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Fifth Industrial Revolution (New Perspectives)

Sabah Hameed Ali, Hayder Ayad, Mithaq Taher Al Rubaie

Al Bayan University

Abstract

While we are rushing towards the future quickly and without stopping, there is a debate in the scientific community and business forums today about the upcoming industrial revolution and what it is related to, is it the revolution of artificial intelligence, or the revolution of nanotechnology, or the revolution of sustainability, or is it the revolution of the Internet of things, cloud computing and 3D printing? We believe that the Fifth Industrial Revolution will be the result of all these technologies. And through our research paper, we will address the concept of the industrial revolution in general and the major industrial revolutions in human history and their historical context. Then we will look at the Fourth Industrial Revolution, whose events we are living today, its most important technologies, and its future development. Then we will look at the future features of the upcoming Fifth Industrial Revolution and the controversy surrounding it from the point of view of several experts and the most important opportunities and challenges that are likely to emerge.

Keywords: Industrial, Revaluation, Perspectives

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1. Introduction

The first three industrial revolutions brought to the world steam power, railways, electricity, the telephone, the radio, and television. Then came the era of digital transformation and the invention of computers and home computers. When technological development reached its climax and integrated the physical, digital, and biological worlds, we entered the Fourth Industrial Revolution era. This process of rapid technological development leads us to the question of what tomorrow will be? Are we on the cusp of a fifth industrial revolution? The answer to this question is, there is no doubt that this revolution will come, but what we are trying to do is diligence by anticipating its merits according to what the specialists have said. To start preparing for the future by finding the best ways to adapt to the massive transformations expected to bring in the social, economic, environmental, and political systems.

Research Importance

The importance of the research stems from the topic of the study, which focuses on the matter and role of the industrial revolution as it is a pivotal player at the level of societies in the field of technological changes and how these changes are dealt with in a manner that serves the production process, whether in the area of goods or services, as well as from the opportunities it offers in the field of work and jobs that It is an essential part of the economic systems of the countries of the world.

2. Literature review

2.1. Industrial Revolution Concept

The concept of the industrial revolution includes the replacement of manual labor with automated/mechanical work, and then the transition from the production system in the workshops to the production system in the factories / industrial firm or the change, also from manual machines to the sizeable, automated industry, based on advanced devices. Thus, the machine announced the industrial revolution, and the computerized system in production is working continuously to reduce the volume of manual work and replace the human hand with automatic physical tools (Arabic Encyclopedia. Volume VII), and this includes, for example, today, robots, artificial intelligence, and others of advanced technologies. Therefore, as a start, the Industrial Revolution is the process of rapid change witnessed by the countries of Europe through their adoption of scientific research projects, which led them to move from the era of agriculture and handicrafts to the generation of an industry that depends on mechanization.

2.2. The Major Industrial Revolutions in Human History

From the end of the seventeenth century to the present time, man has been using the term "revolution" to express the radical transformations in society, resulting from the outputs of human thought represented in innovation and technological innovation that touches all aspects of life, starting with the revolution of steam engines, railroads, and the spinning industry, textiles,

and finally with the revolution of computers and information, biotechnology and nanotechnology (Al-Iskandarani, M. S, 2010).

We will review the historical, approximate, and brief context of the industrial revolutions to avoid entering an institutional and academic dispute over the number of revolutions, and when one of them ended and when the other began, including the fifth revolution, the subject of our research paper, as shown in the table1 below.

Table 1. Industrial Revolutions over time

	1 st Industrial Revolution	2 nd Industrial Revolution	3 rd Industrial Revolution	4 th Industrial Revolution	5 th Industrial Revolution?
Date of emergence	End of 18 th Century	End of 19 th Century	Mid-20 th Century	End of 20 th Century	Mid-21 st Century?
Country of origin	United Kingdom and France	Germany and United States	United States	United States and China	China and United States?
World population*	0.8 to 1.1 billion	1.5 to 1.8 billion	2.5 to 3.3 billion	4.4 to 5.7 billion	8.5 to 11.1 billion?

Source The Algorithmic Code of Ethics by Jerome Beranger; 2018.

The first industrial revolution was characterized by the invention of steam engines, which led to a qualitative leap in the economies of scale and industrial settlement. The second witnessed the discovery of electricity, oil, telephone, radio, and television communications and contributed to developing new products that changed production patterns and people's lives. Then came the third revolution, which is called the digital revolution. This led to technology from advancing electronic and mechanical analog devices to the digital technology available today. The most important inventions are the personal computer, the Internet, and information and communication technology.

2.3. The Fourth Industrial Revolution and Its Tools

The term “Fourth Industrial Revolution” was first used in 2017 by Mr. Schwab, CEO, and founder of the World Economic Forum, at the annual meeting of the World Economic Forum 2016. In his book, “The Fourth Industrial Revolution,” he referred to it as “a set of new technologies” merging the physical, digital, and biological worlds, which will affect all disciplines, economies, and industries comprehensively and profoundly, being unique for three reasons: speed, depth and breadth, and the interaction of systems (Schwab, K, 2016).

In addition, it has brought about wide-area technological changes that have enabled the world to communicate as if it were one village. In the aspects of information technology, robotics, and intelligent computers, as well as a boom in the manufacture of self-driving cars and crewless

aircraft [Drones], as well as nanotechnology, cloud computing, synthetic biology, and robotics, all of which will essentially replace any digital progress that has been made in the past sixty years.

2.4. The Most Prominent Tools of the Fourth Industrial Revolution and Its Future

2.4.1. Nanotechnology

The word nano is taken from the ancient Greek language and means “Nanos.” In science, nano means one part of a billion, meaning that one meter contains one billion parts of the nanometer. Accordingly, we can define nanotechnology as that advanced technology based on the rational and creative understanding and study of nanoscience and other basic sciences with the technological ability to synthesize nanomaterials and control their internal structure by restructuring and arranging the atoms and molecules that make them up, allowing for different and unique products to be employed in various applications (Al-Iskandarani, M. S, 2010).

The future: This promising technology heralds a massive leap in all branches of science, and many of the technologies that have developed recently or almost all depend on nanotechnology. Who made anything we can imagine, so some expected that the next nano discoveries would be the expected fifth industrial revolution?

2.4.2. Artificial intelligence

Artificial intelligence (AI) is a simulation of human intelligence processes by machines, especially computer systems. These processes include learning (obtaining information and rules for using data), reasoning (using rules to reach approximate or definite conclusions), and self-correcting. Artificial intelligence will produce a generation of fast-learning machines capable of speaking and seeing, and understanding gestures, which will lead to a massive boom in all sectors that use it, where artificial intelligence is now a big part of our reality. In factories, in the field of intelligent transportation, even in the medical area, in short, artificial intelligence (AI) is everywhere.

The future: According to the approved statistics of the Bughin et al, 2017 investment in artificial intelligence (AI) is proliferating. And digital leaders like Google spent between \$20 billion to \$30 billion on AI in 2016, with 90% of this money going to research, development, and publishing and 10% to AI acquisition (Bughin et al, 2017).

According to the International Data Corporation World Economic Forum, by 2019, 40% of digital transformation initiatives will deploy some form of AI variation. By 2021, 75% of enterprise applications will use AI, with spending increasing to an estimated \$52.2 billion.

2.4.3. Internet of Things – IOT

The Internet of Things is an extensive network of different systems such as computers, mobile phones, car systems, elevator systems, and other various systems that exist in our daily lives. These systems are quickly and seamlessly integrated through the Internet to be able to exchange information between them. The internet is the source of the data rather than the task being done by humans (Charter et al., 2017). This means that these different tools and devices can connect to

the Internet and link to each other, allowing the exchange of information between them by sending and receiving. But the term has recently expanded to include all fields, as it includes the so-called wearable devices such as smartwatches, smart clothes, concepts of smart cities, smart homes, intelligent buildings, devices that provide us with medical and health information, and related to the provision of intelligent transportation systems and many more. We can say that anything that has a processing unit, and an Internet connection feature can be installed; it falls under the concept of the “Internet of Things.”

The future: There is no doubt that the most crucial variable that will support the Internet of Things in its development and expansion of its connectivity is the transition to 5G technology. According to the McKinsey Institute, more than nine billion devices worldwide can currently communicate with each other via the Internet. This number will rise to one trillion devices in the next decade (Manyika et al., 2013). Also, the value or revenues of the Internet of Things market will rise to a record about 56 billion dollars at the end of 2018. It is expected that in the year 2025, every car will be connected to the Internet in the context of the development in the communications and information technology markets and the expansion of the concept of the “Internet of Things” (Global). Digital Report. 2018). Despite all these achievements, the Internet of Things is still only in its infancy. It is expected to revolutionize the way we use various devices and the various services associated with them.

2.4.4. The Self-Driving Car

They are ordinary cars, but they are equipped with maps and technologies that help drive. The passenger only has to tell them where he wants to go, and they have the rest of the matter, as they are similar to a robot and contain many sensors that help in the driving process (Methaq et al., 2017).

The future: Experts working in significant car companies began researching, studying, and testing to develop ordinary cars into self-driving cars since the late eighties of the last century, such as Tesla, Ford, Toyota, and the giant Google. And by the end of 2019, Spinoff Waymo, Uber, and GM, all of which are affiliated with Google, plan to deploy fleets of self-driving cars in various US cities to provide on-demand rides for passengers. The fare for these cars is expected to be much cheaper than taking a regular Uber or Lyft taxi. The research also predicted that nearly 10 million cars with self-driving features would be on the road by 2020 (Business Insider. 2018).

2.4.5. Mobile phones

Today's mobile or mobile phones have evolved to include many additional features, such as web browsers, games, cameras, video players, and even navigation systems through the presence of millions of applications. Many companies now rely on applications to support their activities, from business planning and development to social media and customer relationship management. As customers spend more and more time on social media, mobile apps allow business owners to create and enhance a relationship with them.

One of the main app offerings is its low price point, where in the past, companies had to buy expensive software to get things done that you can now delegate to an app for a dollar or two.

Even small businesses, in particular, can take advantage of the lower cost of these applications without having to get lower quality than before. Smartphone apps are, without a doubt, one of the most important inventions in recent times, and since the launch of the Apple App Store in 2008, around 2.2 million apps have made their way onto the platform. Today, the Google Play Store alone offers about 3.6 million applications, according to the global statistical website Statista.

The future: According to a major report by the Groupe Speciale Mobile Association, the so-called mobile economy contributed \$2.4 trillion to the international economy in 2013, accounting for about 3.6% of global GDP. This number includes more than 10 million jobs and has contributed at least \$336 billion in public funding in the United States alone. Not only that, but the size of the mobile economy is growing at a robust pace, with estimates that it could contribute up to 4.8% to global GDP by 2023. Moving to 5G technology is expected to contribute \$2.2 trillion over 15 years coming. Also, globally, the penetration of smartphones has doubled dramatically. In 2010, it was estimated that about 20% of the world's population used smartphones, while by 2018, that figure was 67%. It is expected to become 71% of the world's population by 2025 (Groupe Speciale Mobile Association, 2014).

2.4.6. Bitcoin and Blockchain

Bitcoin is an entirely electronic currency that is traded online only without any physical presence. It is the first decentralized digital currency, as it is a system that operates without a central repository. That is, it differs from traditional currencies by the absence of a significant regulatory body behind it. It is dealt with directly between users without an intermediary through encryption and blockchain (Xu, et al 2018).

The total value of Bitcoin in the Blockchain is estimated at \$20 billion, or 0.025 percent of the global GDP, or \$80 billion trillion (Schwab, K.2017).

As for the blockchain, it is considered as the so-called ledger, which is a database or a new method for organizing data in an electronic record system for processing and recording transactions, allowing all relevant parties to track information over a secure network that does not require third-party verification such as banks or central trading systems such as the system SWIFT is widely used worldwide. More specifically, it maintains tamper-resistant lists of ever-growing data records and allows for the secure exchange of valuables such as money, shares, or data access rights. Contrary to the traditional trading systems, they do not need an intermediary or a central registration system to follow up the exchange movement. Instead, all parties deal directly with each other, and they have many public and private issues that are used according to business requirements (Sarmah, 2018).

The Future: According to the Bitcoin Market magazine website, although the popularity of Bitcoin (the digital currency) has boomed in 2017, the actual number of Bitcoin users globally is still tiny compared to users of other payment systems such as Paypal credit cards or Visa. By the year 2018, Nearly 32 million bitcoin wallets had been created globally. 2.3 million people use bitcoin to make payments, while 4.8 million users hold bitcoin to facilitate speculative trading in cryptocurrency to make a profit. However, the number of Bitcoin or other digital currencies users is expected to grow exponentially in the next few years (Henry, et al ., 2019).

As for the blockchain, IBM has conducted a study in this aspect, where it collected data from 200 banks in 16 countries to determine the most need for blockchain innovations and said that it is expected that 65% of banks will have blockchain projects within three years, with the lead This orientation by large banks with more than 100 thousand employees. It is also expected that about 15% of the largest global banks will switch to launching commercial Blockchain products in 2017 (IBM., 2016, Chowdhury, et al 2021). Although Blockchain technology appeared mainly in the context of digital currencies, it is used within 64 applications currently in more than 200 A world-class company thanks to the high degree of security and reliability in which it operates, in addition to simplifying and speeding up transactions (Manyika et al., .2013).

2.4.7. Smart Clothes

The working mechanism of these clothes is related to the fact that they contain electronic chips connected to smartphones via Bluetooth technology. Which in turn sends signals to the desired place or application. Recently, another type of clothing has also appeared, made mainly of electronic textiles that can generate self-electric energy from the human body without the need for chips or batteries to generate electric power. According to research conducted by the University of Texas at Dallas by Professor Carter Haines and his team in 2017, they found the possibility of generating energy through chest movement resulting from breathing, as each only 31 milligrams of carbon nanotube yarn that makes up the fabric of these clothes can generate electrical power—required to transmit a 2 KB data packet over a 100-meter radius every 10 seconds to the Internet of Things. It is expected that this technology could be developed to generate electricity by sensing from natural external sources, such as the movement of sea waves, for example. (Haines. C., 2017).

In addition, there is also a vast Google project called "Jacquard" to develop fabrics suitable for bright clothes of all kinds. However, everything related to this technology is only the beginning of vast and promising future projects that will be recorded by the facts of the Fifth Industrial Revolution.

2.4.8. Implantable Technologies

Implantable technologies are not new. Pacemakers implanted in the chest of heart patients and hearing aids for the hard of hearing have been around since the late fifties of the last century. Still, the enormous digital technological development that the world witnessed was reflected in this aspect in a big way. Transplant operations have become diversified according to their function. They are once implanting electronic chips in the body, supported by near-field communication technology, or it is the cultivation of artificial organs to replace a damaged organ in the human body such as a prosthetic leg or hand, or the implantation of electrodes in the human brain to improve memory and increase intelligence. And to many other innovations, some of which have been tried, and some are still in the research process.

The future: There is no doubt that the technologies implanted in the body will blur the boundaries between the human body and technology. Perhaps soon, we will see the human being as half human and half god, and this is what the technology giant Google is seeking through many projects that it has not mentioned in detail so far.

2.5. The Fifth Industrial Revolution

Man's first passion has always been to explore the future and what it involves, so the question of what after the fourth industrial revolution? It was a legitimate question, and no matter how much it was asked by many specialists, especially if we consider the shrinking time distances incrementally for technological development between each industrial revolution and the other. While the period between the first and second industrial revolutions lasted nearly 90 years, it was reduced to 44 years between the second and third revolutions. And to about 31 years between the third and fourth, which means that the future is happening faster than we can imagine and that the fifth revolution may knock on our doors within the next ten years. Therefore, during this short time, we must know what is required of us, whether to prepare for jobs that do not currently exist, define using technologies that have not been invented, or solve problems that we have not identified yet.

Despite that, and although we do not know what the Fifth Industrial Revolution will bring, according to the logic of the cumulative construction of the revolutions that preceded it, it will depend, like the Fourth Revolution, on data, digital devices, and artificial intelligence, and the virtual space will be its playground. According to the state of the art research papers, managing director of Epic Erp, the Fifth Industrial Revolution will crush barriers between natural and virtual worlds. New technologies will be more advanced than anything we've known before, faster and more scalable, and built globally. People will have greater access to hardware, where vast amounts of data can be extracted and processed intelligently to improve efficiency and productivity while creating new business opportunities. Scanlon adds that the future is happening now, and we must face challenges if we are to succeed in the next revolution (Leahy, et al 2019). Proceeding from the text of Scanlon's phrase "the future is happening now," we have to anticipate the details of this future according to the facts of now.

2.6. The Expectations

We cannot consider that the Fifth Industrial Revolution will be limited to one specific invention to determine what it is. Still, there are several predictions by some specialists or experts, which are based on what emerged from the reality of the revolutions that preceded it. We will summarize the most logical and common ones as follows:

2.6.1. Expect the Fifth Industrial Revolution to be about trust and values.

The large and complex transformations caused by rapid technological development raise many ethical challenges, including data privacy and trust problems because it can be manipulated to serve the interests of certain parties, a proposition that was deliberated and adopted at the World Economic Forum in Davos held earlier this year (world economic forum 2016). Drafting some negative terms to denote the problem, including trust deficit, a crisis of trust, and loss of confidence in technology, and he cited the most erroneous incident, which is the privacy violation scandal in Facebook, which leaked the data of 50 million subscribers for the benefit of Cambridge Analytica during the US presidential election, which represented a blatant challenge to ethics profession and maintained the trust of users. There is also another takeaway that touches the ethical and value aspect, such as the manipulation of the human genome through innovations

in biology (the science of genetic engineering and genetics). The same happened with the Chinese in the notorious eugenic movement in the early twentieth century, which moved from experiments on the animal genome to humans. As well as the ethical problems that resulted from the use of artificial intelligence as a substitute for humans in some areas, which is expected to dominate most places in the next few years, is also considered a significant challenge, and the recent uproar about accidents caused using self-driving cars and those who Responsibility in the event of accidents? An indication of that importance. Based on all these ethical challenges and many more, especially in the field of equality and social responsibility resulting from the use of excessive digital technology, there is no doubt that we need global solutions and frameworks, or perhaps a “new digital social contract” to preserve the moral system that was formed over time and distinguished humans from other creatures, It is logical that the compass of the next industrial revolution should be directed towards it to consolidate the basic rule that serves man and achieves justice and prosperity for him in every technological development he seeks.

2.6.2. The second expectation of the Fifth Industrial Revolution to be, the AI revolution

This prediction was issued by several researchers, led by Professor George Muir, in his article Artificial Intelligence / The Fifth Industrial Revolution (Muir, G.2018). Muir expected that the use of artificial intelligence and robotics would change the social and economic situation of all humankind and change the way we work. From 9-5, typical jobs will disappear. He also predicts that AI will replace more than 50 percent of the tasks we do today over the next five years. There is no doubt that artificial intelligence has been present in many things around us and for more than half a century. Still, the critical and expected transformation of artificial intelligence in the fifth industrial revolution is that it will move to taking tasks away from humans and leaving them in the hands of machines that can think, learn, evaluate and make decisions independently without No human intervention. But this transformation will generate a serious problem that was previously a rich material for science fiction films. Still, it will soon become a reality due to the logical development of use, which is that these machines will become a choice, not a march! Who will be responsible for her actions, and what are the controls that will govern her behavior?

2.6.3. Revolution of Saving the Planet

It is the third prediction in the series of expectations that we are reviewing. The World Economic Forum also launched under the slogan "The Fifth Industrial Revolution, a revolution to save the planet." Salesforce Founder and World Economic Forum Co-CEO Marc Benioff believe that sustainability takes on greater importance with the growing awareness that sooner or later, our resources will be exhausted and that only technology can provide an alternative (world economic forum.2019). Added to the depletion of natural resources, environmental pollution, and global warming, which led to rising temperatures and changed our ecosystems.

2.6.4. The Fifth Industrial Revolution is The Nanotechnology Revolution

Under this title, many users of this technology and those who believe in its capabilities expected that it would be the next revolution, including Dr. Nasser Afifi, who wrote a book under this title

as well, in which he says that thirty years ago, as soon as scientists had the right tools, such as the scanning tunneling microscope (STM) and microscope The atomic force (AFM), capable of ultra-fine microscopic vision, gave birth to the era of nanotechnology. Through these techniques, scientists could control and control individual atoms and molecules, which was considered fantastic progress in nanotechnology. Scientists and engineers today have been able to find a wide range of ways to produce what has been termed as nanomaterials, which did not exist before, taking advantage of the characteristics and properties of individual atoms and molecules that are not similar to their original material separated from them, and mixing them with another non-material in different proportions to produce new materials that have qualities Different, such as being more powerful or lighter weight (Maynard, 2015). Today, nanotechnology plays a crucial leading role in reviving the global trade market by offering its goods and products, which are increasing day by day. Today, about 1,860 companies belonging to twenty-seven countries of the world produce various nano-goods and products, the volume of sales in 2007 amounting to about \$146 billion. As for the number of patents on topics related to nanomaterials between 2000 and 2007, it reached 44,867 patents (Al-Iskandarani, M. S, 2010).

3. Research Method

Based on the statement of the problem, and the data that is supposed to be collected from literature. The research can be considered as descriptive research.

4. Discussion

4.1. Challenges and Opportunities

Two and a half centuries ago, i.e., since the first technological revolution in the seventies of the nineteenth century and the subsequent revolutions, recurring aspects of human societies emerged from replacing new technologies with previous ones, which are termed challenges and opportunities. In the following, we will try to summarize some common challenges and opportunities. The purpose of mentioning it is to find the best ways to deal with its consequences, adapt to its effects and mitigate it, and seize its best future opportunities.

4.1.1. Challenges

A. The Challenges of Jobs and Unemployment

What the Fourth Industrial Revolution brought us from the change like business and jobs due to technological progress led to many traditional jobs. It is expected that the automation of most jobs will continue until the arrival of the Fifth Industrial Revolution, which will lead to a decline in demand for traditional employment, as it is estimated that Between 400 million and 800 million people will be displaced by automation by 2030 worldwide (Manyika et al .2017). All of these will need to find new jobs.

According to the jobs report issued by the World Economic Forum for the year 2016. It is expected that the period from 2015 to 2020 will witness the disappearance of about five million administrative and office jobs, about 6.1 million jobs in the field of manufacturing and

production, about half a million jobs in the construction and extractive industries, and 151 A thousand jobs in the field of education, sports, games and entertainment, about 109 thousand jobs in the area of law and 40 thousand jobs in the field of maintenance (World Economic Forum.2016). It is clear that the challenge is very significant in this aspect, but the picture is not that bleak, and there are inadequate opportunities that can compensate for some of the jobs that were lost. We will address them when we address the options available later.

B. Environmental Challenges

Climate change is one of the significant challenges created by the continuous technological development from the first industrial revolution until today. Massive industrialization, the rapid development of technologies, increasing urbanization, excessive deforestation, limitless resource depletion, desertification, rapid population growth, water scarcity, food insecurity, etc., impede the natural ecological balance of the earth.

Also, the rapid migration of people for a better chance and accumulation in one place, leaving the other, creates pressure on one part of the land while the development of the other parts lags. These challenges have led to environmental imbalances and inequalities in global growth, which have led to social inequality at the international level and the outbreak of conflicts, social tensions, and violent extremism. We will explain the two most important types of challenges facing the environment today:

i. Electronic Waste

Rapid innovation and cost reduction have led to a significant increase in production and easy access to electronic products and digital technology. An increase in electronic devices and equipment by people has inadvertently led to a rise in electronic and electrical waste.

If we want to count the number of electrical goods produced annually, we will face difficulty. Still, considering the devices connected to the Internet, the number of them will become more than human beings, no doubt. It is expected that the number will be between 2550 billion by the year 2020. E-waste is now the fastest growing waste in the world. Some of its forms have grown exponentially and have been described by the United Nations as a tsunami of e-waste. It is estimated that this influx of waste reached 48.5 million in 2018, and this number is expected to nearly triple globally unless a shift to a circular economy is made. Primarily since societies today only deal with 20% of this e-waste appropriately, there is little data on what happens to the rest, which mostly ends up in landfills or is disposed of by informal workers in poor conditions. However, e-waste is worth at least \$62.5 billion annually, which is more than most countries GDP. Furthermore, 123 countries have a GDP lower than the global pile of e-waste (world economic forum. 2019).

ii. Energy Consumption

The excessive use of electronic devices and equipment, as we mentioned above, and living in a permanently connected life (On life) requires unimaginable large amounts of energy, which contribute significantly to the increase in emissions that cause our current environmental crisis. Statistics indicate that in 2012, data warehouses worldwide consumed about 30 billion watts of electricity annually, which is roughly equivalent to the output of 30 nuclear plants. According to statistics, in the year 2000, data centers consumed 0.6 percent of the world's electricity, and this figure rose to 1 percent in 2005. In 2007, information and communication technology accounted for 830 million tons of carbon dioxide or about 2 percent. It is estimated that this percentage will increase to about 6 percent annually, or 1.43 billion tons, until 2020 if the situation remains as it is (Jha and Topol, 2016).

C. Challenging Inequality and Monopoly

The relationship between technology, inequality, and monopoly is not a matter of the day. Instead, it accompanies all industrial revolutions - but it may be more severe this time due to high technological development and rapid transition - where technology, according to specialists and experts, has always been considered a threat to social stability through several facets. There is technological inequality between Countries or even within a single country (between rural and city) due to the digital divide. This also results in a slowdown in growth levels, especially in emerging countries, due to the lack of ICT infrastructure, due to weak investments in technology and development.

The rapid transition also produces vast, autonomous monopolies that achieve fantastic profits. Companies such as Amazon, which dominated the retail market; Uber, which overlooks the transportation market; and Google, which swallowed the digital content market unchallenged, led to the concentration of wealth in very few people. Hands and eliminate competition. In a report by Oxfam for the year 2019, it describes the gap between these wealthy people and the rest of the world as "obscene," as the information explained that in 2016 the total owned by nine people was equivalent to what owned by 3.6 billion people who make up the poorest half of humanity (World Economic Forum,(2019).

The process of concentrating wealth and power in the hands of a small number of people invites us to think about the dangerous future roles that these technological giants can play and their ability to usurp the traditional role of the state as the rule-maker, regulator, and implementer, and what this process can pose from the significant challenges to all societies at the global level.

