IntechOpen

IntechOpen Series
Business, Management and Economics,
Volume 13

Business and Management Annual Volume 2023

Edited by Vito Bobek and Tatjana Horvat

Business and Management Annual Volume 2023

Edited by Vito Bobek and Tatjana Horvat

Published in London, United Kingdom

Business and Management Annual Volume 2023
http://dx.doi.org/10.5772/intechopen.113983
Edited by Vito Bobek and Tatjana Horvat

Contributors
Oluwatosin Olushola, Pa Lamin Beyai, Alexander Anagbado, Siti Kurnia Rahayu, Andri Kusdianto, Mª Gabriela Lagos-Rodríguez, Kevin Ow Yong, Michelle Zou, Fei (Phoebe) Gao, Janet Tan, Iryna Heiets, Tamara Oleshko, Oleg Leshchinsky, Garazi Carranza Ruiz de Loizaga, Olatz Amorrortu, Oihane de la Rua Losada, Rajenlall Siriram, Chantelle du Plessis, Chanel Bisset, Ockert Koekemoer, Akram .Abdulraqeb Sultan Al-Khaled, Hemmat Safwat, Chulatep Senivongse, María Del Carmen Martínez Serna, Javier Eduardo Vega Martínez, Herbert Nold, Lukas Michel

First published in London, United Kingdom, 2023 by IntechOpen
IntechOpen is the global imprint of INTECHOPEN LIMITED, registered in England and Wales, registration number: 11086078, 5 Princes Gate Court, London, SW7 2QJ, United Kingdom
Printed in Croatia

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Additional hard and PDF copies can be obtained from orders@intechopen.com

Business and Management Annual Volume 2023
Edited by Vito Bobek and Tatjana Horvat
p. cm.

This title is part of the Business, Management and Economics Book Series, Volume 13
Series Editor: Taufiq Choudhry

Print ISBN 978-0-85014-522-9
Online ISBN 978-0-85014-523-6
eBook (PDF) ISBN 978-0-85014-524-3
ISSN 2753-894X

IntechOpen Book Series

Business, Management and Economics

Volume 13

Aims and Scope of the Series

This series will provide a comprehensive overview of recent research trends in business and management, economics, and marketing. Topics will include asset liability management, financial consequences of the financial crisis and covid-19, financial accounting, mergers and acquisitions, management accounting, SMEs, financial markets, corporate finance and governance, managerial technology and innovation, resource management and sustainable development, social entrepreneurship, corporate responsibility, ethics and accountability, microeconomics, labour economics, macroeconomics, public economics, financial economics, econometrics, direct marketing, creative marketing, internet marketing, market planning and forecasting, brand management, market segmentation and targeting and other topics under business and management. This book series will focus on various aspects of business and management whose in-depth understanding is critical for business and company management to function effectively during this uncertain time of financial crisis, Covid-19 pandemic, and military activity in Europe.

Meet the Series Editor

Prof. Choudhry holds a BSc degree in Economics from the University of Iowa, as well as a Masters and Ph.D. in Applied Economics from Clemson University, USA. In January 2006, he became a Professor of Finance at the University of Southampton Business School. He was previously a Professor of Finance at the University of Bradford Management School. He has over 80 articles published in international finance and economics journals. His research interests and specialties include financial econometrics, financial economics, international economics and finance, housing markets, financial markets, among others.

Meet the Topic Editors

Dr. Vito Bobek is a Professor of International Management at the University of Applied Sciences FH Joanneum (Graz, Austria); Faculty of Economics and Business, University of Maribor; and Faculty of Social Sciences, University of Ljubljana. He published over 500 units in his academic career and visited 22 universities worldwide as a visiting professor. He is a member of the editorial boards of six international journals. He has a long history in academia, consulting, and entrepreneurship. Among his previous functions, he was a member of the Supervisory Board of KBM Infond Management Company Ltd, an advisor to the Minister of Economic Relations and Development, and a member of the Strategic Council of the Minister of Foreign Affairs of Slovenia.

Dr. Tatjana Horvat is an Associate Professor of Accountant and Auditing at the University of Primorska, Slovenia. She is a certified state internal auditor (licensed by the Ministry of Finance of the Republic of Slovenia), a certified internal auditor for the business sector, and a certified accountant. At the Ministry of Justice of Slovenia, Dr. Horvat is a member of examination boards for court expert candidates and judicial appraisers in the following areas: economy/finance, valuation of companies, banking, and forensic investigation of economic operations/accounting. At the leading business newspaper Finance in Slovenia (Swedish ownership), she is the editor and head of the area for business, finance, and tax-related papers, as well as educational programs. She has written over 300 articles, papers, books, and manuals, and was a guest at many international scientific and business conferences and universities.

Contents

Preface

Welcome to the Annual Volume 2023 of Business and Management. This collection of chapters presents a diverse panorama of contemporary topics shaping the realms of business, innovation, economics, and strategic management. Instead of focusing on presenting novel scientific data and research results, this volume encapsulates a fusion of insightful perspectives, analyses, and critical discussions.

The chapters herein navigate multifaceted dimensions of organizational commitment, innovation, and competitiveness across diverse sectors. Exploring the confluence of commitment, learning, and innovation within the agribusiness domain, we delve into the critical linkages influencing organizational dynamism.

Innovation, a cornerstone of sustained competitive advantage, is scrutinized across several chapters, uncovering its intricate relationship with firm success. From the strategic implications of technological maturity in rail sectors to the disruptive potential of energy taxation on innovation in the European Union, these explorations illuminate the evolving contours of innovation-driven economies.

The economic landscape receives due attention in chapters dissecting the knowledge-energy-capital triad, re-evaluating fiscal sustainability paradigms in resource-rich developing nations, and deploying accounting analytics for workforce and project management. These discussions lay the groundwork for informed decision-making in dynamic economic ecosystems.

Further, this volume navigates the intricate terrain of tax policies and administration, unveiling the challenges and opportunities entwined within the tax landscape. Chapters dissecting the digital transformation of tax administration in Indonesia and the strategic implications of taxing energy serve as pertinent guides in an ever-evolving fiscal world.

Strategic maneuvering, underpinned by game theory and competency profiling, constitutes a fascinating exploration in the context of business strategy and organizational adaptability. Understanding the nuances of decision-making and organizational agility becomes paramount in the contemporary business environment.

As editors, we refrain from detailed scientific expositions in this preface, opting instead to offer a glimpse into the broad canvas this volume paints. Each chapter, penned by seasoned contributors, encapsulates a wealth of insight, analysis, and thought-provoking discourse.

We extend our gratitude to the contributing authors whose scholarly contributions enrich this volume. We hope that this collection serves as an engaging resource, fostering critical reflections and sparking intellectual dialogues within the expansive landscape of business and management.

Finally, we would like to thank IntechOpen Publishing Company for allowing us to become the editors of this book. We appreciate that they believed we could provide the necessary knowledge and technical assistance. We together managed to find the other great colleagues who contributed to this book. We thank each author for their valuable contributions that resulted in this book; it will be an asset to the professional community. We also thank our technical reviewers and colleagues at IntechOpen. We could not have done it without you.

Vito Bobek
Institute of International Management and Entrepreneurship,
University of Applied Sciences FH Joanneum,
Graz, Austria

Tatjana Horvat
Faculty of Management,
University of Primorska,
Koper, Slovenia

Chapter 1

Application of Game Theory to Business Strategy

Iryna Heiets, Tamara Oleshko and Oleg Leshchinsky

Abstract

Game theory is the most popular mathematical tool, the spheres of application of which are economics, finance, management, politics, and military science. The game theory is a multifaceted phenomenon, which, despite being theoretical in nature, highly affects real-life business situations. This article briefly reviews the literature regarding game theory and business and introduces the basic concepts of game theory within the context of business strategy. The authors seek to provide insights into the winning business strategy which includes the elements of competition and cooperation. They determined the main rules of the sequential and parallel interaction in the game. Likewise, the authors focused on the prisoners' dilemma and highlighted two obvious alternatives that managers can use to ensure compliance with agreement. The four characteristics of a successful business strategy were presented as a prerequisite for decision-making using game theory.

Keywords: game theory, business, prisoners' dilemma, strategy, cooperation, competition

1. Introduction

Nowadays game theory attracts particular attention in terms of its use as a strategic tool for conducting business. However, many business leaders underestimate this theory and believe that it is more theoretical than applied. But nevertheless experience shows that the higher manager's level is the more important for him to develop strategic thinking and the ability to apply game theory methods in practice.

During the last years, the importance of game theory for making strategic management decisions has increased significantly in many areas of economic science. In economics, it is applicable not only to solve general economic problems but also to analyze the strategic problems of industries, markets, enterprises, development of organizational structures, management accounting systems, and forms of effective activity stimulation. Examples include decisions on pricing policy, access to new markets, cooperation and joint ventures, identifying leaders and executive agents in innovation, vertical integration, and so on. Generally, game theory can be used for all types of decisions if their decision-making is influenced by other actors. These persons or players are not necessarily market competitors; sub-suppliers, main customers, employees of organizations, and work colleagues may act as them. Due to game theory, the company's management has an opportunity to predict its partners and

competitors' moves. The practical significance of game modeling is also evidenced by the fact that researches conducted in this area have been awarded the Nobel Prize in Economics twice in the past 20 years.

2. Literature review

Game theory is the most popular mathematical tool, the spheres of application of which are Economics, Finance, Management, Politics, and Military Science. It is an economic and mathematical tool for modeling by different persons their optimal performance under competitive (conflict) conditions or cooperation with other persons. The form and applied methods of this theory are mathematical, but by nature of the tasks resolved it refers to the economic analysis. Game theory is a branch of mathematics, but its conclusions have long been applied to economics and business. It studies decision-making processes under conflict conditions, i.e., game theory provides a mathematical prediction of a conflict situation [1].

In any market situation, there is an opportunity to act differently and get the answer to the question—which option will lead to the desired goal with the lowest cost? If you can simulate the player companies' actions, you will get an answer. Has the competitor lowered the price of a product that is already sold at cost again? Has the supplier company made shipments to a noncore retail chain, and now they go to the supermarket to buy a hammer and nails instead of to you? Why do competitors and suppliers destroy the market? And what company strategy is appropriate in this situation? These are the questions that game theory answers. Until the mid-twentieth century, all existing models of decision-making in economic systems considered a participant in a vacuum, who was only interested in increasing their own profits and did not take into account the activities of other economic system participants when your steps affect other participants (players), and their actions affect you. It contradicted the market economy realities, because one of the main factors affecting market participants' performance—competition—was not taken into account. In 1944, John von Neumann and O. Morgenstern published the book "Theory of Games and Economic Behavior," which revealed the idea to consider the economic model as a special case of the game, and its participants—as those who compete with each other, the players, and using mathematics scientifically substantiated the behavior of players in any games designed to cause competition between players (noncooperative games). They mathematically described a way to find optimal strategies in such a game.

They saw the main purpose of game theory as an attempt to accurately describe the individual's desire for maximum utility, or, in the case of the entrepreneur, for maximizing possible profit. In the game theory, the tougher decisions call for the use of the more effective approaches such as game trees. Decision trees are important for the optimization of one player without necessarily indigenizing the other players in the market. For instance, when determining the feasibility of entering a new market where only one firm is operational, the issue of market profitability is considered first which also depends on the reaction of the incumbent firm toward the new entrant ([2], p. 708). On the positive side, the incumbent firm could welcome the new entrant and allow them to take a share in the market or otherwise react negatively through aggression.

A precondition for using game theory and building mathematical models of conflicts is the presence of antagonistic interests between the participants. First of all, this is true for the economic sphere, where the efforts of each participant are aimed at obtaining optimal financial results. Achieving this goal requires effective interaction

with other participants (partners, contractors, etc.). That's why, the result of an individual's actions in a business environment depends not only on their own efforts but also on the these persons' actions.

In 1949, John Nash significantly extended the theory of games, allowing situations where players do not compete with each other but cooperate to achieve a common goal (cooperative games). He also introduced the concept of nonzero-sum games, where the payoff was not a constant (zero-sum games), but could change from the players' actions. It was a real breakthrough in the study of game interaction, which clearly showed obsolescence of the classic competition concept (when every man is for himself).

He developed analysis methods according to which all participants either win or lose. These situations are called Nash equilibrium. According to his theory, the participants should use the optimal strategy, which leads to the stable equilibrium creation. It is advantageous for players to maintain this equilibrium, because any change will worsen their situation. These Nash's works made a serious contribution to the development of game theory, and the mathematical tools of economic modeling were revised. John Nash has shown that the classic Adam Smith approach to competition, where every man is for himself, is suboptimal. More optimal strategies are when everyone tries to do better for themselves by doing better for others. In the Nash equilibrium, the egoistic thinking of each player in the long-term (strategic) perspective leads to a general loss. The result is optimal when each member of the group does better for themselves and for other players. A player's decision that contradicts Nash equilibrium results in their loss. Moreover, Nash equilibrium requires each player to trust others in their rational actions regarding gaining their own benefits, and if one of the players receives information about Nash equilibrium, they must inform other players about the strategies to be followed to increase their payoffs.

Since each organization is one part of a conglomerate of interactions, any decision or action taken by companies will affect several entities that are in direct or indirect contact with the organization. In this regard, the ideal scenario in any industry is the one that entails interactive decision-making where each player's actions depend on the decisions of others. Organizations not only utilize different strategies when handling competitors but are also keen when dealing with suppliers ([3], p. 59). Each supplier will always act based on self-interest, and the collective decisions of the players will not always lead to an optimal outcome for the chain. Shareholders are also an important part of the game, since the actions of the managers will determine the organization's performance and hence the value of shareholders. Notably, there have been numerous companies that sought to increase their profits through malpractices, which were disadvantageous for the shareholders in the long run ([4], p. 101). In this regard, this article argues that the practice of organizational decision-making is a process that necessitates serious consideration of all stakeholders to ensure that the payoffs work in the best interests of all parties.

In 1996, Adam M. Brandenburger and Barry J. Nalebuff published a book called "Coopetition," where they applied game theory conclusions as a branch of mathematics to economics and business. They created a classification of business games and their elements and rules. The proposed principle of "co-competition" allows you to leave the game as a winner without ruining your competitors.

As a revolutionary and interdisciplinary phenomenon, the game theory utilizes mathematical, philosophical, psychological, and a wide range of knowledge in other fields. In the business context, the theory is commonly used to conduct economic analysis for the highly competitive market such as the oligopolistic market.

As a result, the game theory is a particularly useful tool in identifying high-risk versus high-reward strategic decisions in which strategy games are utilized. The game theory has indeed enables many organizations to grow into veterans in their respective industries and consequently maintain their influence in the long term.

The game theory is an ideal approach where competitive modes can be easily remodeled. In this regard, multiple strategy games will be played for the purposes of averting the different pressures caused by different competitors. The games are aimed at recommending multiple strategic decisions to guide competitive processes and analyzing how the possible strategies can aid in predicting competitive outcomes. The involved strategic decision, number of players, and the available information will hence help to determine the type of game that is best suited for the organization's immediate needs ([5], p. 121). The concerned organization must also consider that the methodologies tend to have several shortcomings. In this regard, the game theory is based on the assumption that: the players will act in a rational manner and only pursue personal interests; the players conduct themselves strategically; and that the outcome is only desirable if managers fully grasp the anticipated positive and negative outcomes of the targeted decision. In reality, however, humans do not always act rationally, managers do not always think strategically, and companies often neither understand their payoffs nor that of competitors.

Since its roll-out, the game theory has grown tremendously. The approach has helped organizations optimize their marketing strategies, roll out decisions that wage war with competitors, develop tact in auctioning activities, and establish authentic styles of voting. For instance, the Nash equilibrium that was developed by John Nash has helped organizations plan and strategize their decisions ([4], p. 104). The equilibrium assumes that the market is operating at a stable state, and hence no organization is advantaged over the other whether or not it changes its strategy unilaterally. Through such an assumption, companies can engage in a noncooperative game when implementing their strategies.

The theory is an imminent part of modern decision-making practices. Through the simultaneous strategies, for instance, rivals need not inform their competitors about their decisions before taking them. For example, if two airline companies are required to submit sealed bids for the price of several jet airliners to a foreign national airliner. Both organizations will be free to set either low or high prices, in which case, the lower bidder will be awarded the order. However, should both companies bid the same amount, and then they will share the bid especially if both have the capacity to build all 10 airplanes. The benefits realized for both firms are therefore dependent on the choices of each company ([4], p. 106). The dominant strategy is also a well-known approach that was developed as part of the game theory. The dominant theory is applicable in situations where the only means of achieving optimization is through a specific strategy regardless of the rival's actions ([5], p. 123). In such a case, the equilibrium is attained when each player settles for their own dominant strategy.

Indeed, with the dominant strategy, the payoffs could involve profit or loss. According to [6] (p. 158), the preferences and needs of the end user (dimensions of value) can be used as a means of beating competitors. One form of aggression is a cut-throat price war ([3], p. 62). To cut down on operational costs, the new entrant can venture into moderns technology or otherwise settle for the high cost case by using existing technologies. In such a case, the game theory dictates that the incumbent would benefit more by accommodating the new entrant. In this regard, the theory discourages indifference and irrationality among firms, as doing so can thwart optimization [7].

The game theory is a multifaceted phenomenon, which, despite being theoretical in nature, highly affects real-life business situations [8]. The principles thereof account for the different forms and sizes of organizations regardless of the industry in which they operate. For instance, the emphasis the theory puts in the concepts of equilibriums offers a clear-cut depiction of the need for organizations to pay attention to the potential impact of their short-term and long-term decisions. The theory is also rich in perspectives and allows for real-life investigation of decisions before embarking on them [9]. Doubtlessly, the game theory has had a revolutionary effect on the business world since its inception.

3. Main part

From the game theory point of view, economics is identified with the strategic game. Each participant in this game tries to maximize some function (result). In order to obtain this payoff (optimal financial result), the participant needs to make a choice in favor of such a behavior strategy that minimizes influence of the opponents' strategies. A good strategy is not just a way to win a competitive war. Avinash K. Dixit [10] and Barry J. Nalebuff are sure that winning strategy should combine elements of competition and cooperation. And the manager needs to have a special type of thinking that will allow him to create good strategies and act correctly in difficult situations.

Strategic thinking, according to Dixit [10] and Nalebuff, is the ability to outperform the opponent, knowing that he is also trying to outperform you. It is also the ability to find ways to cooperate, even if others are guided only by their own interests. This is the ability to convince others (and even yourself) to do what you have promised. This is the ability to interpret and disclose information. This is the ability to put yourself in the other person's place in order to predict their actions and influence them.

They claim that strategic thinking is based on the principles of a science called game theory. Although people sometimes tend to behave irrationally, their behavior can still be predicted using this knowledge.

One of the principles to keep in mind when playing the "strategy game" is that you are not acting in a vacuum. Your moves affect other players, and their actions affect you. This game provides two main types of interaction (**Figure 1**):

- sequential, when decisions are taken in succession and players in this case need to look ahead to try to calculate what their actions will lead to, what the responses may be, etc.

- parallel, when players act simultaneously, not knowing what moves are made by their opponents. In this case, in order to win, you need to think about how the competitor can act, because you must not forget that you are not alone in this game.

Your steps affect other players, and their steps affect you. That's why, before forming your strategy, you need to understand what type of interaction you are dealing with. Sometimes, it happens that there are both parallel and sequential interactions in the game.

The main rule of games with sequential steps is the following: to look ahead and think in reverse order. In other words, you need to analyze what your opponents will do next and use your conclusions to make a decision right now.

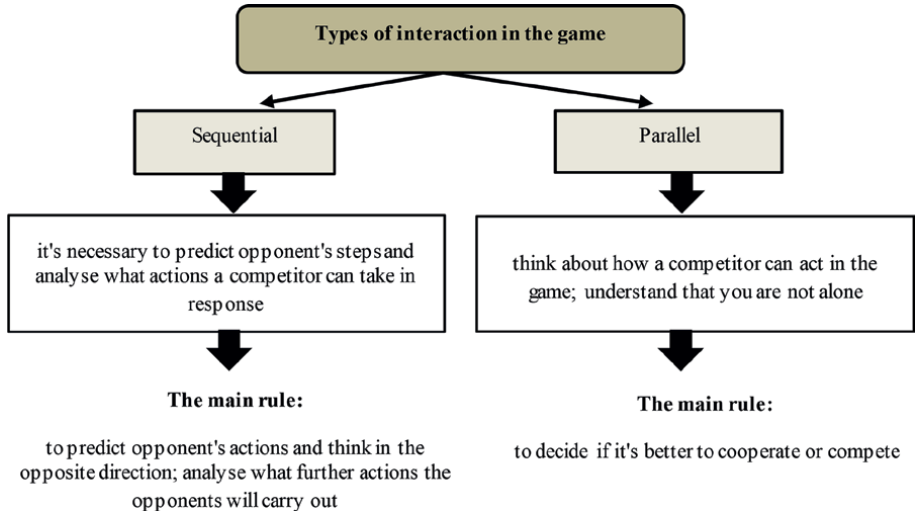


Figure 1.
Types of interaction between participants in the game.

This allows you to resolve problems correctly and choose a strategy in situations where players take turns at making their steps. Those who do not do this (whether consciously or not) are impeding their own goals achievement. However, sometimes unexpected difficulties occur. In particular, if the opponent "plays an ultimatum," it becomes very difficult to predict the results.

One of the basic game theory concepts is the prisoners' dilemma. That's the name of a situation when both opponents are forced to act in a way that is not in their mutual interests, i.e., the players will not always cooperate with each other, even if it is in their interests.

Two prisoners, for example, A and B, are accused of committing a joint crime, which is punishable by deprivation of liberty for a period of 10 years. However, if one of them confesses to what they have done and blames the initiative of the crime on the other one, his prison term will be reduced to 3 years, and the other prisoner will get the full term (10 years). If both prisoners confess to the crime, they get 5 years each. It is possible that both prisoners will deny their involvement in the crime, and then they will be released for failure of guilt evidence (**Table 1**). However, to do so they need to agree to remain silent. But prisoners are kept in different cells and cannot coordinate their behavior during interrogation.

Of course, everyone wants to be free from restrain, but to achieve this goal both prisoners must not confess to the crime. At the same time, those who do not confess to the crime risk to stay in prison for 10 years if their partner does. To confess or not,

	Prisoner B remains silent	**Prisoner B testifies**
Prisoner A remains silent	0, 0	10; 3
Prisoner A testifies	3; 10	5; 5

Table 1.
Game matrix of prisoners' dilemma.

that's the question. It is obvious that in noncooperative behavior conditions, everyone will choose the least risky option. The rational assumption in this case is the worst option scenario (the partner in crime confesses to the crime). According to this strategy, both criminals will confess and get 5 years each.

