitivity, can make a crucial contribution to overcoming these challenges and give him a unique voice for good.

With best wishes for *Mr. Cand. PhD. mgr inż Rajiansyah* for becoming a **Dr. PhD.**, which will be so highly deserved, even *With Distinction*, and for his entire future and also for you,

and with friendly regards,
yours sincerely,