D. Education

Despite the enormous changes like work and the type of skills and knowledge required. We do not find any significant difference in the education system itself. Although it is costly to the beneficiaries, it remains practical in its basic structure, content, and practices that do not correspond to the magnitude of these changes. The process of lifelong education that everyone is

calling for today, which has become an urgent necessity, is one of the means of adapting to a rapidly developing work environment; not much is being done to make it a practical reality. On the other hand, the advantage of the availability of this tremendous amount of information and the ease of access to it, which enhances the learning process and contributes to its development, turns today into a factor of the challenge unless it undergoes a process of sorting out the fake from the real. Also, weak cooperation between the private sector, academia, and policymakers to develop customized, relevant, and adaptable curricula will be another added challenge in the educational reality. Also, the validity of the reluctance of many companies to take the initiative in supporting the skills of the current workforce in continuous learning and lifelong learning, from the principle of social responsibility and for the benefit of both parties increases the level of challenges in the educational aspect, whose development benefits everyone.

4.1.2. Opportunities

Just as we talked about the challenges expected to be faced in many aspects, such as jobs and unemployment, the environment, inequality, monopoly, education, and many other challenges that space did not allow to mention all of them, there are also solutions to these challenges. They can be turned into essential and promising opportunities with the help of technology as well. We'll try to get through it quickly.

On the practical side, today, there is a growing concern about whether there will be enough jobs for workers, as we talked about the challenges of employment and unemployment due to the changing nature of employment and the adoption of automation. But going back to history and the similar difficulties that occurred with all previous industrial revolutions, we see that such fears may be accurate. Still, over time, labor markets have adapted to changes in demand for workers due to these technological disruptions. But workers everywhere are also required to rethink traditional notions of where they work, how they work, and what talents and abilities they bring to this job to speed up the adaptation process. To explore the most critical future opportunities for work, we will use the McKinsey International Foundation report for the year 2017, which expected that the volume of job creation in the future because of the impact of automation on the workforce would vary significantly by country, and depending on four factors: wage level, demand growth, demographics, and economic sectors and professions. She believes that 8 to 9 percent of labor demand in 2030 will be for new occupations that did not exist before. Seventy-five million to 375 million people may need to switch occupational categories and learn new skills. It is possible to create 250 million to 280 million new jobs in the health sector, with up to 50 million to 85 million additional jobs in education. Jobs related to the development and diffusion of new technologies may also grow and, by 2030, become from 20 million to 50 million jobs globally. And 200 million jobs in buildings and infrastructure by 2030 (Manyika et al., 2017).

In the transportation sector, the coming industrial revolution promises us a limitless future in transportation in general. The invention of the pilot and the self-driving car, which has already begun to be manufactured and tested, will improve reality in a positive and significant way, as it will reduce deaths caused by road accidents and high insurance costs, in addition to reducing bottlenecks. Traffic and pollution, primarily if cars are powered by electric power, significantly

reduce carbon emissions. And let us also not forget to talk about the booms that this sector witnessed in the past few years, with the presence of the Internet taxi, which enabled people to order cars that transport them while sitting in their homes without having to go to the street at any time they want and to any place they want, such as Uber, Raft and similar means of transportation. Non-traditional local.

Technology is considered a significant source of continuous environmental deterioration in the ecological field by generating unintended and undesirable side effects. It has enabled the considerable expansion of production and consumption. The environment is expected to contribute to finding solutions to problems that have always been intractable before. Perhaps the most important of which is access to clean and cheap energy, which showed its beginnings in the early twenty-first century, and as we enter the era of the Fifth Industrial Revolution, it is expected that we will also reach the end of the period of using fossil fuels, which contributed mainly to polluting the air of our cities.

By going to the exploration of opportunities in the field of education, it is expected that the rapid technological development and innovations witnessed by the digital devices, computing devices, and networks sector will significantly contribute to the ease of access to information and distance learning in any part of the world and to create an advanced participatory and interactive learning environment. Also, the gradual development of technologies and scientific innovations will lead to the creation of new educational disciplines and new skills, which usher at the end to opening more fields to obtain better opportunities. The Fifth Industrial Revolution is also expected to eliminate the traditional paper-based education and turn it into a fully digital one.

The Sharing economy or the cooperative economy depends on “the sharing of unused assets or services and making them available through electronic markets, innovative phone applications with the help of GPS services or other technology-based platforms. As Jeremy Rifkin, the American thinker described it, equality and monopoly will reduce the cost margins of marginal goods and services to nearly zero (Rifkin, 2014). Still, despite this, the challenge remains excellent in this aspect, especially for those who do not have the means to access these platforms or those who do not have the technical capabilities to stand up to the tech giants who invaded.

E-currencies and blockchain technology are also expected to change the reality of the financial sector in terms of abolishing the role of intermediaries and banks and perhaps even canceling the supervisory role and tax collection for the state, as their effects are still not well known due to their recent use.

Advances in medical sciences and neurosciences are expected to lead to a healthier life, increase human lifespan, and expand human beings' intellectual and mental capabilities.

On the agricultural side, it is also expected that larger quantities of crops can be produced with the help of bioengineering and with the help of artificial intelligence-powered machines, which provide the possibility to measure the number of crops and detect weeds or pests. And the future is open to more opportunities, the nature of which we cannot imagine without a doubt.

5. Conclusion

Addressing the subject of the Fifth Industrial Revolution today and exploring its nature is only a way to describe a group of continuous and imminent transformations in the systems that surround us and lead to a brilliant society, which will later be known as the society of the Fifth Industrial Revolution. which will be his next few years of the most exciting period of human creativity and achievement.

The expectations that we mentioned about the nature and nature of the Fifth Industrial Revolution, from our point of view, were not an imagined prediction but rather stemmed from one of the most scathing criticisms leveled at the previous four industrial revolutions and the policies associated with them, which is the failure to solve the most pressing issues that still face modern societies overall. It poses challenges, such as environmental pollution, climate change, disruption of consumer confidence in technology, inequality, machine control over jobs, and other issues mentioned in the preceding context.

We had discussed the most prominent technologies of the Fourth Industrial Revolution and its future, as these. Other technologies will be of importance in the reality of the Fifth Industrial Revolution. This is confirmed by the McKinsey International Institute, which expects that by 2025 there will be twelve technologies he called new, such as artificial intelligence, the Internet of things, and cloud technology. Renewable energy, self-driving vehicles, etc... will change the economic and social landscape, the way of work and life, and even the value system itself (Manyika et al., 2013).

On the other hand, these technologies, combined with their combination, will create significant opportunities to significantly improve the efficiency of businesses and institutions, help renew the natural environment through better asset management, and get rid of all the damage caused by previous industrial revolutions. It will also create new challenges, some of which are expected, and some are not yet known. But wherever we end up, whether in terms of problems and challenges to be solved, or opportunities that are perhaps highly innovative that require a lot of flexibility and speed to exploit, we aim through our modest research paper to draw attention to this vital topic that calls from all researchers and academics to do more research and investigation for everything related to it from many and varied aspects.

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Homo-Hetero Pairing Effect Correlation Coefficient: A Modified Correlation Technique for Social Science Studies

Ntogwa Ng'habi Bundala

Tanzania Police Force, Mara Police Regional,
Criminal Intelligence Bureau
Mob: +255(0)73360418/+255(0)782 33 87 70
E-mail: bundalantogwa@gmail.com

Abstract

The study aimed to examine the pairing relationship between economic growth and psychological human behaviour (psychological well-being) of individuals by application of the homo-hetero pairing effect correlation coefficient technique. The cross-sectional data were used. The data were collected from 211 individuals randomly sampled from two regions in Tanzania. The data were analysed by the homo-hetero pairing effect correlation coefficient and the results were compared to that of the Pearson correlation coefficient and simple regression model. The study found that economic growth and psychological well-being are positively changing in pairs, and the psychological well-being of the individual is the true enabler (optimal independent) of the linear modelling. The study concluded that the improvement of the psychological well-being of individuals significantly improves economic growth and not vice versa. Therefore, the paper recommended that psychological well-being-based initiatives should be established and encouraged in society as found to have a positive impact on economic growth. Moreover, the study specifically, recommends the application of the homo-hetero pairing correlation coefficient in studies of cardiology, neurology, epidemiology, psychology, economics, anthropology, sociology and other fields of the social sciences.

Keywords: Homo-hetero pairing effects; correlation techniques; Bundala ratios; enabler and enabled variables, and Pearson correlation coefficient

JEL: C01, C02, C18, C51, D91

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1. Introduction and Literature Review

Social science is the system or procedural rule that scientifically defines society; this is why it is termed a social science. Social science differs from natural science. However, there is no field of study that is more important to human beings than the social sciences (Samuel and Okey, 2015; Maravelakis, 2019; Hernandez and Alpizar-Jara, 2018). The study of social science is more

helpful for understanding what factors or conditions for a better life and what social opportunities are available for human development. Social science studies involve a lot about societies' behaviours and practices, mostly including anthropology (study of the relationship between biological traits and socially acquired characteristics), sociology (study of the relationship among people), economics (study of ways individuals satisfy their unlimited wants and needs-demands relative to limited resources), political science (study of social arrangement to maintain peace and order in society), and psychology (deals with the mind and personality of individual), and other. One of the most debatable issues in social science studies is the relationship between the economic growth and psychological well-being (psychological human behaviour) of the individual that resulted from the Easterlin paradox effect (Easterlin, 1973; 2017). The studies such as Diener and Seligman (2004), Roka (2020), Stevenson and Wolfer (2008; 2013), and Talhelm, Zhang, Oishi, ..., and Kitayama (2014) evidence the positive impact (correlation) between economic growth and psychological well-being, which contradicts Easterlin's (1973; 2017). On the other hand, Stoop, Leibbrandt and Zizzamia (2019) found a negative relationship between economic growth and psychological well-being. In addition, the studies such as Diener and Seligman (2004) and Baro and Sala-i-Martin (2004) suggested that the socio-economic and political measures of GDP have seriously failed to provide a full account of policy decisions at the organizational, corporate, and governmental levels. They concluded that the exclusion of variables such as psychological factors (e.g., personal traits, values, etc.) is not accounted for in the economic principle of demand and supply.

Moreover, the exclusion of the non-economic variables such as motivation, metacognition, and lifestyle leads to economic performance failure in some regions or countries (Diener and Seligman, 2004, Bundala, 2021). One of the potential problems of measuring the relationship between economic growth and psychological well-being is based on the *methodological incompleteness* of the existing correlation technique, particularly the Pearson correlation coefficient. Samuel and Okey (2015) emphasised that Pearson correlation is a *sine qua non* in social science studies; it is an excellent analytical tool when implement correctly and used with its partner regression. Since correlation remains a very important tool in social science study and its techniques are almost inevitable, especially in quantitative studies that involve variables (Samuel and Okey, 2015; Senthilnathan, 2019).

Despite the massive support of the Pearson correlation technique in social science studies, some empirical studies negate its advantages. Some studies condemn the correlation coefficient for its inability to detect the cause-and-effect (Bertoldo, Callegher and Altoe, 2022; Janse, Hoekstra, Jager... and van Diepen, 2021; Coppack, 1990; Grogty and Thatte, 2017; Rahman and Zhanga, 2016). The coefficient correlation is developed in early 1896 by Karl Pearson, to determine the *strength* which is measured by magnitude ranging from -1 to +1 and the *direction* of the magnitude which is indicated by the negative or positive signs (Janse, et al, 2021; Coppack, 1990; Gogtay and Thatte, 2017; Danacica and Babucea, 2007; Kumar and Chong, 2018). That is, the correlation coefficient is aimed to measure how the two observed variables x and y are moving together or changing together, i.e, co-vary (Akoglu, 2018; Mukaka, 2012; Emerson, 2015; Bertoldo, Callegher and Altoe, 2022). For example, a cancer disease may be associated or go together with the smoking behaviour of an individual (smoking frequencies), or the Human

immunodeficiency virus (HIV) can be associated with Tuberculosis (TB) disease, but you cannot conclude or say that the TB is caused by HIV, or HIV is caused by TB. But one of the factors or variables can be “an enabler” of another (enabled); not dependent and independent factors or variables. However, sometimes the relationship between enabler and enabled variables may be similar to that of independent and dependent variables, depending on the nature of the data.

The enabler factor or variable is the factor that increases the opportunity for another factor (enabled) to happen. In simple language, enabler factors are inviting agents but may not be loosely defined as cause-and-effect factors. For example, in the correlation between TB and HIV, which one can be an enabler and another is enabled? The question is how to determine the enabler and enabled factors. It is still impossible to determine the enabler and enabled factors/variables by using the available (current) correlation techniques. Substantially, this is the major methodological flaw of the available correlation coefficient techniques. Understanding the strength in terms of the figure (magnitude) and direction in terms of signs is not enough to make a clear decision relating to the paired variables. A lot of methodological questions are left unanswered by the Pearson correlation coefficient, r . For instance, if you say x and y have $r = 0.60$, it means that they are moving in the same way in the strength of 0.60 (medium), that is, an increase of x results in an increase of y and it is vice versa for decreasing. Moreover, if $r = -0.60$, it indicates that the variables x and y are moving in the opposite direction. That is the increase of x leads to a decrease of y . But, how “they are accurately moving in pairs, i.e., changing up (increases) and down (decreases) together in either direction? What is the pairing effect (error) of the observed variables x and y as they are moving in pairs (co-related) downwards or upwards? What is an enabler and enabled variables or factors in the linear modelling?

In most practice, when correlation techniques are used in social science, the identification of the enabler and enabled factors/variables was done by using experience or additional knowledge or skills of researchers or decision-makers. For example, if it is found that there is a high correlation between cancer and smoking behaviour, an expert for medical issues (medical officer or practitioner) can identify the *enabler and enabled factors* by using his/her medical skills or experience on the related variables or factors. However, these methods of identification of the enabler and enabled factors have many flaws because they are based on individual expertise, skills, or experience which varies from individual to individual, so the contradiction in interpretation may happen which can cause a dilemma or contra-conclusion problem. Although, the Pearson correlation coefficient gets massive applicability support in social sciences studies (Gokul, Srinivasan, and Swaminathan, 2021; Samuel and Okey, 2015; Senthilnathan, 2019; Onwuegbuzie and Daniel, 1999; Rahman and Zhang, 2016; Li, Chu, Li, and Jiang, 2022; Sverko, Vrankic, Vlahinic and Rogelj, 2022; Chinnadurai and Bobin, 2021); it requires a complementary technique to answer some of the left methodological questions (Onwuegbuzie and Daniel, 1999; Senthilnathan, 2019; Benesty, Chen and Huang, 2008; Sedgwick, 2012). For this reason, this paper developed a homo-hetero pairing effect correlation coefficient that explained the left methodological flaws by the Pearson correlation coefficient technique. This modern correlation technique can be used in parallel to the Pearson correlation technique. It would be easier and more helpful for decision-makers to determine which variable is enabled and which an enabler is. The identification of enabler and enabled variables is very important and

needy in decision making particularly in social science studies. Therefore, the study aimed to examine the pairing relationship between the economic growth and psychological human behaviour (psychological well-being) of individuals by application of the homo-hetero pairing effect correlation coefficient technique to fill both contradictory evidence and methodological gaps resulting from the studies of Easterlin (1973; 2017), Roka (2020), Stevenson and Wolfers(2008; 2013) and others. Specifically, the study determines the enabler and enabled variables and optimal independent (true enabler) variables in the linear modelling of the economic growth and psychological well-being of the individual. Moreover, the study examines the empirical relevance of the linear modelling (regression model) and methodological coincidence between the homo-hetero pairing correlation coefficient and Pearson correlation coefficient techniques with respect to the linear regression model. The next sections of the paper cover the analytic framework and idea generation, methodology, findings, discussion, and the last sections cover the conclusion and recommendation, and references.

2. Literature Review and Model Development

2.1. Analytic Framework and Idea Generation

Given the pair of the observed variable x and y in an array of descending order, ask how the relationship of x and y can be determined? Obviously can be determined in the two directions of changes, that is, hetero pairing change (the change of difference of paired variable), that is, $(x_1 - y_1)$ to $(x_2 - y_2)$. This change determined the “pairing effect or error” of the observed variables x and y . Moreover, the homo pairing change can be used to determine the relationship of the observed variables. The homo pairing change is the change of difference of the same variable, either x or y , that is, the change of x , $(x_1 - x_2)$ if is moving together with the change of y , $(y_1 - y_2)$. The traditional correlation analysis such as Pearson correlation used this *homo-pairing change* or effect to determine the correlation of the observed variable x and y , that is, how the change of x ($x_1 - x_2$) is co-vary with the change of y , $(y_1 - y_2)$. Therefore, the covariance of x and y is weighted to their standard deviation (variability error). In practice this method does detect or predict the “causality effect” of the paired variables x and y , instead, it shows the positional pairing effect (error) of homo variables (same variables). That is if there is a co-variation of the change of x from x_1 to x_2 and the change of y from y_1 to y_2 . That is, both x and y are changing or moving in approximately equal “distance” (values) and in the same or opposite direction. This is why the scale of Pearson correlation takes both positive and negative values in the range of -1 to +1.

To measure or examine the correlation of the two observed variables by using only “homo pairing effects have been evidenced to lack its methodological completeness. Some of the relational attributes are left untouched! Arranging the data in the paired data array the Pearson correlation analysis only considers the vertical co-movement or variation of the data (increasing or decreasing upward and downward). That is, the observed variables x and y change x_1 to x_2 and y_1 to y_2 respectively. Unfortunately, the horizontal co-movement or variation of the paired data, that $x_1 \leftrightarrow y_1$ to $x_2 \leftrightarrow y_2$ was not considered. Overlooking this correlational dimension in which the observed variable x and y move horizontally (leftwards or rightwards) to the paired data array leads to the methodological incompleteness of the Pearson correlation analysis.

Consequently, this study introduces a new way of measuring the correlation which considers all the change effects of pairing, that are, homo and hetero pairing effects of the paired data x and y . That is, the homo-hetero pairing effect correlation coefficient, or simply “pairing effect correlation coefficient. This method is very sensitive to data order or arrangement and powerful technique to determine the pairing correlation direction and strength of the paired variables in terms of the *homo-hetero pairing effect*. The method identifies the enabler and enabled factors quantitatively.

To be clear, the Pearson correlation does not consider the “homo-hetero pairing effect” of the paired data array; therefore, its applicability is still limited in social science studies /decisions (Taylor, 1990; Asuero, Sayago and Gonzalex, 2006; Shelef and Schechtman, 2018; Coppack, 1990). Cautionary, the concept of enabler and enabled factors or variables cannot be conceptually considered or confused with dependent and independent variables or factors; they are two different terms and concepts. The enabler factor or variable is the factor that increases or decreases the occurrence opportunity of enabled factors or variables. In other words, the enabler is the factor that increases the “occurrence probability” of the enabled factor/variable; it is the “host” factor or variable. For example, rainfall is an enabler for a farmer to farm. Now, the relationship between rainfall and farmer, intuitively, can be considered positive as when the rainfall falls on the land the farmer would go to the farm. That is, the farmer does not farm because of the rainfall consequences, but he/she is enabled by the falls of the rainfall (he/she would be waiting for rainfall) to fulfil his/her course of action. Another example is a thief that is waiting for the housekeeper to leave out the house and snap/steal a piece of valuable metal. The presence or absence probabilities of the housekeeper at the house determine the will of a thief to steal or not. Therefore, the frequency of leaving out the house of a housekeeper (absence) will be positive related or correlated to the number of theft attempts at the house. In that case, the presence or absence probability of a housekeeper is the enabler factor of the thief or stealing attempts, as he was waiting for that opportunity. Stealing is an enabled event or variable.

On the other hand, the dependent and independent variables or factors are terms that are usually used in regression analysis to determine the causality effect of the independent or explanatory variables or factors on dependent variables. In this concept, the dependent variables or factors are the factors that vary as the independent variables vary and not vice versa. In other words, the dependent variables are the variables or factors that depend on the change or influence of independent variables. Therefore, the independent variables are variables or factors that are not dependent on others, instead are “causal factors” of the dependent variables or factors. Take an example, the two variables advertisement efforts or costs and sales. We expect that once the advertisements efforts are done intensively (increase) would increase the marketing awareness and hence convince or persuade more customers to buy the products or services advertised, that is, more buyers, increase sales. But do the increase or decreases in sales affect or influence the advertisement efforts or costs? In other words, do the increases in advertisement efforts or costs due to the increases in sales? The answer is no! The advertisement efforts or costs are independent of sales; do not depend on sales but sales depend on advertisement efforts or costs. Therefore, the sale is a dependent variable (it depends on the advertisement efforts or costs) and the advertisement efforts or costs are independent variables because do not depend on the sales.

We can notice the difference between the enabler and the enabled factors by the stated examples. Recall the example of a thief and a housekeeper, the one can say that the probability of presence or absence of the housekeeper in the house and the number or frequency of theft attempts do not qualify to carry the degree or attributes of dependent and dependent variables. The frequency of theft attempts is not due to or not depends on the probability of the presence or absence of the housekeeper in the house or the probability of the presence or absence of the housekeeper at the house is not due to the frequency of theft attempts by theft, but they are associated in a pairing effect order; one can lead another-a paired predecessor and successor factors (enabler and enabled paired variables). For a clear illustration of the pairing effect (error) correlation coefficient, consider the paired observed data x and y (Table 1). The data are assumed to be linearly related and normally distributed.

Table 1: The Data array of the paired observed variables x and y

x	y
x_1	y_1
x_2	y_2
x_3	y_3
$\cdot$	$\cdot$
$\cdot$	$\cdot$
$\cdot$	$\cdot$
x_n	y_n

Source: Author (2022).

Table 1 describes that the variables x and y can decrease or increase vertically (upward or downwards). The change of x from x_1 to x_2 is paired to the change of y from y_1 to y_2 and the change difference is co-related between them. Moreover, the change of x from x_2 to x_3 is paired or associated with the change of y from y_2 to y_3 . In general, for each change of x from x_i to x_j , there is a corresponding or associated change of y from y_i to y_j which correlated with it. We measure the change difference as the proportion of change of x , and y , that is x -homo pairing effect (∂_x) and y -homo pairing effect (∂_y), and their x and y mean homo pairing effect, $\bar{\partial}_x$ and $\bar{\partial}_y$ respectively.

$$\partial_x = \frac{(x_i - x_j) - (y_i - y_j)}{(x_i - x_j)}$$

$$\bar{\partial}_x = \frac{1}{n-1} \sum_{i=1}^n \frac{(x_i - x_j) - (y_i - y_j)}{(x_i - x_j)}$$

$$\partial_y = \frac{(y_i - y_j) - (x_i - x_j)}{(y_i - y_j)}$$

$$\bar{\partial}_y = \frac{1}{n-1} \sum_{i=1}^n \frac{(y_i - y_j) - (x_i - x_j)}{(y_i - y_j)}$$

Now, the methodological question is whether these pairing effects are moving together, i.e., correlated. The relationship between parameters ∂_x and ∂_y will indicate the pairing effect correlation of the observed variables x and y . Therefore, to get the correlation between the two parameters, we use the common technique of standardised variance or the ratio of signals and their noises. That is, the covariance of ∂_x and ∂_y , is given by

$$\text{Cov}(\partial_x, \partial_y) = \frac{\sum(\partial_{xi} - \bar{\partial}_x)(\partial_{yi} - \bar{\partial}_y)}{n-1}$$

Now, the Homo-hetero pairing effect correlation coefficient, Ψ_b is given by,

$$\Psi_b = \frac{\text{Cov}(\partial_x, \partial_y)}{\sigma_{\partial_x} \sigma_{\partial_y}}$$

$$\text{Since, } \sigma_{\partial_x} = \sqrt{\sum \frac{(\partial_{xi} - \bar{\partial}_x)^2}{n-1}}, \sigma_{\partial_y} = \sqrt{\sum \frac{(\partial_{yi} - \bar{\partial}_y)^2}{n-1}}$$

Therefore,

$$\Psi_b = \frac{\frac{\sum(\partial_{xi} - \bar{\partial}_x)(\partial_{yi} - \bar{\partial}_y)}{n-1}}{\left(\sqrt{\sum \frac{(\partial_{xi} - \bar{\partial}_x)^2}{n-1}}\right) \left(\sqrt{\sum \frac{(\partial_{yi} - \bar{\partial}_y)^2}{n-1}}\right)}$$

$$\Psi_b = \frac{\left(\frac{\sum(\partial_{xi} - \bar{\partial}_x)(\partial_{yi} - \bar{\partial}_y)}{n-1}\right) \sqrt{(n-1)^2}}{\left(\sqrt{\sum(\partial_{xi} - \bar{\partial}_x)^2} \sqrt{\sum(\partial_{yi} - \bar{\partial}_y)^2}\right)}$$

$$\Psi_b = \frac{\sum(\partial_{xi} - \bar{\partial}_x)(\partial_{yi} - \bar{\partial}_y)}{\sqrt{\sum(\partial_{xi} - \bar{\partial}_x)^2 \sum(\partial_{yi} - \bar{\partial}_y)^2}}$$

The formula looks like the Pearson correlation coefficient but is quite different, this is the correlation of parameters ∂_{xi} and ∂_{yi} which built on the x -and y -homo change of the observed variables x and y . The substituting the x and y in the *parametric equation* the formula will be

large and more complex to understand. Therefore, this parametric equation is more simplified and easy to use.

2.2. Meaning and Interpretation of Ψ_b

The homo-hetero pairing effect correlation coefficient or simply Bundala pairing effect (error) correlation coefficient is denoted by the Greek letter Psi, (Ψ_b). The subscript small b indicates the name of the author, Bundala. For simplicity, Ψ_b would be termed as Bundala's Psi coefficient or Bundala pairing effect correlation coefficient. This correlation analysis measures the "homo-hetero pairing relationship" of the observed variables x and y . The homo-hetero pairing relationship can be defined symbolically, $(x_i \leftrightarrow x_j) \leftrightarrow (y_i \leftrightarrow y_j)$. Where, $(x_i \leftrightarrow x_j)$ is the x -homo pair and $(x_i - x_j)$ is the x -homo pair effect (error), and $(y_i \leftrightarrow y_j)$ is y -homo pair and $(y_i - y_j)$ is the y -homo pairing effect. Therefore, $(x_i \leftrightarrow x_j) \leftrightarrow (y_i \leftrightarrow y_j)$ is the homo-hetero, i.e., different homo-pairs (x, y). Technically, (Ψ_b) is based on the standardised covariance technique of the x -homo pairing effect and y -homo pairing effect.