In any case, the strategy of testifying for each prisoner (player) is dominant. The dilemma is that payoff in the dominant strategy for each player is smaller than for option that takes into account all players' interests. The situations described by the term "prisoners' dilemma" include a very common situation in business—price wars between competitors. In this situation, the best result for one company does not always mean the worst result for another one. In addition, this kind of game does not mean that somebody will be the loser and somebody—the winner. In many games, such as prisoners' dilemma, the main issue is how to avoid losing or achieve a payoff for both participants. If in a game with parallel steps, the optimal player's choice does not depend on other players' choices, and it is said that the player has a dominant strategy—both Dixit and Nalebuff recommend to use exactly this one. In the prisoners' dilemma, each player has a dominant strategy.

People or companies that found themselves in the prisoner's dilemma can achieve better results if they reach agreement and cooperate. In reality, however, it's not so easy to do. Each participant has a serious temptation to break the agreement (betray) and get even more. For example, to preserve the fish population, fishermen may decide to set a certain catching quota. However, how can we ensure compliance with this agreement? There are two obvious alternatives: either promise the participants a reward for sticking to the decision or determine the penalty for violating the agreement. Of course, the reward can be given to players only after they have made a step (otherwise, the temptation to betray might turn out to be stronger). It means that the player may not believe the promise.

However, despite all these difficulties, the reward can be effective and useful. For example, you can entrust the reward to a neutral third party. In real life, the situation is often different: since players interact in several directions, cooperation in one of them is rewarded with a corresponding favor in something else. The option of punishment for breach of the agreement is more common. Because, many games are part of a long-term interaction between the players. And if someone cheats, they will get only short-term benefits. Cheating will damage relationship with the other player, which means that in the long-term outlook it will turn out to be a loss. Punishment is often quite an effective way to achieve cooperation which benefits the participants in the game. However, to achieve the result, the punishment system must meet several criteria: deception detection, punishment form, comprehensibility, inevitability of punishment, scale of punishment, and repeatability. So, deception detection is the first necessary prerequisite for adequate punishment, then it is necessary to determine the punishment nature before the agreement comes into force, and it is also important for the participants to realize what is acceptable behavior in this game conditions, and what is not, and understand possible consequences of deception. It is important for the participants in the game to understand: deception will necessarily be disclosed and punished, and cooperation—rewarded; the participants must know that a serious punishment is more likely to keep them from deception—opponents simply will not want to risk, while deception and destruction of confidence that follows it must cost more than the potential profit it can deliver. Unfortunately, the prisoner's dilemma very accurately describes the situation in business, namely, market competition, when competing companies lower prices, not trusting each other. Although there is a

Company strategy	Company B reduces the price	Company B leaves the price unchanged
Company A reduces the price	–1000, –1000	1500; –1500
Company A leaves the price unchanged	–1500; 1500	0; 0

Table 2.
The winning matrix the prisoners' dilemma application in a duopoly.

solution, you need to negotiate and maintain the price level. However, as part of the strategy of fighting for the consumer, based on a low price, companies are forced to focus primarily on their competitors' moves. As an example, let us consider the following game model, namely the prisoners' dilemma application in a duopoly. Let us assume that there are two light industry products companies A and B in the market, competing with each other. These companies' price reduction strategy is considered. If company *A* starts to reduce prices and company *B* does the same, none of them will increase their market share, and their profits will be reduced by UAH 1000 thousand. However, if company B reduces the price, and company *A* leaves the price unchanged, company *A*'s profit will increase by UAH 1500 thousand, and company B's profit will be decreased by the same amount and vice versa. If both companies leave their prices unchanged, their profits will not change. While developing its price strategy, company *A* calculates possible company *B*'s responses (**Table 2**).

Which strategy will company *A* choose? The best option for it is to reduce prices when company *B*'s policy is stable because in this case the profit increases by UAH 1500 thousand. However, this option is the worst from the point of view of the company *B*. For both companies, it would be reasonable to leave prices unchanged. At this, profits would remain at the same level. At the same time, fearing the worst possible scenario, companies will reduce their prices, while losing profits in the amount of UAH 1000 thousand each. Company B's reduction price strategy will be the strategy of the minimum losses.

Achieving high profits remains the most important goal of any company. That's why, along with competition, they tend to strive for cooperation and coordination of actions, maintaining price stability. Even when demand changes, these companies tend to try maintaining prices at the same level, fearing to be misunderstood by competitors. Oligopolies closely monitor each other's behavior, and if one of them changes prices, others may perceive this decision as the beginning of a price war that is not profitable for everyone. Although many researches have been written about the prisoners' dilemma, there are only a few its solutions (**Figure 2**).

1. *Create a punitive rule* that will remove the betrayal strategy. That is, reducing prices from the dominant ones. For example, each time after another price reduction made by some competitors, the others can influence them in some way. Options for suppliers: stop shipments, marketing support deprivation, or purchase discount reduction.

2. *Get out of the dilemma*. That is, simply leave the consumer no choice. This strategy was once used by GM in the automotive market. Tough competition in the market has led to a sharp drop in car prices. Customers increasingly focused on discounts and sales. Then GM issued a credit card that accumulated annual bonuses from purchases. They could spend bonuses on GM car or service only.

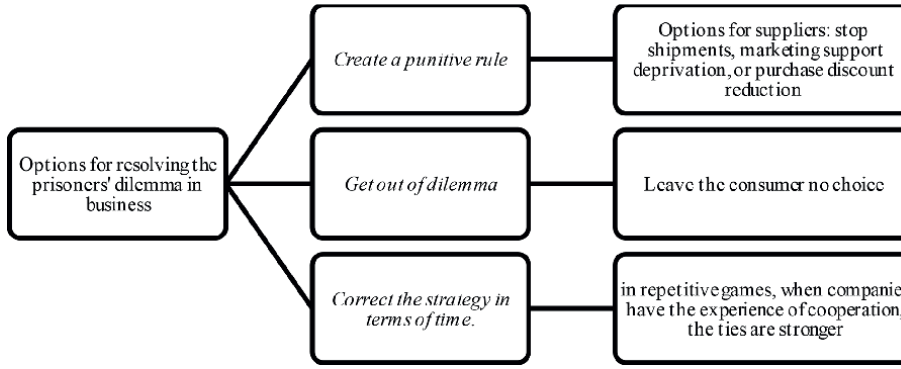


Figure 2.
Solutions to the dilemma are coherent in business.

The company canceled all promotions and directed its efforts to promote the bonus program. As a result, the cards were very popular. The holder could accumulate up to $3500 bonuses during the year, and the issue of choosing a car brand is resolved. By the way, then other car companies followed this way.

3. *Correct the strategy in terms of time*. Before that, when describing the prisoners' dilemma, we assumed that the game develops within a short time frame. However, when companies already have experience of previous games, this situation better responds to the reality and is more interesting in terms of the result options.

The research of R. Axelrod showed that when conducting repeated games at a larger number of players, the strategy to give up, that is, to reduce the price, gives a lower result. The optimal is an "eye for an eye with forgiveness" strategy. Analyzing the strategies that gave the best results, Axelrod named several conditions necessary for the strategy to get a high result (**Figure 3**):

1. Virtue. Never be the first to reduce prices, that is, the most important condition is that the strategy must be good, that is, not betray until the opponent does so. Almost all of the strategy leaders were kind.

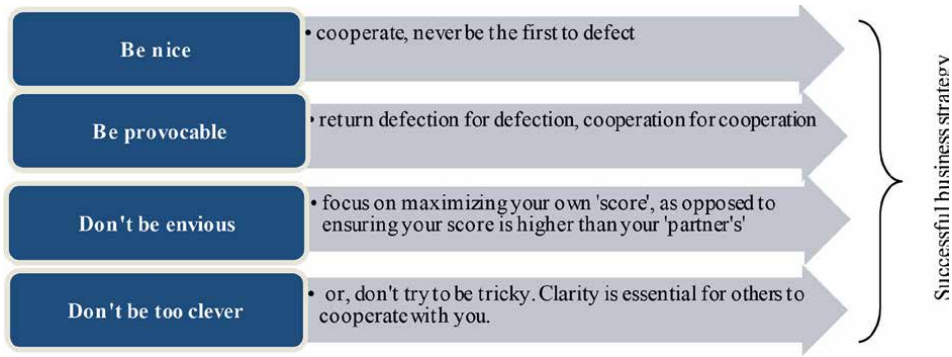


Figure 3.
The characteristics of successful business strategy (Axelrod).

2. Vindictiveness. A successful strategy should not be a blind optimist, and it should respond with a stroke to the competitors' stroke, not to give them a break, maintain control over prices.

3. Forgiveness. After taking revenge on the competitor, return to cooperation if the opponent does not continue to betray. This prevents endless revenge on each other and maximizes your payoff.

4. Unenviousness. Not to try to destroy a competitor at any cost. To look less at other people's business, and more at your own one.

In the modern business, company orientation on unilateral advantages is strategically unjustified as a benefit can and should be provided to all partners.

Based on the fact that many participants can simultaneously win in the market, they proposed to conduct an effective business policy that is based on game theory: to change, in accordance with the company's goal, the composition of players and the added values made by players (business participants), to determine the rules and tactics of the game, its scope and framework. For example, in the fighting for a customer, two companies are competitors, and in issues concerning equipment purchase it is desirable for these companies to cooperate. If they order several identical models of equipment, they can have profit, which will be acceptable for the supplier itself. Thus, the concept of A.M. Brandenburger and B.J. Nalebuff called for a flexible competitive policy that would combine the struggle for leadership with cooperation, and as a result, the company's competitive position would be formed. It will help businessmen successfully conduct business by playing a game that is beneficial for their company.

4. Conclusion

In this article, the authors concluded that game theory is the most popular mathematical tool, the spheres of application of which are Economics, Finance, Management, Politics, and Military Science. The authors conclude that the winning strategy for companies should combine elements of competition and cooperation. The identified two main rules of games are sequential and parallel interaction. Based on this, the main rule of games with sequential steps is the following: to look ahead and think in reverse order. This allows to resolve problems correctly and choose a successful strategy in situations where companies take turns at making their decisions. For parallel interactions, the main rule is to decide if it's better to cooperate or compete. One of the basic game theory concepts is the prisoner's dilemma. The situation described by this term includes a very common situation in business know as price wars between competitors. In this situation, the best result for one company does not always mean the worth result for another one. The authors highlighted that two obvious alternatives that managers can use in business: either promise the participants a reward for sticking to the decision or determine the penalty for violating the agreement. The game model, namely the prisoners' dilemma, is also applicable in duopoly. The authors presented three options solution to the dilemma in business such as create a punitive rule, get out of the dilemma, and correct the strategy in terms of time. In addition, the characteristics of successful business strategy by Axelrod were presented as a required condition for successful strategy in business.

Application of Game Theory to Business Strategy
DOI: http://dx.doi.org/10.5772/intechopen.111790

Author details

Iryna Heiets[1*], Tamara Oleshko[2] and Oleg Leshchinsky[3]

1 RMIT University, Australia

2 National Aviation University, Ukraine

3 College of Engineering and Management of National Aviation University, Ukraine

*Address all correspondence to: iryna.heiets@rmit.edu.au

IntechOpen

References

[1] Heiets I, Oleshko T, Leshchinsky O. Game-theoretic principles of decision management modeling under the coopetition. International Game Theory Review. 2021;**23**(1):1-18

[2] Neumann JV, Morgenstern O. Game theory and economic behavior. Science. 1970;**1970**:708

[3] Brandenburger AM, Nalebuff BJ. The Right Game: Use Game Theory to Shape Strategy. Chicago: Harvard Business Review; 1995

[4] Erhun F, Keskinocak P. Game Theory in Business Applications: Management Science and Engineering. Stanford: Stanford University; 2003

[5] Saloner G. Modeling, game theory, and strategic management. Strategic Management Journal. 1991;**12**(S2):119-136

[6] Budler M, Trkman P. The role of game theory in the development of business models in supply chains. In: 2017 IEEE Technology & Engineering Management Conference (TEMSCON). Santa Clara, CA: IEEE; 2017. pp. 155-159

[7] Brickley J, Smith C, Zimmerman J. An introduction to game theory and business strategy. Journal of Applied Corporate Finance. 2000;**13**(2):84-98

[8] Heiets I, Prakittachakul V. Optimizing the marketing strategies of Qantas Airways and Thai Airways. Transnational Marketing Journal. 2020;**8**(1):95-124

[9] Heiets I, Oleshko T. Coopetition strategies for airlines based on game theory. In: Australian International Aerospace Congress (AIAC18). Engineers Australia, Royal Aeronautical Society. Australia, Melbourne; 2019. pp. 204-209

[10] Dixit AK, Susan S. Games of strategy: Fourth international student edition. WW Norton & Company. 2015

Chapter 2

Innovation and Firm Competitive Advantages

Rajenlall Siriram, Chantelle du Plessis, Chanel Bisset and Ockert Koekemoer

Abstract

Innovation provides many advantages in terms of competitive advantages; however, many firms fail to seize innovation opportunities. There are different types of innovation, namely product innovation, process innovation, architectural innovation, marketing innovation, service innovation, organisational innovation, and transformational innovation. The different types of innovation offer different opportunities across the product life cycle. In this chapter, some interesting questions are posed: (a) is it necessary to invest in all the different types of innovation, (b) can a firm benefit from one or two of the different types of innovation and (c) how important innovation timing is to extract maximum value across the product life cycle. Responses to these questions are explored, and insights are provided. Interesting lessons are provided to firms as these lessons may enable firms to improve innovation opportunities and competitive advantages.

Keywords: innovation, competitive advantages, value, product life cycle, innovation portfolio

1. Introduction

In a firm, there are different types of innovation, namely product innovation, also referred to as new product development (NPD), process innovation, architectural innovation, marketing innovation, service innovation, organisational innovation, and transformational innovation [1]. These different types of innovation offer different competitive advantages; it is essential to understand better when and how firms can derive competitive advantages from these different types of innovations. Trott [2] positions that the different types of innovation may be time and market-dependent. Porter [3] argues that to achieve competitive success, firms in a particular economy, meaning a specific nation or country, must possess "competitive advantage in the form of either lower costs or differentiated products". Porter [3] further argues that to "sustain competitive advantage, firms must achieve more sophisticated competitive advantage over time, through providing higher-quality products and services or producing more efficiently". Moreover, Porter [3] positions that the influence of the nation, economy or country influences the industry segments rather than the firm. Considering this Porter [3] highlights that many researchers have not fully answered

the question of: Why do firms based in some nations, economies, or countries innovate more than others? To this end, we borrow from Schumpeterian economic growth theory, which states that economic growth arises from competition amongst firms. The competitive advantages may differ in terms of different economies; for example, world countries may claim more competitive advantages stemming from NPD, while less developed countries may claim competitive advantages stemming from other types of innovation. However, these are not mutually exclusive. Notwithstanding that different economies give rise to different types of innovation, some firms are more innovative than other firms, and as such, these firms are more risk-seeking and continually innovate, taking new products and services to market. These firms can and may extract innovation value across different types of innovation spanning the entire product life cycle (PLC). Such firms also have the necessary resources to exploit the different types of innovation across the PLC. Other firms are less risk-seeking and may be risky; moreover, they may not possess all the resources to enable them to exploit the different types of innovation across the PLC. Kay [4] argued that while competitive advantage can come from the possession of assets, size, etc., it is increasingly becoming apparent that firms that can mobilise knowledge, technological skills and experience to create new products and services are at an advantage. These knowledge, skills and experience reside in firm capabilities. In other words, firms need to possess the necessary capabilities to develop competitive advantages in the goods and services they produce. It is important to note that while firms develop these capabilities, they always stick to their core competencies and ensure capabilities are built to protect their core competencies.

Core competencies are the resources and capabilities that enable a firm to develop and or sustain competitive advantages. Some firms are more product-driven, and therefore, their core competencies reside within NPD; other firms, while they develop new products, are more comfortable and excel in process innovation, and hence they invest more in infrastructure and sophisticated manufacturing systems and techniques. Other firms may feel more comfortable outsourcing marketing and service innovation and prefer to focus on NPD and/or process innovation. Whatever the firm decides to do, it is essential that they stick to their core competencies.

Porter [3] further argues that firms gain and sustain "competitive advantages in international competition through improvement, innovation, and upgrading". Porter [3] further describes innovation as inclusive of "both technology and methods, encompassing new products, new production methods, new ways of marketing, identification of new customer groups, and the like". Within this chapter, we explore how firms may explore and exploit the different types of innovation specific to the risk appetite, availability of resources and core competence. Ahmed et al. [5] highlights that "the development of technology and innovation has increased rapidly over the last few decades giving rise to intense competition. Siriram [6] positions that "innovation creates opportunities to improve productivity, reduce waste and thus improves competitive advantages".

The PLC, as depicted in **Figure 1**, shows the different phases of innovation. First, a product goes through a period of infancy. This is also referred to as the fluid phase [2] within the fluid phase NPD in the industry is the highest. There is much competition amongst different products as well as between competitor firms. This is the era of the explosion of different designs; it is the era of radical product innovation [2]. In this phase, the dominant design has yet to emerge. The dominant design is a technology management concept that was introduced by [7], identifying vital technological features that win the allegiance of the marketplace. The emergence of the dominant design signals scientific maturity and acceptance of agreed-upon standards based upon which typical scientific research can proceed [8]. This phase favours firms that

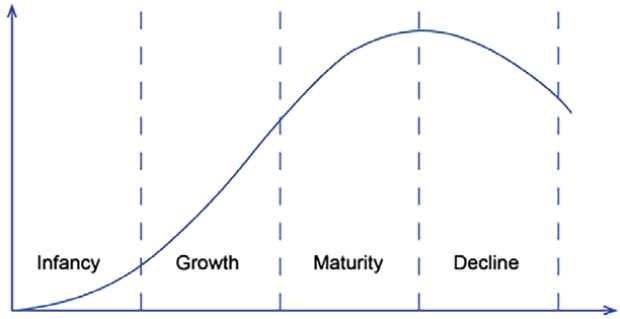


Figure 1.
PLC [1].

have the capabilities to mobilise knowledge, technological skills, and experience to create new products and services. This is the phase of NPD. New products help capture and retain market shares and increase profitability in those markets [9]. Moreover, there is a strong link between market performance and new products [9]. In the twenty-first century, this phase is characterised by short product cycles, which in some cases are in mere months. Therefore, firms must continually innovate by bringing new products to market. Innovation does not end once the dominant design has emerged; innovation now occurs downstream.

Once the dominant design has emerged from **Figure 1**, we see the phase of growth. This phase is the phase of process innovation. Process innovation is about finding better ways to produce products in ways that no one else can or in ways that can be better than anyone else. This can also be categorised as a source of competitive advantage [9]. This phase is the transitional phase, which is characterised by the standardisation of design, and it gives rise to process innovation [2]. For example, the Toyota production system and other such equivalents offered productivity improvements which could not be rivalled by competitors [9]. Process innovation can also be a barrier to entry as firms can introduce sophisticated technologies in the manufacturing process, which require huge investment and mastering these technologies can also be a huge learning curve. Competitor firms may need more risk appetite or capabilities to enter into such markets, and hence, process innovation in such industries becomes a barrier to entry.

From **Figure 1**, the next phase in the PLC is one of maturity, where the product and market have matured, and product and process innovation have diminished; this is where firms explore opportunities for organisational innovation. This phase is also referred to as the specific phase, which is characterised by the contraction of competitors. It is the era of incremental innovation where small changes are made to extend the product's life. Firms may explore other ways to take products and services to the market where firms adopt different business models in terms of how best to structure the business to able to react quicker to market requirements in terms of ease of accessibility to products through more accessible distribution channels, lower business operating costs and so forth. In this phase, the market is more sensitive to price. In terms of process innovation, many strides have been made in adopting manufacturing methods that reduce costs. Organisational innovation is also about reducing business operating distribution and logistics costs, amongst others. Organisational innovation does not occur at the end of process innovation; it is a parallel process to process innovation. Some firms that are more aggressive and confident about NPD may initiate organisational innovation in the infancy or product innovation phase.

From **Figure 1**, also in the maturity phase, firms explore opportunities in service innovation. Service innovation is where firms can offer better service, which is faster, cheaper, and higher quality, which is also a source of competitive advantage [9]. Service innovation occurs throughout the PLC, during the product development phase once the dominant design has emerged, emphasising beyond being able to capitalise on price advantages but also being able to offer benefits in design, customisation, and quality [9]. The rise of the internet has enabled the scope of service innovation to grow enormously. Services can be customised for mass markets or customised to individuals who are able to pay high prices.

Marketing innovation can be described as the "firm's ability to adopt different marketing approaches that will enable the firm to be more effective in the use of channels of communication to facilitate the delivery of goods and services to serve its customers better".

In NPD, there is much uncertainty regarding the capabilities of new products and whether new products fit the needs of potential customers [10]. Marketing innovation can play a significant role in reducing these uncertainties and can enable the firm to develop new relationships with potential new customers to understand their behaviour and learning requirements [1]. "Leveraging marketing resources such as brand name, reputation, and loyalty can also play a significant role in driving product diffusion" [1]. As pointed out by [1, 11], marketing innovation goes beyond NPD, and manufacturing firms have achieved competitive advantages through product differentiation and cost leadership through marketing efforts.

Transformational innovation does not fit into the PLC. Transformational innovation is of such a nature that it can destroy existing markets and firms [1]. It is a rare and powerful form of innovation that creates opportunities for many generations [1]. Transformational innovation rarely stems from existing industries, firms, and products because such entities have vested interests in established innovations; therefore, it stems from outside entities with no vested interest in existing innovation investments and infrastructure" [1]. Due to the sheer potential of the failure of transformational innovation, large firms do not favour venturing into transformational innovation activities on their own, and they instead rely on technological advancements of start-ups or other partners or suppliers to initiate transformational innovation because the risks are so high. Furthermore, transformational innovation requires capabilities and expertise that the firm does not possess [1, 12].

From **Figure 1**, the last phase is the phase of decline, where the product has reached the end of its life, and only a little value can be extracted from this phase. Only some firms will invest further in products, processes, marketing, organisational or service innovations in this phase of the life cycle. This phase is the end of the life of the product.