Logically, the (Ψ_b) it measures how the difference of change (effect) of one variable is correlated with the change (effect) of the other variables. That means it measures how accurately the "correlated variables are paired". The higher Ψ_b indicates the pairing closeness or shortness of pairing distance which is a separation distance (effect) of the paired data. The lower Ψ_b indicates that the two variables are poorly paired. In practices, there is no benchmark value of Ψ_b ; it depends on the nature of the studies. In some studies the lower value of Ψ_b is desirable but in some studies is not desirable, and it is vice versa.

2.2.1 Meaning and Interpretation of Ψ_b , when $\Psi_b = 0$ and $r = 1$

Notably, if (Ψ_b) is interpreted along with the Pearson correlation coefficient, r , the r with a higher (Ψ_b) will be considered the optimal or correct one. The values of Ψ_b range from -1 to 1, that is, $-1 \leq \Psi_b \leq 1$. Notably, if the observed variable x and y are perfectly correlated, that is, $r = 1$, then $\Psi_b = 0$. In other words, Ψ_b does not depend on r . The value of Ψ_b can be 0 (perfectly unpaired) while $r = 1$ (perfectly paired). Considers a hypothetical example with data of paired variables x and y and parameters of Ψ_b in the hereunder table,

x	y	∂_x	a	∂_y	b	$a.b$	a^2	b^2
1	6	-5	0	0.83	0	0	0	0
2	12	-5	0	0.83	0	0	0	0
3	18	-5	0	0.83	0	0	0	0
4	24	-5	0	0.83	0	0	0	0
5	30	-5	0	0.83	0	0	0	0
6	36	-5	0	0.83	0	0	0	0
7	42	-5	0	0.83	0	0	0	0
8	48	-5	0	0.83	0	0	0	0
9	54	-5	0	0.83	0	0	0	0
10	60							

From the table,

$$\bar{\partial}_x = \frac{1}{n-1} \sum_{i=1}^n \frac{(x_i - x_j) - (y_i - y_j)}{(x_i - x_j)} = -5$$

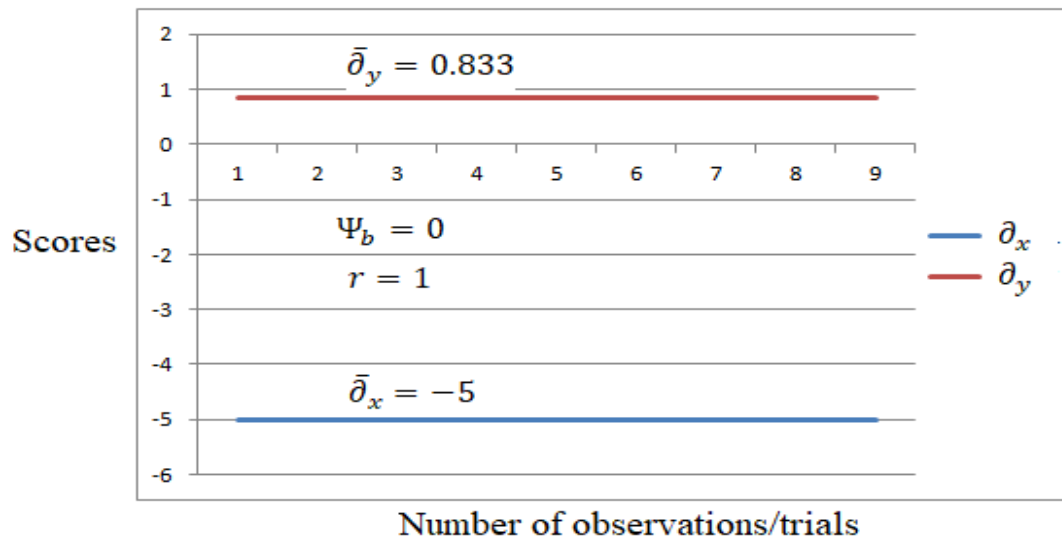
$$\bar{\partial}_y = \frac{1}{n-1} \sum_{i=1}^n \frac{(y_i - y_j) - (x_i - x_j)}{(y_i - y_j)} = 0.83$$

$$\sum (\partial_{xi} - \bar{\partial}_x)^2 = \sum a^2 = 0 \text{ and } \sum (\partial_{yi} - \bar{\partial}_y)^2 = \sum b^2 = 0$$

$$\sum (\partial_{xi} - \bar{\partial}_x)(\partial_{yi} - \bar{\partial}_y) = \sum a.b = 0$$

$$\Psi_b = \frac{\sum (\partial_{xi} - \bar{\partial}_x)(\partial_{yi} - \bar{\partial}_y)}{\sqrt{\sum (\partial_{xi} - \bar{\partial}_x)^2 \sum (\partial_{yi} - \bar{\partial}_y)^2}} = \frac{0}{\sqrt{0 \times 0}} = 0$$

The $\Psi_b = 0$, means that the data of the variable x and y are perfectly unpaired but are perfectly correlated (co-vary with zero homo-hetero pairing effects). That is, the x and y -homo pairing effects are not paired, hence not correlated, $\Psi_b = 0$. This can be checked by using x and y -homo pairing effect trends (Figure 1).



Source: Author (2022)

Figure 1: The x and y - homo pairing effects trends in Ψ_b analysis

Figure 1 shows x and y -homo pairing effects trends. Both x and y homo pairing effects are constant, hence not correlated. That is, the mean x -homo pairing effect(error) is -5 which

indicates the x always changing (decreasing) with a constant ratio of 5, and the mean y -homo pairing effect(error) is 0.833 which indicates that the values of y are always or constantly changing (increasing) with a ratio of 0.833. Since all means of x and y -homo pairing effects (errors) are constant, there is no overlapping or down and upward co-movement of the observed variables x and y ; therefore, the straight lines are exhibited. That is, why the value of Ψ_b is equal to zero, meaning that there is no homo-hetero pairing effect because the x and y -homo pairing errors (standard deviation) are zero.

On the other hand, the Pearson correlation coefficient was calculated to re-check the concept of independence of Ψ_b on r .

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}$$

x	y	$x_i - \bar{x}$	$y_i - \bar{y}$	$(x_i - \bar{x})^2$	$(y_i - \bar{y})^2$	$(x_i - \bar{x})(y_i - \bar{y})$
1	6	-4.5	-27	20.25	729	121.5
2	12	-3.5	-21	12.25	441	73.5
3	18	-2.5	-15	6.25	225	37.5
4	24	-1.5	-9	2.25	81	13.5
5	30	-0.5	-3	0.25	9	1.5
6	36	0.5	3	0.25	9	1.5
7	42	1.5	9	2.25	81	13.5
8	48	2.5	15	6.25	225	37.5
9	54	3.5	21	12.25	441	73.5
10	60	4.5	27	20.25	729	121.5
Sum	330	0	0	82.5	2970	495

Now from the table, the Pearson correlation coefficient can be calculated by using the formula,

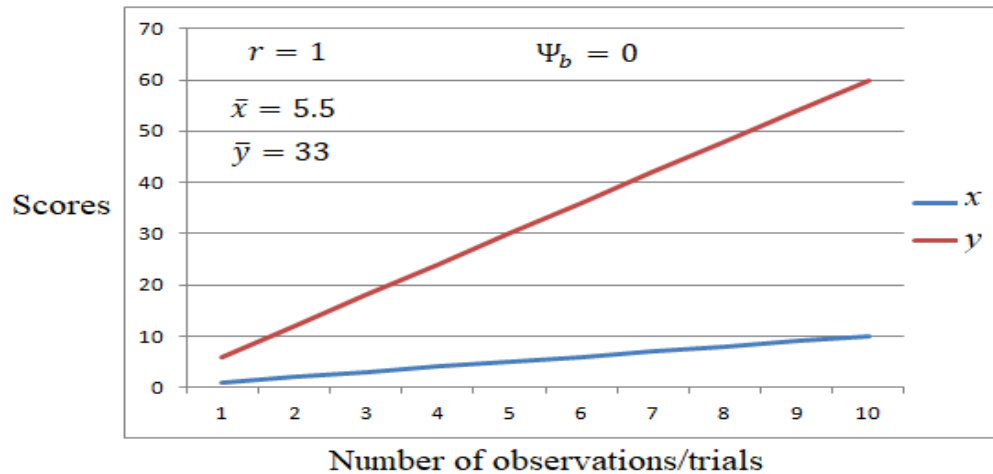
$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}$$

$$\sum(x_i - \bar{x})(y_i - \bar{y}) = 495$$

$$\sum(x_i - \bar{x})^2 = 82.5, \quad \text{and} \quad \sum(y_i - \bar{y})^2 = 2970$$

$$r = \frac{495}{\sqrt{82.5 \times 2970}} = 1$$

Therefore, we get $r = 1$ while $\Psi_b = 0$, this means that the data of the variables x and y are perfectly correlated, $r = 1$ (both are trending, i.e., moving positively upward) with no homo-hetero pairing effects, $\Psi_b = 0$ (Figure 2).



Source: Author (2022)

Figure 2: Data directional trending in the Pearson correlation analysis

Figure 2 shows the graphical presentation of data from the observed variables x and y as described by the Pearson correlation analysis. The graph shows that the data are perfectly correlated as both are moving in the same direction, with a mean value of x , $\bar{x} = 5.5$ and mean value of y , $\bar{y} = 33$. The paired data x and y are perfectly fitted or matched about their respective means values, $\bar{x}$ and $\bar{y}$. Therefore, we conclude that where there is the perfect correlation of paired data x and y , $r = 1$, then $\Psi_b = 0$.

2.2.2 Meaning and Interpretation of Ψ_b , when $\Psi_b \neq 0$ and $r \neq 1$

To get a clear and thorough meaning and interpretation of the concept of Ψ_b and r , considers a more hypothetical example with empirical paired data that explains the conditions of $\Psi_b \neq 0$ and $r \neq 1$. The data and Ψ_b estimates parameters were provided hereunder in the table,

x	y	∂_x	a	∂_y	b	$a.b$	a^2	b^2
3	6	-0.50	-0.33667	0.33	0.279167	-0.09399	0.113347	0.077934
5	9	-1.00	-0.83667	0.5	0.449167	-0.3758	0.700017	0.201751
4	7	-0.5	-0.33667	0.33	0.279167	-0.09399	0.113347	0.077934
6	10	0.25	0.41333	-0.33	-0.38083	-0.15741	0.170842	0.145034
10	13	0.22	0.38333	-0.29	-0.34083	-0.13065	0.146942	0.116167
19	20	-0.09	0.07333	0.08	0.029167	0.002139	0.005377	0.000851
53	57	0.09	0.25333	-0.11	-0.16083	-0.04074	0.064176	0.025867
32	38	-0.37	-0.20667	0.27	0.219167	-0.0453	0.042712	0.048034
62	79	0.17	0.33333	-0.2	-0.25083	-0.08361	0.111109	0.062917
86	99	0.15	0.31333	-0.17	-0.22083	-0.06919	0.098176	0.048767
11	35	0.11	0.27333	-0.13	-0.18083	-0.04943	0.074709	0.032701
20	43	-0.49	-0.32667	0.33	0.279167	-0.0912	0.106713	0.077934
57	98	Sum				-1.22917	1.747467	0.915892

From the table the Ψ_b can be calculated by using the formula,

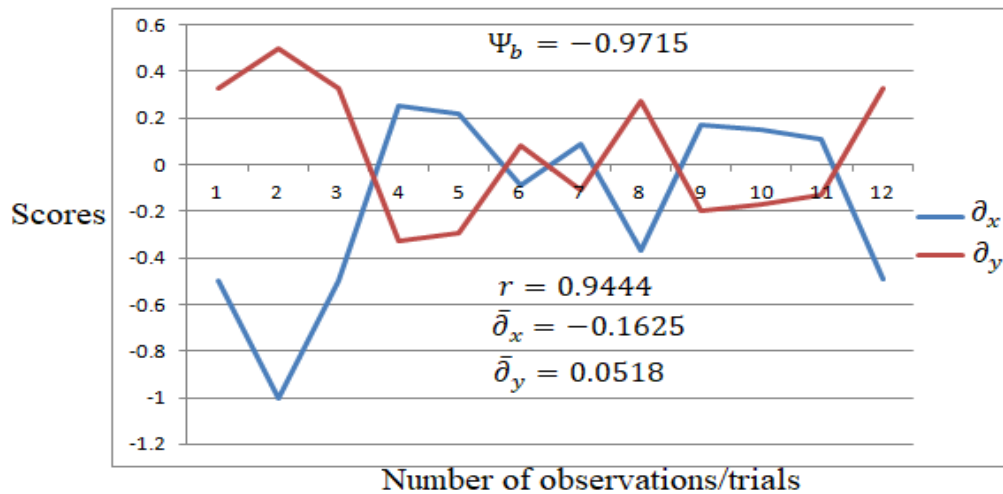
$$\Psi_b = \frac{\sum(\partial_{xi} - \bar{\partial}_x)(\partial_{yi} - \bar{\partial}_y)}{\sqrt{\sum(\partial_{xi} - \bar{\partial}_x)^2 \sum(\partial_{yi} - \bar{\partial}_y)^2}}$$

$$\sum(\partial_{xi} - \bar{\partial}_x)^2 = \sum a^2 = 1.747467 \text{ and } \sum(\partial_{yi} - \bar{\partial}_y)^2 = \sum b^2 = 0.915892$$

$$\sum(\partial_{xi} - \bar{\partial}_x)(\partial_{yi} - \bar{\partial}_y) = \sum a.b = -1.22917$$

$$\Psi_b = \frac{-1.22917}{\sqrt{1.747467 \times 0.915892}} = -0.9715$$

Now, we get $\Psi_b = -0.9715$ indicating that the changes (increase and decrease) of x and y are pairing oppositely. That is, the homo-hetero pairing effect is negative (when a change of x is up, the change of y is down). This movement cannot be shown or detected in this Pearson correlation analysis; however, it is evidenced when the x and y -homo pairing effect trending in Bundala pairing correlation analysis is established (Figure 3).



Source: Author (2022)

Figure 3: The x and y -homo pairing effects trending in Bundala correlation analysis

Figure 3 shows the data trending of the x and y -homo pairing effects of variables x and y respectively. It detects the homo effects of the variables x and y as they move up (increasing and decreasing). The graph shows how the homo pairing effects/changes of x and y is going up and down as they move together upwards. The graph depicts the mean x - homo pairing effects, $\bar{\partial}_x$ is

−0.1625. This means that x changes are decreasing at the ratio or constant values of 0.1625. On the other hand, the mean y - homo pairing effects of y , $\bar{\partial}_y$ is 0.0518. This means, that values of y are increasing positively by a constant ratio $\bar{\partial}_y = 0.0518$. Because, $\bar{\partial}_x \neq \bar{\partial}_y$, then there are unequal up and down movements of x and y -homo pairing changes/effects of variables x and y .

On the other hand, we use the same data we computed the Pearson correlation coefficient, r by using the formula, the condition is $r \neq 1$.

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}$$

The hypothetical empirical data and estimates parameters of r are presented in the table hereunder,

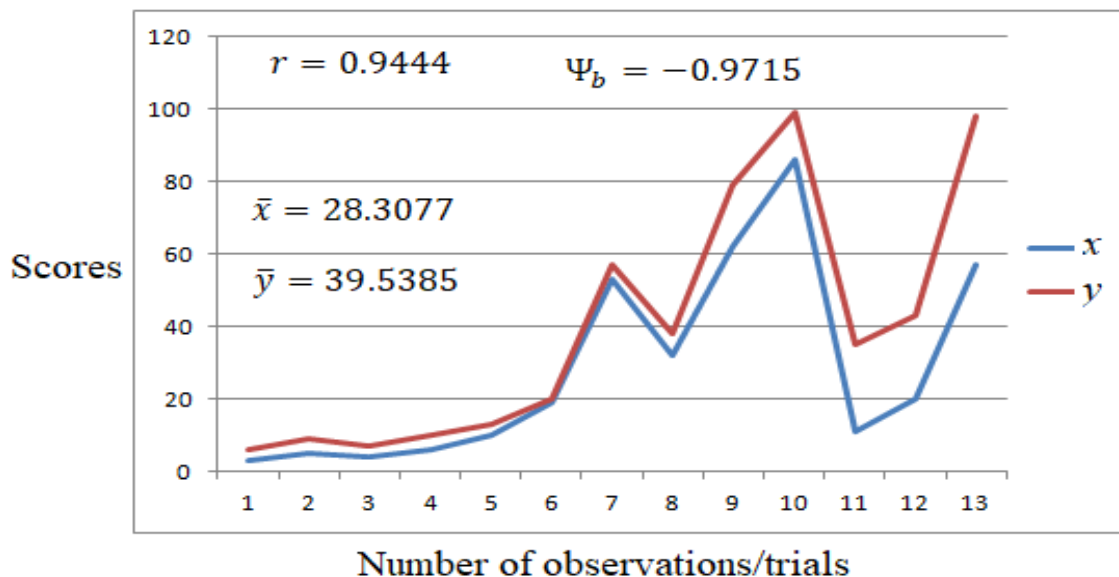
x	y	$x_i - \bar{x}$	$y_i - \bar{y}$	$(x_i - \bar{x})^2$	$(y_i - \bar{y})^2$	$(x_i - \bar{x})(y_i - \bar{y})$
3	6	-27.42	-33.54	751.8564	1124.932	919.6668
5	9	-25.42	-30.54	646.1764	932.6916	776.3268
4	7	-26.42	-32.54	698.0164	1058.852	859.7068
6	10	-24.42	-29.54	596.3364	872.6116	721.3668
10	13	-20.42	-26.54	416.9764	704.3716	541.9468
19	20	-11.42	-19.54	130.4164	381.8116	223.1468
53	57	22.58	17.46	509.8564	304.8516	394.2468
32	38	1.58	-1.54	2.4964	2.3716	-2.4332
62	79	31.58	39.46	997.2964	1557.092	1246.147
86	99	55.58	59.46	3089.136	3535.492	3304.787
11	35	-19.42	-4.54	377.1364	20.6116	88.1668
20	43	-10.42	3.46	108.5764	11.9716	-36.0532
57	98	26.58	58.46	706.4964	3417.572	1553.867
Sum	-	-	-	9030.773	13925.23	10590.89

Now from the table, compute the Pearson correlation coefficient by using the formula,

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}$$

$$\begin{aligned} \sum(x_i - \bar{x})(y_i - \bar{y}) &= 10590.89 \\ \sum(x_i - \bar{x})^2 &= 9030.773, \quad \text{and} \quad \sum(y_i - \bar{y})^2 = 13925.23 \\ r &= \frac{10590.89}{\sqrt{9030.773 \times 13925.23}} = 0.9444 \end{aligned}$$

From these calculations, $r = 0.9444$ indicates that the paired data are highly correlated in positive ways, and that, the trending changes are done in the same direction (either decreasing or increasing are occurring in the same directions). In other words, the paired data are increasing simultaneously or decreasing simultaneously. But how many degrees of change differences (decreases and increases) of the paired data are co-vary? This question is not answered in r but it answered in Ψ_b . In other words, the question can be asked how the x and y perfectly fit relative to their means values. The paired data trending graph is the best way of interpreting the data (trending) behaviour in r , which indicates either the data x and y are increasing simultaneous or decreasing simultaneously (Figure 4).



Source: Author (2022)

Figure 4: The data trending in the Pearson correlation analysis

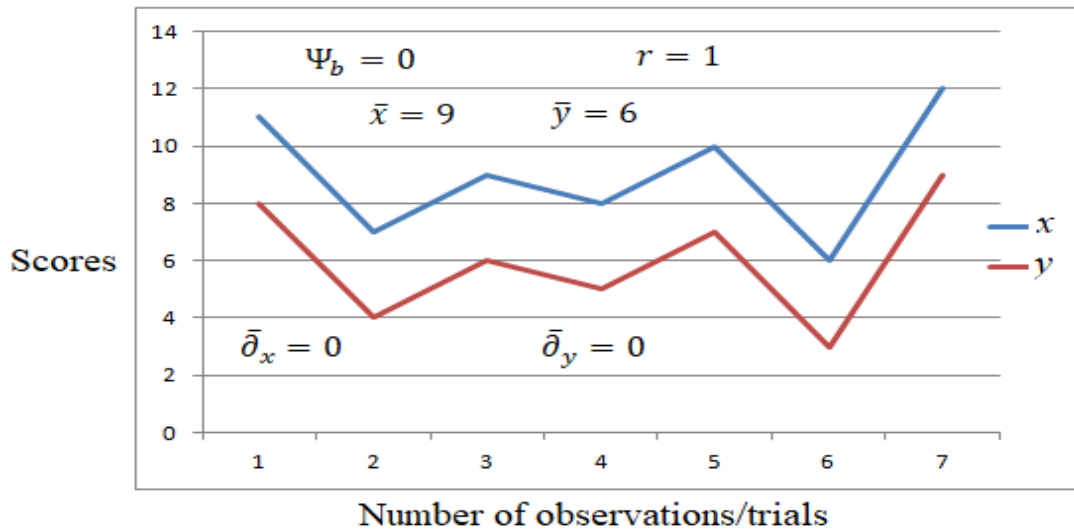
Figure 4 shows how x and y are trending positively. The data are trending up and down in a positive way, hence a positive $r = 0.9444$. That is, the data are increasing and decreasing simultaneously. The data changes are associated with unequal paired increments which are explained in Ψ_b . The graph shows the data moving in the same direction, with a mean value of x , $\bar{x} = 28.3077$ and mean value of y , $\bar{y} = 39.5385$. The paired data x and y are highly fitted to their respective means values, $\bar{x}$ and $\bar{y}$.

2.2.3 Meaning and Interpretation of Ψ_b , when $\bar{\partial}_x = \bar{\partial}_y = 0$

When $\bar{\partial}_x = \bar{\partial}_y = 0$, we get a single straight line separator which combines both x and y -homo pairing effects of variables x and y . When the both $\bar{\partial}_x$ and $\bar{\partial}_y$ are equal to zero, then, $\Psi_b = 0$ and $r = 1$ (Figure 6). Consider the hypothetical empirical data and the x and y -homo pairing effects of the variable x and y in the table below,

x	y	∂_x	∂_y
11	8	0	0
7	4	0	0
9	6	0	0
8	5	0	0
10	7	0	0
6	3	0	0
12	9		

Computing the Ψ_b and r from the above data we get, $\Psi_b = 0$ and $r = 1$. Since the $\partial_x = 0$ and $\partial_y = 0$, the x and y -homo pairing effect trend cannot be established, instead of the data trending of the Pearson correlation analysis (Figure 5).



Source: Author (2022)

Figure 5: The data trending in the Pearson correlation analysis

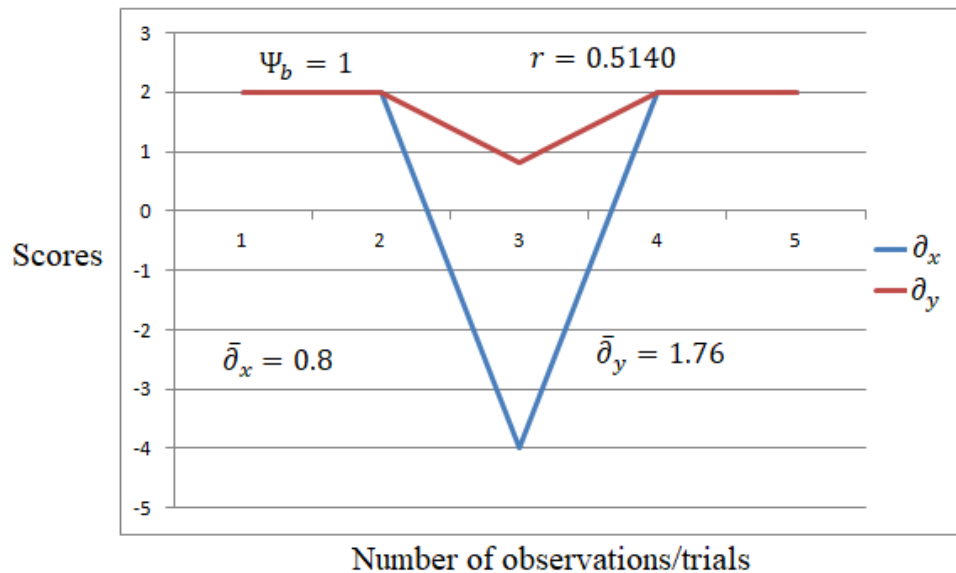
Figure 5 evidences the co-movement of the paired data is equal in magnitude and direction. The x and y -homo pairing effects are equal, that is, $-\partial_x = -\partial_y$ and $\partial_x = \partial_y$. Therefore, the mean x and y -homo pairing is zero ($\bar{\partial}_x = \bar{\partial}_y = 0$), hence $\Psi_b = 0$. The graph shows the data moving in the same direction, with a mean value of x , $\bar{x} = 9$ and mean value of y , $\bar{y} = 6$. The paired data x and y are perfectly fitted to their respective means values, $\bar{x}$ and $\bar{y}$.

2.2.4 Meaning and Interpretation of Ψ_b , when $\Psi_b = 1$ and $r \neq 1$

When there is a perfect homo-hetero pairing effects of the two variables, x and y , $\Psi_b = 1$. This does not grant $r = 1$. Consider the hypothesis empirical data and their x and y -homo pairing effects in the table below,

x	y	∂_x	∂_y
2	7	2	2
4	5	2	2
7	2	-4	0.8
9	12	2	2
12	9	2	2
10	11		

From the table, we compute the homo-hetero pairing effect coefficient, Ψ_b and the Pearson correlation coefficient, r . The $\Psi_b = 1$ and the $r = 0.5140$. The $\bar{\partial}_x$ is 0.8 and $\bar{\partial}_y$ is 1.76 (Figure 6).



Source: Author (2022)

Figure 6: The x and y-homo pairing effects trending in Bundala correlation analysis

Figure 6 shows x and y-homo pairing effects trending of variables x and y respectively. The figure shows the perfect homo-hetero pairing effect coefficient, $\Psi_b = 1$, and $r = 0.5140$. The graph depicts the mean x-homo pairing effects, $\bar{\partial}_x$ is 0.8. This means that x changes are decreasing at the ratio or constant values of 0.8. On the other hand, the mean y- homo pairing effects of y, $\bar{\partial}_y$ is 1.76. This means, that values of y are increasing positively by a constant ratio $\bar{\partial}_y = 1.76$. This evidences that the perfect homo-hetero pairing effect correlation of the two variables, x and y, does not guarantee for perfect Pearson correlation of the variables.