Having given a brief overview of the different types of innovation, in this chapter, we explore managing technological innovation in firms, the innovation portfolio, innovation processes, and the diffusion of innovation. Insight into some interesting questions are as follows: (a) is it necessary to invest in all the different types of innovation, (b) can a firm benefit from one or two of the different types of innovation and (c) how important is the timing of innovation to extract maximum value across the PLC; are also provided.

2. Managing technological innovation in firms

It is prudent to delve further into the definition of the different views of innovation. [13] describes technical innovation as "the embodiment, combination, or synthesis of

knowledge into new products, processes, or services". Siriram [14] positions that "innovation is a mechanism enabling firms to adapt to changing environments, and it is closely related to a firm's performance as well as its competitive advantage. Innovation may provide opportunities for firms to manoeuvre in turbulent environments" [15], which may include leverage networks, amongst other things [14]. Innovation creates opportunities to improve productivity as well as reduce waste [16] and hence improve competitive advantage [6]. Hesselbein and Johnson [17] positioned that "innovation is a change that creates a new dimension of performance". Whilst these views are not exhaustive, there are many variations of the definition of innovation, and the body of knowledge is quite broad, and it is not the intention to cover this body of knowledge in this chapter. It is, however, important to highlight that almost every industry or a set of leading firms has faced a period of discontinuous change in which they fail to maintain market leadership in the new emerging technological era [18].

It is acknowledged that innovation is complex, and many firms fail at it; however, innovation is essential to the sustainability of the firm. There are many examples of firms that were once winners but have later become losers as they have lost their competitive edge. Examples of firms that have such challenges include "Xerox in the US, Michelin in France, Philips in Holland, Siemens in Germany, EMI in England, and Nissan in Japan" [18]. There are many factors which have led to this situation. Sometimes, the factors that lead to a firm's success are the same factors that lead to its demise [19]. Katz [18] highlights that it is "the leadership strategic focus, valued propositions, structures, policies, rewards and corporate success" that were once the criteria for success and competitive advantage at a certain period can become the stumbling blocks in another period as technological and market conditions change over time. To this end, we refer to [20], who positioned there are five stages of competitive transient advantage: launch, ramp-up, exploit, re-configure, and disengage. Where transient embraces the idea of constant change and evolution. Therefore, instead of firms relying on a single competitive advantage like product innovation, firms develop capabilities that enable them to develop competitive advantages across different competitive advantages, as in the case of this chapter, which is the different types of innovation. There are parallels between these stages and the stages in the PLC. The launch is the same as the infancy or fluid phase; ramp-up is the same as the growth phase; exploit and re-configure can be seen as spanning both the growth and maturity phases, and disengage can be seen as the same as the decline phase. McGrath [20] argues that while exploiting a transient advantage is advantageous for competitive advantage, business leaders must be cautious of building up excessive assets and people, which prevent the business from moving to the next advantage. In such cases, firms often remain stuck in current operations, favouring existing innovations. This is mainly because they have vested interests and cannot easily transition to more disruptive innovations that will make current innovations obsolete. It is essential that it is acknowledged that there is a need to develop capabilities that are easily transitioned across the PLC.

To this end, Katz [18] also points out that industry forces and corresponding organisational priorities operate differently between the different types of innovation, Katz [18] refers explicitly to product and process innovation; however, this can be extended to the other types of innovation such as architectural, marketing, service, and transformation innovation. Tushman and O' Reilly [21] also argued that firms should take "a broader focus on innovation, simultaneously producing streams of innovation over time to succeed over multiple innovation cycles". This implies that firms need to invest across the different types of innovation to survive. Tushman and O' Reilly [21] also emphasises that "innovation streams emphasise the importance of maintaining

control over core product subsystems and proactively shaping dominant designs while generating incremental innovations, profiting from architectural innovation, introductions that re-configure existing technologies, and most importantly introduce other radical product substitutes". Moreover, Tushman and O' Reilly [21] positions that for firms to sustain their competitive advantage, they must simultaneously operate in multiple modes of innovation; they state that firms that are able to operate in multiple modes of innovation are referred to as 'ambidextrous organisations'.

Ambidextrous firms organise themselves for different modes of operation, first for managing the business with consistency, efficiency, and reliability and second for managing the business for new innovations and thinking [18]. Each of these modes of operation requires different kinds of business organisational structures. This is where organisational innovation can also be the source of competitive advantage. For incremental, sustained and competence-enhancing innovations, organisational structures can fit the current mode of operation, which requires centralised control, formalised roles, standardised procedures, structures, and an organisational culture structured more around efficiency. On the opposite end, there are high levels of innovation in the infancy of the fluid phase of the PLC, where the focus is on more novel types of discontinuous innovations which require a different type of organisational structure. Such an organisational structure is more entrepreneurial and favours skunkworks, a start-up spirit, and an innovative and creative thinking organisational structure. Such organisational structures are small and favour decentralisation and fluidity in roles, networks, and work processes. In such an organisation, employees have a culture of pushing the boundaries rather than adhering to standardised processes and organisational routines.

In ambidextrous firms, there are two opposing views. The business or that part of the organisation that is focused on the status quo is often more profitable and focused on efficiency and sees the entrepreneurial part of the business as inefficient, risky, and out of control. This challenges business leaders in ambidextrous firms as they must manage both cultures for sustainable competitive advantage. Business leaders need to have a balanced approach. They need to safeguard the current business, which is more conservative, while at the same time giving the entrepreneurial business the freedom to be innovative and creative so that the future of the business can be secured through more innovative products and ideas which the future market will eventually demand. Some firms have the necessary resources to operate in these different types of businesses separately and distinctly. However, they still need to decipher how to integrate strategies, accomplishments, and markets [18]. The risk of separating the entrepreneurial business is that it comes all too easy to shut down or sell off the smaller unit; this can often happen through changes in leadership where new leadership steps in and finds some of the entrepreneurial innovations too risky. In other cases, where appropriability is weak, the new innovations are often easily commercialised by competitors, and hence, the entrepreneurial entity is at risk of being shut down [18]. There are motivations for separation given the different cultures and work orientations between the two; however, clear thought needs to be given in terms of how the successful entrepreneurial business can be integrated back into the larger organisational structure.

Another motivation to separate entrepreneurial business from existing business is the case for transformational innovation, which is of such a nature that it has the potential to destroy existing business due to the risk associated with such a type of innovation. The benefits, if successful, are enormous, but the risks are equally significant. Transformational innovation has the potential to disrupt existing industries and firms, and as such, firms opt to initiate such types of innovation through start-ups which are external to the firm. Ambidextrous firms have the risk appetite for such a

type of innovation. They also have the necessary resources, capabilities, capacity, and organisational culture to venture into this type of innovation.

3. The innovation portfolio

From an innovation portfolio perspective, firms must have a portfolio of innovations with different innovations in different stages of the PLC. This is the same concept as not having all your eggs in one basket. Firms must diversify their investments and ideally have different pockets or buckets for innovation. Some innovations in NPD, others in the process innovation stage and so forth in that way they can capitalise across the PLC. It was pointed out by [1] that NPD is approximately 50% of the PLC; therefore, firms need to invest in process innovation, organisational, marketing and service innovation to capitalise on the second half of the PLC. Firms spend vast sums of money on NPD, and NPD is itself risky. Not being able to capitalise on the total PLC is not being effective, and it will hamper the competitive position of the firm.

A strategic alignment map can be used to obtain balance in terms of the different types of innovation. From **Figure 2**, we can see a portfolio of the different innovation types. In the infancy phase, there are mainly product innovations which are either radical or disruptive in nature. There can be many products in this stage of the PLC as the dominant design has yet to emerge, and firms could experiment with different types of products. However, it is optional that firms invest in more than one type of domain-specific product because NPD is expensive and also very risky. Some firms with the available funding and other resources may opt for more than one innovation in NPD. The level of investment in this phase can also vary depending on the available resources and risk appetite of the firm. Firms can make large, medium, or small investments. In this phase, there is also an opportunity for radical marketing innovation. In the growth phase of the PLC, we see growth in the radical and disruptive products; we also see the opportunity for architectural innovation, which is novel combinations of existing products; we also see incremental process innovation; some firms can opt for radical or disruptive process innovations. Disruptive marketing and service innovation are also opportunities here. In the maturity phase, most of the

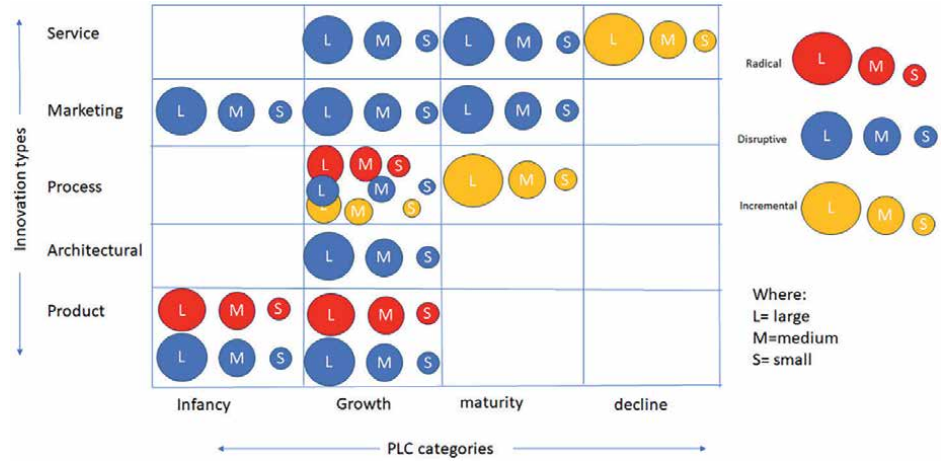


Figure 2.
Strategic alignment map reflecting portfolio of innovations.

innovation will be in the process marketing and service innovation phase because the product has already matured. Finally, in the decline phase, the product is at the end of its life cycle, and service innovation is the main area that some firms may invest in; however, it is also an option to refrain from investing further in this phase of the PLC.

The strategic alignment map gives a graphical representation of the portfolio of investments. It indicates that firms have investments in the different innovation types across the PLC. Taking this approach to innovation also will indicate gaps in the different types of innovation. For example, in **Figure 2**, in architectural innovation, we do not see any novel combination of existing products which can further extend the life of the product. Another example of the decline phase is that we are still seeing significant investments in service innovation. Is this necessary? In this way, firms can take a holistic view of the different types of innovation across the product life cycle. As such, they can determine the necessity to invest in the different types of innovation, providing answers to question (a) Is it necessary to invest in all the different types of innovation? As well as identifying the benefits and return on investment of the different types of innovation and answering question (b) Can a firm benefit from one or two of the different types of innovation? Identifying when to invest in the different types of innovation and responding to question (c) how important is the timing of innovation to extract maximum value across the PLC. For example, in the growth phase, we see much innovation which requires large, medium, and small investments across the different types of innovation from product, architectural, process, marketing and service innovation; the question arises: does the firm have the necessary resources and capabilities to run multiple streams of innovation across one PLC? Note that the firm may not be limited to a single product. There may be multiple products, and as such, investing this much in one product or more will place significant constraints on the firm's resources, capabilities, and capacities. Firms must be cautioned that while they may be eager and willing, there is a risk of doing too much too soon.

4. Innovation process

In terms of the innovation process, we focus on the technology-push process and the market demand-pull process, as these two innovation processes are relevant for obtaining a better understanding of the driving factors for innovation. Takayama and Watanabe [22] position the concept of technology-push and market-pull, where the firm and market act and react to changes in the broader environment by responding with new products. Technological innovation is the catalyst for technology, that is, product innovation, whilst market-driven product innovation has emphasised the importance of market needs and customer needs [22]. In terms of novel, unique technology products, product innovation is the major driving factor to introduce new products to the market; it is also recognised that market knowledge can also stimulate NPD. Therefore, it may be concluded that technology and market knowledge contribute to NPD. Takayama and Watanabe [22] also highlights that many strong firms have lost their strong position in the market when new products have emerged. The question then arises: why cannot leading firms maintain their position in the market? To better understand this problem, it is necessary to delve further into the concept of technology push and market pull.

Technology push is the traditional research-based model. Developments in science and technology drive this model. More investment in research and development is believed to lead to more innovation [23]. This approach is purely a technological

view where the market, to a large extent, is seen as secondary [23]. Pharmaceutical Industries favour this approach. It is a very linear and sequential approach. This approach rests on NPD, and as in pharmaceutical industries, NPD and process innovation occur simultaneously. Marketing innovation is about keeping abreast of market and customer needs and feeding this information to the product development teams. In technology, it is also possible to capitalise on organisational and service innovation. Organisational innovation will evolve around how the firm should structure itself to improve collaboration between marketing and product development teams. Service innovation will evolve to deliver products and better service to customers better. Service innovation will encompass ease of access to products; it will involve delivering products and services economically and, as such, will focus on the cost, quality, speed, dependability, and flexibility of delivery that are the dimensions of the Sand cone model.

In demand-pull, marketing takes the lead. In this model, the market forms the source of new innovative ideas [23]. Some of the challenges here are that this approach is prone to incremental innovation to meet market needs, and new technologies seem to lag, which has the potential to become radical innovations [24]. Lead users have been used quite successfully to improve NPD. The market leader is in the best position to collect technology requirements, and market needs through the collaborative networks already in place. The market leader is well-positioned to identify the next technology product and collect sufficient information [22]. Takayama and Watanabe [22] also hic is sometimes a failure factor for successful Ncese failures as follows:

a. A new product can either be a differentiated product or a superior product.

b. The existing product can either act in direct opposition to NPD, enhancing or hampering.

c. For a new superior product, the existing product's position is enhanced.

d. For a new differentiated product, the existing product position is hampered.

e. A strong existing product significantly hampers the development of new products with differentiated points but enhances the development of new superior products.

While technology-push is predominately focused on NPD, demand-pull and marketing knowledge can significantly enhance NPD. Demand-pull has a strong incremental innovation around products; it also has a focus on process and service innovation.

5. Diffusion of innovation

It is also important to understand how innovation diffuses across the PLC; to this end, we refer to the body of knowledge on appropriability and complementary assets. Appropriately is defined as the ability to generate rents, and complementary assets are the competencies and resources required to enable innovation to diffuse. The regime of appropriability refers to the environmental factors which exclude the firm and market structure that govern the innovator's ability to generate profits from the innovation [25]. Teece [25] argues that "the most important dimensions of such a regime are the nature of the technology and the efficacy of the legal mechanisms". It is widely

known and accepted that patents are the weakest form of protection. Bar a few exceptions, as in the chemical, pharmaceutical and simple products, they offer little protection to the innovator. In industries where innovations are embedded in processes, trade secrets are a viable source of protection compared to patents, for example, in the case of McDonald's and Coke. Another mechanism that could be used to protect the leakage of profits is tacit knowledge, which is not easily codified and transmitted. Tacit knowledge is difficult to articulate and can also be transferred through learning by doing; hence, it offers good protection to the innovator. Oversimplified, one may state that an appropriability regime is tight or weak, where tight appropriability regimes are difficult to replicate and easy to protect and weak appropriability regimes are difficult to protect and difficult or impossible to protect.

Complementary assets can be grouped into two categories, namely competencies and resources. Competencies include, for example, manufacturing capabilities, sales, and service expertise. Resources include, for example, brand name, distribution channels, and customer relationships. Teece [25] takes a value chain approach to complementary assets and argues that complementary assets occur downstream and include capabilities, which include, amongst others, manufacturing capabilities, sales, and service expertise. Later, Taylor and Helfat [26] expanded the definition of complementary assets by [25] to include tangible, intangible, and organisational capabilities. Where tangible assets are things that one can feel, see, and touch, intangible assets are things like brand name and reputation, and organisational capabilities are the things that a firm is good at and has the necessary capabilities to do such things well. Organisational capabilities can be further emphasised to progress towards distinctive organisational capabilities, things that the firm can do better than others and, as such, charge a premium for this, and this is then a source of competitive advantage.

In the infancy phase, there are multiple competing products; therefore, complementary assets are limited as firms do not wish to invest in complementary assets that may not be useful if the product innovation is unsuccessful. However, in this phase, the innovator may have a high-risk appetitive and may have high confidence in the innovation; therefore, this is an opportunity to buy up complementary assets before complementary asset holders realise the true value of the complementary asset. In this way, the innovator can protect themselves from being held hostage by the complementary asset holder. In the growth phase, the dominant design has already emerged, and complementary assets are more readily available. In this phase, the innovator has more options in terms of choosing partners to take the product to market. In the maturity and decline phase, complementary assets are abundant, and the product innovation has lost its uniqueness and been surpassed by other newer innovations. In this phase, the product innovator has many options for complementary asset holders.

6. Conclusions

In this chapter, we explored the different types of innovation. We divulged into how to manage innovation in firms and, in so doing, introduced the concept of ambidextrous firms, that is, firms that can explore and exploit multiple streams of innovation simultaneously. We also cautioned against the challenges of operating both a current profitable business that is focused on efficiency and a more entrepreneurial business that is focused on the future and more risk, seeing as there is a clash in terms of the organisational culture. In addition, we positioned the concept of the strategic alignment map to give firms a holistic view of the portfolio of the different

types of innovation across the PLC. A strategic alignment map enables the view to identify areas which are over-invested and areas that are under-invested, and as such, firms can take a portfolio approach to manage the different types of innovation across the PLC. We also alluded that firms in first-world economies experiment more with NPD than less developed economies, where these less developed economies engage more with the other types of organisations. This is mainly because less developed economies do not have the factor conditions in the economies and do not have the economies of scale and scope to invest in NPD. Notwithstanding this, there are cases where there has been excellent NPD from less developed economies.

The innovation process in terms of technology and demand or market-pull innovation was also emphasised. It was highlighted that this should not be a linear process between the two, and these are also not mutually exclusive but are complementary and interdependent. Finally, diffusion of innovation was discussed, emphasising two important concepts, namely appropriability and complementary assets. We have also provided interesting insights into the different types of innovation. It is positioned that it is necessary to invest in more than one type of innovation across the PLC as the risk of not doing so restricts the firm from capitalising across the PLC. The benefits of investing in the different types of innovation were also highlighted, and moreover, the timing of when to invest in what type of innovation was also discussed.

Innovation is difficult, and many firms struggle with innovation. Therefore, it is important that firms take a broader view of innovation and explore opportunities across the different types of innovation and, as such, derive competitive advantages across the PLC and not only restrict themselves to product and process innovation. It was also emphasised that transformational innovation is of such a nature that it is often not ventured into established structures and firms and often initiated start-ups which are separated from the firm. This is due to the high risk associated with such types of innovation. However, it is recognised that transformational innovation stems from newcomers, and firms must be weary for long-term survival.

Conflict of interest

"The authors declare no conflict of interest."

Author details

Rajenlall Siriram*, Chantelle du Plessis, Chanel Bisset and Ockert Koekemoer
Faculty of Engineering, School of Industrial Engineering, North-West University, Potchefstroom, North-West, South Africa

*Address all correspondence to: raj.siriram@nwu.ac.za and raj@alpha-concepts.com

References

[1] Siriram R, Du Plessis C, Bezuidenhout FR. Exploring the different types of innovation for firm competitive advantages. In: Aldieri A, editor. Innovation-Research and Development for Human, Economic and Institutional Growth. London, UK: IntechOpen; 2023. DOI: 10.5772/intechopen.111820

[2] Trott P. Innovation Management and New Product Development. United Kingdom: Pearson; 2021

[3] Porter ME. The Competitive Advantage of Nations. London: Macmillan Business; 1998. 855 p

[4] Kay J. Foundations of Corporate Success: How Business Strategies Add Value. Oxford: Oxford University Press; 1993. p. 416

[5] Ahmed W, Najmi A, Ikram M. Steering firm performance through innovative capabilities: A contingency approach to innovation management. Technology in Society. 2020;**63**:101385. DOI: 10.1016/j.techsoc.2020.101385

[6] Siriram R. An innovative approach to overcoming technological challenges and improving firm performance in South Africa. Technology in Society. 2022;**68**:101865. DOI: 10.1016/j.techsoc.2022.101865

[7] Utterback JM, Abernathy WJ. Patterns of industrial innovation. Technological Review. 1978;**80**:40-47

[8] Teece D. Profiting from technological innovation: Implications for integration, collaboration, licensing, and public policy. In: Burgelman RA, Christensen CM, Wheelwright SC, editors. Strategic Management of Technology and Innovation. 5th ed. New York: Mc-Graw Hill; 2009. pp. 32-48

[9] Tidd J, Bessant J, Pavitt K. Managing Innovation Integrating Technological, Market and Organisational Change. 2nd ed. Chichester, London: Wiley; 2001. p. 388

[10] Gupta S, Malhotra NK, Czinkota M, Foroudi P. Marketing innovation: A consequence of competitiveness. Journal of Business Research. 2016;**69**:5671-5681. DOI: 10.1016/j.jbusres.2016.02.042

[11] Naidoo V. Firm survival through a crises: The influence of market orientation, marketing innovation and business strategy. Industrial Marketing Management. 2010;**8**:1311-1320. DOI: 10.1016/j.indmarman.2010.02.005

[12] Kupitman Y. Three Types of Innovation and How You Can Interpret Them. Available from: https://proov.io/blog/3-types-innovation-can-implement/ [Accessed: April 1, 2023]

[13] Luecke R. Essential of Managing Creativity and Innovation. Cambridge. MA: Harvard Business School Press; 2002. p. 192

[14] Siriram R. Technological and non -technological innovation effects on firm performance. Journal of High Technology Management. 2022;**33**:100429. DOI: 10.1016/j.hitech.2022.100429

[15] Arranz N, Arroyabe MF, Li J, de Arroyabe FJC. An integrated model of organisational innovation and firm performance: Generation, persistence and complementary. Journal of Business Research. 2019;**105**:270-282. DOI: 10.1016/j.jbusres.2019.08.018

[16] Hung SW, Li CM, Shen MY. Does a U shaped relationship exist between performance and size threshold? The

evidence from Taiwan biotech industry. Technology in Society. 2019;**58**:101147. DOI: 10.1016/j.techsoc.2019.101147

[17] Hesselbein F, Johnson R. On Creativity, Innovation, and Renewal. New York: John Wiley; 2002. p. 120

[18] Katz R. Managing technological innovation in business organisation. In: Shavinina LV, editor. The International Handbook on Innovation. 1st ed. Amsterdam: Pergamon; 2006. pp. 775-789

[19] Henderson R, Clark KB. Architectural innovation: The reconfiguration of existing product technologies and the failure of existing firms. Administrative Science Quarterly. 1990;**35**:9-30. DOI: 10.2307/2393549

[20] McGrath RG. The End of Competitive Advantage: How to Keep Your Strategy Moving as Fast as Your Business. Harvard Business Review Press.; 2017. p. 240

[21] Tushman M, O' Reilly C. Winning through Innovation. Cambridge MA: Harvard Business School Press; 1997. p. 260

[22] Takayama M, Watanabe C. Myth of market needs and technology seeds as a source of product innovation – an analysis of pharmaceutical new product development in an anti-hypertensive product innovation. Technovation; **22**:353-362. DOI: 10.1016/S0166-4972(00)00092-4

[23] David D. Exploring Innovation. UK: McGraw-Hill; 2006. p. 315

[24] Christensen CM. The Innovator's Dilemma. Boston MA: Harvard Business School University Press; 1997

[25] Teece DJ. Profiting from technological innovation: Implications for integration, collaboration, licensing, and public policy. Research Policy. 1986;**15**:285-305. DOI: 10.1016/0048-7333(86)90027-2

[26] Taylor A, Helfat CE. Organisational linkages for surviving technological change: Complementary assets, middle management, and ambidexterity. Organization Science. 2009;**20**:718-719. DOI: 10.1287/orsc.1090.0429

Chapter 3

Competency Profiling of Organization's Absorptive Capacity Development

Chulatep Senivongse

Abstract

This study examines the relationship between competencies and absorptive capacity in organizations. Absorptive capacity, defined by Cohen and Levinthal, is a firm's ability to acquire, assimilate, transform, and leverage external knowledge for business opportunities. Competency refers to individual capabilities for effective task performance. The study explores the recursive nature of absorptive capacity, where individual competencies contribute to its development within the firm. Four competency domains - learning capability, business-orientation, self-orientation, and social intelligence - are identified, forming a framework for analyzing competencies required at different absorptive capacity stages. Aligning competency development with specific stage requirements enhances absorptive capacity. Valuable insights are provided for management, especially HR professionals, to design and manage competency, foster absorptive capacity development, and support organizational growth strategies.

Keywords: competency management, competency assessment, absorptive capacity, absorptive capacity competency, HR development

1. Introduction

This study examines the relationship between absorptive capacity (ACAP) and competency management (CM). ACAP refers to a firm's ability to effectively acquire, assimilate, and utilize external knowledge to enhance its internal capabilities [1]. ACAP strongly connects to CM [2–4]. CM involves identifying and developing the skills, knowledge, and abilities required by individuals within an organization to perform their roles effectively [5–7]. Individual-level competencies play an important role in the development and utilization of ACAP at the firm level.

Competencies enable individuals to effectively acquire and assimilate external knowledge, collaborate, and share knowledge with others, and adapt to changing business environments. By aligning CM efforts with ACAP, organizations can enhance the necessary skills and capabilities in their workforce [8, 9].

Competency models serve as valuable tools in organization talent acquisition, development, and reward systems, enabling the evaluation of personnel performance

across various departments [9]. These models and the associated assessments are widely utilized in all areas of business operations. It is crucial to have a skilled team of experts who can not only apply their knowledge but also utilize their acquired skills, experience, and a blend of traditional, unconventional, and contemporary approaches [10]. This team plays a vital role in facilitating employees' understanding and comprehension of the information, ideas, and data exchanged during work processes.

In the dynamic and competitive global economy, characterized by globalization, innovation, and advancements in information technology, the development of knowledge is pivotal and serves as the foundation for success. To effectively adapt to change, organizations must identify and define the specific skills required across various roles. By implementing a competency benchmarking and assessment system, companies can strategically enhance their employees' capabilities [8]. This system should be embraced by organizations aiming to improve the competence of their workforce and stay up-to-date with evolving trends. Through the establishment of a comprehensive capacity enhancement system that encompasses all levels of the organization, significant progress can be achieved.

Organizations need to build their absorptive capacity [11–13] to leverage their competitive advantage. This literature review seeks to shed light on the competencies that drive the development of ACAP and provide valuable insights for organizations seeking to strengthen their competitive position.

2. Literature review

This section is to identify the competency components that are essential to the development of organizational ACAP.

2.1 Why competency management matters

Competencies encompass the skills, personal traits, and behaviors that contribute to exceptional performance [14]. In the context of a job, competencies comprise both technical skills and personal qualities that distinguish high performers, who consistently exhibit these competencies with superior outcomes compared to average employees. By assessing which career paths hold greater importance for the organization and which are of lesser significance, the company can strategically plan for future growth [15]. Additionally, identifying employees who meet the company's expectations in terms of performance level enables targeted skill and knowledge development opportunities through reassignment to new responsibilities that transcend traditional work function boundaries.

Competency refers to an individual's ability [16] to undertake assigned tasks and deliver results that align with the expected level of quality. Competency provides a sustainable competitive advantage [17]. Each employee possesses a distinct competency profile, and this profile needs to align with the required competencies for performing assigned tasks effectively.

The effectiveness of the CM system hinges on its integration with the performance measurement system. It is important to note that CM systems can vary across different companies [18]. Each system needs to be implemented and tailored to suit the specific requirements of the company and align with its unique business context. The concept of "performance" landscape is shifted from following rules to avoid

errors to focusing on objective of responding to customer's needs [19]. These distinct performance approaches reflect varying values, beliefs, norms, and cultures, thereby necessitating different sets of competencies.

2.2 Evolution of the competency management model and organizational learning

A job competence model defines the specific roles or positions that are often unique to a particular job type or work unit. This model provides a robust framework for designing individualized training and development programs, as well as conducting performance evaluations. The design principles of the CM model are largely derived from an understanding of how individuals learn [20].

Bloom's taxonomy of educational objectives [21] has provided a foundation framework for the development of numerous competency models [22–24]. Bloom designed the learning competency model based on the progression of information from initial reception, cognitive processing, and the translation of results into observable behavior during task performance [25]. The structure of Bloom's model aims to capture the broad essence of competencies, avoiding excessive specificity associated with various organizational contexts [26].

Bloom's taxonomy model of learning revolves around three competency domains: the cognitive (knowledge) domain, which pertains to an individual's ability to recognize, process, and recall information to develop knowledge; the affective (attitudes) domain, which relates to an individual's capacity to internalize, adjust, lead, and exhibit values, attitudes, and cultural alignment in task execution for the business; and the psychomotor (skills) domain, which encompasses an individual's capability to regulate, manage, adapt, anticipate, socialize, and respond to oneself. The psychomotor domain is often referred to as the manipulative domain, as it involves the competency to organize and control one's own actions. It is worth noting that Bloom's original study in 1956 solely focused on the cognitive domain, with the affective and psychomotor domains remaining unexplored. Within the cognitive domain, there are six sub-domains: (1) knowledge; (2) comprehension; (3) application; (4) analysis; (5) synthesis; and (6) evaluation.

To enhance comprehension and simplify the terminology used in Bloom's taxonomy within the cognitive domain, Krathwohl [23] revised the model by shifting the focus from contextual considerations to the learning process itself. The proposed cognitive sub-dimensions were redefined as follows: (1) remember, (2) understand, (3) apply, (4) analyze, (5) evaluate, and (6) create. This updated version of the cognitive domain competency model, developed by Krathwohl, has gained widespread acceptance and adoption by many scholars and practitioners [24, 27, 28].

Building upon Bloom's work, Eiss and Harbeck [25] (see also: Naim and Lenka [29]) expand the scope of competency development by focusing on the affective domain. Their approach emphasizes a behavioral-based learning sequence rather than a sequence based on the absorption of information. In this behavioral-based sequence, the development of competency begins with identifying the desired learning outcomes. The learning process is then broken down into smaller steps, with the final step being the performance feedback loop. They highlight the significance of the feedback loop, which is often overlooked but plays a crucial role in the learning process. They proposed that the observation of behavior should encompass the following processes: (1) receiving or attending, (2) responding, (3) valuing, (4) organizing values, and (5) categorizing the complexity of values. The learning cycle is initiated by external stimuli, which, in combination with attitudes, interests, and motivation,

drive individuals to engage in performance and learning. They view the affective domain as central to competency evaluation, recognizing its importance in assessing and developing competencies effectively.

Competency, as defined by Giesecke and Mcneil [30], encompasses an individual's skills, technical knowledge, and personal attributes that contribute to successful task performance. The CM model emphasizes twelve distinct abilities: (1) analytical skills, problem-solving, and decision-making; (2) communication skills; (3) creativity and innovation; (4) expertise and technical knowledge; (5) flexibility and adaptability; (6) interpersonal and group skills; (7) leadership skills; (8) organizational understanding and global thinking; (9) ownership, accountability, and dependability; (10) planning and organization skills; (11) resource management; and (12) service attitude and user satisfaction. This comprehensive model encompasses both the cognitive domain and the affective domain, considering attitudes, interests, and the iterative learning process.

According to Begam and Tholappan [31], the psychomotor domain within Bloom's model is not a suitable psychometric indicator for assessing business competency. It is more applicable as a measure for elementary school children, focusing on the control and coordination of motor skills such as agility, coordination, strength, flexibility, balance, and endurance. Simpson [32] further elaborates on the psychomotor domain, outlining five sub-domains: (1) perception, (2) set, (3) guided response, (4) mechanism, and (5) complex overt response. Building upon Simpson's model, Hoque [33] expands it by introducing two additional psychomotor sub-domains: (6) adaptation and (7) origination.

Tomassini and Zanazzi [34] have constructed a competency model based on reflexivity theory, which focuses on an individual's mental capacity to reflect on oneself within social relationships. The model encompasses two distinct types: the reflexive stance and the self-development stance. The reflexive stance is individual-specific and involves the construction of self-identity. Reflection plays a crucial role in shaping individual strategies, while self-development aligns with both formal and informal learning approaches. Within the reflexivity domain, there are six sub-domains: (1) identifying and decision-making; (2) communication; (3) judgment; (4) inter-relationship analysis; (5) entrepreneurship; and (6) balancing individual life and society. On the other hand, the self-development stance comprises three components: (1) fundamental cognitive skills, which encompass systems thinking and pattern recognition; (2) emotional intelligence, which involves self-awareness and self-management; and (3) social intelligence, which encompasses social awareness and relationship management.

Cripe and Mansfield [14] put forward a three-prong competency model that encompasses dealing with people, dealing with business, and self-management. The attributes associated with dealing with people align with the cognitive domain competency, encompassing skills such as critical thinking, interpretation, and understanding. Dealing with business, on the other hand, can be categorized as business orientation, focusing on the ability to navigate and operate within a business context. Lastly, self-management pertains to self-orientation, emphasizing the capacity to effectively manage oneself in various aspects.

Capaldo et al. [6] classified competency into four domains: technical-specialistic—technical capabilities that are necessary to perform the job; self-efficacy—individual capabilities; managerial competencies—individual capability to lead; and radical competencies—individual capability on interrelationship.

Rocha Fernandes et al. [35] classified competency into two domains: business domain and socializing domain. The business domain constitutes of creativity and innovation, strategic direction, focus quality, KM, self-development, customer orientation, result orientation, project management, safety, and decision making. The socializing domain consists of communication, leadership, negotiation, change management, relationship building, and teamwork.

Hsieh et al. [36] focus their CM study on learning organization culture. This perspective categorizes the competency model into five domains: knowledge sharing and learning, skills development, self-concept and self-worth, personal characteristics, and motivation and behavioral aspects. Lopes et al. [7] also focus their study on competency development in learning organization and knowledge management. Their study confirms that KM led to an efficient CM system.

Table 1 represents the possible combinations of competency.

In this context, the cognitive domain is now referred to as Learning Competency, encompassing activities such as observation, recognition, interpretation, processing, matching, and understanding. The affective domain has been renamed as business orientation, emphasizing the ability to perform, coordinate, collaborate, and lead within a business context. The psychomotor domain is now called Self-orientation, as it encompasses the intention to improve oneself and acquire the necessary skills to handle challenging tasks. The Social Intelligence domain has been introduced to reflect the importance of cultivating social or network capital within job roles.

All competencies from **Table 2** are combined and normalized to eliminate duplicate values and categorized into competency attributes. Attributes are mapped to the competency domains **Table 3** shows the result of normalization and categorization.

2.3 Absorptive capacity and the business implications

2.3.1 Absorptive capacity and its evolutions

Cohen and Levinthal [1] define the term "absorptive capacity" as a firm ability to acquire, assimilate, and exploit new external knowledge to create the firm's competitive advantage. Zahra and George [37] reify the construct by grouping the ACAP components into two main categories: Potential ACAP (PACAP) and Realized ACAP (RACAP). PACAP combines acquisition and assimilation competencies and pertains to the ability to acquire and disseminate external knowledge within the organization. RACAP combines transformation and exploitation competencies, focusing on the adaptation of internal resources, integration of newly acquired knowledge, and leveraging this equipped knowledge to create a competitive advantage for the firm. Todorova and Durisin [38] propose that the transformation competency is not a sequential step following assimilation but an interconnected alternate path. As a result, they introduced an additional competency called "recognition of value" as a preceding process before acquisition. Furthermore, they emphasized that "social integration" is not solely a required competency for knowledge assimilation but also has an impact on the entire ACAP generation process. Senivongse et al. [39] identify the relevant factors that influence the efficacy of ACAP development. A factor to have a significant impact on the flow and utilization of knowledge is the feedback mechanism. Feedback is necessary at every stage of the flow. Feedback is not only limited to internal units but also extends to external entities within the value chain.

Source	Mapping detail to competency domains			
	Cognitive (Knowledge; individual skill)	**Affective (Attitude; personal attribute; business-orientation)**	**Psychomotor (Skills; self-management; self-orientation)**	**Social intelligence**
Bloom [21]	• Recognizing • Processing • Recalling	• Absorb • Adjust • Lead • Demonstrate value • Attitude • Culture	• Regulate • Manage • Adapt • Adjust • Foresee • Socialize • Respond	–
Krathwohl [23]	• Remember • Understand • Apply • Analyze • Evaluate • Create	–	–	–
Eiss and Harbeck [25]	–	• Receiving or attending • Responding • Valuing • Organizing values • Categorizing value complexity	–	–

Source	Mapping detail to competency domains			
	Cognitive (Knowledge; individual skill)	**Affective (Attitude; personal attribute; business-orientation)**	**Psychomotor (Skills; self-management; self-orientation)**	**Social intelligence**
Giesecke and Mcneil [30]	• Analytical skill • Creativity and Innovation	• Leadership • Organizational understanding and global thinking • Ownership, accountability, dependability • Planning and organizing • Resource management • Service attitudes	–	• Interpersonal and group skills • Communication skill
Ali Begam et al. [31]	–	–	• Agility • Coordination • Strength • Flexibility • Balance • endurance	–
Simpson [32]	–	–	• Perception • Set • Guided response • Mechanism • Complex overt respond	–
Hoque [33]	–	–	• Adaptation • origination	–

Source	Mapping detail to competency domains			
	Cognitive (Knowledge; individual skill)	**Affective (Attitude; personal attribute; business-orientation)**	**Psychomotor (Skills; self-management; self-orientation)**	**Social intelligence**
Tomassini and Zanazzi [34]	• System thinking • Pattern recognition • Identifying	–	• communication • Interrelationship analysis • Self-awareness • Self-management • Decision-making • judgment	• Social awareness • Relationship management • Balancing life, work, and social relations
Cripe and Mansfield [14]	• Conceptual thinking • Forward thinking • Initiative	• Preventing and solving problems • Achieving result • Strategic thinking	• Self confidence • Stress management • Personal creditability • Flexibility • Thoroughness	• Leading • Communicating and influencing
Capaldo et al. [6]	• Information search and diagnostic	• Transfer of knowledge • Perform KM • Lead project of change	• Rules and regulation compliance • Self-control • Problem solving • Monitor activities and process	• Listen to others • Communicate and willingness to discuss • Manage conflicts
Rocha Fernandes et al. [35]	• Creativity and Innovation • Strategic direction	• KM • Planning, organizing, and controlling • Safety, health, and environment • Customer orientation	• Focus on quality • Result orientation • Decision making • Teamwork	• Communication • Negotiation • Relationship building • Leadership/people management

Source	Mapping detail to competency domains			
	Cognitive (Knowledge; individual skill)	**Affective (Attitude; personal attribute; business-orientation)**	**Psychomotor (Skills; self-management; self-orientation)**	**Social intelligence**
Hsieh et al. [36], Lopes et al. [7]	–	• KM	• Self-concept • Self-worth • Personal characteristics	• Motivation and behavior traits

Source: author's own elaboration.

Table 1.
List of possible competency values, elicited from systematic literature review.

Competency Level	Competency attribute	Description	Competency domain
• Remember • Understand • Apply • Identifying • Search and diagnostic	Knowledge recollection and interpretation	Matching existing knowledge to new opportunities	Learning Competency
• Analyze • Evaluate • Categorizing value complexity • Valuing	Analytic and synthetic thinking	Analyzing and synthesizing information for business value	
• System thinking • Pattern recognition	Conceptual thinking	Think in system dynamic landscape	
• Origination • Foresee (forward thinking) • Creativity and Innovation	Creativity and Innovation	Ability to foresee the value and identify solution for current and next problems.	
• Decision-making • Judgment • Problem-solving	Decisiveness	Ability to make decision.	

Competency Level	Competency attribute	Description	Competency domain
• Responding • Compiling with firm's culture • Receiving or attending	Drive for success	Ability to carry on the work to reach the target.	Business-Orientation Competency
• Thoroughness • Focus on quality • Result orientation	Attention to details	Ensure work accuracy and completeness.	
• Entrepreneurship • Organizational understanding and global thinking • Ownership, accountability, dependability • Strategic thinking	Entrepreneurial Capability	Ability to see the big picture, strategize ways to deliver result, and take on responsibility for the course of actions.	
• Resource management • Planning and organizing • Perform KM	Planning, Organizing, and Controlling	Ability to manage and execute tasks.	

Competency Level	Competency attribute	Description	Competency domain
• Service attitudes • Perception or growth mindset • Creditability • Perform as instructed or guided process	Self-Confidence and Integrity	Demonstrating personal creditability, reliability, and consistency in the eyes of others.	Self-orientation Competency
• Respond • Strength • Endurance or persevere	Stress Management	Ability to work under pressure	
• Complex overt respond • Flexibility • Agility • Adapt • Adopt	Flexibility	Ability to adapt and change to condition of working	
• Self-awareness • Self-management • Balancing life and work • Regulate oneself • Manage oneself • Self-concept • Self-worth • Personal characteristics	Personal Goal and Development	Have clear life goals and take action to achieve the goals.	

Competency Level	Competency attribute	Description	Competency domain
• Interpersonal and group skills • Relationship management • Leadership • Lead project of change • Manage conflicts	Leading	Ability to lead others.	Social Intelligence
• Communication skill • Listen to others • Communicate and willingness to discuss	Communicating	Ability to communicate clearly and precisely to others, as well as ability to understand clearly.	
• Coordination	Collaborating and Teamworking	Ability to work as a team, be a good supporter.	
• Social awareness • Motivation and behavior • Negotiation	Influencing	Convincing others to provide support, including noticing, interpreting, and empathizing others when in concerns.	
• Interrelationship awareness and analysis • social relations • Relationship building	Socializing	Developing and maintaining network of socializing and collaborating.	

Author's own coding and interpretation.

Table 2.
Competency mapping, normalization, and categorization.

ACAP Step	ACAP characteristics	Competency Attributes Required in Each Step of ACAP Development			
		Learning capability (Cognitive domain)	**Business-orientation (Affective domain)**	**Self-orientation (Psychomotor or skills domain)**	**Social intelligence**
Value identification	See potential of new knowledge to business. Analyze and decide to absorb.	• Knowledge recollection and interpretation	–	• Self-confidence and integrity • Personal goal and development	–
Acquisition	Incept the external knowledge with focus on intensity, speed, and direction based on prior knowledge. Entire value addition process is seen.	• Analytic and synthetic thinking • Conceptual thinking • Creativity and innovation	–	• Self-Confidence and Integrity • Personal Goal and Development	–
Assimilation	Utilize existing knowledge structure to understand the new knowledge. Cognitive structure remains intact. Using old frame to explain the phenomena.	• Knowledge recollection and interpretation • Decisiveness	• Drive for success • Attention to details. • Planning, organizing, and controlling	• Stress Management • Flexibility	• Communicating • Collaborating and teamworking • Leading
Transformation	Combine the new knowledge structure with the existing knowledge structure. Cognitive structure is altered for new knowledge to fit. Need new frame to understand the phenomena.	• Knowledge recollection and interpretation • Decisiveness	• Drive for success • Attention to details • Entrepreneurial capability • Planning, organizing, and controlling	• Stress management • Flexibility	• Communicating • Collaborating and teamworking • Leading
Exploitation	Leverage new potential with new resource re-configuration. Knowledge in market management is the key enabler of success.	• Decisiveness	• Entrepreneurial capability • Planning, organizing, and controlling	• Flexibility • Stress management	• Communicating • Collaborating and teamwork

ACAP Step	ACAP characteristics	Competency Attributes Required in Each Step of ACAP Development			
		Learning capability (Cognitive domain)	**Business-orientation (Affective domain)**	**Self-orientation (Psychomotor or skills domain)**	**Social intelligence**
Socialization	Support the ACAP building process by lowering the barrier among each ACAP component	–	–	–	• Leading • Communicating • Collaborating and teamworking • Influencing • Socializing
Appropriability	Foresee the value of knowledge and the path that lead to innovation	• Knowledge recollection and interpretation • Creativity and innovation • Analytic and synthetic thinking • Conceptual thinking • Analytic and synthetic thinking	• Entrepreneurial capability	–	–
Feedbacking	learn and adjust the process and routine to ensure the correct path is followed	• Analytic and synthetic thinking	• Drive for success • Entrepreneurial capability	• Flexibility • Stress management	• Influencing • Communicating

Source: author's synthesis.

Table 3.
Competency required for ACAP development.