2.3. Relationship Between r and Ψ_b

The Pearson correlation coefficient, r measures the “degree (strength) and direction of the co-variation of the x and y about their means $\bar{x}$ and $\bar{y}$ values respectively. The direction measure in r is indicating the “trend direction” of the paired data. Therefore, the paired data can be trending in a negative direction (negative r), or trending in a positive direction (positive r). On the other, the Bundala’s Psi coefficient, Ψ_b measures the strength (pairing distance between the changes/effects of x and y) and direction of the co-variation of the x -homo pairing effects, ∂_x , and y -homo pairing effect, ∂_y , about their means homo pairing effects, $\bar{\partial}_x$, and $\bar{\partial}_y$, respectively. The direction measured in Ψ_b indicate the pairing direction or relationship of the paired data x and y . That is, the opposite direction of the pairing effects or changes of x and y indicated by negative Ψ_b , and the change of x and y occurs in the same direction (either increasing or decreasing) together, the value of Ψ_b is positive.

Both r and Ψ_b can be used to measure the correlation behaviour or information of the observed data, but Ψ_b explains how the observed data are “paired”, that is the degree and direction of the pairing effect. Advantageously, Ψ_b can be used to check the robustness and perfectness of the r accuracy of co-movement of x and y as indicated by the dispersion (error) of the increase or decrease of the observed data in the pair. Noting that the co-movement of the paired variable x and y , increase or decrease may not always equal, i.e., $(x_i - x_j) = (y_i - y_j)$, it sometimes defers in size or magnitude, although are moving in the same direction, i.e., $(x_i - x_j) \neq (y_i - y_j)$. The variances or deviation of the magnitude change (decrease and increases) are detected by Ψ_b . In other words, if the Ψ_b is related to the r , the value of Ψ_b will indicate or measures the variance or variation of the changes (perfectness) of the observed variable x and y , as the Ψ_b measures the correlation of the difference or error pairing in r .

Technically, Ψ_b can be used to indicate or measure the pairing error in r . In this case, the r can be positive indicating that the data are either increasing or decreasing in the same direction but does not describes or explains the level or degree of the decrease of x and y or increase x and y are different or co-vary. In this case, it is impossible to identify the enabler and enabled factor or variable in r . In practice, r may be positive but Ψ_b is negative, which indicates that with either increase or decrease of paired variable x and y , the homo pairing change effect of observed variables x and y changes oppositely (∂_x going up and ∂_y going down). On the other hand, the r can be positive with a positive Ψ_b , indicates that either increase or decrease of paired variables x and y , the homo pairing effect (error) changes in the same direction (∂_x and ∂_y upwards ∂_x and ∂_y downwards). And, the r can be negative and Ψ_b is positive, indicates that the data are oppositely changes (decrease or increases) while the magnitude or size of the changes is positively co-vary or related; they are going (moving) up (increase) and down (decrease) together. Also, the

negative r can be associated with negative Ψ_b indicates that the data are oppositely changing and the homo pairing effect also is moving oppositely (∂_x is going up and ∂_y is going down).

Generally, we can conclude that there is no either magnitude (strength) or directional relationship between Pearson correlation coefficient, r , and Bundala pairing correlation coefficient, Ψ_b . The r can be higher and Ψ_b is higher, or r is higher but Ψ_b is low and it is true and vice versa. Moreover, the r can be negative while Ψ_b positive or negative. This is because the Ψ_b does depends on r .

2.4. Enabler and Enabled Variable or Factor

Consider two correlated data, x and y in the paired data array. The methodological question is which between the two variables x and y , one is the enabler of the other variable (enabled variable)? This question traditionally was talked about by using experience or skills on the attributes of the variables in the study. This study introduces a new scientific way of identifying the enabler and enabled variables. The basic principle underpinning this concept is that the enabler should be totally or wholly absorbed in the enabled variable (Kenny, 1979; Onwuegbuzie and Daniel, 1999). In non-technical language, the enabler variable is a sub-part or element of the enabled variable. If x is the enabler variable of y , then, the following “pair-rule” would be adhered to, that $x \leftrightarrow y, x < y; x \rightarrow y$. This means, that the value of x is less than the value of y and is totally or wholly absorbed in the value of y , i.e., $y > x$. On the other hand, if y is an enabler of x , then, the paired relationship will adhere to $x \leftrightarrow y, x > y; x \leftarrow y$. That is, if the value of y is less than x than y , then y is totally and wholly absorbed in the value of x , i.e., $y < x$; this is the mathematical reasoning. In logical reasoning, take an example of the pairing relationship between the risk factors of the infection of TB and HIV. Using the “pair-rule”, that is,

$$TB \leftrightarrow HIV, TB > HIV; TB \leftarrow HIV$$

This means, in clinical language or reasoning, HIV is one of the clinical symptoms or signs of TB. Therefore, HIV is a sub-part or element of the symptoms or signs (risk factors) of TB. Now, alternatively,

$$TB \leftrightarrow HIV, TB < HIV; TB \rightarrow HIV$$

This means that if the risk factor of TB is less than the risk factors of HIV, then the risk factors of TB are part of the risk factors (symptoms and signs) of HIV. In other words, the risk factors of TB are the enabler factors or variables of HIV, and therefore HIV is the enabled variable (factor). For paired data (homo-hetero paired data) the enabler and enabled are identified with the same principle, but the mean x and y - homo pairing effect are applied. That is when x is an enabler of y the pairing rule is given by, $\bar{\partial}_x \leftrightarrow \bar{\partial}_y, \bar{\partial}_x > \bar{\partial}_y; x \leftarrow y$ and when x is an enabler of y the pairing rule is given by $\bar{\partial}_x \leftrightarrow \bar{\partial}_y, \bar{\partial}_x < \bar{\partial}_y; x \rightarrow y$. For more clarity, take examples from Figures 1 and 5. In Figure 1, the data have $r = 1$ and $\Psi_b = 0$. The mean homo paring effect for x and y are -5 and 0.833 respectively. Using the pair-rule we can identify the enabler and enabled variable, that is, $\bar{\partial}_x = -5$ and $\bar{\partial}_y = 0.833$, then,

$$\bar{\partial}_x \leftrightarrow \bar{\partial}_y, -5 > 0.833; x \leftarrow y: \text{Not true}$$

$$\bar{\delta}_x \leftrightarrow \bar{\delta}_y, -5 < 0.833; x \rightarrow y: \text{True}$$

Now from this example, we identify that x is an enabler factor or variable and y is the enabled factor or variable. That is, the change of the x will influence or enable y to change. The nature of change can be determined by the mean homo-hetero deviation, denoted as ϖ_b ; this is the enabling effect value, or simply the enabler value. It is calculated by using the formula,

$$\begin{aligned} \bar{\delta}_y - \bar{\delta}_x &= \varpi_b; \text{ If } x \text{ is an enabler factor/variable} \\ \bar{\delta}_x - \bar{\delta}_y &= \varpi_b; \text{ If } y \text{ is an enabler factor/variable} \end{aligned}$$

Now, using the mean homo-hetero deviation equations, enabling effect value is obtained from the formula, $\bar{\delta}_y - \bar{\delta}_x = \varpi_b$, since x is an enabler factor; $\bar{\delta}_x = -5$ and $\bar{\delta}_y = 0.833$, we get, $0.833 - (-5) = 5.833$. This implies that the increases in effects of x are positively influenced by the increases in effects of y . The 5.833 indicates the trending-off effect value over the y -homo pairing effect. This extra mean value of y is totally and wholly absorbed in the value of x , to affect it (enabling it to change). This is why the Pearson correlation is positive. This value is always positive and indicates the positive or enabling effect of the variable. Furthermore, take another example in Figure 5 where $r = 1$, $\Psi_b = 0$, $\bar{\delta}_x = 0$ and $\bar{\delta}_y = 0$. From the pair-rule, since all the values of homo pairing changes in x and y are zero, indicating that the data has no homo-hetero pairing effect (x and y are not paired). The change of x is not paired with the change of y . That is why we say the paired data x and y have no homo-hetero pairing relationship because $\Psi_b = 0$. A question to ask is, which enabler and enabled variable? When $\Psi_b = 0$, there is a relationship between the enabler and enabled variable in the linear modelling. The mean homo-hetero deviation value is zero, which explains that there is no trending-off change value of either the x or y -homo pairing effect on y or x respectively. No variable its effect exceeds the other. The enabling effect of each variable is zero. These kinds of data are either all dependent or independent variables or all are enablers or enabled variables.

Let's learn a more example in Figure 3, in which $r = 0.9444$, $\Psi_b = -0.9715$, $\bar{\delta}_x = -0.1625$ and $\bar{\delta}_y = 0.0518$. In this case, the paired data of the observed variables x and y are positively correlated since it has a positive value of $r = 0.9444$. On the other hand, the paired data has a negative highly pairing relationship since it has negative values of $\Psi_b = -0.9715$. This means the positive correlation of x and y is associated with opposite changes in the homo pairing effects of x and y . The data are paired in a negatively way. That is, there is an enabler and enabled variable. Using the pair-rule, that is,

$$\begin{aligned} \bar{\delta}_x \leftrightarrow \bar{\delta}_y, \bar{\delta}_x > \bar{\delta}_y; x \leftarrow y: \text{ If } y \text{ in an enabler variable of } x \\ \bar{\delta}_x \leftrightarrow \bar{\delta}_y, -0.1625 > 0.0518; x \leftarrow y: \text{ Not true} \\ \bar{\delta}_x \leftrightarrow \bar{\delta}_y, \bar{\delta}_x < \bar{\delta}_y; x \rightarrow y: \text{ If } x \text{ is an enabler variable of } y \\ \bar{\delta}_x \leftrightarrow \bar{\delta}_y, -0.1625 < 0.0518; x \rightarrow y: \text{ True} \end{aligned}$$

Therefore, the x is an enabler variable of the variable y . Now use the mean homo-hetero deviation to calculate the enabler value or enabling effect value.

Since x is an enabler variable of variable y , then we used, $\bar{\partial}_y - \bar{\partial}_x = \varpi_b$

$$0.0518 - (-0.1625) = 0.2143$$

We notice that the increase of the change of the x variable positively influences the change of variable y . The trending-off change value of 0.2143 indicates the enabling effect value of the variable x on y . The higher the trending-off change values the stronger the enabling effect. Hence, we conclude that x and y are positively correlated with a highly negative homo-hetero pairing effect correlation.

2.5. Statistical Significance Test

It is a formal procedure of comparing the observed data with a claimed truth (hypotheses) (Moore, Notz and Flinger, 2013). Therefore, the statistical significance test aims to draw statistical or empirical evidence (inference) that the claimed hypotheses are representing the population of the study sample. The common statistical significance is the student t-test which is suitable or appropriate for small sample size, in practice, not more than 30 observations because as the sample becomes large the sample becomes normally distributed according to the central limit theorem and therefore is approximated to z-tests, and becomes relevant for a normal distribution (Moore, et al. 2013). The assumption of Ψ_b is that the observed variables x and y are linearly pairing or matched variables, therefore the appropriate statistical significance test is the *homo-hetero paired t-test*, modified from the normally paired t-test (Moore, et al. 2013). That is,

$$t_{\Psi_b} = \frac{\sum(\partial_{xi} - \partial_{yi}) \sqrt{n-1}}{\sqrt{n \sum(\partial_{xi} - \partial_{yi})^2 - (\sum(\partial_{xi} - \partial_{yi}))^2}} \sim t(n-1)df$$

Where $t(n-1)df$ is the degree of freedom, given by $n-1$.

2.6. Hypotheses Test

The hypothesis is the tentative solution or claimed truth of the problem on hand (Paiva, 2020). The hypotheses are of two types, null hypothesis (H_0) which is a negation statement about the claimed truth or expected facts. By default, the null hypothesis is represented with a negative statement about the fact in the issue (Massey and Miller, n.d). The second hypothesis is an alternative hypothesis or research hypothesis put down or described by a researcher concept. It is denoted by (H_1) or (H_a). It is a positive statement that explains the attentive solution to the research problem (Massey and Miller, n.d; Paiva, 2020). The alternative hypothesis H_1 can be formulated in three forms; it can follow the upper-tailed, lower-tailed and two-tailed tests (Paiva, 2020; Massey and Miller, n.d). For example, a researcher may want to know if $H_0: t_{\Psi_b} = t_{\alpha/2}$ for the null hypothesis and set an alternative $H_1: t_{\Psi_b} \neq t_{\alpha/2}$ (two-tailed test). The alternative

hypothesis $H_1: t_{\psi_b} \neq t_{\alpha/2}$ can be further decomposed into two tests, upper (right)-tailed test ($H_1: t_{\psi_b} > t_{\alpha}$) and lower (left)-tailed test ($H_1: t_{\psi_b} < t_{\alpha}$). Where t_{ψ_b} , $t_{\alpha/2}$ and t_{α} are computed statistic t-values and critical statistics t-value in a two (left and right)-tailed test and one-tailed test respectively.

2.7. Bundala's Ratios of Linear Correlation (Modelling)

Bundala's ratios or values are ratios that describe the conditions for optimality and empirical validity of the linear correlation techniques or models. The ratios are based on the relationship between true enabler (independent) and true enabled (dependent) variables in the linear modelling. The ratios are called by the name of the author to make them distinctive from other common ratios. There are two ratios developed by the author, which are the Gamma ratio (Γ_b) and Zeta ratio (Z_b). They are explained in detail in the next sections.

2.7.1. Gamma Ratio (Value)

The Bundala's gamma value or ratio (Γ_b) is the ratio used to identify or classify the enabler variables into either dependent or optimal independent variables. In other words, it is the test of independence of the variables for linear modelling (regression). In linear modelling, the enabler variables can be either dependent or independent variables.

Let x and y be two paired variables, that if x is an enabler variable of y , then, $x \rightarrow y$ and its regression model or function is $y = a_1 + b_1x$, and when y is an enabler of x , that $x \leftarrow y$, the regression equation becomes $x = a_2 + b_2y$. From the concept of Bundala's Gamma ratio, Γ_b

$$\Gamma_b = \frac{\text{Regression Coef. when enabled variable (y) is independent}}{\text{Regression Coef. when enabler variable (x) is independent}}$$

$$\Gamma_b = \frac{\text{Coef. } y}{\text{Coef. } x} = \frac{b_2}{b_1}$$

The coefficient of the linear equation $y = a_1 + b_1x$ and $x = a_2 + b_2y$ can be written in expanded form, that is,

$$b_1 = \frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum x^2) - (\sum x)^2}$$

$$b_2 = \frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum y^2) - (\sum y)^2}$$

Therefore,

$$\Gamma_b = \frac{\text{Coef. } y}{\text{Coef. } x} = \frac{b_2}{b_1} = \frac{\left(\frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum y^2) - (\sum y)^2} \right)}{\left(\frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum x^2) - (\sum x)^2} \right)}$$

This can be simplified to,

$$\Gamma_b = \frac{n(\sum x^2) - (\sum x)^2}{n(\sum y^2) - (\sum y)^2}, \text{ if } x \text{ is an enabler of } y$$

$$\Gamma_b = \frac{n(\sum y^2) - (\sum y)^2}{n(\sum x^2) - (\sum x)^2}, \text{ if } y \text{ is an enabler of } x$$

Alternatively, the Γ_b can be computed using the concept of the total sum of the squares errors (TSSE) and total mean squares errors (TMSE) of the linear modelling (regression). That is,

$$\Gamma_b = \frac{\text{TSSE or TMSE of regression model when enabled variable (y) is independent}}{\text{TSSE or TMSE of regression model when enabler variable (x) is independent}}$$

$$\Gamma_b = \frac{TSSE_x}{TSSE_y} = \frac{TMSE_x}{TMSE_y} = \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{\sum_{i=1}^n (y_i - \bar{y})^2}; \text{ if } x \text{ is an enabler variable}$$

$$\Gamma_b = \frac{TSSE_y}{TSSE_x} = \frac{TMSE_y}{TMSE_x} = \frac{\sum_{i=1}^n (y_i - \bar{y})^2}{\sum_{i=1}^n (x_i - \bar{x})^2}; \text{ if } y \text{ is an enabler variable}$$

That is, if Γ_b implies x is an enabler of y , then Γ_b^{-1} implies that y is an enabler of x .

Specifically, Γ_b is used to evaluate the validity of the enabler variable to qualify for “an optimal independent variable”. The optimal or true independent is the variable that maximises the output (dependent) with fewer predictive errors or noise. Therefore, it is possible by using Bundala’s Gamma value or ratio to identify the dependent and independent variables in the correlation analysis or linear modelling. The optimal range (true independent variable) of Bundala’s gamma value Γ_b is from 0 to 1, that is $0 < \Gamma_b < \pm 1$. If $\Gamma_b = 0$ or $\Gamma_b = \pm 1$ indicates the data are not paired; hence there is no effect of enabler and enabled variables, and if the $\Gamma_b > \pm 1$ the variable x is not a true enabler or not a truly independent variable, it is an enabled (dependent) variable. Therefore, the Bundala Gamma value can be the most applicable statistical test in regression modelling/linear modelling to identify the optimal dependent and independent variables if they are wrongly regressed. It is an appropriate test to identify scientifically, the optimal independent and dependent variables in linear modelling.

2.7.2. Zeta Ratio (Value)

Bundala’s Zeta ratio of the linear correlation (Z_b) describes the empirical relevance of the linear models, such regressions model. The ratio is taken as the percentage of the value of a unit contribution or impact of the true enabler (optimal independent) variable on the true enabled (dependent) variable when the true enabler variable takes the value of 0 and 1, that is, x (0,1). This ratio can be derived from the general linear equation,

$$f(x) = \sum_{i=1}^n \beta_i x_i + \beta_0, \text{ for } x(0,1)$$

$$f(1) = \sum_{i=1}^n \beta_i + \beta_0 \text{ and } f(0) = \beta_0$$

Therefore,

$$Z_b = \frac{f(1) - f(0)}{f(1)}$$

$$Z_b = \frac{\sum_{i=1}^n \beta_i + \beta_0 - \beta_0}{\sum_{i=1}^n \beta_i + \beta_0} = \frac{\sum_{i=1}^n \beta_i}{\sum_{i=1}^n \beta_i + \beta_0}$$

If the linear equation is reduced to simple regression with one dependent and one independent variable, the Zeta value or ratio is calculated by using the formula,

$$Z_b = \frac{\beta_i}{\beta_i + \beta_0}$$

Where β_i and β_0 are beta coefficient and y-intercept or regression constant values respectively; β_i and β_0 are calculated as

$$\beta_i = \frac{n(\sum x_i y_i) - (\sum x_i)(\sum y_i)}{n(\sum x_i^2) - (\sum x_i)^2}$$

$$\beta_0 = \frac{1}{n} \sum_{i=1}^n y_i - \beta_i \frac{1}{n} \sum_{i=1}^n x_i$$

The value of Z_b can take positive or negative values but never becomes zero. Positive values indicate the true enabler (optimal independent) variables in the model have a positive empirical impact on the true enabled (dependent) variable. Moreover, if the value is negative implies that the true enabler variable has a negative empirical impact on the dependent variable. The constant value β_0 is the value where the true enabler variables do not exist or are valued at zero scores. The interpretation of the Zeta ratio follows the following rule, when $\beta_0 = \beta_i$ or $\beta_0 < \sum_{i=1}^n \beta_i$ (for multiple regression), the Z_b value is 0.5, therefore, the recommended Z_b value is at least 0.5 which indicates that $\beta_0 < \beta_i$ or $\beta_0 < \sum_{i=1}^n \beta_i$ (for multiple regression). In the optimal linear equation, i.e., $\beta_0 = 0$ the Zeta value is equal to one, $Z_b = 1$. This implies that all the impacts or enabling effects in the enabled variable are due to the enabler variable. The value of constant or natural value is zero. On the other hand, when the constant value is negative, that is $\beta_0 < 0$, the Zeta value or ratio becomes more than 1, that is $Z_b > 1$. Moreover, the value of Z_b may become less than a critical value of 0.5, if $\beta_0 > \beta_i$ or $\beta_0 > \sum_{i=1}^n \beta_i$ (for multiple regression). If the Zeta value or ratio is greater than one, the model has more noise and is influenced by an unexplained value (constant value) or zero value of the independent variable (true enabler). In most practice, the optimal value of Zeta values should fall under the optimality range of $0.5 < Z_b \leq 1.5$ (Bundala, 2021).

3. Methodology

The study aimed to determine the pairing relationship between the economic growth and psychological human behaviour (psychological well-being) of the individual by application of the homo-hetero pairing effect correlation coefficient, or simply Bundala pairing correlation coefficient, Ψ_b technique. The study used the cross-sectional survey research design. The data were collected from 211 individuals randomly sampled from two regions in Tanzania, in 2020. Tabachnick and Fidell's (2019) approach was used to determine the sample size of the study. They suggest the sample size of $N > 50 + 8m$ for multivariate data analysis, and $N > 104 + m$ for testing individual predictors, where N is the sample size, m is the number of independent variables. The minimal sample size is $N > 104 + 1 = 105$ for a single independent variable. Therefore, the sample size of 211 individuals is reasonable for this study.

The psychometric scale technique was used to process the data as suggested by Bundala (2022), which is suitable for cross-sectional studies. The data is primarily analysed by using Ψ_b , and the results are compared with that of the r and regression model. This is to cross-examine the conclusion of the Ψ_b with r and regression model. The study variables are average gross domestic product (AGDP) per capita (measured in monthly annualised personal income) and psychological well-being. The annualised personal income is the summarization of the monthly monetised income from farming, business activities, salary, and other activities of the individual which are computed on the monthly consumption basis of the individual. Therefore, average GDP per capita (AGDP) = monthly income of an individual, $i \times 12$ (number of months in a year). The monthly income is assumed to be constant over a year due to the nature of economic activities being similar and has almost constant monthly returns. On the other hand, the psychological human behaviour of an individual (psychological well-being) is measured by a psychometric scale developed by Bundala (2021). This psychometric scale is directly converting the 5-Point scale to an index number that ranges from 0 to 1. The general formula of the psychometric scale is,

$$Hube = \frac{\sum_{i=1}^n \sum_{j=1}^m Q_i \times LS_i}{\sum_{i=1}^n Q_i \times LS_{max}}$$

Where n is the number of variables measured in psychological factor, m is the number of questions that measure or is a proxy for variables, Q_i the question posed for variable i , LS_i the score of individual questions on the Likert Scale, and LS_{max} is the maximum score of individual questions on the Likert scale. The psychological human behaviour (Hube) which measures the psychological well-being of the individual is composed of three observed variables namely lifestyle, metacognition and motivation of the individual. The indicators of lifestyle are hedonistic, adventurous and individualistic behaviour characteristics/attributes of the individual. Metacognition which measures the psychological awareness of the individual is indicated by three indicators namely, knowledge-based awareness, regulation awareness-based awareness and experiences-based awareness. The motivation of the individual is measured by two indicators

namely geographical motives of the individual to work and government policy and regulations support-based motive on work. The 5-Point Likert Scale was used to scale the observed variables lifestyle, metacognition and motivation.

The tests of linearity assumptions were done. The normality test was done by using the Jarque-Bera normality test and was found to be 7.04 and Chi (2) is 0.0296 which indicates that the data are normally distributed (Thadewald and Herbert, 2004). On the other hand, the multicollinearity test was done by using variance inflation factors (VIF) and was found to have a mean VIF of 4.38 which indicates the absence of a collinearity problem because it is below 5 (Murray, Nguyen, Lee...and David, 2012). Moreover, the reliability test was done for cross-sectional data by using Cronbach alpha which is found to be 0.6617 which is reasonably better as suggested by Tavakol and Dennick (2011).

4. Result and Discussion

The study examined the pairing relationship between economic growth and psychological well-being. The Bundala pairing correlation coefficient technique is used and its results are compared with other linear (bivariate) analytic techniques which are Pearson correlation and simple regression analysis. The data were analysed with the aid of the Microsoft (MS) Excel program.

4.1. Relationship Between Economic Growth and Psychological Well-Being

The objective is to examine the pairing relationship between economic growth and the psychological well-being (psychological human behaviour) of the individual by the application of t_{ψ_b} . The null hypothesis is stated as “there is no significant pairing relationship between economic growth and the psychological well-being ($H_0: t_{\psi_b} = t_{\alpha/2}$). The alternative hypothesis stated that “there is a significant pairing relationship between the economic growth and psychological well-being ($H_1: t_{\psi_b} \neq t_{\alpha/2}$). The descriptive statistics are displayed (Table 2).

Table 2: Descriptive statistics for cross-section survey data in 2020 in Tanzania

Variable	Obs	Mean	Std. Dev.	Min	Max
Hube	211	.7250284	.1592616	.201	1
lnAGDP	211	.3978714	.5228518	-1.261602	1.607837
d_Hube	210	-.0635013	2.353792	-5.124332	4.94572
d_lnAGDP	210	.7557632	1.084683	-3.328894	4.3129

Source: Author (2022).

Table 2 shows the descriptive statistics for average gross domestic product transformed in natural logarithm (lnAGDP). The average of lnAGDP is 0.3979 TZS million (natural logarithm) and ranges from -1.2616 to 1.6078 TZS millions in natural logarithm. The other variable is psychological well-being measured in Hube (human behaviour index composed of three sub-

indicators, lifestyle, motivation and metacognition). Hube has an average of 0.7250; the score is based on the psychometric scale developed by Bundala (2021).

The study applied Ψ_b to examine the pairing relationship between economic growth and psychological well-being. The results were compared to the r and linear regression model. The parameters of Ψ_b and r is computed with the aid of the MS Excel program and it is summarised (Table 3).

Table 3: Parameters of Bundala's Psi and Pearson's rho coefficients

Ψ_b parameters		r parameters	
Hube observations (x)	211	Hube observations (x)	211
lnAGDP observations (y)	211	lnAGDP observations (y)	211
$\bar{\partial}_x$	-0.0635	$\bar{x}$	0.725028
$\sum (\partial_x - \bar{\partial}_x)^2$	1157.93	$\sum (x - \bar{x})^2$	5.326494
$\bar{\partial}_y$	0.755763	$\bar{y}$	0.397871
$\sum (\partial_y - \bar{\partial}_y)^2$	245.8965	$\sum (y - \bar{y})^2$	57.40855
$\sum (\partial_x - \bar{\partial}_x) \cdot (\partial_y - \bar{\partial}_y)$	155.4533	$\sum (x - \bar{x})(y - \bar{y})$	7.550915
$\sum (dx_i - dy_i)$	-172.046		
$\sum (dx_i - dy_i)^2$	1233.871		
$\left(\sum (dx_i - dy_i) \right)^2$	29599.67		

Source: Author (2022).