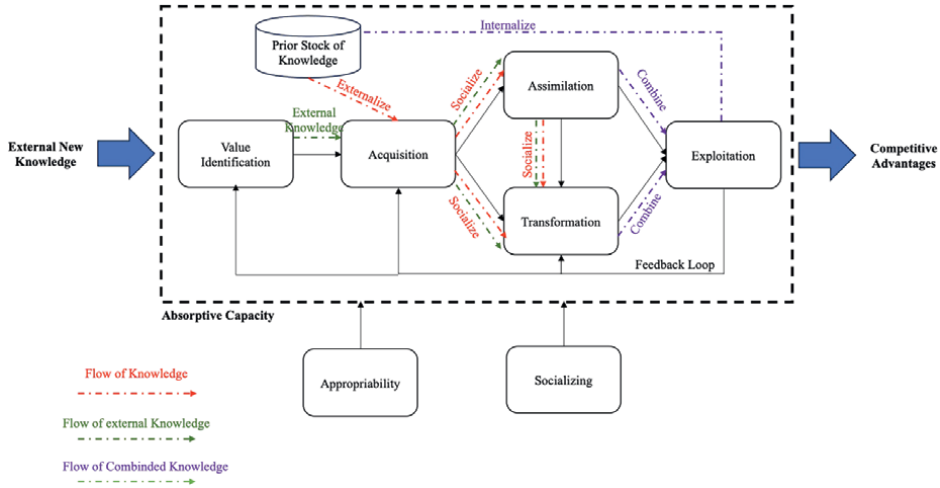


Figure 1.
ACAP construct references for this study (sources: Adapted from Todorova and Durisin [38]).

Figure 1 is the ACAP framework used for this study. It depicts the flow of knowledge flow from external sources and internal existing knowledge stock in the organizational learning process of socializing, externalizing, combining, and internalizing [37–40].

2.3.2 Absorptive capacity recursive property

According to Nonaka and Takeuchi [41], knowledge generation begins at the individual level and expands to the group and organizational levels through socialization. Davenport and Prusak [42] support this view, highlighting the process of transforming information into knowledge through individual internalization, interpretation, and contextual experimentation. The newly absorbed knowledge has a transformative effect on an individual's behavior and outcomes. This includes sharing new knowledge with colleagues, co-constructing new routines and processes, and even shaping new working cultures, ultimately expanding knowledge from the individual to the team and the entire organization [43].

The development of ACAP involves a multi-level learning process [44–46]. It begins with an individual's recognition of new information and the decision to acquire and internalize it as knowledge. Individual knowledge is then assimilated within the team or department, leading to the development of new internal processes, routines, procedures, policies, cultures, and norms within the organization. As a result, ACAP is a recursive process that encompasses the acquisition, assimilation, transformation, and exploitation of new knowledge, progressing from the individual (Micro) level to the team and department (Meso) level, and finally to the organizational (Macro) level.

Therefore, it becomes evident that ACAP possesses a recursive nature in terms of knowledge creation and expansion, starting from the individual level and extending throughout the organizational hierarchy. This further emphasizes the significance of people's competencies within the organization for ACAP development. By assessing and planning competency development at the individual level, with a specific focus on enhancing the organization's ACAP, it becomes possible to measure the effectiveness of ACAP construction.

2.3.3 Competency factors that impact the development of a firm's absorptive capacity

In the process of absorption of new external knowledge, ACAP is generated at different levels from the individual to the firm. As introduced above, ACAP development requires the preparation of individual competencies, with an individual's competencies incorporating the firm's ACAP. However, different levels of ACAP development involve different sets of competencies. It is crucial to examine which competency components are necessary for different levels of ACAP development.

Value Identification of external knowledge is the primary step of ACAP development, the key component to efficiently define external knowledge. At this stage, an information analysis needs to be performed to assess the value of the new knowledge. With the purpose of the organization in mind, the strategic opportunity and constraints need to be identified before deciding to absorb the knowledge. The trustworthiness of the source is also vital for the reliability and success of value realization [47, 48]. The individual who foresees the potential of new knowledge must have the technical knowledge, as well as the understanding of company's values, visions, strategies, the need for change, and how to lead from beginning to ending systematically [49]. The capability to explore for information, understand the context, judgment, and decision-making are the cognitive abilities highly utilized at this stage.

Acquisition is the process of incept external knowledge [37]. This process focuses on intensity, speed, and direction. Intensity and speed are the capabilities of how a firm can see the necessity of having new knowledge and how fast the adoption can occur. Direction is the path to accommodate the implementation of external knowledge into the firm. In acquiring knowledge, the process involves a multidisciplinary inception team [39]. Working with members from multiple teams requires interpersonal management skills, functional knowledge of related fields, social capability to help with learning, individual self-organization, project management skills, leadership skills, and communication skills [50].

Assimilation, the recollection of prior knowledge, plays an important role in easing the absorption, interpretation, patterning, and conceptualizing to integrate new knowledge into the existing knowledge structure of the organization [51]. Assimilation process requires individual analysis, synthesis, interpretation, comprehension, learning, and understanding ability [37]. At this point, the individual's cognitive structure is not altered [38].

Transformation is the stage of new knowledge creation (1). This stage involves problem-solving and combined-knowledge internalization. Creativity and innovation lead the transformation, and new knowledge is added to the stock of existing knowledge [37]. Effort intensity is the key enabler for success in generating and integrating new knowledge. The combined knowledge enforces the entrepreneurial action with the recognition of business opportunity [52]. At this point, the individual's cognitive structure is altered [38].

Exploitation is where combined knowledge is applied [1] and operationalized [53, 54]. The outcome of this stage is the new product or service [37]. This will leverage the firm's competitive advantage. The balance between the firm's objective and profitability goals must be met for business sustainability [55]. At this stage, market knowledge is the key success enabler. The individual must understand the customers' dynamics to identify the business opportunity. Analytic capability, understanding of the firm's strategy, information analytic capability, market testing, and conceptual thinking are required to successfully perform [56].

Socialization is an important capability that eases the ACAP building process by lowering the barrier between each ACAP component. Socializing strengthens the relationships among the external knowledge sender and internal knowledge receivers, and among internal knowledge transferers and internal recipients. It eases the coordination for resource configuration, operational process integration, and improves the relationship between the individual and the firm's customers.

Appropriability is the ability to foresee how external knowledge can be leveraged and benefit the firm's commercial advantage. This competency allows individuals to identify opportunities for the organization, within the area of responsibility to develop alternatives and innovate new processes, and pattern for the solution to the existing or the next problems [57].

Feedback plays an important role in enabling individuals to learn and adjust to ensure they are on the right path. Feedback requires giving and taking comments. Reflexive learning is the key activity of this element. Feedbacking can be stressful, thus, communication is the key enabler for success.

3. Construct of competency for ACAP development

With the defined competencies in the categorized domains, these competencies are to be mapped with the entire process of ACAP development. **Table 3** denotes the competencies required at each step of ACAP. The selection and assignment of competencies are reviewed and validated by KM experts at the Institute for Knowledge and Innovation-Southeast Asia.

4. Discussion

Competency is an inherent attribute that resides at the individual level. Each person within the organization plays a role in the development of ACAP, starting from the foundational level and gradually building up through an escalation process to achieve firm-level ACAP. Effectively managing individual competency is a critical initial step towards securing a sustainable competitive advantage for the organization. Managing competency entails collaborative efforts between leaders and the HR department. It involves three key activities [6]: (1) Identifying the specific competencies required for each occupational role; (2) Administering assessment tests to evaluate the presence of these competencies; and (3) Establishing a correlation between individual competencies and performance indicators to gauge effectiveness. By implementing these activities, organizations can proactively manage and leverage the competencies of their workforce to drive success.

To begin with, the leader of the team collaborates with the HR department to determine the specific competencies and their corresponding competency levels required for each functional role [6]. This process involves engaging in discussions and establishing a benchmark by identifying the competencies exhibited by the top-performing individuals in each role. The top performer is then invited to undergo a competency assessment, which serves as a reference point for exceptional job performance.

Next, the same assessment test is administered to all employees within the organization, enabling their individual competencies to be benchmarked against the established references. This step reveals any competency gaps and facilitates

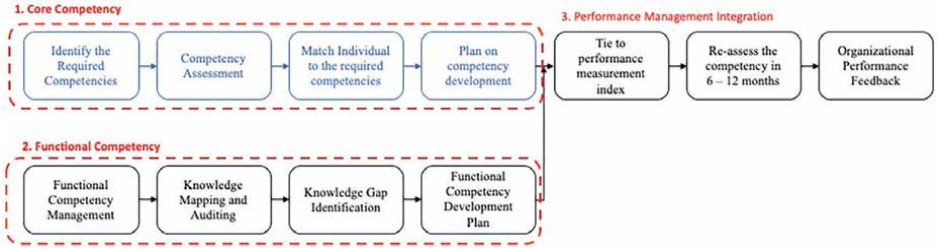


Figure 2.
Competency management process (source: author's own construct).

the formulation of competency development plans tailored to individual's needs. Additionally, it results in the creation of a group competency profile that serves as a baseline for periodic comparisons during subsequent assessment cycles.

Lastly, once the competency gaps have been identified, personalized competency development plans are devised for everyone, considering the projected development requirements for the entire group. The progress of development is assessed through performance evaluations, and the level of competency development achieved may be linked to merit-based performance awards. **Figure 2** illustrates the comprehensive process of CM, including competency assessment, functional assessment, and performance management integration [58].

Functionality assessment focuses on evaluating technical proficiency and the ability to perform specific tasks. To assess functional competency, a suitable approach is to employ knowledge mapping and auditing methodologies [59, 60]. This involves identifying the necessary knowledge and skills required to fulfill a particular job, identifying any knowledge gaps, and determining the areas of scarce knowledge that need to be addressed. A plan is then formulated to develop the required knowledge, either through internal resources or by acquiring it externally.

Furthermore, CM serves as a foundation for various strategic HR initiatives [61]. Job values and career paths can be systematically identified, and intangible values can be quantified for objective evaluation. The organization's corporate culture and values can also benefit from competency management, as they are shaped by the competencies reflected in competency profiles. Additionally, the delegation of authority and signature regulations can be established as byproducts of the CM system [62, 63].

5. Conclusion

In conclusion, ACAP plays a vital role in leveraging external knowledge and enhancing the firm's ability to seize business opportunities. It is a firm-level capability that relies on the competencies of individuals within the organization. This study highlights the recursive nature of ACAP, wherein competencies at the individual level contribute to the development and accumulation of the firm's ACAP.

The review of competency literature has provided valuable insights into the specific competencies required for effective learning and ACAP development. The four domains of Learning Capability, Business-orientation, Self-orientation, and Social Intelligence have been identified as key components of competency. It is important to note that each stage of ACAP development may necessitate a distinct set of competencies, tailored to the individuals responsible for that stage.

By recognizing and fostering the required competencies, firms can strengthen their ACAP and enhance their ability to integrate external knowledge into existing resources. This understanding underscores the importance of aligning competency development initiatives with the stages of ACAP, ultimately driving the firm's competitive advantage and growth.

Author details

Chulatep Senivongse
Institute for Knowledge and Innovation, Bangkok, Thailand

*Address all correspondence to: chulatep.s@bu.ac.th

References

[1] Cohen WM, Levinthal DA. Absorptive capacity: A new perspective on learning and innovation. Administrative Science Quarterly. 1990;**35**(1):128-152

[2] Mao H, Liu S, Zhang J, Zhang Y, Gong Y. Information technology competency and organizational agility: Roles of absorptive capacity and information intensity. Information Technology and People. 2021;**34**(1):421-451

[3] Park T. Antecedents of knowledge competency and performance in born globals: The moderating effects of absorptive capacity. Management Decision. 2012;**50**(8):1361-1381

[4] Lee J, Lee H, Park J. Exploring the impact of leadership competencies on team social capital and performance in IT service team. In: 2013 46th Hawaii International Conference on System Sciences. Jan 2013. pp. 4344-4353. DOI: 10.1109/hicss.2013.224

[5] Athey TR, Orth MS. Emerging competency methods for the future. Human Resource Management: Published in Cooperation with the School of Business Administration, The University of Michigan and in alliance with the Society of Human Resources Management. 1999;**38**(3):215-225

[6] Capaldo G, Iandoli L, Zollo G. A situationalist perspective to competency management. Human Resource Management: Published in Cooperation with the School of Business Administration, The University of Michigan and in alliance with the Society of Human Resources Management. 2006;**45**(3):429-448

[7] Lopes FJ, Maltadeabreu VG, Kumasaka RS, Rosini AM. Competency management, knowledge management and corporative education: A study on Brazilian companies. Journal on Innovation and Sustainability RISUS. 2020;**11**(4):147-158

[8] Leigh IW, Smith IL, Bebeau MJ, Lichtenberg JW, Nelson PD, Portnoy S, et al. Competency assessment models. Professional Psychology: Research and Practice. 2007;**38**(5):463-473

[9] Osteen J. Assessment maturity model for competency mapping - a talent management enabler. IOSR Journal Of Humanities And Social Science (IOSR-JHSS). [Internet] 1 Jan 2013;**15**(3):50-54. e-ISSN: 2279-0837, p-ISSN: 2279-0845

[10] Li ST, Chang WC. Exploiting and transferring presentational knowledge assets in R&D organizations. Expert Systems with Applications. 2009;**36**(1):766-777

[11] Bradford J, Saad M. Towards a method for measuring absorptive capacity in firms. International Journal of Technology Management and Sustainable Development. 2014;**13**(3):237-249

[12] Flatten TC, Engelen A, Zahra SA, Brettel M. A measure of absorptive capacity: Scale development and validation. European Management Journal. 2011;**29**(2):98-116

[13] Pu K, Liu W. Is absorptive capacity the "panacea" for organizational development? A META analysis of absorptive capacity and firm performance from the perspective of constructivism. PLoS One. 2 Feb 2023;**18**(2):1-24. DOI: 10.1371/journal.pone.0282321

[14] Cripe EJ, Mansfield RS. The Value-Added Employee: 31 Competencies

to Make Yourself Irresistible to any Company. Woburn, MA: Butterworth-Heinemann; 2002

[15] Gul R, Khan K. Measuring employee retention and organizational development through competency development. KASBIT Business Journal. [Internet]. 30 Sep 2022;**15**(3):96-109

[16] Zarifian P. Acquisition et reconnaissance des competences dans une organization qualificante. Prof En Form Textes Fondam. 2016:207-215

[17] Clardy A. The strategic role of human resource development in managing core competencies. Human Resource Development International. 2008;**11**(2):183-197

[18] Lustri D, Miura I, Takahashi S. Knowledge management model: Practical application for competency development. The Learning Organization. 2007;**14**(2):186-202

[19] Saul P. Using Management Competencies to Improve Management Performance and Stimulate Self Development. Asia Pacific Journal of Human Resources [Internet]. 1989;**27**(1):74-85

[20] Elkin G. Competency-based human resource development. Industrial and Commercial Training. 1990;**22**(4):20-25

[21] Bloom BS. Benjamin S. Taxonomy of Educational Objectives; the Classification of Educational Goals. Green: Longmans; 1956

[22] Engelhart MD, Furst EJ, Krathwohl DR. Taxonomy of Educational Objectives: The Classification of Educational Goals. Cognitive Domain. Longmans; 1956

[23] Krathwohl DR. A revision of Bloom's taxonomy: An overview. Theory Into Practice. 2002;**41**(4):212-218

[24] Wilson LO. Anderson and Krathwohl–Bloom's taxonomy revised. Ohio, USA: Understanding the new version of Bloom's taxonomy; 2016

[25] Eiss AF, Harbeck MB. Behavioral Objectives in the Affective Domain. Washington DC: National Science Supervisors Association; 1969

[26] Furst EJ. Bloom's taxonomy of educational objectives for the cognitive domain: Philosophical and educational issues. Review of Educational Research [Internet]. 1 Dec 1981;**51**(4):441-453

[27] Huitt W. Bloom et al.'s taxonomy of the cognitive domain. Educational Psychological Interactions. 2011;**22**:1-4

[28] Savickiene I. Conception of learning outcomes in the Bloom's taxonomy affective domain. Quality in Higher Education. 2010;**7**:37-59

[29] Naim MF, Lenka U. Organizational learning and gen Y employees' affective commitment: The mediating role of competency development and moderating role of strategic leadership. Journal of Management & Organization. 2020;**26**(5):815-831

[30] Giesecke J, Mcneil B. Core Competencies and the Learning Organization [Internet]. Lincoln: University of Nebraska; 1999 Available from: https://digitalcommons.unl.edu/libraryscience

[31] Begam AA, Tholappan A. Psychomotor domain of Bloom's taxonomy in teacher education. Shanlax International Journal of Education [Internet]. 1 Jan 2018;**16**(3):11-14

[32] Simpson EJ. The Classification of Educational Objectives, Psychomotor Domain. U.S. Department of Health, Education and Welfare, Office of Education; 1966

[33] Hoque ME. Three domains of learning: Cognitive, affective and psychomotor. Journal of EFL Education and Research. 2016;**2**(2):45-52

[34] Tomassini M, Zanazzi S. Reflexivity and self-development of competencies as key drivers in individuals' learning and career paths: Cases from Italy. Research in Comparative and International Education. 2014;**9**(3):301-312

[35] Rocha Fernandes BH, Cristina Bitencourt C, Maria Comini G. Competence management models in leading Brazilian organization. Brazilian Journal of Management/Revista de Administração da UFSM [Internet]. 1 Jul 2021;**14**(3):458-77

[36] Hsieh PJ, Chen CC, Liu W. Integrating talent cultivation tools to enact a knowledge-oriented culture and achieve organizational talent cultivation strategies. Knowledge Management Research and Practice. 2019;**17**(1):108-124

[37] Zahra SA, George G. Absorptive capacity: A review, reconceptualization, and extension. Academy Management of Proceedings and Membership Directory. 2002;**27**(2):185-203

[38] Todorova G, Durisin B. Absorptive capacity: Valuing a reconceptualization. Academy of Management Review. 2007;**32**(3):774-786

[39] Senivongse C, Mariano S, Bennet A, Tsui E. Absorptive capacity efficacy in SMEs: Evidence from multiple case studies in the information technology industry. Knowledge Management Research and Practice. 2022;**20**(5):672-685

[40] Nonaka I, Toyama R, Konno N. SECI , Ba and leadership : A unified model of dynamic knowledge creation. Leadership. 2000;**33**(1):5-34

[41] Nonaka I, Takeuchi H. The Knowledge Creating Company. New York, NY: Oxford University Press, Inc.; 1995

[42] Davenport TH, Prusak L. Working Knowledge: How Organizations Manage What they Know. Boston, MA, USA: Harvard Business Press; 1998

[43] Levitt B, March JG. Organizational learning. Annual Review of Sociology. 1988;**14**:319-340

[44] Nooteboom B. Learning by interaction: Absorptive capacity, cognitive distance and governance. Journal of Management and Governance. 2000;**4**(1-2):69-92

[45] Schmidt T. Absorptive capacity-one size fits all? A firm-level analysis of absorptive capacity for different kind of knowledge. Managerial and Decision Economics. 2010;**31**:1-18

[46] Su Z, Ahlstrom D, Li J, Cheng D. Knowledge creation capability, absorptive capacity, and product innovativeness. R&D Management. 2013;**43**(5):473-485

[47] Helfat CE, Finkelstein S, Mitchell W, Peteraf MA, Singh H, Teece DJ, et al. Dynamic capabilities: Understanding strategic change in organizations. Strategic Management Journal. 2007;**18**:147

[48] Tripsas M. Unraveling the process of creative destruction: Complementary assets and incumbent survival in the typesetter industry. Strategic Management Journal. 1997;**18**:119-142

[49] Leonard-Barton D. Core capabilities and core rigidities: A paradox in managing new product development. Strategic Management Journal. 1992;**13**(S1):111-125

[50] Strang KD. Assessing team members' interpersonal competencies

in new product development e-projects. International Journal of Project Organisation and Management. 2009;**1**(4):335-357

[51] Cohen WM, Levinthal DA. Innovation and learning: The two faces of R & D. The Econometrics Journal. 1989;**99**(397):569-596

[52] Chuang F, Morgan RE, Robson MJ. Customer and competitor insights, new product development competence, and new product creativity: Differential, integrative, and substitution effects. Journal of Product Innovation Management. 2015;**32**(2):175-182

[53] Lane PJ, Lubatkin M. Relative absorptive capacity and interorganization learning. Strategic Management Journal. 1998;**19**(5):461-477

[54] Inkpen AC, Beamish PW. Knowlegde, bargaining power, and the instability of international joint ventures. Academy of Management Review. 1997;**22**(1):177-202

[55] Claudy MC, Peterson M, Pagell M. The roles of sustainability orientation and market knowledge competence in new product development success. Journal of Product Innovation Management. 2016;**33**:72-85

[56] Li T, Cavusgil ST. Measuring the dimensions of market knowledge competence in new product development. European Journal of Innovation Management. 1999;**2**(3):129-146

[57] Wickramasinghe V, De Zoyza N. Managerial competency requirements that enhance organisational competences: A study of a Sri Lankan telecom organisation. International Journal of Human Resource Management. 2011;**22**(14):2981-3000

[58] Abel M. Competencies management and learning organizational memory. Journal of Knowledge Management. 2008;**12**(6):15-30

[59] Hellstrom T, Husted K. Mapping knowledge and capital intelectual in academic environments: A focus group study. Journal of Intelectual Capital. 2003;**5**(1):165-180

[60] Tuggle FD, Goldfinger WE. A methodology for mining embedded knowledge from process maps. Human Systems Management. 2004;**23**:1-13

[61] Saha N, Chatterjee B, Gregar A, Sáha P. The impact of SHRM on sustainable organizational learning and performance development. International Journal of Organizational Leadership. 2016;**5**:63-75

[62] Ansari S, Munir K, Gregg T. Impact at the "bottom of the pyramid": The role of social capital in capability development and community empowerment. Journal of Management Studies. 2012;**49**(4):813-842

[63] Caniëls MCJ, Neghina C, Schaetsaert N. Ambidexterity of employees: The role of empowerment and knowledge sharing. Journal of Knowledge Management. 2017;**21**(5):1098-1119

Chapter 4

The Dunning-Kruger Effect on Organizational Agility

Herbert Nold and Lukas Michel

Abstract

Designing organizations to quickly adapt to changing conditions, agility, has become a key dynamic capability for success in the 21st century. The Dunning-Kruger effect suggests that people overestimate their ability and that of the organization because they are ignorant of unknown, unkowns. Said another way, people tend to overestimate their ability because they do not know what they do not know. Conversely, executives tend to underestimate the ability of subordinates in the organization. This research project used the Performance Triangle model and accompanying diagnostic instrument to analyze the difference in perceptions between executives and workers in 374 organizations to identify possible disconnects in important capabilities of organizational agility: success, leadership, systems, culture, people, and resilience, along with 27 underlying individual elements. The results show that executives consistently, and significantly, overestimate the ability of themselves and their organization to adapt a change while underestimating the capabilities of workers. Executives were significantly overconfident in the dimensions of success, culture, people, and resilience. Differences in trust emerged as the single most statistically significant element that drives organizational agility. The authors conclude with a discussion of the managerial implications on how this condition influences the ability of organizations to quickly adapt to changing conditions ...agility.

Keywords: organizational change, organizational agility, Dunning-Kruger effect, metacognition, organizational culture

1. Introduction

In 1999, David Dunning and Justin Kruger published their highly influential paper in the Journal of Personality and Social Psychology where they introduced what has become known as the "Dunning-Kruger effect". The Dunning-Kruger effect describes a bias where people of low ability tend to overestimate their abilities [1]. This mental bias in the minds of people of low ability causes these people to develop an illusion of their own superiority. People are unable to recognize their own lack of ability and overestimate their capabilities. Without sufficient self-awareness, this cognitive bias causes people to be unable to objectively evaluate their own competence or incompetence. Additionally, evaluating the competence or incompetence of others becomes distorted as well. Dunning and Kruger's paper suggested that people in the bottom three quartiles of performance tend to overestimate their own abilities while people in

the top quartile of performance tend to underestimate their own abilities. Essentially, this seemingly common cognitive state says that there is a tendency for poor performers to overestimate their abilities relative to other people and conversely, to a lesser extent, for high performers to underestimate their own abilities. Dunning and Kruger contended that this inherent bias results from an internal illusion by people of low ability and an external misperception in people with high ability. The resulting overconfidence in executives and managers and bias in evaluating the performance of peers or subordinates shapes the critical thinking and decision-making process that affects the performance of an organization.

The concept, interest, and number of researchers or theorists on organizational agility has been growing in recent years. In a volatile, uncertain, complex, and ambiguous (VUCA) 21st Century where rapid change driven by technology, fierce competition, knowledge work, and governmental regulation make the ability of an organization to sense and adapt to a new environment an essential capability for success. According to a 2017 McKinsey Global Survey, organizational agility is defined as the ability to quickly reconfigure strategy, structure, processes, people, and technology toward value-creating and value-protecting opportunities [2]. The McKinsey Survey concluded that designing organizations to be agile is elusive for most organizations. It is important to recognize that organizational agility in this context refers to the ability of an entire organization to make rapid adaptations and changes, not agile software development processes. Agile software development are processes that link departments and functions to accelerate the speed and quality of computer-based software development. Organizational agility describes dynamic capabilities embedded in an organization that allows the organization to make fundamental adjustments to the DNA of all components of the organization without disruptive and largely ineffective change initiatives.

The performance triangle model (PTM) developed by Lukas Michel offers a practical model to help executives identify strengths and weaknesses in many key organizational elements that enable or inhibit organizational agility. The PTM provides a roadmap into key elements of organizational dimensions needed for success in a VUCA world, culture, leadership, and systems [3, 4].

While there is no universally accepted definition of organizational culture, there appears to wide agreement with Edgar Schein's definition of organizational culture as a set of beliefs, values, and shared assumptions "invented, discovered, or developed by a given group as it learns to cope with its problems of external adaptation and internal integration—that has worked well enough to be considered... the correct way to perceive, think, and feel in relation to those problems" ([5], p. 9). Geert Hofstede observed that organizational culture consists of core values that are often unconscious and rarely discussable [6]. These descriptions and many variants appear throughout the literature on organizational cultures. Many researchers and authors have demonstrated the power of culture on organizational performance using both qualitative and quantitative methods. Twenty-seven elements of primary dimensions of the PTM provide insight into many "unconscious and rarely discussable" components of the culture that can interfere with the flow of knowledge throughout an organization. These interferences or viruses infect the organization and inhibit the ability of the organization to be agile in a VUCA world and achieve superior performance [4].

We view the disconnect between senior executives' actual ability with their perceived ability along with that of subordinates as one of many possible conditions that inhibit the ability of organizations to adapt and change, quickly. The primary objectives of the study are to provide insight into three questions; (1) is there a difference

between the perceptions of executives and workers in the dimensions of the PTM, (2) if yes, do executives demonstrate the Dunning-Kruger effect by overestimating their capabilities, and (3) if they do, what is the effect on the organization's dynamic capabilities needed for organizational agility.

2. Background

2.1 The Dunning-Kruger effect

The Dunning-Kruger effect says that people with low levels of competence will judge themselves to be more competent than they really are, while very competent people tend to underestimate their abilities [1, 7]. Key elements to the Dunning-Kruger effect are the ability of people to be aware of "known unknowns" (concepts, skills, or experiences that a person is aware of, but have not yet been mastered) and "unknown unknowns" (conditions, events, information, knowledge, or circumstances that the individual is not aware of). The ability to recognize that there may be unknown unknowns that are beyond one's realm of knowledge is referred to as "metacognition". Metacognition is unique to humans because of the human capacity for self-reflection [8]. The Dunning-Kruger effect implies that many people lack metacognition ability which results in them being unaware of the extent of their own ignorance [9].

A second aspect of the Dunning-Kruger effect is that low achievers with inflated perceptions of their own abilities tend to be less capable of critically evaluating the input from peers and subordinates or objectively evaluating their performance [10]. Huang [8] observed that people in positions of authority may make decisions even though they may be (a) ignorant of the subject matter, (b) not aware of circumstances or important occurrences, or (c) act as if they are experts, when in fact they are not. Clearly, this tendency for people, to ignore their own ignorance and rank their own expertise higher than it really is, particularly for individuals in executive or management positions, can have a significant effect on their organization and the individuals throughout the organization.

Dunning et al. [11] observed that if individual competency is required for someone to recognize incompetence, then people who are truly incompetent will be both incompetent and unaware of their own incompetence or that of others. Consequently, people who would benefit most from understanding the limits of their reasoning are the people who are least likely to do so [12]. Pennycook et al. continued to observe that the degree of miscalculation among incompetent people is key to understanding the causes and effects of biased decision-making and the resulting judgments. This flaw or weakness in logical reasoning creates a gap between actual and perceived abilities that become a strong influence on decisions made by executives and managers.

Franklin [13] reported results from the 2021 Gartner Hybrid Work Employee Survey of 4000 employees in January 2021. The survey explored perceptions in several areas that are key to providing a healthy employee experience when working in a hybrid or remote environment. Results indicated a significant gap between what executives and workers perceive in numerous areas that are important to employee engagement and performance. **Table 1** shows the percentage of executives and workers who believe that a specific leadership attribute is positive or good.

These results illustrate a clear disconnect between the perceptions of executives and workers concerning the working environment and culture. As quoted by Franklin

Attribute in the survey	Executives	Workers
The company has a culture that promotes a flexible working experience	75	57
The company provides adequate tools for remote work	76	66
Senior leaders act in the employees best interest	69	41
There is a high level of trust when employees are working remotely	70	58
Leaders consider employees when making decisions	75	47
Leaders communicate effectively with employees	71	50
Leaders and workers have a shared sense of purpose	77	59

Table 1.
Results from the 2021 Gartner hybrid work employee survey.

[13], Alexia Cambon (director in the Gartner Human Resources practice) said, "If left unaddressed, this division may lead to a critical failure to build trust and employee buy-in for future work plans."

The gap between the actual and perceived capabilities of managers and executives shapes how managers interpret information, engage with peers and subordinates, and make decisions that influence organizational strategy and operations. Charles Darwin [14] observed that "Ignorance more frequently begets confidence than does knowledge". Bertrand Russell [15] commented that "...in the modern world the stupid are cocksure while the intelligent are full of doubt". Both observations succinctly sum up the Dunning-Kruger effect.

2.2 The performance triangle model

The performance triangle model (PTM) for agile organizational design in a turbulent world emerged from nearly 20 years of observation and research with over 200 organizations worldwide [3, 16]. The PTM provides a workable and practical methodology with tools to help executives design agile organizations that can be successful in the VUCA 21st Century. Agile thinking and strategies must originate in the boardroom and flow from there to the C-suite then throughout the entire organization. Agile principles, beliefs, values and attitudes, center around people and the massive body of tacit knowledge embedded within their minds and experience. Agile principles and capabilities include developing the ability to facilitate change, collaboration through the organizations vertically and horizontally, focus on excellence, engage in interactive dialog and conversation at all levels, self-organization, and continuous improvement as a way of life. Agile management is very different and should not be confused with agile software development methodologies to develop better software, faster and more efficiently. Agile management originated as a bottom-up culture change from those who do the work. On the other hand, comprehensive culture change needs to be led from the very top and adopted by everyone from top to bottom of the organization chart. When one considers that organizational culture exists in the minds of people in their values, beliefs, and shared assumptions, changing the culture is easier said than done.

The performance triangle model (PTM) illustrated in **Figure 1** is a visual representation of a dynamic system of culture, leadership, and systems that is powered by people who work in a resilient environment that nurtures healthy relationships, collaboration, and a strong sense of purpose where people share their unique and

Source: Adapted from Michel, L. (2013). *The performance triangle: diagnostic mentoring to manage organizations and people for superior performance in turbulent times*, London, UK: LID Publishing Ltd.

Figure 1.
The performance triangle. Source: Adapted from Michel [3].

valuable tacit knowledge. Culture is a major component of the dynamic system and cannot be effectively changed without recognizing and addressing key elements of the ENTIRE system. Since the culture resides in the minds and experiences of people, people become the focus of attention because power for the entire PTM system comes from the ability of people to maximize their inherent capabilities to fuel change. However, culture with all its intangibles and people with all their idiosyncrasies and uncertainties make actively creating a people-centric management design very difficult. Senior executives intrinsically know that "people are our most valuable asset" and write that in the corporate mission or vision statement.

Figure 2 illustrates the structure of the six primary dimensions and twenty-seven elements that compose the PTM.

2.2.1 Success

Success in the PTM is evaluated using the following characteristics with the assumption that if the answer to these five questions is "yes" then the organization is likely to be successful regardless of the type of organization (public, private, governmental, etc.).

- *Responsiveness*—Is the organization flexible and able to react to changes in the environment?

- *Alignment*—Is the direction of the organization clear? Does the structure fit the strategy? Is it shared broadly and are employees aligned to support the strategies?

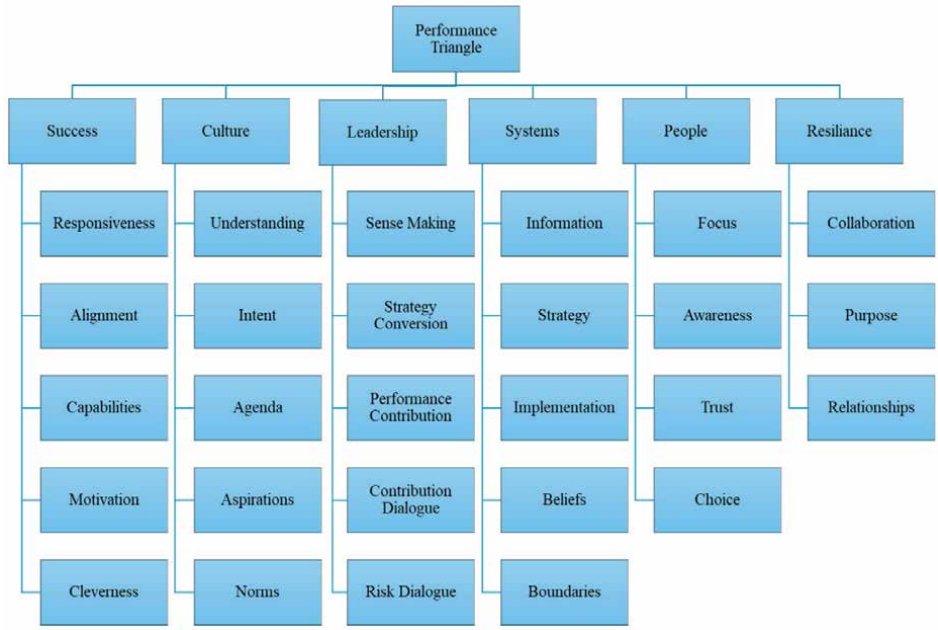


Figure 2.
Structure of the performance triangle model.

- *Capabilities*—Does the organization have the competencies and skills needed to deliver on promises?

- *Motivation*—Are employees throughout the organization inspired to perform above and beyond expectations?

- *Cleverness*—Are employees empowered to be creative and use their creativity to meet expectations or demands from clients or customers within boundaries that do not stifle creativity?

2.2.2 People

It is commonly recognized that people perform at their highest potential by winning their "inner game" and overcoming self-doubt, fear, bias, limiting concepts or assumptions that distort perceptions, decisions, behaviors, actions, and stress that interfere with, and diminish, performance [17, 18]. Awareness about what is going on around them, choice to choose the best solution, and trust in others help people to focus attention on tasks and problems. Reaching a state of flow, the state where performance and creativity are at a peak, must be a primary objective at all levels of an agile, people-centric, organization [19]. Questions applicable for the people dimensions are the following.

- *Focus*—Are people allowed to focus their attention and energy on tasks? Are interferences preventing people from focusing their abilities to complete tasks?

- *Awareness*—Are people aware of forces that influence actions and decisions?

- *Trust*—Do people trust co-workers and management to be treated fairly and with respect? Is management credible?

- *Choice*—Are people allowed the freedom to use their own creative ability to solve problems, respond to customers, or to be innovative?

2.2.3 Systems

In the PTM "systems" represent more than just the computer driven information technology driven systems. Systems consist of an institutional framework with rules, routines, and tools that set the stage for rigorous and disciplined leadership. Technology based information systems accumulate, store, process, and provide access to information and facilitate immediate feedback. Human systems in the form of rules, routines, and guidelines of many types provide frameworks that give technology structure and relevance. To support collaboration among people, systems make information available to assist people to find purpose, support the decision-making process, and set boundaries balancing entrepreneurship with efficiency. The diagnostic questions for systems are the following.

- *Information*—Do decision makers at all levels have access to timely and relevant information to know what is going on inside and outside the organization to make informed decisions?

- *Strategy*—Do leaders and followers clearly understand the rules of the game and what is needed to achieve strategic and operational objectives?

- *Implementation*—Do decision makers throughout the organization clearly understand what actions are needed to be successful?

- *Beliefs*—Do decision makers throughout the organization have a shared ambition to support organizational objectives?

- *Boundaries*—Do decision makers throughout the organization have a firm understanding of boundaries or limits to their decisions or authority?

2.2.4 Leadership

Effective leaders in agile, people-centric, organizations interact with individuals on a personal level, relate to others to facilitate meaningful collaboration, and establish a supportive work environment based on trust [20]. Successful leadership varies depending on the organization and situation. A leadership style that is successful in one organization may not necessarily be effective if applied in a different organization or situation. However, the need for effective communication skills and interaction with followers are recurring themes in the literature [21, 22]. It becomes essential for effective leaders in an agile organization to develop effective communication and interaction skills that are natural and unique to the leader and organization. Ultimately, what is important is that the individuals in the organization adopt shared vision, collaborate in a culture of trust, and engage multiple personalities, while

leaders champion creativity and experimentation. The Performance Triangle diagnostic instrument asks the following question related to leadership.

- *Sense making*—Do leaders have the capability to sense changes in internal and external environments and interpret meaning?

- *Strategy conversion*—Do leaders have an understanding of why the organization has established strategic goals and are goals founded on lessons from the past?

- *Performance conversion*—Do leaders have a clear understanding of whether the organization is on track, what needs to be done to remain on track, and what needs to be done to achieve superior performance?

- *Contribution dialog*—Do leaders have a clear understanding of what they can do to contribute toward moving the organization forward? Do leaders clearly understand their role?

- *Risk dialog*—Do leaders have a clear understanding of the potential risks and the level of risk that the organization can tolerate?

2.2.5 Culture

The culture of the organization creates shared context, enables, or inhibits knowledge exchange, and defines invisible boundaries for collaboration. A vibrant culture establishes shared context as the common ground with a shared agenda, language, mental models, purpose, and relationships [23]. Shared context describes a shared mindset and the behavior of individuals based on shared norms, beliefs, values, and assumptions. Organizational culture becomes the invisible force that, like gravity, shapes all interactions within the universe that the organization exists.

Organizational culture either enables knowledge sharing or is a barrier to sharing even simple pieces of information [24]. Like a virus infecting a living organism, organizational traits like autocratic leadership styles, silos, or lack of trust and respect throughout the organization effectively block knowledge sharing. Unseen or unnoticed viruses make culture an organizational bottleneck that constrains the amount and quality of knowledge sharing limiting the creativity of people, the ability to act, and disrupting flow. Knowledge that is not shared, exchanged, or transferred has no value to an organization. The challenge for any executive is to create a culture that facilitates people working together on tasks that add value to the organization. Effective collaboration requires a shared problem and commitment with people working together with shared ways of doing things. The questions designed to give insight into organizational culture are the following.

- *Understanding*—Do people share an understanding of where the organization is and where it is going or attempting to go?

- *Intent*—Do people share a common intent of how to move the organization forward to meet goals and objectives?

- *Agenda*—Do people share a common agenda on what needs to be done to move the organization toward meeting goals and objectives?

- *Aspirations*—Do people share a common sense of purpose to meet goals and objectives?

- *Norms*—Do people share a common set of norms of behavior needed to get ahead within the organization?

2.2.6 Resilience

A high-energy work environment produces intense collaboration, a high sense of purpose and trusting relationships. These features have a stabilizing effect on organizations known as resilience or "robustness" [25, 26]. Organizations reach higher levels of resilience through collaboration [27], purpose, and relationships [28]. The diagnostic questions targeting the sides of the Performance Triangle Model are as follows.

- *Relationships*—Do co-workers and management have and maintain healthy, trusting, relationships?

- *Purpose*—Do people share a common higher purpose for the organization and organizational objectives?

- *Collaboration*—Do people collaborate effectively by sharing knowledge to achieve common goals and objectives?

2.3 Methodology

2.3.1 The diagnostic instrument

Over a 15-year period the authors developed and perfected a proprietary diagnostic instrument with 55 questions that provides executives insight into key dynamic capabilities essential for organizational agility. As shown in **Figure 2**, 27 elements aggregate into the six primary dimensions that ultimately roll up to a total PTM. Analysis of the summary (top) level and the lower levels give the executive a sense of the organization's agile capabilities. All questions target the same construct, however questions for executives ask for their perception of the organization and people that they command while questions for workers as for their perception within their immediate work group. This approach provides visibility into differences that may exist in many "unseen and rarely discussed" interferences between executives and workers.

In 2016, raw data from the diagnostic instrument was subjected to independent statistical analysis. The resulting analysis provided strong evidence that the instrument was a good fit to the model with high levels of reliability and validity [29]. Participants answer questions in the diagnostic instrument using a Likert-type scale designed to provide insight into the perceived strength of the questions that are the elemental items in the PTM on a 0 to 100 scale. Higher numbers indicate strong or positive sentiment while lower numbers indicate weaker or negative sentiment. Participants take the diagnostic using an online portal and data is collected, collated, and stored on a secure server in Switzerland. Minitab statistical software was used for the calculations.

2.3.2 The sample

The sample consisted of 2885 participants from 374 organizations. Of the participants, 284 were classified as executives (owner, president, vice-president, or

similar title) from 248 organizations while 2601 participants were lower-level workers from 126 organizations. Data was collected between 2016 and 2020 as participants completed the instrument online with data captured and secured on a server in Switzerland. No personal demographic information was collected but demographics of the organizations were captured and are shown in **Table 2**. Means for executives and workers were calculated for each locus then compared and analyzed for statistical significance.

2.3.3 Hypotheses

The general hypotheses for this study are that executives will have a more positive perception of their ability and that of the organization than subordinate workers as measured by the PTM diagnostic instrument at the following locus points in the PTM. The specific hypotheses are as follows:

Hypothesis 1. Executives will have a more positive perception of their ability than subordinate workers at the top, summary, level of the PTM.

Hypothesis 2. Executives will have a more positive perception of their ability than subordinate workers at ass 27 individual elements of the PTM.

Hypothesis 3a. Executives will have a more positive perception of their ability than subordinate workers in the success dimensions of the PTM.

Hypothesis 3b. Executives will have a more positive perception of their ability than subordinate workers in the culture dimensions of the PTM.

Hypothesis 3c. Executives will have a more positive perception of their ability than subordinate workers in the leadership dimensions of the PTM.

Industry		**Location**		**Type**	
Consumer products	35	Africa	5	Cooperative	13
Education	7	Asia	10	Foundation	13
Financial services	76	Australia/New Zealand	11	Private	131
Healthcare	12	Europe	303	Public	171
Infrastructure/construction	16	Latin America	11	Public Administration	*46*
Manufacturing	38	Middle East	2	Total	374
Pharma/chemicals	21	UK/Ireland	2		
Professional services	46	US/Canada	*30*		
Public services	29	Total	374		
Natural resources	14				
Technology	52	**Size**	**Life cycle**		
Telecom	11	Very Large	120	Established	263
Tourism	*17*	Large	78	Growth	26
Total	374	Mid-Size	106	Mature	78
		Small	*70*	Start-up	*7*
		Total	374	Total	374

Table 2.
Demographics of the participating organizations.

Hypothesis 3d. Executives will have a more positive perception of their ability than subordinate workers in the systems dimensions of the PTM.

Hypothesis 3e. Executives will have a more positive perception of their ability than subordinate workers in the people dimensions of the PTM.

Hypothesis 3f. Executives will have a more positive perception of their ability than subordinate workers in the resilience dimensions of the PTM.

To test these hypotheses, a series of paired t-tests were run in an order corresponding to the Performance Triangle Model structure in **Figure 2**. Paired-t test and correlations were conducted for the top, summary, level of the PTM, all 27 elements, and for each of the six dimensions of the PTM.

2.4 Results

The results are presented in the order corresponding to the structure in **Figure 2**. The following tables display descriptive statistics, paired t-test results, and correlations at the top level of the PTM, all 27 elements, and each primary dimension that make up the Performance Triangle Model. The figures for executives and workers are the mean of all participants in that grouping.

Beginning at the top level shown (**Table 3**) which sums the means and compares the difference among the six primary dimensions, executives are 3.3 (4.8%) more positive than workers. There is a positive correlation, 0.907, $p = 0.002$. The paired t-test indicated there is a significant difference between the groups; $t = 6.09$, $p = 0.002$. The greatest gaps between the groups were in people (4.3pts, 6.0%) and resilience (5.0pts, 7.0%). This top-level data suggests that executives believe that they and their organizations are positioned to adapt to rapid change much better than the people who do the daily work in the organizations. Hypothesis 1 is accepted.