From Table 3, the Ψ_b is computed by using the formula,

$$\Psi_b = \frac{\sum (\partial_{xi} - \bar{\partial}_x)(\partial_{yi} - \bar{\partial}_y)}{\sqrt{\sum (\partial_{xi} - \bar{\partial}_x)^2 \sum (\partial_{yi} - \bar{\partial}_y)^2}}$$

$$\Psi_b = \frac{155.4533}{\sqrt{1157.93 \times 245.8965}} = 0.2913$$

The statistical significance test can be computed by using the formula,

$$t_{\Psi_b} = \frac{\sum (\partial_{xi} - \partial_{yi}) \sqrt{n-1}}{\sqrt{n \sum (\partial_{xi} - \partial_{yi})^2 - (\sum (\partial_{xi} - \partial_{yi}))^2}} \sim t(n-1)df$$

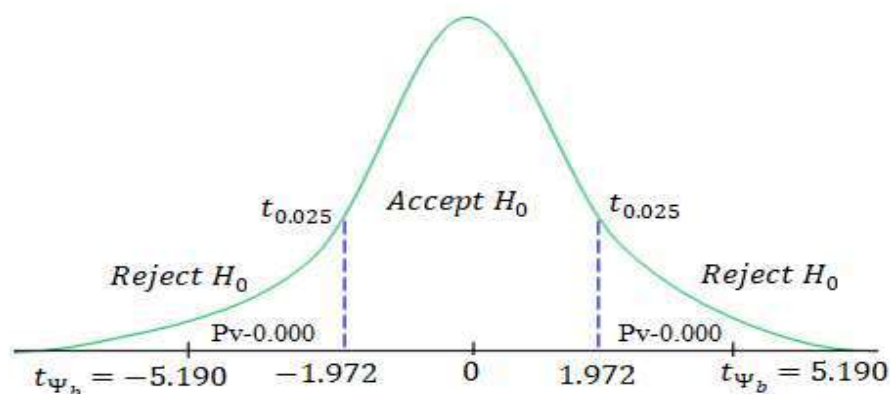
$$t_{\psi_b} = \frac{-172.046 \sqrt{211-1}}{\sqrt{211 \times 1233.871 - 29599.67}} = -5.190$$

From the MS Excel program, we calculate the p-value, with a t-value of $t_{\psi_b} = 5.190$, that is, $(t_{\psi_b} < t_{\alpha/2})$, degree of freedom, $df = 211 - 1 = 210$, t- paired test, two-sided tail test, which is equal to 0.000.

Decision rules: Rule one, is to compare either the p-value and alpha value (significance level) and rule two is to compare the computed statistics t-value and its critical values at the given significance level and degree of freedom. That is if the p-value < alpha value; we reject the null hypothesis and on the other hand, if the computed statistic t-value is greater than the critical value, $t_{\alpha/2}$ then we reject the null hypothesis, that is $t_{\psi_b} > t_{\alpha/2}$. For this study the significant level, $\alpha = 0.05$, and degree of freedom, $df = n - 1$, that is, $211-1=210$.

Decision on rule one: Compare the p-value and alpha value, the p-value is 0.000, and the alpha value is 0.05, which indicates that the p-value is less than the alpha value therefore we have a zero (0.000) probability to accept or support the null hypothesis. Therefore, we reject it and accept the alternative hypothesis that there is a pairing relationship between economic growth and human psychological well-being.

Decision on rule two: The computed statistics t-value, t_{ψ_b} is -5.190 and the critical value is, $t_{0.025} -1.972$ (from the t-table), at the degree of freedom of 210 (two-sided tails). The rule requires $t_{\psi_b} \geq t_{\alpha/2}$ rejecting the null hypothesis. Therefore, we compare $t_{\psi_b} = -5.190 > t_{0.025} = -1.972$. Then from this rule, we conclude that the calculated t-statistic value falls under the rejection area of the null hypothesis; hence we reject the null hypothesis and accept the alternative hypothesis. Rule one and rule two can be summarised by using the t-distribution curve (Figure 7).



Source: Author (2022)

Figure 7: The t-distribution curve for decision rule with Bundala's Psi coefficient

Figure 7 shows the t-distribution curve. The figure describes the two decision rules. Rule one describes that the p-value at $t_{0.025} = \pm 1.972$ is 0.000 which is less than the alpha value (significance level) of $0.5/2 = 0.025$. Moreover, the second rule is shown by the rejection and acceptance boundary value, the critical value at $t_{0.025} = \pm 1.972$. The computed statistic t-value, $t_{\Psi_b} = -5.190$ falls under the null hypothesis rejection area with a more than 95 percent of confidence level. In general, we can combine or summarise the decision rule one and two in a single decisional statement that the probability that the computed t-statistic value, $t_{\Psi_b} = \pm 5.190$ is less than the statistic critical value, $t_{0.025} = \pm 1.972$ is zero. That is $P(t_{\Psi_b} < t_{\alpha/2}) = p - \text{value} = 0.000$. Therefore, the rejection of the null hypothesis is clearly illustrated by using the t-distribution curve.

4.2 Enabler and Enabled Variables /Values

The identification of enabler and enabled variables is very important in the correctional analysis as it helps the decision-makers to establish a work plan (decide accordingly). The enabler and enabled variables can be identified by using the pair-rule conditions as explained,

$$\bar{\partial}_x \leftrightarrow \bar{\partial}_y, \bar{\partial}_x > \bar{\partial}_y; x \leftarrow y: \text{If } y \text{ is an enabler variable of } x$$

$$\bar{\partial}_x \leftrightarrow \bar{\partial}_y, -0.0635 > 0.7558; x \leftarrow y: \text{Not true}$$

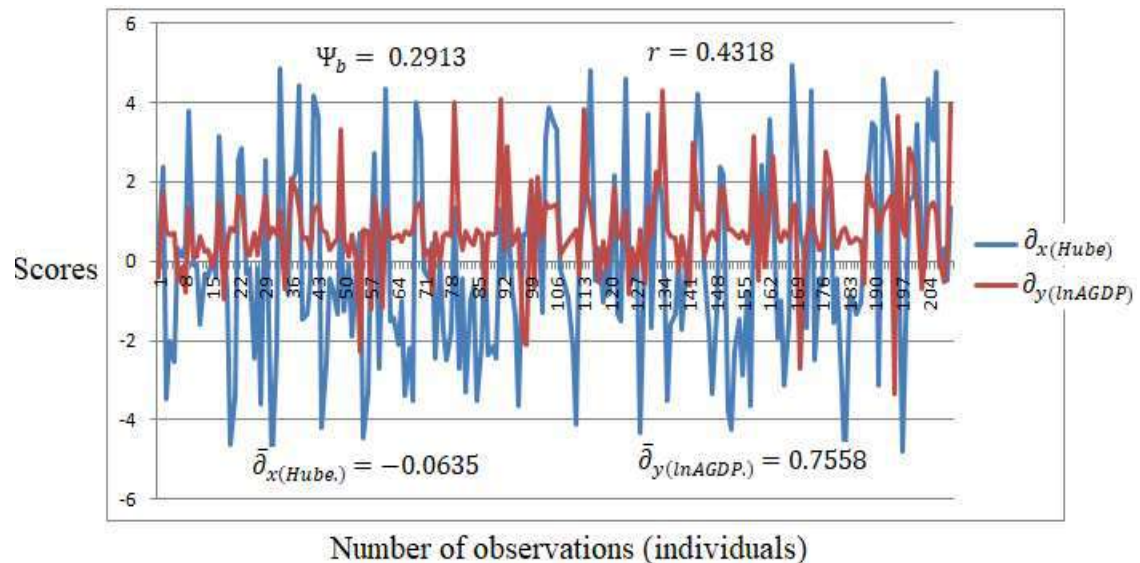
$$\bar{\partial}_x \leftrightarrow \bar{\partial}_y, \bar{\partial}_x < \bar{\partial}_y; x \rightarrow y: \text{If } x \text{ is an enabler variable of } y$$

$$\bar{\partial}_x \leftrightarrow \bar{\partial}_y, -0.0635 < 0.7558; x \rightarrow y: \text{True}$$

Thus, x (Hube) is an enabler variable and y (lnAGDP) is the enabled variable, the value of the enabler effect is computed by using the mean homo-hetero deviation, ϖ_b that is,

$$\begin{aligned} \bar{\partial}_y - \bar{\partial}_x &= \varpi_b; \text{ Since } x \text{ is an enabler variable of } y \\ 0.7558 - (-0.0635) &= 0.8391 \end{aligned}$$

The positive enabling effect value or simply enabler value of 0.8391 indicates the relative increment change of the mean y - homo pairing effect (economic growth) on the mean x -homo pairing effect (human psychological well-being)- the relative trending-off change value. It is the value that indicates the relative change variation of the paired data. Therefore, we have evidence that an increase in human psychological well-being scores increase also economic growth. Therefore, we conclude that there is a positive pairing effect between economic growth and the human psychological well-being of an individual. The homo-hetero pairing effect correlation coefficient (Ψ_b) is 0.2913. This value can be interpreted as “the pairing effect is moderate”. This can be well demonstrated by using the x and y -homo pairing effect trending/variation graph (Figure 8).

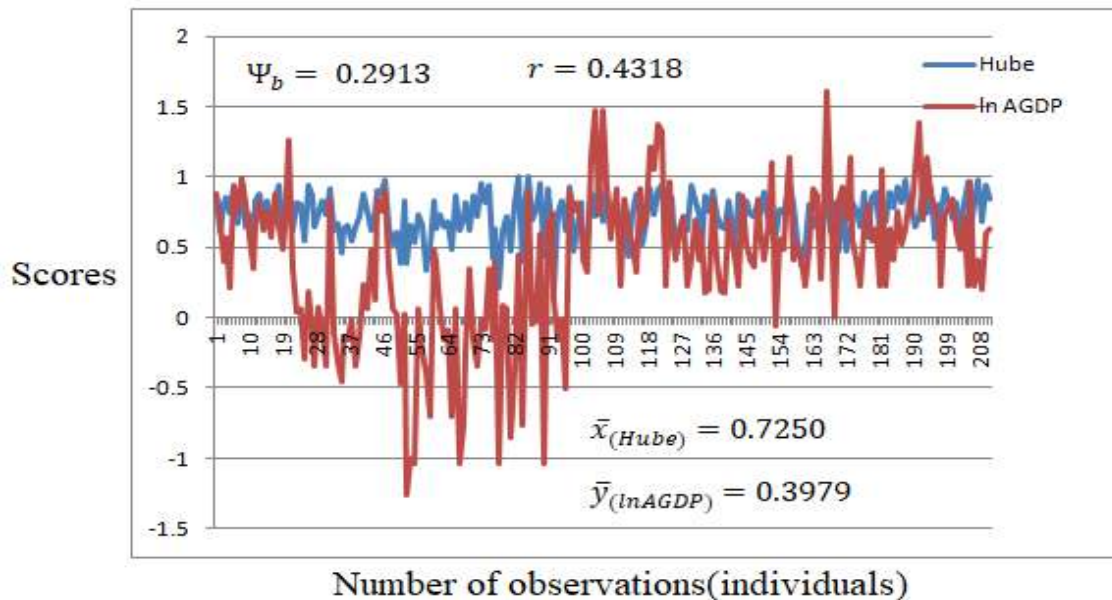


Source: Author (2022)

Figure 8: The x and y- homo pairing effects trending of the paired data

Figure 8 shows the x and y homo pairing effects trending. The figure indicates that there is a positive *relative trending-off changes value* of $\ln AGDP$, which is averaged at 0.8391. The mean x-and y-homo pairing effect is -0.0635 and 0.7558 respectively. The data are paired with $\Psi_b = 0.2913$ and correlated with $r = 0.4318$. The value of Ψ_b indicates the pairing effect of the homo-hetero pairing in the data correlation/relationship between them. This matching or pairing effect cannot be shown or detected in the Pearson correlation analysis data trends (Figure 9).

The directional trending of the paired data in the Pearson correlation analysis shows that there are two classes of the population, the sub-populations that have a low economic growth (annualised monthly personal income) which is indicated with a negative value of $\ln AGDP$ and that class or sub-population that has a high economic growth which is represented by the positive values of $\ln AGDP$ (Figure 9). On the other hand, the psychological well-being of individuals is trending positively with less variance. That is, there are no significant classes based on the psychological well-being status among the individual in the population studied (Figure 9).



Source: Author (2022)

Figure 9: The data directional trending in Pearson correlation data analysis

Figure 9 shows the directional trending of the paired data in the Pearson correlation analysis. The data have $r = 0.4318$, which means that they are moderately positively correlated. On the other hand, the pairing relationship of the data is shown by using $\Psi_b = 0.2913$, which indicates that data are moderately positively homo-hetero paired. The positive value of Ψ_b indicate that the data are paired or pairing in the same direction, not indicate the trending direction as done in the r . The mean value of the x and y variables are 0.7250 and 0.3979 respectively.

4.3 Bundala Ratios of Linear Correlation

Bundala ratios of the linear correlation are used in the correlation analysis to identify the true enabler (optimal independent) and truly enabled (dependent) for linear modelling. There are two types of Bundala ratios. One is the Gamma ratio which measures the “independence degree” of the enabler variable relative to the enabled variable. The second ratio is the Zeta ratio which is used to determine the “empirical relevance” of the enabler in the linear modelling (Bundala, 2021). These ratios are calculated to determine or identify the optimal independent and dependent variables among the enabler and enabled variables.

4.3.1 Gamma Ratio

Bundala’s Gamma ratio is used to evaluate the “degree of the independence” of the enabler variable to the enabled (dependent) variable. In other words, it is used to evaluate the optimality of the independent variable in linear modelling (regression). It is given by the formula,

$$\Gamma_b = \frac{\text{Coef. } y}{\text{Coef. } x} = \frac{b_2}{b_1} = \frac{n(\sum x^2) - (\sum x)^2}{n(\sum y^2) - (\sum y)^2}$$

The coefficient y ($\ln AGDP$) and x ($Hube$) can be simply obtained by running two regression models, that is, $y(\ln AGDP) = a_1 + b_1 x(Hube)$ (Table 4) and $x(Hube) = a_2 + b_2 y(\ln AGDP)$ (Table 5).

$$\Gamma_b = \frac{\text{Coef. } y}{\text{Coef. } x} = \frac{b_2}{b_1}$$

$$y(\ln AGDP) = -0.6299394 + 1.417614x(Hube)$$

$$x(Hube) = 0.6726966 + 0.1315295y(\ln AGDP)$$

Therefore,

$$\Gamma_b = \frac{\text{Coef. } y}{\text{Coef. } x} = \frac{0.1315295}{1.417614} = 0.0928$$

Alternative,

$$\Gamma_b = \frac{TSSE_x}{TSSE_y} = \frac{TMSE_x}{TMSE_y} = \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{\sum_{i=1}^n (y_i - \bar{y})^2}$$

$$\Gamma_b = \frac{TSSE_x}{TSSE_y} = \frac{TMSE_x}{TMSE_y} = \frac{5.3265}{57.40855} = 0.0928$$

We interpret that Γ_b is within the optimal range of $0 < \Gamma_b < \pm 1$, therefore, the $Hube$ is a true enabler (optimal independent) variable that maximises the impact of economic growth, the enabled (dependent) variable.

To be clear with the optimal independent variable or true enabler variable, let's consider the linear equations when both enabler and enabled variables are involved and the independent and dependent variables are reversed. In the first equation, y ($\ln AGDP$) is the dependent variable, and x ($Hube$) is the independent variable (Table 4).

Table 4: $y(\ln AGDP) = -0.6299394 + 1.417614x(Hube)$

Source	SS	df	MS	Number of obs	=	211
Model	10.7042859	1	10.7042859	F(1, 209)	=	47.90
Residual	46.7042613	209	.223465365	Prob > F	=	0.0000
				R-squared	=	0.1865
				Adj R-squared	=	0.1826
Total	57.4085472	210	.273374034	Root MSE	=	.47272

lnAGDP	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
Hube	1.417614	.2048257	6.92	0.000	1.013825	1.821404
_cons	-.6299394	.1520284	-4.14	0.000	-.9296452	-.3302337

Source: Author (2022)

Table 4 shows the linear regression model of economic growth (lnAGDP) and human psychological well-being or simply psychological well-being (Hube). Economic growth is the dependent variable and psychological well-being is the independent variable. The unit impact of the Hube on economic growth (coefficient) is positive 1.41764, with a range of 1.013825 to 1.821404 at 95 percent of the confidence interval. The t-value is positive 6.92, with a p-value of 0.000, and the model is determined at an R-squared value of 0.1865. This implies that, although the data are poorly fitted to the model as indicated by the small value of R-squared, human psychological well-being has a positive impact on economic growth and is significant at a 95 percent of confidence level, since its p-value of 0.000 is less than the critical value of significance level, 0.05. Therefore, we reject the null hypothesis as we have zero probability of acceptance of the null hypothesis (p-value). We accept the alternative hypothesis that there is a pairing relationship between economic growth (dependent) and human psychological well-being (independent).

On the other hand, the linear regression was run when the variables are interchanged, the psychological well-being becomes the dependent variable and the economic growth becomes the independent variable. The aim is to evaluate or examine how the unit impact of each variable will be affected by the misallocation or use of a non-optimal enabler in linear modelling. In other words, it tests the unit independence impact of each variable in the linear modelling, and then we can able to identify which variable has a high unit independence impact on another variable, hence it is an optimal independent or true enabler of its pair variable, enabled (dependent) variable. The linear equation of Hube against economic growth is established (Table 5).

Table 5: $x(Hube) = 0.6726966 + 0.1315295y(\ln AGDP)$

Source	SS	df	MS	Number of obs	=	211
				F(1, 209)	=	47.90
Model	.993167656	1	.993167656	Prob > F	=	0.0000
Residual	4.33332611	209	.020733618	R-squared	=	0.1865
				Adj R-squared	=	0.1826
Total	5.32649377	210	.025364256	Root MSE	=	.14399
Hube	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
lnAGDP	.1315295	.0190042	6.92	0.000	.094065	.1689939
_cons	.6726966	.0124674	53.96	0.000	.6481187	.6972746

Source: Author (2022)

Table 5 shows the regression model for the relationship between the Hube (dependent) and (lnAGDP) as an independent variable. The model is determined at an R-squared value of 0.1865, with a positive coefficient of 0.1315295, a t-value of 6.92, a p-value of 0.000, and a range of 0.094065 to 0.1689939 at 95 percent of the confidence interval. The model shows that there is a positive relationship between human psychological well-being (dependent variable) and economic growth (independent variable). Since its p-value is 0.000 which is less than the critical value of significance level, 0.05, therefore we reject the null hypothesis at a 95 percent of confidence level and accept the alternative hypothesis that there is a significant pairing relationship between economic growth and human psychological well-being (remember in the correlation analysis the variable can be interchanged without the effect of the strength or magnitude of the correlation coefficient).

From both regression models comes the same findings, we reject the null hypothesis at a 95 percent of confidence level. Also, we noticed a change in unit independence impact of the variable when the variable is interchanged, the enabler variable (Hube) to be enabled variable and the enabled variable (lnAGDP) to be the enabler variable. This difference can be measured or noticed by the *resource input-output (RIO) ratio*. The RIO ratio is the ratio that measures the relative unit impact of independent to dependent variables. For example, in the linear regression equation present in Table 4, the RIO is 1: 1.417614 or 0.7054, which means that a unit impact of the independent variable on the dependent variable is 1.417614 or about 70.54 percent of the total output (dependent variable) is due or explained by a unit impact of the independent variable. The remaining 28.46 percent (100-70.54) is explained by the y-intercept or the regression constant value. This ratio is very important in economic decisions as can be used for resource allocation, this is why the ratio is called the resource input-output (RIO) ratio. Simply, it is the ratio of input resources to output resources. In other words, RIO is the percentage that defines or explains the independence degree of the independent variable in the linear model. Moreover, in the linear regression equation in Table 5, when the Hube becomes or is treated as

the dependent variable and regressed to $\ln AGDP$, the unit impact of the $\ln AGDP$ on Hube is 0.1315295 (Table 5). This means that the RIO ratio is changed to 0.1315295:1 which is equal to 0.1315 or 13.15 percent of the total output (dependent variable) is explained by a unit impact of the independent variable. About 86.85 percent is explained by the constant value of the regression model. We can notice that RIO ratios differ significantly. The RIO ratio for the optimal independent variable or true enabler (Hube) is higher than that of the non-optimal independent variable ($\ln AGDP$). Therefore, the RIO ratio is the best statistical tool that can also be used to identify the optimal independent or test the optimality of the independence of the independent variable in linear modelling.

Therefore, from the concept of RIO ratio, we notice the relevance of relating (use of pair-rule) the value of β_0 and β_i . That is, the linear equation with a higher y -intercept, β_0 than beta coefficient, β_i has a less RIO ratio, that is, $\beta_0 > \beta_i$ and it is vice versa for $\beta_0 < \beta_i$. This concept originated from the enabler and enabled variables identification principle that the impact or effect of the “enabler coefficient” on the linear model should be totally and wholly absorbed in the effect of the “enabled coefficient” in the linear model. The enabler coefficient value should be greater than the enabled coefficient value. That is, $\beta_0 < \beta_i$ if β_0 enabler coefficient of is β_i and $\beta_0 > \beta_i$ if β_i is the enabler coefficient of β_0 . The empirical relevance of the linear model is obtained when the true enabler variable or coefficient is used in the regression model; therefore the general rule is regression constant (y -intercept) to be less than the beta coefficient. To achieve the optimality of the independent variable the rule should be adhered to $\beta_0 < \beta_i$. We conclude that, for empirical relevance of the linear model, the beta coefficient should be greater than the constant value (y -intercept). We can apply this rule and get the same conclusion or results as the RIO ratio conclusion. Therefore, from the regression model in Table 4,

$$y(\ln AGDP) = -0.6299394 + 1.417614x(Hube)$$

$$\beta_0 = -0.6299394, \text{ and } \beta_i = 1.417614$$

Therefore, $\beta_0 < \beta_i$ is true since $-0.6299394 < 1.417614$, then we conclude that the variable (Hube) is a true enabler (optimal independent) and $\ln AGDP$ is a dependent variable or truly enabled variable. Moreover, when the Hube (independent) variable is treated as the dependent (enabled) variable, the linear model becomes differently (Table 5). We apply the same concept of enabler coefficient and enabled coefficient; that is,

$$x(Hube) = 0.6726966 + 0.1315295y(\ln AGDP)$$

$$\beta_0 = 0.6726966 \text{ and } \beta_i = 0.1315295$$

Therefore, $\beta_0 < \beta_i$ is not true since $0.6726966 > 0.1315295$, then we conclude that this model is empirically non-optimal, the enabler variable ($\ln AGDP$) is not a true enabler; hence is not an optimal independent variable. If the values of RIO ratios are adjusted by their constant value

(commonly y-intercept), the value at a unit value of the independent variable, x (Hube) =1 the Bundala's Zeta ratio is used to identify the empirical optimality of the linear model (explained later).

4.3.2 Zeta Ratio

Another important Bundala linear correlation ratio is the Zeta ratio. The Zeta ratio describes the ability of the true enabler or identifies the true enabler by examining the “relevance of unit impact of the enabler variable (optimal independent variable) on the dependent variable in the empirical model. The rule described by Bundala (2021), the optimality of the Zeta ratio is at least 0.5. Therefore, by computing the Zeta ratios for regression equations in Table 3 and Table 4, and comparing them, a researcher or decision-maker can able to identify which linear model is relevant for empirical use. The higher the Zeta ratio, the higher the empirical relevance of the linear model is. The Zeta ratio is calculated by using the formula,

$$Z_b = \frac{\beta_i}{\beta_i + \beta_0}$$

Where β_i and β_0 are beta coefficients and y-intercept or regression constant values respectively. Consider the equation in Table 4,

$$y(\ln AGDP) = -0.6299394 + 1.417614x(Hube)$$

$$\beta_0 = -0.6299394, \text{ and } \beta_i = 1.417614$$

$$Z_b = \frac{\beta_i}{\beta_i + \beta_0} = \frac{1.417614}{1.417614 - 0.6299394}$$

$$Z_b = 1.800$$

Then, compare the Zeta ratios from the equation in Table 4 to that of the equation from Table 5, that is,

$$x(Hube) = 0.6726966 + 0.1315295y(\ln AGDP)$$

$$\beta_0 = 0.6726966, \text{ and } \beta_i = 0.1315295$$

$$Z_b = \frac{\beta_i}{\beta_i + \beta_0} = \frac{0.1315295}{0.1315295 + 0.6726966}$$

$$Z_b = 0.1635$$

Therefore, we compare the Zeta ratio of the equation in Table 4 which is 1.800 and that of the equation in Table 5, which is 0.1635, the Zeta ratio of the equation in Table 4 is greater than that of the equation in Table 5. This means, that the true enabler variable is Hube in the equation in Table 4. Moreover, in the equation in Table 4, its Zeta ratio exceeds the recommended upper optimality value of 1.5; therefore, the equation was violated with higher noises (standard deviation) in comparison to that of the equation in Table 5. Its standard deviation error is 0.2048257; hence the model has a less predictive accuracy compared with that in an equation in

Table 5. The equation in Table 4 has a higher sum of squares (SS) than that of the equation in Table 5 which is 57.4085472 and 5.32649377 respectively. On the other hand, the equation in Table 5 has the lowest value Zeta ratio which is 0.1635 indicating that the “assumed enabler” is not optimal; its effect on the output (Hube) is about 16.35 percent of the total effect of its unit value. This equation has fewer noises (standard deviation error) of 0.0190042 and higher predictive power than that in Table 4. Therefore, we concluded, that the true enabler variable which maximises the impact of the enabled (dependent) variable is human psychological well-being (Hube) and the dependent variable is economic growth (lnAGDP) exhibited in the equation in Table 4.

4.4 Pearson Correlation Coefficient, r

To enhance the conclusion of the finding, the conclusion or finding of Ψ_b is compared with the conclusion or finding of the Pearson correlation analysis. Therefore, the Pearson correlation coefficient, r is computed by using the formula,

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}$$

$$r = \frac{7.550915}{\sqrt{5.326494 \times 57.40855}} = 0.4318$$

Calculate the statistic significance test for r , use the formula

$$t_r = \frac{r \cdot \sqrt{n-2}}{\sqrt{1-r^2}}$$

$$t_r = \frac{0.4318 \sqrt{211-2}}{\sqrt{1-(0.4318)^2}} = 6.92$$

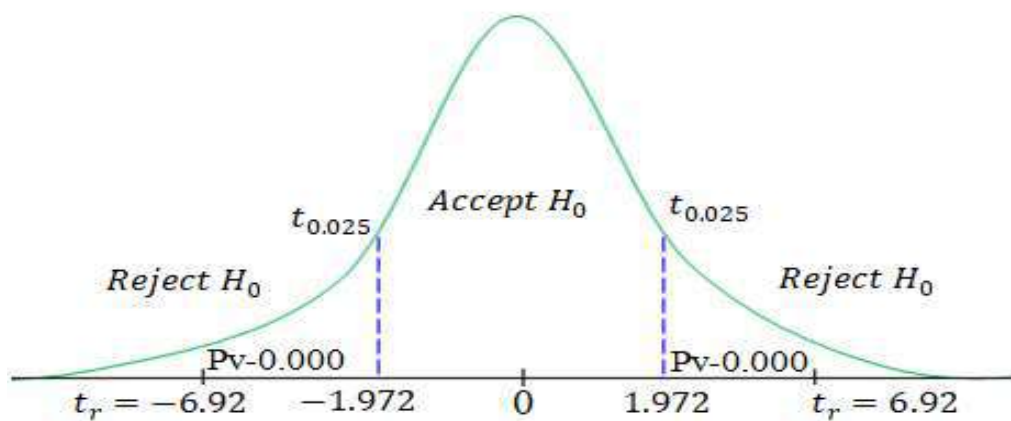
From the MS Excel program, we calculate the p-value, with a t-value of $t_r = 6.92$, that is, $(t_r < t_{\alpha/2})$, degree of freedom, $df = 211 - 2 = 209$, t-paired test, two-sided tail test, which is equal to 0.000.

Decision rules: Rule one is to compare either the *p-value* and *alpha value* (significance level) and rule two is to compare the computed statistics t-value and its critical values at the given significance level and degree of freedom. That is if the *p-value* < *alpha value*; we reject the null hypothesis and on the other hand, if the computed statistic t-value is greater than the critical value, $t_{\alpha/2}$ then we reject the null hypothesis, that is $t_r > t_{\alpha/2}$. For this study the significant level, $\alpha = 0.05$, and degree of freedom, $df = n - 2$, that is, $211-2 = 209$.

Decision on rule one: Compare the *p-value* and *alpha value*, the *p-value* is 0.000, and the *alpha value* is 0.05, which indicates that the *p-value* is less than the *alpha value*, therefore we have a

zero (0.000) probability to accept or support the null hypothesis. That is, we reject it and accept the alternative hypothesis that there is a positive correlation between economic growth and human psychological well-being.

Decision on rule two: The computed statistic t-value, t_r is 6.92 and the critical value is $t_{0.025} = 1.972$ (from the t-table), at the degree of freedom of 209 (two-sided tails). The decision rule requires $t_r \geq t_{0.025}$ rejecting the null hypothesis. Therefore, we compare $t_r = 6.92 > t_{0.025} = 1.972$. Then from this rule, we conclude that the calculated t-statistic value falls under the rejection area of the null hypothesis; hence we reject the null hypothesis and accept the alternative hypothesis. Rule one and rule two can be summarised by using the t-distribution curve (Figure 10).



Source: Author (2022).

Figure 10: The t-distribution curve for decision rule with r

Figure 10 shows the t-distribution curve. The figure describes the two decision rules. Rule one describes that the p-value at $t_{0.025} = \pm 1.972$ is 0.000 which is less than the alpha value (significance level) of $0.5/2 = 0.025$. Moreover, the second rule is shown by the rejection and acceptance boundary value, the critical value at $t_{0.025} = \pm 1.972$. The computed statistic t-value, $t_r = 6.92$ falls under the null hypothesis rejection area with a more than 95 percent of confidence level. In general, we can combine or summarise the decision rule one and two in a single decisional statement that the probability that the computed t-statistic value, $t_r = \pm 6.92$ is less than the statistic critical value, $t_{0.025} = \pm 1.972$ is zero. That is $P(t_r < t_{\alpha/2}) = p\text{-value} = 0.000$. Therefore, the rejection of the null hypothesis is clearly illustrated by using the t-distribution curve.

4.5 The Methodological Cross-Examination of Ψ_b and r

The term cross-examination is commonly used in legal or law applications. It means the detailing of the witness (fact) provided to clear the doubt rose during the direct examination of the fact in issue. In this study, the term is used with the same meaning but for different purposes and logic.

Cross-examination aims to test the testimony (methodological completeness) provided by the two competing correlation techniques, the Pearson correlation coefficient and its competing partner Bundala pairing correlation coefficient before the Judge linear regression. It looks like a comical fact but it is a logical fact.

If we start the trial, the testimony or witnessed evidence by the Pearson correlation coefficient about the relationship between economic growth and human psychological well-being is that they are positively correlated at 0.4318. It is statistically supported with a rule that its empirical probability of t-value of 6.92, i.e., the p-value is 0.000 which indicates the probability to support the null hypothesis that it is true is zero (error type I). This is the empirical evidence provided by the Pearson correlation coefficient before the Judge linear modelling (regression model). On the other hand, the Bundala pairing correlation coefficient provided its testimony before the Judge that an increased change difference in the human psychological well-being level of the individual leads to an increased change difference (positively) in economic growth level. It is determined by the relative trending-off changes value (x-enabler effect value) of 0.8391. Moreover, the change difference of variables are paired as homo-hetero pairing effect coefficient, $\Psi_b = 0.2913$. Hence, it concludes that economic growth is positively influenced by the human psychological well-being of the individual. This evidence is supported by the same rule that its empirical probability of t-value -5.190, i.e., the p-value is zero, indicates the probability to accept the null hypothesis is zero.

Based on the direct empirical evidence provided by both correlation techniques before the Judge linear regression, some criteria were set to cross-examine the testimony (empirical evidence) provided by each of the two correlation techniques in the trial session (finding presentation). The criteria are based on the question that “who can be my best close partner”. A Judge prepares a judging criteria matrix (Table 6).

Table 6: Methodological judging criteria matrix for Ψ_b and r coefficients

Judging criteria	r	Regression (Judge)	Ψ_b	Ruling
Do you quantify the strength and direction of the relationship between the two variables	Yes	Yes	Yes	Out
Do you predict how x(enabler variable) enables y (an enabled variable)	No	Yes	Yes	Yes
Both x and y are assumed to be random variables	Yes	No	No (one variable is an enabler of other	Yes
Do x and y are interchangeable, i.e., identical results are obtained when x and y are interchanged	Yes	No	Yes	Fair
Produces a statistical model	No (single statistic	Yes	Yes (Gamma and Zeta ratios)	Yes
Do you detect the homo paring effect of the x and y trending	No	No	Yes	Extra
Do you identify the optimal independent and dependent variable from the two related variables	No	Yes	Yes	Yes

Source: Author (2022).

Table 6 shows the methodological judging criteria matrix for the Bundala pairing correlation and Pearson correlation coefficients before the Judge linear regression. In the common language “the methodological completeness of the two correlation techniques Ψ_b and r were evaluated by using the attributes of the linear regression model as the standard linear technique, henceforth, a Judge. The ruling was done by three outcomes namely “out” which means all the judging criteria are evidenced (possessed) in each technique, either they have which is indicated by Yes or they have not which is indicated by No. The second judging ruling is “Yes” which indicates the Bundala correlation coefficient judging criteria are paired with that of the Judge and are contra to the Pearson correlation. A fair ruling is assigned when the outcome of the Bundala and Pearson correlation is contra to the Judge. The Judge is stand-alone to its criteria. The extra ruling is done when only one technique, particular Ψ_b has unique criteria that the Judge and r have not. In this trial, the Bundala pairing correlation coefficient has the extra ruling of having the ability to detect the homo-pairing effect of the trending paired data. The Judge rules out –that the Bundala correlation coefficient has hit the goal. That is, before the Judge linear regression the Bundala pairing correlation is a close partner because they share several decisional criteria.

5 Discussion

Principally, the paper aimed to examine the pairing relationship between economic growth and psychological well-being. The study applied the homo-hetero pairing effect correlation coefficient technique. This method is used to fill both the contradictory evidence gap on the relationship between the economic growth and psychological well-being of individuals (Roka, 2020; Easterlin, 1973; 2017; Stevenson and Wolfers, 2008; 2013) and the methodological gap (incompleteness) in the Pearson correlation coefficient technique that is raised or highlighted in several studies (Kenny, 1979; Rahman and Zhang, 2016; Janse, et al. 2021; Bertoldo, Callegher and Altoe, 2022). In other words, the homo-hetero pairing effect correlation coefficient or Bundala’s Psi coefficient, Ψ_b (Bundala pairing correlation coefficient) for brevity is a new technique for correlation analysis in social science studies. The traditional correlation technique fails to identify the dependent and independent variables in linear modelling (Rahman and Zhang, Kenny, 1979; Emerson, 2015; Samuel and Okey, 2015; Maravelakis, 2019; Mudelsee, 2003). With the application of the Bundala pairing correlation coefficient, the study identified the enabler and enabled variable in the pairing relationship between the economic growth and psychological well-being of the individual, which further was classified into optimal independent and dependent variables by using the Bundala’s ratios namely Gamma ratio (Γ_b) and Zeta ratio (Z_b). These ratios help to identify which variable in the pair is a true enabler of the other.

The study uses Ψ_b and found that the economic growth and psychological well-being of the individual are pairing related positively. That is, the increase of paired changes of the variable y is due to the increase of the paired changes of the variable x . Moreover, the study found that the psychological well-being of the individual is a true enabler (optimal independent) variable and has a positive impact on economic growth. This study confirms Roka (2020), Stevenson and Wolfer (2008; 2013), Talhelm et al. (2014), Diener and Seligman (2004), and Baro and Sala-i-Martin (2004). Moreover, this finding contradicts Stoop et al.(2019), and Easterlin (1973; 2017).

On the other hand, the Bundala pairing correlation coefficient has shown a significant role in linear regression. It was used to test the effectiveness of the independence of the variable in linear modelling. The study found that psychological well-being has a higher degree of independence than economic growth. Hence, psychological well-being is an optimal independent variable (true enabler) in linear modelling. The identification of the true enabler variable is most important in correlation studies because it helps to separate the paired variables into dependent and independent variables, which was not done in the Pearson correlation coefficient technique (Akoglu, 2018, Kumar and Chong, 2018; Senthilnathan, 2019). In other words, the Bundala pairing correlation coefficient has solved the problem of the Pearson correlation coefficient failing to define/classifies the paired variables into independent or dependent variables. The Bundala ratios either the Gamma ratio or Zeta ratio are the best techniques or methods that separate or identify which variables are either dependent or independent. The adverse effect of failing to identify the optimal independent or true enabler is that the use of non-optimal independent will have minimum impact on the output or dependent variable in the linear modelling. Consequently, may mislead the decision-makers.

Considering a finding of this study, in the linear correlation analysis of economic growth and psychological well-being, without the knowledge of which variable is independent and which other is dependent, the two possible regression models can be established, one can regress economic growth as the dependent variable and the psychological well-being as an independent variable. On the other hand, psychological well-being can be regressed as a dependent variable and economic growth as the independent variable. The two results are not similar in terms of unit independence impact (coefficient)-RIO ratio, statistical noises (standard deviation) and predictive accuracy (sum of the squares), which can confuse the decision-makers. Notably, this methodological error cannot be detected in the Pearson correlation coefficient instead by using the Bundala pairing correlation coefficient. The regression model that has a true enabler or optimal independent (psychological well-being) has a higher coefficient value (unit impact) or resource input-output (RIO) ratio than that has a non-optimal independent variable (economic growth). Therefore, the uses of this technique help to solve the methodological flaws that are exhibited in the traditional correlation techniques as claimed by several researchers (Kumar and Chong, 2018; Akoglu, 2018; Mukaka, 2012; Emerson, 2015; Bertoldo, Callegher and Altoe, 2022; Coppack, 1990; Shelef and Schechtman, 2018).

6 Conclusion and Recommendations

This paper aimed to examine the pairing relationship between economic growth and psychological well-being by the application of the homo-hetero pairing effect correlation technique or simply Bundala pairing correlation coefficient. The application of this technique is due to claimed methodological flaws of the existing correlation techniques, particularly, the Pearson correlation coefficient and the contradictory evidence gap on the relationship between economic growth and the psychological well-being of the individuals. The study found that the changes in economic growth are increases in pair with the increases in the change in the psychological well-being of the individual. In other words, the change in economic growth is positively paired with the change in the psychological well-being of the individual. Moreover, the psychological well-being of the individual is the optimal independent variable because have

found to have a positive empirical relevance in the regression model. Therefore, the study concluded that as far as the economic growth and psychological well-being are positively changing in pair, the improvement of the psychological well-being of the individual significantly improves the economic growth and not vice versa. Therefore, the paper recommended that psychological well-being-based initiatives should be established and encouraged in society as found to have a positive impact on economic growth.

The comparison of the Bundala pairing correlation coefficient and Pearson correlation coefficient techniques evidenced that the Bundala pairing correlation coefficient is a more robust and effective correlation technique. Hence, the Bundala pairing correlation coefficient is strongly recommended for contemporary social science studies. In addition, the specific recommendations for the application of the Bundala pairing correlation coefficient include the use in medical studies such as cardiology to examine risk factors or symptoms and signs of the heart diseases such as the homo-hetero pairing effect of systolic pressure and diastolic pressure can be detected by using the Ψ_b . Moreover, Ψ_b can be applied in other branches of medicine such as in neurology and epidemiology; it can be used to study the brain coordination disorders and control and monitoring of communicable and non-communicable diseases. This is because the Bundala pairing correlation coefficient identifies or detects the pairing effect or associate disease and its enabler risk factors or symptoms and signs. Moreover, the paper recommends the application of the Bundala pairing correlation coefficient in other branches of social science such as anthropology, sociology, economics, psychology and others.

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The Effect of Competence, Job Placement and Job Satisfaction on Employee Performance at the Regional Office VII BKN

Lusi Sartika^a, Fatimah^b, Diah Isnaini Asiati^c

Departement of Magister Management, Universitas Muhammadiyah Palembang,
Indonesia

Lusisartikaump20@gmail.com, fatimahma@yahoo.co.id, diah_isnaini@yahoo.com

Abstract

This study aims to determine and analyze 1) the effect of competence, job placement and job satisfaction on employee performance at the Regional Office VII BKN, 2) the effect of competence on employee performance at the Regional Office VII BKN, 3) the effect of job placement on employee performance at the Regional Office VII BKN and 4) Job Satisfaction on employee performance at Regional Office VII BKN. The object of research is the employee at the Regional VII BKN office. The research method is associative using primary data. The population of this study was 140 employees, the sample selection technique used in this study was a probability sampling technique with a cluster random sampling method obtained through the formula of Isaac and Michael as many as 100 employees. The analysis technique used is multiple linier regression analysis. The results showed tha 1) simultaneously competence, job placement and job satisfaction had a significant effect on employee performance at Regional Office VII BKN, 2) competence had a significant effect on employee performance at Regional Office VII BKN, 3) job pacement had a significant effect on employee performance. At Regional Office VII BKN 4) job satisfaction has a significant effect on employee performance at Regional Office VII BKN.

Keywords: Competence, Job Placement, Job Satisfaction, Employee Performance

JEL Code: M54, O16.

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1. Introduction

Increasing human resources for the development of organizational management is the main requirement to be able to compete and be independent in the era of globalization. In the context of future government development, it is important to prepare a professional State

Civil Apparatus (ASN), able to compete and participate in world development in various aspects of life, so that employees can improve the quality of high service for the public. Indonesia is challenged to be able to realize good governance and clean governance. In the context of public organizations, performance is a measure of the results in managing and running the organizational bureaucracy related to things that will and are being done. According to Yaslis (2013: 62) performance is the appearance of the work of personnel both in quantity and quality in an organization. Performance in the form of individual appearances and groups of personnel. The appearance of the work is not limited to personnel holding functional and structural positions, but also to the entire range of personnel in the organization.

Employee performance is influenced by competence, development, work design, personality, job satisfaction, work environment, loyalty, commitment, work discipline, work motivation, leadership, leadership style, and organizational culture (Kasmir, 2016: 65). Meanwhile, according to Nitisemito (2011: 66) these factors include: the amount and composition of compensation given, proper job placement, training and promotion, a sense of security in the future, relationships with colleagues and relationships with leaders. To form the good performance of a government employee, he has regulated regulations related to the importance of competence and the addition of employees to the performance of agencies within the government. Employees must have the right competence in doing work to realize employee work performance and success in the long term. Each competence will appear in individuals on various characteristics, in the BKN Regional VII office there is still a low competence shown by limited knowledge of employees, low understanding can be seen from the slowness in completing work and facing public complaints besides that there is still an unenthusiastic attitude in completing work and low interest in improving ability to work. Empirical studies with different results related to competence were shown by the research of Ngebu, Sintaasih & Subudi (2018) and Hermawan (2019) whose research results stated that competence affects performance while Susanto & Sukoco research (2019) stated that different research results, namely Competence did not have a significant effect on performance.

In addition to competence, the suitability of employee work placements can also affect performance. The suitability of work placement between position positions and the educational status or competence of employees greatly affects the way employees work in carrying out agency governance so that they appear in the form of employee performance. Inappropriate job placements will cause employees to display lower productivity, feel saturated and bored so that it will be difficult to achieve the expected performance. This is more or less also still happening to employees of the Regional VII BKN Office, job placements which are still not in accordance with education, skills, experience and age factors that have received less attention so that this ha will affect employee performance. Empirical studies on job placement showed the results of research by Siahaan (2019) and Manullang, Kennedy & Tiara Puspa (2020) which stated that job placement partially affects employee performance while Lussy's research (2018) showed results that job placement had no effect on employee performance.

Job satisfaction is also closely related to employee performance, a person who is satisfied in his job will have high motivation, commitment and work participation so that he will continue to strive to improve their performance. Most people generally feel satisfaction with their work even though there are differences in satisfaction between them. At the BKN

Regional VII Office, employees still often feel that they do not get enough attention from the agency accompanied by a promotion system that tends to be unhealthy, weak leadership supervision and there are still competitors and jealousy between colleagues. An empirical study of job satisfaction studies showed the results of Rosmaini & Tanjung research (2019) which proved that job satisfaction has an influence on employee performance. An empirical study that contradicts the above results was shown by Nabawi (2019) where in his research showed the results that job satisfaction did not have a significant effect on employee performance.

2. Literature Review

2.1 Employee Performance

Kasmir (2019: 182) states that employee performance is the result of work and work behavior that has been achieved in completing tasks and responsibilities given in a certain period. Employee performance is about doing the work, what is done and how to do it which then produces work that has a strong relationship with the company's strategic goals and contributes to the economy.

Performance indicators according to Abdullah (2014: 197) are: quality, quantity, punctuality, effectiveness, independence and work commitment. Meanwhile, Malthis & Jackson (2012: 378) stated that the indicators that are a measure of employee performance are: Quantity, quality, punctuality, attendance and ability to cooperate.

2.2 Competence

According to Wibowo (2016: 272) competence as a person's ability to produce at a satisfactory level in the workplace, including the ability of a person to transfer and apply these skills and knowledge in new situations and increase the agreed benefits.

Hutapea and Thoha (2012: 28) stated that the main components of competency formation are: knowledge, skills and attitudes. while according to Sutrisno (2019: 204) the concept of competence that is used as a measure is as follows: knowledge, understanding, skill, value, attitude and interest.

2.3 Job Placements

According to Hartatik (2014: 77) Job placement is job title analysis information that is used to place employees on job jobs that match the skills in order for them to work effectively. Job placement indicators According to Yuniarsi & Suwatno (2013: 42) are placement according to education, placement according to knowledge, placement according to skills, placement according to experience, and placement according to age factors.

2.4 Job Satisfaction

Job satisfaction is an assessment of the worker, namely how far his work as a whole satisfies his needs, job satisfaction is related to the attitude of the employee towards the work itself, work situation and work relationship (Sukrispiyanto, 2019: 182).

According to Sedarmayanti (2017: 168) indicators in measuring job satisfaction are job content, supervision, organization and management, opportunities to advance, payments (wages/salaries), colleagues and working conditions.

3. Research Method

The object in this study is Employee Performance (Y) as a dependent variable while as an independent variable is Employee Competence, Employee Job Placement and Employee Job Satisfaction at the Regional Office VII BKN Palembang. The population in this study was all civil servants (PNS) at the Regional Office VII BKN with a total of 140 employees. The sample in this study used isaac and michael's formula for a population of 140 people with an error rate of 5% then the number of samples as many as 100 people were selected using the cluster random sampling method.

Data collection techniques are questionnaires, interviews and documentation. Questionnaires are those submitted and collected by researchers by meeting respondents directly. Interviews are direct communication with BKN Palembang employees to obtain information related to the necessary data. Documentation is by collecting data related to the study under study. The data analysis technique in this study was used regression linier. However, previously, instrument tests and classical assumption tests will be carried out first against the data. The analysis model used is multiple linear regression analysis; this analysis model is used because of the variables that affect more than one, the model of multiple linear regression equations as follows:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + \varepsilon$$

4. Findings and Discussions.

Based on the number of research samples of 100 respondents, the authors distributed 100 questionnaires to selected respondents from the Regional Office VII of BKN, with the result of returning 100% of the questionnaire, which was 100 copies, which had been received again, then the research sample had met the research requirements. The general description of respondents was seen through the demographics of respondents which included: gender, age, last education, length of service, working class and employment status.

4.1 Instrument Test

Instrument tests include validity tests and reliability tests. Validity test with Cronbach's Alpha method rhitung value is represented by Corrected Item-Total Corelation value, Based on the validity test that has been carried out, the overall indicators used in each question item in employee performance, competence, job placement and job satisfaction are said to be valid, because the overall indicators used have a rhitung value of > rtabel (0.361).

Reliability tests are carried out jointly on all question items. If the value of Cronbach Alpha ≥ 0.7 then it is reliable. If the Cronbach Alpha value < 0.7 then it is not reliable. Based on reliability tests, the overall value of employee performance, competence. Job placement, and job satisfaction used in this study are said to be reliable, because overall it has a value of > 0.7 .

4.2 Test of Classical Assumptions

4.2.1 Normality Test

The normality test is a test to measure whether the data owned is normally distributed so that it can be used in statistics. Test the Kolmogorov-Smirnov sample to test the normality of the regression model, provided that if it is significant > 0.05 then the variable is normally distributed. The results of the normality test can be seen, as follows:

Table 1. Normality Test Result

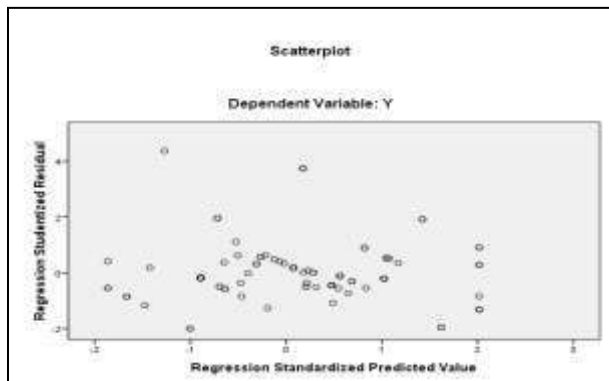
	Kolmogorov-Smirnov ^a		
	Statistic	df	Sig.
Unstandardized Residual	0,146	100	0,90

Source: Data processing, 2022.

Based on the normality test above, it can be seen that if the significant value is $0.090 > 0.05$, then it can be ascertained that the regression model meets the normality.

4.2.2 Uji Heteroskedastisitas

The heteroskedasticity test is used to test for the occurrence of residual variance differences of one observation period to another observation period. How to predict the presence or absence of heteroskedasticity in a model can be seen with the Scatterplot image pattern, as follows:



Picture 1. Heteroskedasticity Test Result

Source: Data processing, 2022.

Based on the figure above, it can be seen that the dots on the Scatterplot are spread above and below / around the number 0, and the data points do not collect only above or below only. The spread of data points does not form a wavy pattern of widening and then narrowing and widening again, even the spread of data points is not patterned. So it can be said that there is no herteroskedasticity in the regression model in this study.

4.2.3 Multicholinearity Test

The multicholnearity test applied to multiple regression analysis consisting of two or more free variables or independent variables, will be measured the closeness of the relationship between the free variables through the magnitude of the correlation coefficient (r). If the VIF value in the output result has a value of no more than 10 and a Tolerance value of not less than 0.1, then it can be declared that the multiple linear regression model is free from classical assumptions and can be used in research. Then the results of the multicholnearity test can be seen, as follows:

Table 2. Multicholnearity Test Result

Model (Constant)	<i>Collinearity Statistics</i>	
	<i>Tolerance</i>	VIF
Competence (X_1)	0,305	3,275
Job Placement (X_2)	0,444	2,253
Job Satisfaction (X_3)	0,536	1,867

Source: Data processing, 2022.

Based on the multicholnearity test in Table, all variables used in this study have a VIF value of < 10 , and a Tolerance value > 0.1 , so it can be ascertained that the model used in this study did not occur multicholnearity.

4.3 Linearity Test

The data linearity test aims to find out whether two or three variables have a significant linear or non-linear relationship. Then the results of the data linearity test can be seen, as follows:

Tabel 3. Linearity Data Test Result

	Variabel	df	F	Sig.
<i>Linearity</i>	Competence (X_1)	1	201,492	0,000
	Job Placement (X_2)	1	120,329	0,000
	Job Satisfaction (X_3)	1	62,447	0,000

Source: Data processing, 2022.

Based on the linearity test of the data in Table, it can be seen that the sig value. competence (X_1) of 0.000, job placement (X_2) of 0.000 and job satisfaction (X_3) of 0.000, meaning a sig value. < 0.05 . Then it can be concluded that between a free variable and a bound variable has a linear relationship.

4.4 Multiple Linear Regression Analysis

Multiple linear regression analysis is used to determine the regression between competency variables, job placement and job satisfaction with employee performance at the Regional Office VII BKN. with the following results

Table 4. Multiple Linear Regression Analysis

		Unstandardized Coefficients		Standardized Coefficients
Model		B	Std. Error	Beta
1	(Constant)	0,480	0,172	
	X ₁	0,405	0,085	0,476
	X ₂	0,238	0,069	0,285
	X ₃	0,165	0,067	0,184

Source: Data processing, 2022.