The analysis of all 27 individual elements displayed in **Table 4** shows that executives are 3.0 (4.5%) points more positive. There is a positive correlation, 0.874, $p = 0.000$. The paired t-test indicated there is a significant difference between the groups; $t = 8.41$, $p = 0.000$. This, more detailed look at the data provides even stronger evidence that executives are not necessarily in tune with the beliefs, values, and perceptions of the people in their organization. An interesting observation here is that trust was flagged as exerting a significantly greater influence on the total than all other elements. Hypothesis 2 is accepted.

	Executives	Workers	Var.	Var. %	t	p	Correlation
Top level - Mean	67.5	64.2	3.3	4.8%	6.09	0.002	0.907**
Standard deviation	2.68	1.11					
Success - Mean	68.0	65.5	2.5	3.7%			
Culture - Mean	66.9	63.2	3.7	5.5%			
Leadership - Mean	64.9	63.4	1.5	2.3%			
Systems - Mean	64.2	61.7	2.5	3.9%			
People - Mean	70.8	66.5	4.3	6.0%			
Resiliance - Mean	70.1	65.1	5.0	7.1%			

*Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

Table 3.
Analysis of top level dimensions paired t-test and correlation, N = 6.

	Executives	Workers	Var.	Var. %	t	p	Correlation
All elements - Mean	67.1	64.1	3.0	4.5%	8.41	0.000	0.874***
Standard deviation	3.93	3.28					

*Note: * p < 0.05, ** p < 0.01, *** p < 0.001; Trust was identified as having an unusually large influence.*

Table 4.
Analysis of all elements paired t-test and correlation, N = 27.

The success dimension (**Table 5**) shows a 2.4 (3.6%) point gap between the groups with a positive correlation of, 0.980, p = 0.003, The paired t-text indicated there is a significant difference between the groups, t = .18, p = 0.007. The greatest gap between the two groups are motivation (3.1pts, 4.6%) and cleverness (3.7pts, 5.7%). This result suggests that executives believe that they have created an environment that allows people to use their creative energy to solve problems and innovate and that workers are motivated and engaged. Neither sentiment is shared by workers. Hypothesis 3a is accepted.

The culture dimension (**Table 6**) indicated a 3.4 (5.2%) point difference between the groups with a correlation of 0.974, p = .005. The paired t-test shows there is a significant difference between executives and workers, t = 17.51, p = 0.000. The gap between the groups is consistent among the elements with the greatest difference in aspirations (4.2pts, 6.0%) with the smallest difference of 3.2 points (4.8%) for both intent and agenda. These results indicate that executives and workers may not be working in lockstep for the general good of the organization. Hypothesis 3b is accepted.

The leadership dimension (**Table 7**) produced the widest range of results for executives (M = 64.9, SD = 5.14) and workers (M = 63.4, SD = 4.05). However, the difference between executives and workers was only 1.5 (5.2%) points. Correlation of leadership dimensions of 0.914, p = 0.030 was significant but t-value, t = 1.51, p = 0.205 was not significant. The mean scores for leadership are close which suggests that executives and workers share similar sentiments. However, the wide range indicated by the standard deviation suggests that leadership varies widely from organization to organization. For the elements of strategy conversation and contribution dialog, workers had a slightly more positive perception than executives. The small gap in these two elements suggests that both executives and workers have a similar understanding of the strategy and what they must do to contribute toward success. The gap between the groups on risk dialog was among the highest of all elements in

	Executives	Workers	Var.	Var. %	t	p	Correlation
Success - Mean	68.0	65.5	2.4	3.6%	5.18	0.007	0.980**
Standard deviation	1.85	2.81					
Responsiveness	69.4	67.0	2.4	3.4%			
Alignment	69.9	68.8	1.1	1.6%			
Capabilities	67.9	66.1	1.8	2.7%			
Motivation	67.5	64.4	3.1	4.6%			
Cleverness	65.2	61.4	3.7	5.7%			

*Note: * p < 0.05, ** p < 0.01, *** p < 0.001.*

Table 5.
Analysis of success dimension & elements paired t-test and correlation, N = 5.

	Executives	Workers	Var.	Var. %	t	p	Correlation
Culture - Mean	66.7	63.2	3.4	5.2%	17.51	0.000	0.974**
Standard deviation	1.34	0.99					
Understanding	65.4	62.0	3.4	5.2%			
Intent	65.9	62.8	3.2	4.8%			
Agenda	66.7	63.5	3.2	4.8%			
Aspirations	68.9	64.7	4.2	6.0%			
Norms	66.5	63.2	3.3	4.9%			

*Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

Table 6.
Analysis of culture dimension & elements paired t-test and correlation, N = 5.

	Executives	Workers	Var.	Var. %	t	p	Correlation
Leadership - Mean	64.9	63.4	1.5	2.3%	1.51	0.205	0.914*
Standard deviation	5.14	4.05					
Sense making	70.1	68.7	1.4	2.0%			
Strategy conversation	63.1	63.4	−0.3	−0.5%			
Performance conversation	59.3	57.9	1.4	2.4%			
Contribution dialog	61.5	61.7	−0.2	−0.4%			
Risk dialog	70.6	65.5	5.1	7.2%			

*Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

Table 7.
Analysis of leadership dimension & elements paired t-test and correlation, N = 5.

the PTM diagnostic which suggests that executives believe that they and their workers understand the organization's tolerance for taking risks. Workers, on the other hand, are unsure of what level of risk taking is acceptable and what is not. Hypothesis 3c is rejected.

Analysis of the data for the systems dimension (**Table 8**) indicates that there is a 2.5 (3.9%) point (3.9%) difference between executives and workers but the correlation of

	Executives	Workers	Var.	Var. %	t	p	Correlation
Systems - mean	64.2	61.7	2.5	3.9%	2.48	0.068	−0.144
Standard deviation	0.80	1.98					
Information	64.7	63.1	1.5	2.4%			
Strategy	64.1	59.1	5.0	7.7%			
Implementation	63.3	61.4	1.9	3.0%			
Beliefs	63.7	64.2	−0.6	−0.9%			
Boundaries	65.3	60.9	4.4	6.7%			

*Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

Table 8.
Analysis of systems dimension & elements paired t-test and correlation, N = 5.

−0.144, p = 0.818 was not significant. Similarly, results from the paired t-test, t = 2.48, p = 0.68 were also not significant. The mean scores for the systems dimension are the lowest of all six dimensions. This suggests that neither executives nor workers are satisfied with the systems in their organizations. There are wide gaps in strategy (5.0pts, 7.7%) and boundaries (4.4pts, 6.7%) which suggests that leaders believe that rules and boundaries support organizational goals and are clearly understood by workers. The beliefs dimension result indicates that workers are slightly more positive than executives (−0.6pts, −0.9%). The large gaps in strategy and boundaries suggest that there is a disconnect. Executives believe that they have developed systems that adequately support organizational goals and that people know and understand the rules that define the limits of their authority and work. Hypothesis 3d is rejected.

Results from the people dimension (**Table 9**) reflect the second largest difference between executives and workers with a 4.3 (6.0%) difference with a correlation among the elements of 0.964, p = 0.036. The paired t-test produced a value of t = 5.27, p = 0.013. The greatest gap between executives and workers were in the elements of awareness (5.6pts, 8.0%) and choice (5.2pts, 7.1%). The difference in awareness and choice are second only to collaboration in the resilience dimension. These differences indicate that workers are not aware of what is going on but even if they did, they do not have freedom of choice to respond to a situation. Executives believe that they have adequately made people aware and allow adequate freedom to act. Hypothesis 3e is accepted.

The greatest difference between executives and workers (**Table 10**) at 5.0 (7.1%) points is in the resilience dimension. Correlation of 0.996, p = .054 was just outside

	Executives	Workers	Var.	Var. %	t	p	Correlation
People - Mean	70.8	66.5	4.3	6.0%	5.27	0.013	.964*
Standard Deviation	5.30	4.30					
Focus	63.5	61.5	1.9	3.0%			
Awareness	70.5	64.9	5.6	8.0%			
Trust	75.8	71.6	4.2	5.5%			
Choice	73.2	68.0	5.2	7.1%			

*Note: * p < 0.05, ** p < 0.01, *** p < 0.001.*

Table 9.
Analysis of people dimension & elements paired t-test and correlation, N = 4.

	Executives	Workers	Var.	Var. %	t	p	Correlation
Resiliance - Mean	70.1	65.1	5.0	7.1%	6.19	0.025	0.996*
Standard Deviation	2.95	4.32					
Collaboration	66.8	60.4	6.4	9.6%			
Purpose	71.0	66.0	5.0	7.0%			
Relationships	72.5	68.9	3.6	5.0%			

*Note: * p < 0.05, ** p < 0.01, *** p < 0.001.*

Table 10.
Analysis of resilience dimension & elements paired t-test and correlation, N = 3.

the threshold for significance at 0.054 but is close enough to be considered significant considering results in the other dimensions. The paired t-test yielded a value of t = 6.19, p = 0.025. These results are primarily driven by the difference between executives and workers in collaboration 6.4 (9.6%) points and purpose 5.0 (7.0%) points which are the greatest among all elements and must be carefully considered. The results suggest that executives feel that employees share a common purpose and have healthy relationships that promote effective collaboration. This sentiment is not shared by workers. Hypothesis 3f is accepted.

Results of the statistical analysis confirm that, with a few exceptions, executives significantly overestimate the agile capabilities of their organizations compared to the perceptions of workers. Executives have a more positive perception of the many unseen and rarely discussed elements that may interfere with performance and organizational agility.

2.5 Conclusions and managerial implications

2.5.1 Conclusions

The Performance Triangle diagnostic instrument provides deep insight into many "unseen, and rarely discussed" dynamic capabilities that exist in organizations, but which executives are typically unaware. Through time, interferences and perceived differences in what executives think they know and what workers perceive creep into organizations. These interferences infect all functions and operations throughout organizations to inhibit the flow of knowledge and shape the decision-making process at all levels. Clearly, the results indicate that executives have a much more positive perception of the ability of their organization's agile capabilities than the workers. Significant differences between the groups at all levels and dimensions except for leadership and systems suggest that executives may have a distorted view of their own abilities and those of the organization under their command.

The dimensions of the PTM with the largest gaps between what executives perceive and what workers perceive are in the people and resilience dimensions. This is an important finding because virtually every organizational mission statement contains some wording stating that "employees are our greatest asset". The study suggests that workers do not share this sentiment and do not feel that executives back up the lofty words with significant action. Looking at these results another way, executives believe that they are doing a good job of developing their "greatest asset" but that employees feel very differently. Organizational resilience (purpose, relationships, collaboration) is almost entirely dependent on the people (focus, awareness, trust, choice) to be effective since resilience requires people to work closely together in harmony and coordination. The gap between executives and workers in trust when looking at all 27 elements was singled out as being particularly influential. This is an important finding since trust has been identified in many studies as a powerful, if not the single most powerful, force that enables or hinders tacit knowledge sharing which is an essential dynamic capability in today's VUCA knowledge economy. Simply put, as traditionally trained managers and executives implement processes, procedures, and structure for control they are creating interferences with unintended consequences. Rigid controls cause workers to be unaware of what is going on around them, limit workers ability to make choices to solve unanticipated problems and interferes with their ability to focus their unique talents on value adding tasks that matter. All these unintended

consequences contribute to a lack of trust among the workers and, more importantly, with managers and executives creating an environment where workers and the organization as a whole fail to maximize their potential.

The statistically significant difference between executives and workers perceptions in the dimensions of success and culture help explain one reason why so many change initiatives fail to deliver on expectations or fail completely. Clearly, executives feel that they and their organization have all the needed capabilities to be successful while workers do not share this sentiment. The culture of an organization acts like the glue that binds all parts of the organization and enables or inhibits the flow of critical information throughout. Peter Drucker is reputed to have said that "culture eats strategy for breakfast". The results of the study tend to reinforce this observation because it will be difficult indeed for strategic or change initiatives to be successful if executives believe that the organization has all the essential capabilities needed for success while employees do not. Combined with a lack of shared understanding of where the organization is going, shared intent, a common agenda, a common sense of purpose, and shared norms of behavior even the best strategic plan or change initiative will have a difficult time successfully achieving its objectives. Such initiatives may be unintentionally or sometimes intentionally sabotaged by unseen and rarely discussed interferences within the culture.

The positive variance between the perceptions of executives and workers in the dimensions of leadership and systems were not statistically significant. This finding was revealing particularly with three elements (strategy conversation, contribution dialog, and beliefs) where workers perceptions were slightly more positive than executives. We surmise that since leadership and systems dimensions are means of control almost entirely determined by executives, they are difficult for workers to assess. In organizations with classically trained executives and managers, workers have little or no input into these dimensions therefore they can only assess leadership and systems in the context of their individual situation or how they affect everyday interactions. Hence, workers have limited comparisons on which to base perceptions resulting in an overestimation of the company's infrastructure. In addition, we posit that executives may tend to be more critical about leadership and systems since much is mandated by senior management in response to outside pressures, governmental regulations, or societal demands. Executives may be more critical of the elements in these dimensions because they may have limited freedom to act with processes or procedures over which they may have little or no control.

Our findings tend to support the assertions of the Dunning-Kruger effect in a practical setting. Executives consistently overestimate their abilities and those of their organization which will influence the decision-making process and how executives handle people when initiating and managing change initiatives. One possible explanation is that executives are not aware of "unknown unknowns" within their organization or the environment that shape agile capabilities. The Dunning-Kruger effect as applied to organizational agility and change could, at least partially, explain the low success rate of change initiatives that is common knowledge. In this scenario, executives might dream up and initiate well intentioned change programs that are doomed to fail because they are unaware or ignore the underlying weaknesses or interferences that exist in the organization. For executives, ignorance, or unawareness, overestimating and misjudging their own capabilities and that of the organization is a recipe

for failure. Recognition and acknowledgement of this inherent bias must be the first step in designing agile organizations.

2.5.2 Limitations

The study has limitations that should be considered when evaluating the results, primarily in the demographics of the participating organizations. 81% of the sample organizations are in Europe so expanded participation by organizations in other parts of the world like Africa, Asia, or the Middle East might yield different results. Additionally, 53% are very large or large companies and 91% were in established or mature stages in their life cycle. Smaller organizations in start-up or early growth phases might yield different results. Additionally, we did not capture demographic information from participants such as gender, national origin, age, etc. so further research in these areas is needed.

2.5.3 Managerial implications

Developing organizational agility begins in the boardroom and C-suite. These findings suggest that strengthening the self-reflection capability of executives to raise awareness for the "unknown unknowns" in their organization could improve decision making relative to agile initiatives. Employment of diagnostic information might help provide transparency and insight into unseen elements that interfere with agile capabilities. If the dynamic capabilities needed for organizational agility are embedded deeply within the capabilities of people, then increasing the awareness of executives for the "unseen, and rarely discussed" gaps in key elements might assist executives to intervene quickly and effectively.

Acknowledging the executive bias typified by the Dunning-Kruger effect, paired with diagnostic insights into the dimensions of organizational agility, can help executives bridge the natural metacognition gap and increase the effectiveness and accelerate the process of designing agile organizations. In the VUCA 21st century business environment accelerating the speed and effectiveness of the decision-making process is a vital dynamic capability for success.

For consultants, advisors, and coaches of executives on agile capabilities, the findings demonstrate that diagnostic insights are a powerful way to align executives around an initiative where they lack the experience and where bias prevents effective implementation of agile initiatives. The use of validated diagnostic tools to counter-balance managerial intuition and bias is worthwhile to identify gaps between executive and worker perceptions. Realizing and acknowledging the difference in perception between executives and workers may lead executives to identify better intervention points and ultimately more flexible, agile, and successful organizations. We, therefore, suggest that improving the probabilities of successful change initiatives in the VUCA 21st century requires development of agile capabilities and that executives must recognize their own bias and objectively assess the dynamic capabilities within their organizations. Peter Drucker is reputed to have said "The greatest danger in times of turbulence is not the turbulence; it is to act with yesterday's logic". Our study suggests that successful executives in today's turbulent environment must recognize their inherent limitations to challenge and reject yesterday's logic to create agile and adaptive organizations that maximize all the capabilities within their organizations with people being the centerpiece and most important asset.

Author details

Herbert Nold[1*] and Lukas Michel[2]

1 Polk State College, Lakeland, Florida, USA

2 Management Insights AG, Zuoz, Switzerland

*Address all correspondence to: hnold@yahoo.com

IntechOpen

References

[1] Kruger J, Dunning D. Unskilled and unaware of it: How difficulties in recognizing one's own incompetence lead to inflated self-assessments. Journal of Personality and Social Psychology. 1999;**77**(6):1121-1134. CiteSeerX 10.1.1.64.2655. DOI: 10.1037/0022-3514.77.6.1121

[2] Salo O. How to Create An Agile Organization. Illinois, Chicago: McKinsey & Company; 2017 Available from: https://www.mckinsey.com/business-functions/organization/our-insights/how-to-create-an-agile-organization#

[3] Michel L. The Performance Triangle: Diagnostic Mentoring to Manage Organizations and People for Superior Performance in Turbulent Times. London: LID Publishing; 2013

[4] Nold H, Michel L. Organizational culture: A systems approach. In: Alsharari N, editor. 21st Century Approaches to Management and Accounting Research. London, UK: IntechOpen Ltd; 2021 ISBN: 978-1-83968-571-2Print ISBN: 978-1-83968-570-5

[5] Schein E. Organizational Culture and Leadership. San Francisco, CA: Jossey-Bass; 1985

[6] Hofstede G, Neuijen B, Ohayv D, Sanders G. Measuring organizational cultures: A qualitative and quantitative study across twenty cases. Administrative Science Quarterly. 1990;**35**:286-316

[7] Ehrlinger J, Gilovich T, Ross L. Peering into the bias blind spot: People's assessments of bias in themselves and others. Personality and Social Psychology Bulletin. 2005;**31**(5):680-692

[8] Huang S. When peers are not peers and don't know it: The Dunning-Kruger effect and self-fulfilling prophecy in peer-review. BioEssays: News and Reviews in Molecular, Cellular and Developmental Biology. 2013;**35**(5):414-416. DOI: 10.1002/bies.201200182

[9] Anson IG. Partisanship, political knowledge, and the Dunning-Kruger effect. Political Psychology. 2018;**39**(5):1173-1192. DOI: 10.1111/pops.12490

[10] Helzer EG, Dunning D. Why and when peer prediction is superior to self-prediction: The weight given to future aspiration versus past achievement. Journal of Personality and Social Psychology. 2012;**103**(1):38-53

[11] Dunning D, Johnson K, Ehrlinger J, Kruger J. Why people fail to recognize their own incompetence. Current Directions in Psychological Science. 2003;**12**:83-87. DOI: 10.1111/1467-8721.01235

[12] Pennycook G, Ross RM, Koehler DJ, Fugelsang JA. Dunning-Kruger effects in reasoning: Theoretical implications of the failure to recognize incompetence. Psychonomic Bulletin & Review. 2017;**24**(6):1774-1784. DOI: 10.3758/s13423-017-1242-7

[13] Franklin N. Managers and Workers Have Different Perception of the Future 'Employee Experience'. Newcastle, England. 2021. Available from: https://workplaceinsight.net/managers-and-workers-have-different-perception-of-the-future-employee-experience/

[14] Darwin C. The Descent of Man, and Selection in Relation to Sex. 1st ed. London: John Murray; 1871

[15] Russell B. The Triumph of Stupidity. Mortals and Others: Bertrand Russell's American Essays 1931-1935. New York: Routledge and Waddington CH; 1942

[16] Nold H, Michel L. The performance triangle: A model for corporate agility. Leadership and Organizational Development Journal. 2016;**37**(3):341-256. DOI: 10.1108/LODJ-07-2014-0123

[17] Gallwey T. The Inner Game of Work: Focus, Learning, Pleasure, and Mobility in the Workplace. New York, NY: Random House; 2000

[18] Whitmore J, Gallwey T. What is the inner game John Whitmore and Tim Gallwey in conversation. Coaching at Work Limited. 2010;**5**:36-37

[19] Csikszentmihalyi M. Finding flow. Psychology Today. 1997;**30**:46-48

[20] LaRue B, Childs P, Larson K. Leading Organizations from the Inside out: Unleashing the Collaborative Genius of Action-Learning Teams. Hoboken, NJ: John Wiley & Sons; 2006

[21] Haneberg L. Training for agility. T+D. 2011;**65**(9):50-55

[22] Hugos M. Business Agility, Sustainable Prosperity in a Relentlessly Competitive World. Upper Saddle River, NJ: John-Wiley; 2009

[23] Von Krogh G, Ichijo K, Nonaka I. Enabling Knowledge Creation, How to Unlock the Mystery of Tacit Knowledge and Release the Power of Innovation. Oxford, UK: Oxford University Press; 2000

[24] Nold H. Linking knowledge processes with firm performance: Organizational culture. Journal of Intellectual Capital. 2012;**13**(1):16-38

[25] Beinhocker E. Robust adaptive strategies. Sloan Management Review. 1999;**40**(3):95-106

[26] Deevy D. Creating the Resilient Organization. Englewood Cliffs, NJ: Prentice Hall; 1995

[27] Doz Y, Baburoglu O. From competition to collaboration: The emergence and evolution of R&D cooperatives. In: Faulkner, de Rond M, editors. Cooperative Strategy: Economics, Business and Organizational Issues. New York, NY: Oxford University Press; 2000. pp. 173-192

[28] Alpaslan M, Mitroff I. Bounded morality: The relationship between ethical orientation and crisis management, before and after 9/11. In: Rahim M, Mackenzie K, Golembiewski R, editors. Current Topics in Management. Stanford, CT: JAI Press; 2004. pp. 13-43

[29] Nold H, Anzengruber J, Woelfle M, Michel L. Organizational agility – Testing, validity, and reliability of a diagnostic instrument. Journal of Organizational Psychology. 2018;**18**(3):104-117

Chapter 5

Business Economics: Knowledge and Energy – Capital "KEC"

Hemmat Safwat

Abstract

Cost Estimation in many industries follow traditional methods that makes use of historical data compiled by the enterprise. The Knowledge "K" & Energy "E" (KE) Model recently published by the author takes a different approach, under this approach tasks are represented by combination of K & E referred to the KE pair, the K is represented in Joules. In this paper the KE Model is expanded to include Capital "C", thus the model of KEC model. Before the KEC model is introduced, a comparison of the products and services P&S markets and energy system is presented. This reinforces the presentation of knowledge by Joules. The phases of project development as they relate to capital is discussed. The relevance of profits and risks for capital investments is underlined. The challenges faced for representing the capital C in Joules are discussed. The proposed initial application faces difficulties in obtaining readily available data, However, when the data base is built there could be significant benefit in getting in-depth insights on the effects of the various components in the costs of a product and service.