Based on the table above, it can be arranged into a multiple linear regression equation, as follows:

$$Y = 0,480 + 0,405 X_1 + 0,238 X_2 + 0,165 X_3$$

A constant value of 0.480 indicates that if competence, job placement and job satisfaction are absent or are worth 0 (zero), then employee performance will be fixed. The competency coefficient value of 0.405 indicates that competence has a positive effect on employee performance. This means that if there is an increase in competence, employee performance will increase, and vice versa if competence decreases, employee performance will also decrease, assuming job placement and permanent job satisfaction.

The value of the job placement coefficient of 0.238 indicates that job placement has a positive effect on employee performance. This means that if there is an increase in job placement, employee performance will increase, and vice versa if the job placement is reduced, employee performance will also decrease, assuming competence and job satisfaction remain. The value of the job satisfaction coefficient of 0.165 indicates that job satisfaction has a positive effect on employee performance. This means that if there is an increase in job satisfaction, employee performance will increase, and vice versa if job satisfaction decreases, employee performance will also decrease, assuming competence and job placement remain.

The results of the multiple linear regression analysis above show that the competency variable has a stronger effect in influencing employee performance than job placement and job satisfaction, meaning that competence has the most impact on employee performance at the Regional Office VII BKN.

4.5 Hypothesis Test

4.5.1 F -Test

The F test is intended to test free variables simultaneously/together against bound variables, the results are as follows :

Table 5. F-Test Result

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	68,821	3	22,940	78,393	0,000
	Residual	28,093	96	0,293		
	Total	96,914	99			

Source: Data processing, 2022.

Specifies f table with a confidence level of 95% and an error rate (α) of 5% = 0.05 with a degree of freedom (df) $v_1 = k - 1 = 4 - 1 = 3$, and $v_2 = n - k = 100 - 4 = 96$ (the same df as in Table IV.17). So the Ftable value = 2.69. Based on the F Test Table, it can be seen that the value of F count $78.393 > F_{table}$ is 2.69, with a sig level. $F_{0.000} < 0.05$ (significant), then H_0 was rejected, meaning that there was a significant influence on competence, job placement and job satisfaction on employee performance at the Regional Office VII BKN.

4.5.2 t-Test

This t-test is intended to test free variables partially/individually against bound variables, with the following results:

Table 6. t- Test Result

Model	Unstandardized Coefficients		Standardized Coefficients		t	Sig.
	B	Std. Error	Beta			
1 (Constant)	0,480	0,172			2,785	0,006
	X ₁	0,405	0,085	0,476	4,785	0,000
	X ₂	0,238	0,069	0,285	3,453	0,001
	X ₃	0,165	0,067	0,184	2,444	0,016

Source: Data processing, 2022.

Specifies ttable with a confidence level of 95% and an error rate (α) of 5% = 0.05 and a degree of freedom (df) = n-k. Then : (df) = 0.05 (100-4) is 0.05 = 96. So the value of ttable = 1.984. Based on Table IV.16, it can be seen as follows:

The calculated value for competence is $4.785 > t_{table}$ 1.984, with a sig.t level of $0.000 < 0.05$

(significant), then H_0 is rejected, meaning that there is a significant influence of competence on employee performance at the Regional Office VII BKN. The calculated value for job placements is $3,453 > t_{table} 1,984$, with a sig.t level of $0.001 < 0.05$ (significant), then H_0 is rejected, meaning that there is a significant influence of job placement on employee performance at the Regional Office VII BKN. Calculated value for job satisfaction of $2.444 > t_{table} 1.984$, with a sig.t level of $0.016 < 0.05$ (significant), then H_0 was rejected, meaning that there was a significant effect of job satisfaction on employee performance at regional office VII BKN.

4.6 Discussion

4.6.1 The Effect of Competence, Job Placement, and Job Satisfaction on Employee Performance.

Based on the results of the joint analysis that has been carried out in this study, it proves that there is a positive and significant influence on competence, job placement and job satisfaction on employee performance at the Regional Office VII BKN. This shows a positive or unidirectional linear relationship between the variables of competence, job placement and job satisfaction to employee performance, which means that if competence, job placement and job satisfaction are getting better or can be improved, it will have a positive impact on improving employee performance.

This result is in accordance with the theory proposed by Kasmir (2016:65) that the factors that affect employee performance include competence and job satisfaction, then the theory according to Nitisemito (2011:66) that job placement is one of the factors that affect employee performance. Then this result is in line with the theoretical concepts expressed by the expert.

This result is in line with previous research conducted by Manullang, et al (2020), with the results of their research proving the influence of competence and job placement on employee performance. In addition, research conducted by Putri & Latrini (2013), proves the effect of job satisfaction on employee performance. The results differed in Afriana's research (2021) with the results of her research which proved that job placement did not have a significant effect on employee performance. Results that are different from the study can occur due to different research samples and research objects, because the influence caused by job placement variables depends on the number of position structures and company needs. So that if the company only provides a small position structure, the job placement in any position and in any location will remain the same result because it is filled by the same employee with the same position as well, then there is little possibility of any change in its performance.

This result is evidenced by descriptive data that shows the level of employee performance at the Regional Office VII BKN is in a moderate condition. The descriptive results of the data between free variables and bound variables have a similar pattern, which explains the mutual relationship, if competence, job placement and job satisfaction are not optimal, it will have an impact on employee performance which is less than optimal.

4.6.2 The Effect of Competence on Employee Performance.

Based on the results of a partial analysis that has been carried out in this study, it proves that there is a positive and significant influence of competence on employee performance at the Regional Office VII BKN. This shows a positive or unidirectional linear relationship between competencies and employee performance, which means that if the competence is getting better or can be improved, it will have a positive impact on improving employee performance. So that if employees at the Regional Office VII of BKN can improve their competence at work, it will affect their performance for the better.

This result is in accordance with the theory proposed by Kasmir (2016:65), which states that competence is one of the factors that affect employee performance. This result is in line with previous research conducted by Manullang, et al (2020) and Friolina (2017) with the results of their research which proves the influence of competence on employee performance. Thus, between previous research and current research, similar results are shown, namely competence has a significant effect on employee performance. The results differed in Rosmaini's research (2019) with the results of her research which proved that competence did not have a significant effect on employee performance. The results that are different from the study can occur because the research sample used 72 respondents while this study used 100 respondents, and the object of different research was the Public Works and Public Housing Office of Aceh Tamiang Regency while this study examined the Regional Office VII of BKN, the influence caused by competency variables depends on the performance needs of employees in their agencies. So that if the company only needs low-frequency performance without special skills, the competencies needed do not have a significant effect on the field of work.

4.6.3 The Effect of Job Placement on Employee Performance.

Based on the results of a partial analysis that has been carried out in this study, it proves that there is a positive and significant influence of job placement on employee performance at the Regional Office VII BKN. This shows a positive or unidirectional linear relationship between job placement variables and employee performance, which means that if the job placement is more in accordance with the right position, it will have a positive impact on improving employee performance. So that if employees at the Regional Office VII of BKN can be placed in the appropriate position or field of work, it will affect their performance for the better.

This result is in accordance with the theory proposed by Nitisemito (2011: 66), which states that competence is one of the factors that affect employee performance. This result is in line with previous research conducted by Manullang, et al (2020), with the results of their research proving the influence of job placement on employee performance. Thus, between previous research and research now, similar results have shown that job placement has a significant effect on employee performance. The results differed in Afriana's research (2021) with the results of her research which proved that job placement did not have a significant effect on employee performance. Results that are different from the study can occur because the research sample used 94 respondents while this study used 100 respondents, and the object of different research was Public Sector in and Emerging Country while this study examined the Regional Office VII BKN, the influence caused by job placement variables depends on the number of position structures and company needs. So that if the company only provides a small position structure, the job placement in any position and in any location

will remain the same result because it is filled by the same employee with the same position as well, then there is little possibility of any change in its performance.

4.6.4 The Effect of Job Satisfaction on Employee Performance.

Based on the results of a partial analysis that has been carried out in this study, it proves that there is a positive and significant influence on job satisfaction on employee performance at the Regional Office VII BKN. This shows a positive or unidirectional linear relationship between job satisfaction variables and employee performance, which means that if job satisfaction is getting better or can be improved, it will have a positive impact on improving employee performance. So that if employees at the Regional Office VII of BKN can have better satisfaction at work, it will affect their performance for the better.

This result is in accordance with the theory proposed by Kasmir (2016:65), which states that job satisfaction is one of the factors that affect employee performance. This result is in line with previous research conducted by Putri & Latrini (2013), Jusmin and Said (2016) and Rosmaini (2019) with the results of their research which proves the effect of job satisfaction on employee performance. Thus, between previous research and current research, similar results are shown, namely job satisfaction has a significant effect on employee performance.

The results differed in the research of Mira, Choong and Thim (2019) with the results of their research which proved that job satisfaction did not have a significant effect on employee performance. Different results from the study can occur because the research sample used 115 respondents while this study used 100 respondents, and a different research object was Saudi Arabia while this study examined the Regional Office VII of BKN, the influence caused by the job satisfaction variable depends on who the individual employee works for and for which company he works. So that employee job satisfaction is difficult to equalize because there are employees who are easily satisfied and some are not easily satisfied, thus the measure of job satisfaction to employee performance is relatively not complex, because employees whose job satisfaction is low do not necessarily have low performance because it could be that the employee works harder because they need additional income.

5. Conclusion

Based on the results of research and discussion on the influence of competence, job placement and job satisfaction on employee performance at the Regional Office VII BKN, it can be concluded as follows:

- a. There is an influence of competence, job placement and job satisfaction on employee performance at the Regional Office VII BKN.
- b. There is an influence of competence on employee performance at the Regional Office VII BKN.
- c. There is an effect of job placement on employee performance at the Regional Office VII of BKN.
- d. There is an effect of job satisfaction on employee performance at the Regional Office VII of BKN.

BKN Regional Office VII is expected to be able to improve the competence, job placement, and satisfaction of its employees because these three variables have proven to have a significant effect on performance, by providing motivation, facilitating and giving special awards so that the performance of employees of regional office VII BKN Palembang is even better.

Regional Office VII of BKN is expected to improve the work competence of its employees, while the improvement includes: providing encouragement and guidance to employees to increase knowledge in carrying out their work. Evaluating employees who do not understand their work to be re-trained, as well as fostering the interest of employees to improve their competence through a positive coaching or training.

Regional Office VII of BKN is expected to be able to adjust job placements for its employees, while these adjustments include: job placements based on considerations of disciplines, skills and work experience in accordance with their employees, so that employees can be more optimal in maximizing their work potential for the better.

Regional Office VII of BKN is expected to increase job satisfaction of its employees, while the increase includes: adjustment of the type of work that is in accordance with the character of its employees, provision of a special reward system to appreciate the contribution of individual employees because the promotion system is already bound and does not allow it to be changed. Leaders in the Regional Office VII of BKN should pay more attention to the motivation given to their employees, because this motivation will encourage the strong feelings of employees to contribute more to their company.

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The Effect of Work Communication, Work Motivation, and Job Satisfaction on the Performance of Medical Employees at Public Health Center of Palembang City (Palembang Ilir Region)

M. Alvin Prabu Agung

Management Study Program, University of Muhammadiyah Palembang, Indonesia

Alvin.prabuagung@gmail.com

Abstract

This study intends to determine the effect of communication, motivation, and job satisfaction on the performance of Public Health Center employees in Palembang City (Ilir Palembang region). This research is quantitative and descriptive in nature. Communication, motivation, job satisfaction, and employee performance are the variables used, and 16 indicators are derived from them. This study's sample comprised of 174 medical employees from the Palembang city Public Health Center. Research uses primary data gathered through questionnaires and analyzed using multiple regression approaches. The findings of this study reveal that 1) Work communication, work motivation, and job satisfaction have a significant impact on the performance of public health center medical staff in Palembang City (Ilir Palembang region) 2) Work communication has a strong favorable impact on the performance of the medical staff at the Palembang City public health center (Ilir Palembang region) 3) The performance of Palembang City public health center medical staff is significantly influenced by their job motivation (Ilir Palembang region).4Job satisfaction has a significant impact on the efficacy of medical staff at the public health center in Palembang City (Ilir Palembang region).

Keyword: Work Communication, Job Motivation, Job Satisfaction, Performance Employee

JEL Codes : J24, J28, L31

How to Cite

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1. Introduction

Each organization must be able to cultivate and enhance employee performance. Performance assessment can give employees with opportunity to take remedial actions in an effort to improve performance based on feedback from the organization. The results of the performance evaluation can be used to determine suitable compensation so that employees are adequately motivated. In addition, it can prevent confusion over the organization's expected level of job quality. Certainly, the outcomes of the performance evaluation can be used to

design more efficient training and development programs.

Various Public Health Centers in Palembang routinely conduct staff performance evaluations. At the Public Health Center where the author's investigation was undertaken, employee performance was the phenomenon of interest. According to observations and interviews, it has been determined that the employee's work has not met expectations and that he or she has not given the organization their best effort. Not the maximum performance is defined by poor quality of work, results where there has been a decrease in the accuracy of nurses, such as patients receiving the wrong medication, and complaints from patients on the rigidity of the skills of new nurses in providing services. Currently, each section's patient data processing system uses the Public Health Center's online information system. However, there are numerous issues with the processing of patient data. The problem with - this difficulty in the course is the high rate of errors in patient data processing (registration data, examination data, reference data, and laboratory data).

Moreover, in terms of quantity, Numerous patient complaints on the lack of rapid-response medical personnel at public health centers illustrate the problem. Additionally, the service procedure was deemed to be slow, and a number of customers reported of frequent internet tissue disruptions when entering new patient information. This disorder causes service delays. and the sluggish process of patient service, such as data structure and searching. This impacts the quantity of work performed by health services, as the Public Health Center Regulations standard is 3 to 5 minutes.

Monitoring factors have an effect on performance decline as well. The decline in performance is attributable to the leadership of the Head of the Public Health Center, whose employees are regarded as devoted and disciplined. It is apparent that the employee is performing wonderfully when the Director of the Public Health Center exercises oversight during working hours. However, if the Director of the Public Health Center is not performing surveillance during business hours or is absent from the Public Health Center, surveillance will not be conducted, employees who delay their job, converse with friends, and even play with their cell phones will be discovered. The purpose of supervision is to determine whether the work and outcomes are in conformity with what was intended.

Regarding markers of employee relationships, it was discovered that there was still a reliance on others. As a colleague, it is unquestionable that employees require the assistance of their teammates. However, many are unaware of their excessive dependence on others. Despite the fact that reliance on others is a negative trait that can burden others.

Regarding communication, the objective is to determine how information gets upheaved and transmitted from one individual to another inside a system. Where such communication can connect the perspectives of other organization members and, most significantly, the relevance of the material itself. It was also discovered that Public Health Center personnel lacked a clear knowledge of their roles and bosses' directions. Lack of comprehension of the problem's context between employees and bosses might lead to erroneous assumptions. The surplus information and directives given by superiors to subordinates creates confusion among employees regarding which tasks to prioritize and finish first. This issue will not arise if the organization's HR department can develop effective communication so that subordinates can comprehend and carry out their superior's instructions.

Complex organizations provide and receive information through organizational

communication. Next on the enjoyment indicator (Sutardji, 2016), It appears that several pusat health centers have a new head of the Public Health Center; this makes them slightly uneasy. Even though a more relaxed and pleasant atmosphere will be more conducive to interaction than a tight one. Because communication is flexible. With such an environment, an intriguing impression will develop. Then, based on the attitude indicator (Sutardji, 2016), it appears that many Public Health Center employees are regularly disturbed by what their Leaders say when they are disciplined. Though what must be known in communication is not limited to intercommunicator understanding and individuality, it must also be capable of altering a person's behavior. According to the indication of a better relationship (Sutardji, 2016), the leadership style of the Puskesmas leader is perceived differently by the staff. It is therefore feasible for employees' attitudes to vary during meetings with the head of the public health center.

Participation in decision-making is crucial because it can change the way of life of its members, with whom it communicates, who is liked, how it functions, how it evolves, what it seeks to accomplish, and how to adapt. In conjunction with the action indicator (Sutardji, 2016), it is recognized that superiors rarely or never grant their subordinates autonomy, initiative, and decision-making authority. This is also related to the fact that superiors' communication with subordinates is formal when the organizational structure between them is remote. As a result of this conduct, his subordinates are not employed as sources of information, ideas, or counsel.

The diminishing performance of employees is a result of insufficient motivation; in terms of employee conduct, it indicates that employees are dissatisfied with their workload. However, the Health Service has been unable to match their demand. It appears that, in connection with the employee's business, staff, particularly nurses, have not provided patients with consistent, crisp, and professional nursing care.

Regarding the persistence of employees, it indicates that factors such as a lack of coaching, the awarding of rewards, or a lack of a sense of duty motivate employees more towards their work. The leadership's handling of complaints from medical workers is likewise deficient. Previously, a public health facility might get a prize charter from the Governor of South Sumatra for its achievements, but those days are long gone. This may suggest a loss of motivation, which can impair the public health center's own success. Moreover, based on the observations recorded in the public health center's Performance Assessment book, which contains an evaluation of work outcomes, a number of health programs have not yet achieved their goals.

According to the preliminary findings of various public health centers regarding the relationship between job happiness and supervision, employees prefer to work for supportive superiors. Medical professionals, particularly nurses, must be trained. Leaders must be able to give employees with motivation and psychological correctness, having in mind the significance of human aspects in enterprises. Through training, personnel become more cognizant of the goals and objectives of the organization's primary responsibilities. Consequently, employees will devote greater interest and focus to their subject of work. Then, in terms of benefits, it was discovered that health professionals with the status of state civil apparatus (ASN) complained about a 60 percent reduction in employee income benefits (TPP), which could have an impact on job satisfaction. In addition, there are still complaints regarding Co-workers (coworkers) where late-arriving medical personnel negatively impacts

the task of other colleagues. However, as coworkers they must get along and compliment one another.

To tackle some of the aforementioned issues, it is necessary to identify the primary variables that influence the problem's existence in terms of communication, motivation, and employee performance satisfaction. The author is therefore interested in conducting research with the title "Effect of Work Communication, Job Motivation, and Job Satisfaction on the Performance of Palembang City Puskesmas Medical Employees" whose results are anticipated to be useful for the needs of the organization in general and Public Health Center in particular (Ilir Region Palembang).

2. Literature Review

2.1 Employee Performance

According to Rivai and Basri (Sinambela, 2017:478), employee performance is one of the success criteria in defining the achievement of obligations towards persons who can direct the performance determination of the firm. According to Hasibuan (2020:34), performance is a person's labor in completing a task; the tasks allocated to him are dependent on his skill, experience, sincerity, and time. According to Wibowo (2017:3), performance is the execution of the predetermined plan. Human resources with the necessary skills, knowledge, motivation, and passions are responsible for implementing performance. There are six performance indicators (Kasmir, 2016), including: 1) Quality, 2) Quantity, 3) Cost emphasis, 4) Time, 5) Supervision, and 6) Employee Relationships

Aspects Influencing Performance

According to Kasmir (2016:65-71) there are thirteen aspects that affect performance, and these factors are as follows: 1) Capabilities, 2) Expertise, 3) Work Design, 4) Personality, 5) Work Satisfaction 6) Working Conditions, 7) Loyalty, 8) Dedication, 9) Work Discipline, 10) Motivated Work, 11) Leadership, 12) Leadership Style, 13) Organizational Culture.

Then according to Edison, Anwar & Komatiyah (2018:202), there are various factors that affect employee performance, including: 1) Compensation, 2) Communication, 3) Competence, 4) Corporate culture, 5) Motivation and recognition, 6) Leader & leadership, 7) System/Procedure

2.2 Communication

According to Arni (2016: 4), communication is the interchange of verbal and nonverbal messages between the sender and the recipient of the message in order to influence behavior. Robbins (2016:16) states that communication aids in the creation of motivation by informing employees of their responsibilities, the quality of their work, and what can be done to improve subpar performance. According to Sutardji (2016: 10-11), there are numerous signs of effective communication, including: 1) Comprehension, 2) Pleasure, 3) Impact on attitude 4) More positive interactions, 5) Activity

2.3 Motivation

Hasibuan (Sutrisno, 2017) discovered that motivation is a stimulus to the will and driving force of one's activity since each motive has a specific objective to attain. According to Indicator - Jones and George's (Riniwati, 2016: 175) motivational indicators, among others, are as follows: 1.) Employee Conduct, 2.) Employee Activities, 3.) The tenacity of employees

2.3 Job satisfaction

According to Wibowo (2017:415), job satisfaction is a general attitude toward one's work as the difference between the numerous rewards received by workers and the many perceived difficulties that are accepted. Individuals' job satisfaction is a significant aspect of their employment. As each worker has unique features -beda, the level of job satisfaction varies; a high level of job satisfaction can also have disparate effects. According to Yuwono, cited by Spector in Badriyah (2015: 241), determining indicators of job satisfaction involves a number of factors, including: 1) Salary, 2) Promotion, 3) Supervision, 4) Benefit, 5) Contingents incentives, 6) Operating procedures, 7) Coworkers, 8) Nature of work, 9) Communication.

3. Research Method

This study is an example of associative research since it describes the relationship between workplace communication characteristics, work motivation, and employee performance at a public health center. The population of medical staff personnel at a public health center in Palembang, Ilir Palembang Region, was sampled using 174 individuals.

In this study, the operational variables are work communication, work motivation, job satisfaction and employee performance. For more details operational variables as follows:

Employee performance consists of indicators: quality (quality), quantity (amount), time (term), supervision, and relationships between employees. Communication consists of indicators: Understanding, pleasure, influence on attitudes, better relationships, actions. motivation consists of indicators: Employee behavior, employee effort, employee persistence. Job satisfaction consists of indicators: Supervision, benefit, co-workers

This study employs multiple linear regression analysis methodologies due to the presence of independent variables in numerous studies. This method is used to determine the degree to which independent variables influence dependent variables. Thus, the equation for multiple linear regression in this investigation is:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + e$$

Remarks :

Y = Performance Variable

a = Constants

b₁₂₃ = Regression Coefficient

X₁ = Work Communication

X₂ = Job Motivation

X₃ = Job Satisfaction

E = Error term.

4. Findings and Discussions

4.1 Normality Test

Each variable has a kolmogrov value - smirnov yaiu greater than 0.05, indicating that the variable under consideration is regularly distributed..

4.2 Data Linerity Test

Watson's Durbin value is 1,959, the comparison utilizes a significance level of 5%, sample size of 174 (N), and number of independent variables of 3 (K-3), hence Watson's DU value in the Durbin table will be 1,787. Due to the fact that the DW value is larger than the upper limit (dU) 1,787 and less than $4 - 1,787 = 2,213$, it may be argued that there is no autocorrelation.

4.3 Analysis of Multiple Linear Regression

Table 1. Output Results of Multiple Linear Regression Tests

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,974	,213		4,578	,000
	Communication	,414	,055	,493	7,517	,000
	Motivation	,245	,076	,236	3,242	,001
	Job Satisfaction	,131	,057	,150	2,299	,023

a. Dependent Variable: Performance

When the values of communication, motivation, and job satisfaction are set to zero, the performance of a medical professional at the Public Health Center of the City of Palembang in the Ilir Palembang region remains unchanged at 0.974%. Based on the value of the constant, it appears that if there are no communication factors, motivation, and work satisfaction that support the performance, it is of poor quality..

The regression coefficient for communication variables (b1) is 0.414, indicating a favorable association between the application of communication and the performance of medical staff in the Palembang City Pukesmas region. Therefore, if the communication variable increases, the performance variable of personnel at the Palembang City Public Health Center will be altered, ignoring the work motivation and job satisfaction variables ($X_2 = 0$ and $X_3 = 0$). This implies that with the support of communication factors, the resulting performance is of high quality..

The regression coefficient for the motivation variable is 0.245, demonstrating a favorable relationship between applying motivation and the performance of Public Health Center City Palembang City medical personnel in the Ilir Palembang region. Consequently, if the motivation variable improves, the employee performance variable at the Palembang City Public health center will increase by 0.491%, ignoring the work communication variable ($X_1 = 0$) and the job satisfaction variable ($X_3 = 0$). This means that with the value of motivational variables that support the quality of the performance produced, the performance is of high quality..

The coefficient of regression for the variable measuring job happiness (b3) is 0.131, indicating a positive association between job satisfaction and the performance of medical employees in the Palembang City Pukesmas region. Therefore, if the communication variable grows, the employee performance variable at the Palembang City Public health center will increase by 0.278, ignoring the work communication variable ($X_1 = 0$) and the work motivation variable ($X_2 = 0$). This signifies that the resulting performance is of high quality when supported by communication factors of high value.

4.4 Determination Coefficient Test (R^2)

Table 2. Determination Results (R2)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,776 ^a	,602	,595	,26618	1,959

a. Predictors: (Constant), Job Satisfaction , Communication, Motivation

b. Dependent Variable: Performance

Table 2 reveals that the coefficient of determination, or R Square, has a value of 0.59, or 59 percent. This suggests that Communication, Motivation, and Job Satisfaction exhibited a 59 percent influence on the performance of the Public health center in the Ilir Palembang region, while the remaining 41 percent was influenced or explained by variables beyond the scope of the study.

4.5 Simultaneous Significance Test (Statistical Test F)

Table 3. Simultaneous Significance Test Results (Statistical Test F)

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	18,204	3	6,068	85,647	,000 ^b
Residual	12,045	170	,071		
Total	30,249	173			

a. Dependent Variable: Performance

b. Predictors: (Constant), Job Satisfaction , Communication, Motivation

The significant value for the influence of communication, motivation, and job satisfaction on the performance of medical employees at the Palembang City Health Center in the Ilir Palembang region is 0.000 0.05 and the Fcount value is 85.64 > Ftable 3.05, as shown in table 3. The hypothesis (Ha1) is therefore accepted. In other words, communication, motivation, and job satisfaction all influence the effectiveness of medical professionals at the Palembang City Health Center in the Ilir district of Palembang.

4.6 Partial Significance Test (Test Statistical t)

Table 4. Results of Partial Significance Test (Test Statistics t)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,974	,213		4,578	,000
	Communication	,414	,055	,493	7,517	,000
	Motivation	,245	,076	,236	3,242	,001
	Job Satisfaction	,131	,057	,150	2,299	,023

a. Dependent Variable: Performance

Work Communication (X1) has a probability value of 0.000 0.05 and an arithmetic value greater than t table 1.973. Therefore, H02a is rejected, indicating that communication has a major effect on the performance of medical professionals at the Palembang City Health Center in the Ilir district of Palembang.

Motivation (X2) has a significant probability of 0.001 more than 0.05 and a tcount greater than ttable. Therefore, H02b is rejected, indicating that motivation has a major effect on the

performance of medical staff at the Palembang City Health Center in the Ilir district of Palembang.

The significant probability of job satisfaction (X3) is 0.023 0.05, and tcount is greater than ttable (1.973). Then H02c is rejected, indicating that there is a substantial relationship between job happiness and the performance of medical staff at the Palembang City Health Center in the Ilir Palembang district..

4.7 Discussion

The Influence of Work Communication, Job Motivation, and Job Satisfaction on the Performance of Medical Employees at the Palembang City Public Health Center (Ilir Palembang Region)

Communication, motivation, and job satisfaction have a favorable and significant effect on the performance of medical personnel at the Palembang City Health Center in the Ilir neighborhood of Palembang, according to the test results. Communication, motivation, and job satisfaction influence the performance of medical professionals at the Palembang City Health Center in the Ilir Palembang region. This is demonstrated by the 59 percent contribution of communication, motivation, and job satisfaction factors to the rise and fall of employee performance as determined by the coefficient of determination test.

According to Kasmir (2016), the factors that affect employee performance include motivation and job satisfaction when examined from a theoretical perspective. According to Edison's (2018) hypothesis, communication is one of the elements influencing employee performance. Thus, this outcome is consistent with the expert's theoretical perspective.

As the stability of its link with low-performing employee performance variable responses from survey respondents. Consequently, the results of the respondents' responses demonstrate the relationship between variables, indicating that the impact of communication, motivation, and low job satisfaction leads to a decline in employee performance.

The Influence of Work Communication on the Performance of Medical Staff at the Palembang City Health Center, Palembang Ilir Region.

The test results reveal that communication has a favorable and statistically significant impact on the performance of medical professionals at the Palembang City Health Center in the Ilir Palembang district. According to Edison's (2018) hypothesis, performance is influenced by compensation, communication, competence, corporate culture, motivation and recognition, leadership, and procedures, one of which is communication. The results of this study are consistent with this theory. This demonstrates that the research results align with the expert's theory.

The influence of leadership style and communication on employee performance at upt public health center klungkung 1, klungkung district. The results of this study are consistent with those findings. Specifying that communication has a substantial impact on the performance of upt klungkung personnel. The same results are seen in research by Mayono (2016) titled Communication has a marginally significant effect on employee performance at UPT Public health center Ambalawi, according to The Effect of Work Discipline and Work Motivation on Employee Performance at UPT Public health center Ambalawi.

Previous research conducted by Handayani (2016) showed that communication had no significant effect on the performance of Totikum Health Center personnel in Banggai Regency, Central Sulawesi Islands. These results contradict Handayani's findings. Due to the

variation in sample size and research location, the outcomes are distinct. Prior research utilized an analytical cross-sectional method. The research sample included all 41 Totikum Health Center workers. This study was conducted at a public health center using a sample of 174 medical professionals. This study's findings also reveal that communication in public health centers has a negative relationship with employee performance in terms of affecting the achievement of organizational goals through changes in employee behavior. This indicates that if communication is effective, Totikum Health Center employees' performance will suffer, and vice versa. This may be the result of a lack of employee turnover, so that employees are well-versed in their responsibilities without direct instruction from management. Coordination and cooperation with coworkers have little effect on the completion of a job, as each employee can perform his own duties and obligations because he has been performing the same job for an extended period of time. Consequently, despite the fact that communication inside the Public Health Center is quite limited, the staff's performance is satisfactory.

The Influence of Work Motivation on the Performance of Medical Staff at the Palembang City Health Center, Palembang Ilir Region.

The test results indicate that motivation has a favorable and statistically significant effect on the performance of the medical personnel at the Palembang City Health Center in the Ilir Palembang district. The findings of this study are consistent with the idea proposed by Kasmir (2016) and Edison (2018), according to which motivation is one of the elements influencing employee performance. This demonstrates that the research results are consistent with the expert's theory.

This study's findings are consistent with those of Fajar Budiarto (2016), who demonstrated that work motivation significantly affected the performance of staff at the Payung District Health Center, South Bangka Regency. In addition, this study is consistent with previous research by Hastuti (2017), which reveals that job motivation has a substantial effect on the performance of Public health center staff. Employees who are highly motivated at work will typically exhibit excellent performance. Conversely, personnel with low achievement motivation are likely to provide poor results.

Muhammad Iqbal (2020) published a study titled Contrary to the findings of this study, the influence of work discipline and work motivation on employee performance at UPT Public Health Center Ambalawi District. Providing evidence that partial job motivation has little impact on employee performance. Due to the variation in sample size and research location, the outcomes are distinct. Prior studies employed an analytical cross-sectional approach. All 55 staff of the Ambalawi District Health Center constituted the sample for this study. This study was conducted at the Public Health Center with a sample of 174 medical professionals. Problems with job motivation, such as a lack of mentoring, training, or a greater sense of responsibility for work outcomes. Motivation has little effect due to the influence of other variables (work discipline), which diminishes the significance of motivation.

The Influence of Job Satisfaction on the Performance of Medical Staff at the Palembang City Health Center, Palembang Ilir Region.

The test results indicate that job happiness partially influences the performance of medical staff at the Palembang City Health Center in the Ilir Palembang district. The findings of this study are consistent with Kasmir's (2016) theory that job satisfaction is one of many factors that influence employee performance.

Herlina (2019), author of the study titled the influence of work ethic, job satisfaction, and work environment on employee performance at Karangampel Public Health Center, Indramayu Regency, found that job satisfaction influences the performance of Public Health Center employees in a number of her previous studies. If job happiness is enhanced, employee performance will increase, and if job satisfaction is decreased, employee performance will decrease.

In contrast, the results of Rahmawati's (2020) study titled The Effect of Job Stress, Job Satisfaction, and Social Support on the Performance of Nurses at the Sebatik Public Health Center are different. The claim that job satisfaction has no significant effect on the performance of nurses at public health centers. Due to the variation in sample size and research location, the outcomes are distinct. All 36 participants in the research sample were medical nurses. This research was conducted at a public health facility with 174 physicians, nurses, pharmacists, health analysts, and midwives as participants. The results of this study reveal that nurses are dissatisfied with their compensation since it is insufficient to meet their demands; nonetheless, their dissatisfaction with their salary has no effect on their performance. This is demonstrated by respondent data indicating that they are able to complete their work in accordance with public health center standards, are able to complete their work efficiently, effectively, and seriously, and take their work seriously. In addition, the tasks and obligations of nurses do not influence the performance of nurses, because the duties and responsibilities of nurses are distinct from those of employees at other organizations. The purpose of a nurse in the field of social services is to constantly be patient and able to comprehend the condition of patients who are experiencing pain, fear, and crises, and to attend to all of the patients' needs at the public health center, which is directly tied to the patient's life. Therefore, occupational satisfaction has no effect on nurses' performance..

5. Conclusion

Motivation, communication, and job satisfaction have a significant and favorable impact on the performance of medical staff at the Palembang City Health Center in the Ilir district of Palembang.

Communication has a big and favorable impact on the performance of medical professionals at the Palembang City Health Center in the Ilir Palembang district.

Motivation has a good and considerable impact on the performance of medical personnel at the Palembang City Health Center in the Ilir neighborhood of Palembang.

Positive and significant effects of job satisfaction on the performance of medical staff at the Palembang City Health Center in the Ilir district of Palembang.

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The Effect of Motivation and Competence on Millennial Job Performance and Job Satisfaction

Rahma Charka¹, Trisniarty Ajeng Moelyatie², Fadhil Yamaly³

Department of Management, University of Muhammadiyah Palembang, Indonesia

Corresponding author: Rahma Charka

rahmacharka@gmail.com, trisniartiadjengmoelyatie@yahoo.com, fadilplg@gmail.com

Abstract

Motivation and Competence are things that affect the good and bad performance of employees. Millennials thrive with immediate satisfaction from technology, spend a lot of time on social media, and are most commonly used to represent the lazy generation at work. This research aims to know the effect of motivation and competence on employee performance in the energy and mineral resources office of south Sumatra province. The object of research used in this study is Employee Performance (η_1) as an endogenous variable. The exogenous variables in this study are Motivation (ξ_1) and Competence (ξ_2). This research was conducted at the Department of Energy and Mineral Resources of South Sumatra Province. The research method used is associative research because the author wants to know the effect of Motivation and Competence, on performance. The population in this study was 102 people. Sampling techniques with purposive sampling so that the sample in this study is 82 employees. Research using SEM method with the help of Smart pls software. The results of this study show that either partially or together motivation and competence have a positive and significant effect on performance. Meanwhile, from the results of this study, there is no significant influence between job satisfaction as an intervening variable between motivation and competence on employee performance.

Keywords: Motivation, Competence, Millennial, Performance.

JEL Codes: J24, J28, L31

How to Cite

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1. Introduction

Indonesia is currently experiencing a demographic dividend. It is estimated to end in 2045. According to the Indonesian Central Statistics Bureau is planned Indonesian working-age population (15-64 years old) 179.1 million people in 2020 and millennials (21-36). Contribute to about 63.5 million people. This makes millennials an important growth driver Indonesian economy. But with millennials, the data are similar to them. What is the big difference from the previous generation? More. The more we understand them, the better we

understand them. Judgments and decisions about millennials in the field of our work, and ultimately, we are in that field faster. (IDN Times, 2020)

One of the most important success factors for an organization is high-quality human resources. Job performance is a successful role-performing ability that results from one's actions. (Dewi et al., 2021) Competencies are a combination of knowledge, skills, values, and attitudes that are reflected in our thinking and actions (Supriyanto et al., 2021)

A dynamic process that keeps people alive through motivation and mobilization. Increases an individual's desire and desire to achieve a given individual and organizational goals. Work motivation is an internal process that creates personal preparation and mobilization. An individual to achieve an organization's goals, depending on the satisfaction of the individual's needs. (Özdemir, 2020)

2. Literature Review

2.1. Performance

Job performance is a measurable activity of an employee in fulfilling a specific task and responsibility. This is often referred to simply as the performance level of an employee's task or role. The requirements for a particular task or role are determined by the administrator. Therefore, job performance is an indicator of how well an employee meets the job requirements of a particular job. (Unguren & Arslan, 2021)

Three factors affect performance: the first. Individual factors such as competence, family background, work experience, social level, and demographics of people. Second, psychological factors: perception, role, attitude, personality, motivation, and job satisfaction, and a third organizational factor: organizational structure, workplace design, leadership, and reward system. Achievement is influenced by individual skills, motivation, support received, and the presence of work. They do so and their relationship with the organization. (Dewi et al., 2021)

2.2. Job Satisfaction

Job satisfaction represents the emotion that arises from the perception that work meets material and psychological needs. (Loan, 2020) Job satisfaction is the emotional direction employees have for their work. Can be seen as an overall sensation about work or as a related constellation of different attitudes work side. (Hoboubi et al., 2017) Job satisfaction can manifest itself as employee involvement resulting from increased sense of purpose and improved performance at work. Job satisfaction reflects an employee's perception of their ability to perform their jobs. Employees with high job satisfaction contribute to positive values and results to the organization. They also feel like they have something clear understanding their contribution to work. In addition, satisfied employees feel more likely to be treated fairly both inside and outside the organization. (Choi et al., 2016)

2.3. Motivation

Motivation in management is used to ensure that employees are using the energy available to be effective and productive in their business. Motivation is an important indicator that an employee is enthusiastic and determined to get the job done. At a high level. This increases engagement and personal consistency with the goals you set. (Malkoc & Dal, 2021)

One of the most quoted motivational theories is the hierarchy of needs theory proposed by Abraham Maslow. Maslow sees human needs from a hierarchical perspective from the lowest needs to the highest needs. Basic human needs that Maslow identified in order of importance: Physiological needs (basic needs), security needs, partner needs, acceptance (social needs), reward needs (gratitude needs), and self-actualization. There is a positive relationship between employees' motivation and performance. Higher employee motivation contributes to employee performance. (Setiyani et al., 2019)

2.4. Competence

Points of competency theory that knowledge and skills are at the core of the professional abilities of the members of the organization. Knowledge and skill acquisition are closely linked to an effective input environment. (Wang et al., 2021)

What is competency? Apply what the learner has learned and measuring ability means measuring a person's ability performance. (Kim et al., 2020)

McClelland believes that professional ability is related to personal qualities such as knowledge, attitude, values, and motivation. It is expressed in terms of work outcomes and is measured using specific methods. In this study it works abilities are a characteristic of an individual who can distinguish between different work performances, taking into account that they can be represented by high cognitive abilities, good scores, and good behavioral skills. (Diao & Chen, 2019)

2.5. Research Hypothesis

Based on the survey, this survey assumes that work skills have a positive impact on the well-being of employees in the service industry and that employment insecurity plays an important intermediary relationship. In doing so, this study designed the research framework shown in Figure 1 and proposed relevant hypotheses.

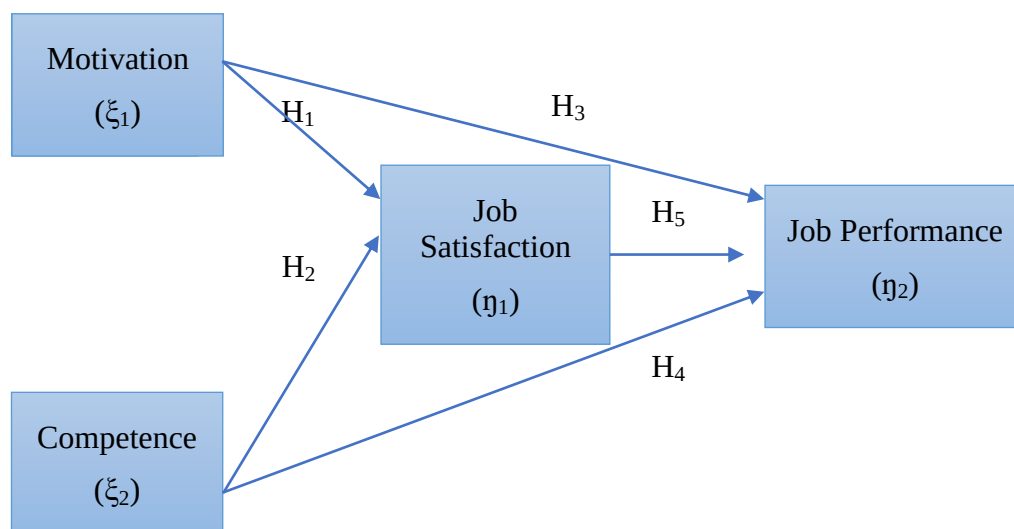


Figure 1. Research Model with variable Artifacts, Motivation, Competency, Job Performance, Job Satisfaction

The author concerning the above conceptual framework made the following hypothesis:

H₁: There is an influence between Motivation and Job satisfaction

H₂: There is an influence of Competence on Job satisfaction

H₃: There is an influence between Motivation and Performance

H₄: There is an influence between Competence and Performance

H₅: There is an effect of Job satisfaction on Performance

H₆: There is an influence of Motivation on Performance through Job Satisfaction

H₇: There is an influence of Competence on Performance through Job Satisfaction

3. Research Methods

The method in this study uses a quantitative method that uses a questionnaire as a research instrument with a Linkert scale of 1-5. The total population of Millennial employees in the Mining and Energy Service of South Sumatra Province is 102 people, and the sample is 82 people. In the study, an associative type of research was used because the author wanted to know the influence of competence, motivation, and job satisfaction on performance.

4. Findings And Discussion

4.1. Statistical Analysis

This research uses the Structural Equation Method model with Smart Pls. this is because the number of samples is below 100 so Smart Pls is the right choice.

4.2. Outer Model

This model is used to measure the validity and reliability of the sample itself. Test validity using Outer loading and AVE. Outer Loading must be >0.7 while for AVE >0.5 it can only be declared valid. While the reliability uses Cronbach Alpha and Composite Reliability must be >0.7. In this study, this can be seen from the following picture:

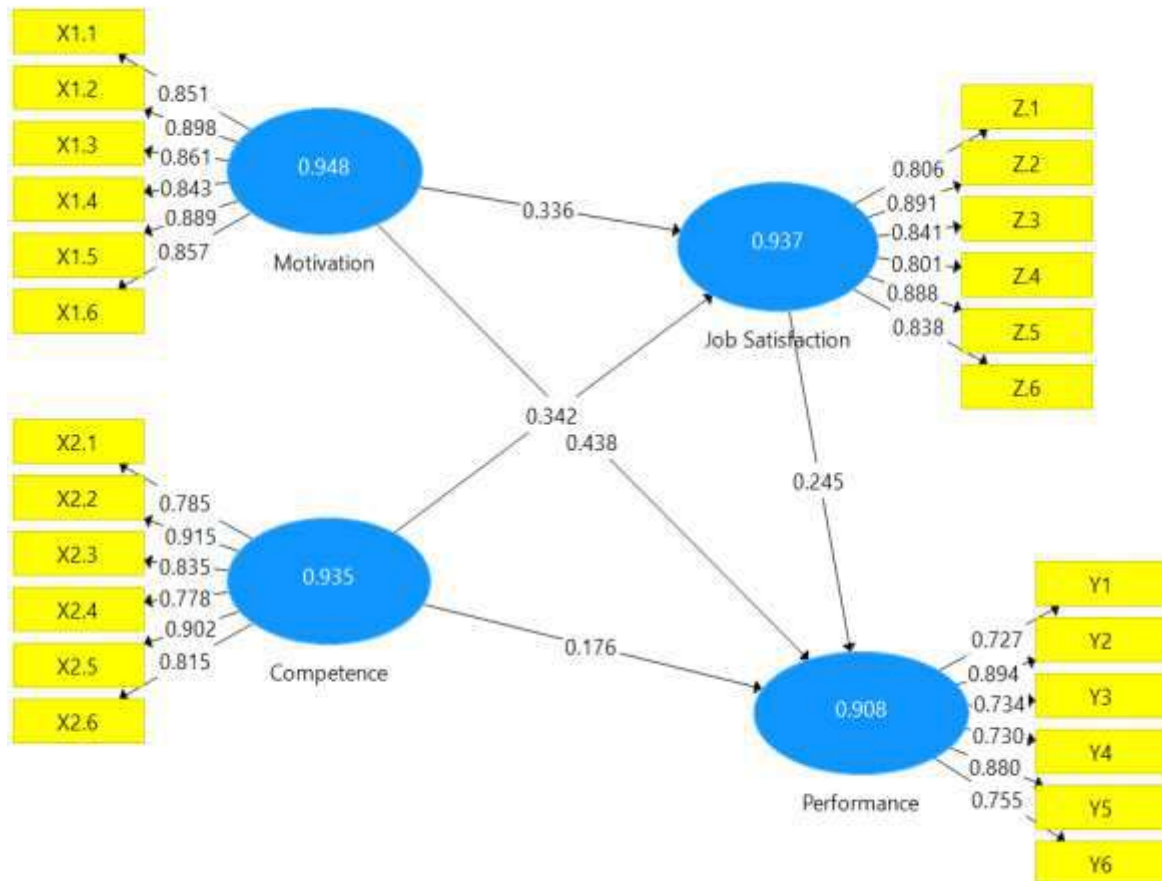


Figure 2. Outer Model

In Figure 2, it can be seen that the sample has met the criteria for validity and reliability. However, this can be further clarified through the table below:

Table 1. Validity test results

Variable	Competence	Job Satisfaction	Motivation	Performance	Result
X1.1			0.851		Valid
X1.2			0.898		Valid
X1.3			0.861		Valid
X1.4			0.843		Valid
X1.5			0.889		Valid
X1.6			0.857		Valid
X2.1	0.785				Valid
X2.2	0.915				Valid
X2.3	0.835				Valid

X2.4	0.778				Valid
X2.5	0.902				Valid
X2.6	0.815				Valid
Y1				0.727	Valid
Y2				0.894	Valid
Y3				0.734	Valid
Y4				0.73	Valid
Y5				0.88	Valid
Y6				0.755	Valid
Z.1		0.806			Valid
Z.2		0.891			Valid
Z.3		0.841			Valid
Z.4		0.801			Valid
Z.5		0.888			Valid
Z.6		0.838			Valid

Table 2. Reability Test Results

Variabel	Cronbach's Alpha	Composite Reliability	Result
Competence	0.918	0.935	Reliable
Job Satisfaction	0.92	0.937	Reliable
Motivation	0.934	0.948	Reliable
Performance	0.88	0.908	Reliable

4.3. Inner Model

The internal model is a structural model for predicting causal relationships (causal relationships) between latent variables or variables that cannot be measured directly. Structural models (inner models) describe causal relationships between latent variables built on the basis of theoretical entities. Structural model test (inner model) using SMART PLS bootstrap method and blindfolding method. Structural model tests are run to test the relationships between latent structures. The structural model has several tests, including: B. (1) R square of the endogenous construct. The value of R Square is the coefficient of determination of the endogenous construct. The determination factor values of 0.67 (strong), 0.33 (medium), and 0.19 (weak) (2) The path coefficient estimates are the magnitude of the relationship / influence of the path coefficient values or latent structures. It is run through the

boot wrapping process. (3) Effect size (f squared). Ready to know how good the model is. (4) Predictive relevance (Q-Squared), also known as Stone-Geisser's. This test is run to determine the predictability of the blindfold. When the obtained values are 0.02 (small), 0.15 (medium), and 0.35 (large). Can only be performed on endogenous constructs with reflex indicators. (Setiawan, 2021)

In this study, the inner model can be seen in the table below:

Table 3. Inner Model

Variable	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values	Result
Competence -> Job Satisfaction	0.342	0.35	0.136	2.516	0.012	Significant
Competence -> Performance	0.176	0.174	0.107	1.643	0.101	Insignificant
Job Satisfaction -> Performance	0.245	0.236	0.108	2.262	0.024	Significant
Motivation -> Job Satisfaction	0.336	0.333	0.131	2.568	0.011	Significant
Motivation -> Performance	0.438	0.451	0.11	3.976	0	Significant

Based on Table 3, the following hypothesis can be produced:

H₁: There is an influence between Motivation and Job satisfaction → Accepted

The results of the test can be seen that the original sample estimate value of motivation towards job satisfaction is 0.328 with a significance of 5% which is indicated by a t-statistical value of 2.714 greater than the table t value of 1.96. The original sample estimate value is positive which indicates that motivation has a positive effect on job satisfaction. This result proves that motivation can contribute to the ups and downs of employee job satisfaction.

H₂: There is an influence of Competence on Job satisfaction → Accepted

Based on Table 3, the results of t-statistics were obtained by 3,087 which is greater than the table t of 1.96 with a significance of 5%. So that it can be concluded that there is a positive and significant influence of competence on job satisfaction in employees of the Energy and Mineral Resources Service of South Sumatra Province. This result proves that competence is able to contribute to employee job satisfaction.

H3: There is an influence between Motivation and Performance → Accepted

Based on Table 3, the results of t-statistics of 3,950 were obtained which were greater than t tables of 1.96 with a significance of 5%. So that it can be concluded that there is a positive and significant influence of motivation on the performance of employees of the Energy and Mineral Resources Service of South Sumatra Province. This result proves that motivation is able to contribute to employee performance.

H4: There is an influence between Competence and Performance → Not Accepted

Based on Table 3, the results of t-statistics of 1.643 were obtained which were smaller than t tables of 1.96 with a significance of 5%. So it can be concluded that there is no positive and significant influence of competence on the performance of employees of the Energy and Mineral Resources Service of South Sumatra Province. This result proves that competence is unable to contribute to employee performance.

H5: There is an effect of Job satisfaction on Performance → Accepted

In Table 3, a t-statistics result of 2,054 was obtained, which is greater than the table t of 1.96 with a significance of 5%. So that it can be concluded that there is a positive and significant effect of job satisfaction on job satisfaction in employees of the Energy and Mineral Resources Service of South Sumatra Province. This result proves that job satisfaction is able to contribute to employee performance.

This study was also conducted to determine the influence of motivation and competence on performance through indirect job satisfaction. Here's a table to find out those influences.

Table 4. Indirect Effects Table

Variable	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values	Result
Competence -> Job Satisfaction						
Competence -> Performance	0.084	0.082	0.054	1.566	0.118	Insignificant
Job Satisfaction -> Performance						
Motivation -> Job Satisfaction						
Motivation -> Performance	0.082	0.082	0.052	1.569	0.117	Insignificant

H6: There is an influence of Motivation on Performance through Job Satisfaction → Not Accepted

As seen in Table 4, the result of t-statistics for motivation to employee performance was 3,950 which is greater than the t-table by 1.96 with a significance of 5%. So it can be concluded that there is a positive and significant influence of motivation on performance, while the influence of motivation on performance through job satisfaction is shown by a t-statistics figure of 1,628 which is smaller than the t-table of 1.96 which means that job satisfaction does not function as an intervening variable between motivation and performance in employees of the Energy and Mineral Resources Service of South Sumatra Province.

H7: There is an influence of Competence on Performance through Job Satisfaction → Not Accepted

Based on Table 4, the results of t-statistics for competence on employee performance were 2,011 which was greater than the t-table by 1.96 with a significance of 5%. So it can be concluded that there is a positive and significant influence of competence on performance, while the effect of competence on performance through job satisfaction is shown by a t-statistics number of 1,608 which is smaller than the t table of 1.96 which means that job satisfaction does not function as an intervening variable between motivation and performance in employees of the Energy and Mineral Resources Service of South Sumatra Province.

5. Conclusion

There is a positive and significant influence between motivation on job satisfaction and performance. So good motivation will provide job satisfaction and good performance for millennial employees at the South Sumatra Provincial Resources and Energy Service.

There is a positive influence of Competence on Job Satisfaction but not on Performance. So that if millennial employees have good competencies it will have a positive influence on Performance Satisfaction, while Competency Performance it does not have any influence.

Neither Motivation nor Competence has any influence if through Job Satisfaction so that no influence occurs.

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Training & Research Institute – Jeramba Ilmu Sukses
Jln. Brigjen Hasan Kasim No 22 Palembang, Indonesia
www.journal.jis-institute.org

Email: contact@jis-institute.org