Keywords: cost estimation, knowledge, energy, KE model, integration of the products and services markets and electric systems, profits and risks, KEC model

1. Introduction

During his long career in the engineering-construction industry, for EPC (engineering, procurement, construction) projects, the author was exposed to many cost estimation methods that typically followed use of historical data compiled by the enterprise. In several instances, the applicability of the data in hand to the new situation entailed some concerns or unanswered questions. For years the underlining approach common to the different resources remained the same. One saw evolution of templates, software.in applications for different industries. Also, a trend of some integration of accounting and cost estimation could be seen. An example of a difficulty encountered, is the applicability of rates from one locality or one country to another.

The field of cost estimation is quite wide. Generally, two practices are used a top-down and a bottom-up. The first is commonly used for quick and indicative estimates and depends to large extent on the expertise of the cost estimator. The latter practice is more detailed and is used extensively in projects, manufacturing, and construction etc. From [1], the KLEMS – Capital, Labor, Energy, Material and Services/supplies serve as one encompassing cost system. The Bureau of Economic Analysis uses this

system for studies of the economy of the USA. It also produces periodical reports for costs and contributions of the different industries to the US Economy. Similarly, on the USA level, the labor Department studies the wages in different industries. Data can be found in public domains e.g., [1, 2]. Specialized Magazines such as ENR [3] provides updated data for the construction industries. Institutions such PMI [4] provide Project Managers with guidance that could be helpful in cost estimation. Large number of cost estimation software are available for project management, construction industry, and manufacturing. Cost estimation covers both direct and indirect costs. The reader is referred to [5] for a comprehensive coverage of cost estimation for a project. The preceding brief is only very short outline to the wide field of cost estimation that evolved over decades but fundamentally using historical rates. For each enterprise it selects the methodology and software it deploys that best fits its needs.

The author together with Professor Dr. Ibrahim Owiess started an investigation of the similarities between Economics and Thermodynamics in 1988. They published [6] in 2002, which included the analogous terms between the two fields. They used this analogy to simulate some economic theories in Thermodynamic methods. This initial approach did not gain acceptance among the Economics community as it was using extensive thermodynamic techniques.

While this topic may appear not directly related to the cost estimation of [1–5], the follow-on work of Ref. [7] noted below will clarify the relevance. The author published [7] in 2022, where he included some refinements in the analogy of [7]. The author used a different approach staying away from the exhaustive use of Thermodynamics. He proposed a model of knowledge & energy "KE" pair for all tasks/activities in an enterprise. He used publicly available data for prices of labor and electricity to produce quantitative results for the KE model. It is noted, [7] suggested using the energy units Joules for knowledge.

In Ref. [7], the author devoted sections addressing the development the enterprise "owner" undertakes to assess what is needed to set up a plant for manufacturing or a services center. This encompasses, required equipment, facilities, buildings etc. A full section for the assessments leading to the final investment decision was included in [7]. These relate quite closely to the main topic covered in this paper that is Capital, i.e., the investments that would go into completing the project "setting up the plant/service center" to start the production or services provision. The financial analyses that are undertaken, of course analyzing projected profitability. The risks are evaluated in scenarios/sensitivity comparisons. The underlining proposition of [7] is all the activities of the enterprise can be represented in terms of K&E. This was further extended to the use of Joules units. The representation of capital was not addressed explicitly in [7].

The author decided to address explicitly Capital in combination with the KE model of [7].

Thus this paper (chapter) is about the expanding knowledge & energy model to include capital that is the "KEC "model.

The reader interested in further details on the forgoing can refer to the [7].

In Section 2, some of the aspects that characterize products and services markets and electric systems are discussed and compared. The objective is to complement the similarities that have been identified in [6, 7] reinforcing the premise of representing knowledge by Joules. Section 3 presents commonly used phases for completing a project as they relate to capital. Section 4 covers profit/risks being key considerations to capital deployment. In Section 5, an outline for the application of the KEC model

building on the quantitative KE model of [7], i.e. adding C is included. A simple demonstrative example for the application of the KEC model is added. Finally, some concluding remarks are presented in Section 6.

2. Products & services markets/electric systems

2.1 Products & services markets

In **Figure 1** a simplified schematic for the market of Products and Services "P&S" is presented.

In the upper part of the Figure, the typical manufacturing is presented. From the right to the left, material goes to manufacturing plants. Products then are transported to whole sellers and then to distributors. Finally, making its way to the end customers. The end customers could be individuals, or commercial.

In the lower part of **Figure 1**, one can see the working of services starting from service providers on the right side to the end users on the left side. Some of the service providers use products as input which they use in the service delivered to the end customers, e.g., a restaurant getting ingredients or ready items.

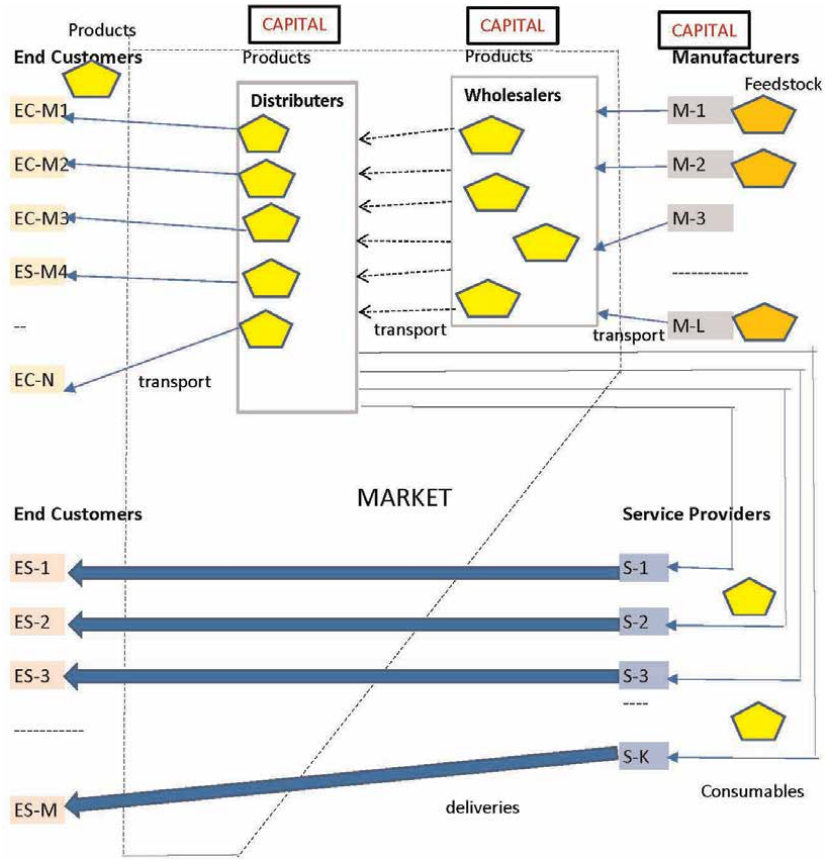


Figure 1.
Schematic for P&S markets.

The black dotted line forms a fictitious boundary for the market across which the products pass from producers or service providers.

The red title at the top of the manufacturers, service providers, transport, wholesalers, and distributors signify the capital each of these enterprises deploys to enable the production or the ready to deliver services.

Within the market, for a particular product there are usually several producers that compete. Customer preferences and marketing features added by the producers and the wholesalers and distributors form the ultimate selections of the end customers.

To note because of changes in demand from season or because of unique occasion e.g., Xmas or back to school cause substantial increase in the demand of various good. Hence, supplier's resort to storage in order to meet the increased demand -adjustment of the supply. A similar increase in the demand of certain services e.g., leisure industry for seasonal travel and tourism.

The transport parts may include marine, onshore railways, trucking etc. Combinations of just in time manufacturing, different packaging together with transport & storage are factors in the operation of the markets.

2.2 Electrical system

Figure 2 forms a simplified schematic for a typical electrical system. The vertically integrated system consisted of generation, transmission, and distribution subsystems.

The generation subsystem has different power plants with different types and capacities. The transmission subsystem has high voltage cabling that carries the generated electricity to the distribution subsystem. From the distribution subsystem the various loads (commercial and residential) are fed through the medium voltage

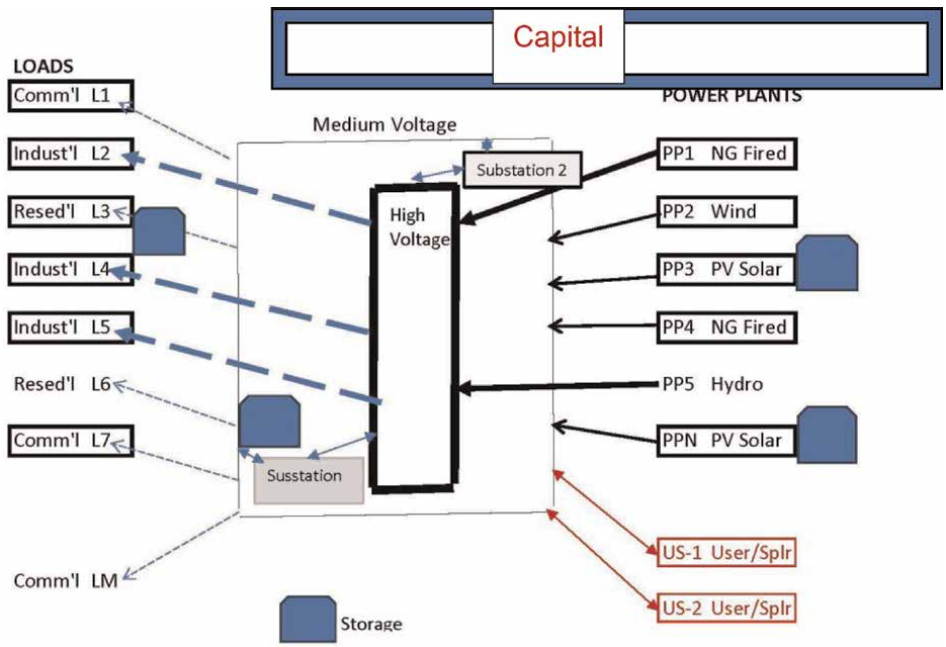


Figure 2.
Schematic for electrical system.

circuits including substations to produce required low voltages. Very large industrial plants could be fed from the high voltage. The reason for the high voltage is to reduce the losses in the transmission and enable use of smaller cross sections for the cables. Under the completely vertically integrated utilities till approximately early 1980s the utility owned the assets of the electrical system, took charge of development of new additions and enhancing elements of the subsystems. Large utilities operated in different regions of the USA. The various regions were interconnected to economize on the spare generation capacities. The state government agencies used to fix the tariff rates for the electricity.

In the 1990's the unbundling of the utilities in the USA and other countries created separate companies for generation and distribution. In many countries the transmission subsystem was taken by the TSO (Transmission System Operator), in many countries the TSO is public owned company. The era of independent power companies that are privately owned grew from the 1990s. Initially these privately owned generation plants produced electricity and sold it to public company under long term PPAs (Power Purchase Agreements). Over the years this evolved to a merchant market (electricity market) which operates mostly in similar manner like stock markets where the producers and the sellers traded. The trading evolved to sophisticated systems.

In another direction for the evolution of the electric system, with increasing interest in renewable energy as the wind turbines and the Photo Voltaic "PV" solar panels technology developed and with increased concern about global warming due to Carbon Dioxide emissions from fossil fuels, wind and PV plants were installed among generation subsystems. Due to the intermittent operation of these plants a big drive for battery storage emerged and as you can see battery & other storage installations were constructed in the generation and the distribution subsystems. Then the generation at the users started with possibilities to sell excess production through the grid.

Many electrical systems focus on certain areas/ regions that could serve several states, country, countries that are regulated under established laws and or inter country agreements.

It is noted that the transport sector is evolving from pure dependence on fuel as it shifts to EV electric vehicles.

Before leaving the electrical system description, we briefly address the energy use as heat for industrial applications primarily burning fossil fuel. Also, for transport marine, onshore, aviation fossil (Petroleum products. Natural gas and LNG) have played a key role over the years. In recent years, electric vehicles (battery charged) picked large and increasing market share in transport, with obvious dependence on the electrical system and preference to renewable energy for environmental and sustainability goals.

2.3 Comparison between P&S markets and electrical system

The discussion in this section is meant to underline the capital needed to build and have the assets of the markets as highlighted in subsections 2.1 and 2.2.

It is worth commenting on the similarities of the functioning the products & services (P&S) markets and the electrical system. To be noted that over the last four decades, many features of the P&S markets now are integrated in the functioning of today's electrical system.

The growth of both the P&S markets and the electrical system correlates with the economy growth (say in a particular country or region). Among the different markets

of the P&S some are highly correlated to the GPD growth index others with lower correlation. The electrical system is generally correlated to the GPD growth.

In **Table 1**, a comparison of key features of the P&S markets and the electrical system is shown.

The intention of making the comparison is to establish the differences and more importantly the similarities that underline the emergence of the electrical system functioning in integral manner with the P&S markets. A trend that continues with privatization of the electrical infrastructure. In the past when there was no power generation on the consumers side, the pricing of the electricity followed rather simple practices but that is now more complex and uses many features from the P&S markets. Another observation the storage in the electrical system which in the past depended mainly on having emergency engines that were called upon in case of emergency to shut off or start the generation plants. In present day, the batteries and other storage systems are called upon to store energy (in the power plants) or in the distribution subsystem (at the substations).

	P&S markets	**Electrical system**
1	*Demand versus supply*	
	Consumer behaviors & Suppliers actions	*System Synchronous V & f*
	Inflation	Voltage. – δV
	Consumer Price Index	Frequency – δf
2	*Currency*	*Current*
3	*Products*	*Voltage Levels*
	Durable	High Voltage
	Non-Durable	Medium Voltage
	Commodities	Low Voltage
	Services	
4	*Growth Rate*	*Growth Rate*
	GPD	Annual Percentage Increase in Generated Electrical Energy
5	Manufacturers – plants	Generation – power plants
	Wholesalers/Transporters	Transmission – Substations/High Voltage Lines
	Distributors/Transporters	Distribution – Substations/Medium & Low Voltage Lines
6	*Storage*	*Storage*
	Warehouses	Electric Batteries
		Hydro Pumped Storage
		Compressed Air
7	*Regulation of operation*	
	Federal Reserve Board/Central Banks	Dispatch Center
	Adjusting Interest Rate	*Dispatch Center – On/Off and adjustment of running reserve*

Table 1.
Comparison between P&S markets and electrical system.

This trend is emerging as the renewable energy takes on a major role in the generation of electricity. The operation of the P&S is highly dependent on the consumers consumption – the interest rate set by the Federal Reserve Board in the USA and by Central Banks controlling the inflation rate to avoid overheating and or recessions of the overall economy as measured by the price consumer index. The response is slow – it takes months to reach the desired target. This is understandable because the target is for an overall market with many different products and services. On the other hand, the electrical system with a very restrict adherence to the synchronous speed -and the system voltage and frequency dictates almost instantaneous adjustment that the minimization of the δV & δf.

3. Capital

As seen from Section 2, Capital is essential for setting up the infrastructure required for manufacturing, transport, storage, service centers, generation power plants (fossil or renewable plants), transmission lines and substations, battery storage, etc. In each case, there are three phases the first two phases CAPEX is sought. In the last phase – one is dealing with part of the OPEX that deals with additional investments that could be deployed in case there is a need or to attain some benefits. The setup take places as a project evolves in three phases.

3.1 Project planning/development (phase 1)

In this phase, sometimes referred to as feasibility study. This phase is led by the development team of the Owner. The development team gets external support as needed. The aim is to crystalize the project's objectives these include the production capacity – typically the annual projections production – products or services. This comes through evaluation of the demand currently and in both the medium and long terms. Also, it factors the competition and the possible sales prices. This task is to estimate the annual revenue from the sales.

Then one starts to tailor make the plans for the equipment that will be utilized in manufacturing the products or completing the services. This is very important as entails selecting the appropriate technology that will be used. This also involved defining the type of energy to be used. This is the core of the manufacturing or the service to be offered. With this step out of the way, the definition of the plant or the service center starts. This involves need for additional equipment to complete other manufacturing steps or support services. Also, definition of feed stock and its sources as well as bought out items. In this regard, the question "buy it or make it" is answered.

With the equipment established then conceptual engineering of the plant is started to produce preliminary layout(s), Flow diagrams, Single Line diagrams, and preliminary designs for services and utilities, as well as required buildings and facilities.

In addition preliminary estimates for the following items is completed, i) engineering of the plant, ii) Permits and Environmental studies, iii) procurement, iv) construction, v) project management.

These estimates are based on envisaged executions for each item.

Based on these preliminary inputs an estimate for total cost of the engineering, procurement and the construction of the equipment and required infrastructure is pulled together. This forms the preliminary estimate for the EPC of the plant.

Then the cost estimate of the annual production is prepared, this follows a simplified methodology of that discussed later in Section 3.3. Lastly, the financial projections are made with the aid of financial model, factoring debt and equity split, interest rate

and loan terms. Other considerations including deprecation, taxes are incorporated in the financial model.

The results of the financial model are submitted to the owner/enterprise decision maker to decide if the second phase is to be initiated. If the second phase is to go forward, a project development manager "PDM" is appointed and a budget for phase 2 activities is also approved. Also, specific instructions are received from the owner/ executive management pertinent to the direction of phase 2.

3.2 Project EPC and plant completion (phase 2)

Based on the investigations of phase 1, securing the land and for the contracting of all the contracts to implement the project – to set up all required infrastructure is completed. This entails identifying and tendering among the candidate contractors to select the most fit contractor covering the previous experiences, the proposed contractors team, the details of the contractor implementation plan, organization of the team, quality, safety, schedule and completion of engineering, procurement and construction, commissioning and testing. Phase 2 estimation is more accurate, compared to that of phase 1 particularly as it uses quotes or signed contracts for the main parts of the scope. Depending on the project, there could be special services, e.g., environmental studies, site investigations. The PDM and his team makes appropriate decisions of dividing of the work into packages to enable efficient and timely completion of different activities with minimum hindrance from one task to another with the contracting plan approved by the Enterprise senior management, the contracts are finalized and signed after the tendering of the various packages. The PDM may engage a development engineer in addition to his internal staff as needed. The detailed project schedule is finalized and all the contracts to complete the project are then used for monitoring the progress of the project tasks. The PDM has the responsibility of directing the contractors project managers and approving the milestone payments.

The PDM prepared periodical reports for the project report that he/she circulates to the executives of the enterprise.

The progress of the project and overcoming any unforeseen problems are key to getting the project to the final goal achieving Commercial Operation – after the commissioning and final tests are concluded successfully – meaning the guarantees of the various contacts have been met. In comparison to phase.

3.3 Production (phase 3)

The production phase starts with completing all preparatory activities by the operation Including hiring and training the staff. The set of the staff in accordance of an Organizational structure reporting to the operations and maintenance managers under the Plant Manager/ or the Service Manager. The decision of internal execution of the tasks or outsourcing is done. The tasks for environmental, quality and safety are planned. Then the production tasks to complete a product or a service are tabulated and each task KEC's are assessed.

4. Profits/risks

Profit is a key driver for individuals, enterprises, and governments etc. in making investment decisions. Realizing or exceeding the anticipated profit is fundamental in the measurement of the performance of an investment.

The return on an investment generally correlates with the risks that could be encountered.

Uncertainties factor considerably in the degree of risk. It is always important to examine tolerances in various parameters. In scenario evaluation, one should avoid the case of all extreme values for different parameters assumed to occur simultaneously. For critical parameters, there should be an identification for fall back positions.

In making an investment, several categories of risks many be faced. To name some examples, technological risks – new technology could have some risks that would impair the performance of intended functions, older technology may become obsolete or be outperformed. For new technologies, prudent review of possible shortcomings, the well strength of the technology provider, record of performance, financial backing. The extent of the guarantees and warrantees the technology provider is willing to provide. The dependence of the technology on rare metals could form vulnerability. Competition by others may outperform the selected approach. Risks associated with failure to address adequately environmental concerns and or failure to deal properly with waste could have large impact. Financial risks related to borrowing terms could expose the borrower to significant risks. In international an investment beyond the original country borders there could be currency risks and non-expatriation/limits of original investment or profits.

The status in the product/service life cycle plays important role in estimation of risks. For a new product, the evaluating some risks could be difficult. As product enters in the growth stage and continues, the learning curve enables better estimates of the risks. As the product reaches advanced maturity, pressures from the competition may dictate adoption of new innovations and the risks could increase.

The condition of the Economy factors in the demand of a product or a service. When the market conditions are favorable, e.g., low interest rate, enterprises borrow money and make expansions while when the market is retrenching the opposite prevails. Thus, market conditions play significant factor in risks the enterprise faces. The same applies for individual as a consumer.

Of course, failures of the management to adopt flexible and robust policies and maintain a healthy culture could be detrimental. The execution of the various tasks in proper way requires continued assessment of the knowledge-energy combination. Always, continued evaluation "make it or source it", all in trying to keep up with an edge over the competition.

From [7], Innovation – optimization of knowledge and energy is a key consideration in the running of plant or the service center. These form a major factor in the establishment of the required capital – the assets of the project as well the running finances during the production phase.

It is noted that profits/ risks as they relate to capital estimation involve judgments as they address future events.

4.1 Profits in investment planning

Section 9 of [7] was devoted to investments, the returns of the investments represents a key factor in making the Final Investment Decision "FID" for the enterprise. The considerations that are usually addressed in preparing the risk analysis that normally precedes the FID were discussed above. These considerations aim towards optimizing and reinforcement of the profits when making the investment.

4.2 Profits in providing/selling products & services

Normally the enterprise makes the pricing of its product based on the production plan adopted at the beginning of the year. The annual production plan is based on the investment decision (Section 4.1) and feedback obtained from the sales and the market departments for prior years and in particular the last year. Th annual plan pricing also factors new information as projected for the coming year. The annual plan also takes into consideration entering new markets and or leaving some markets.

5. Application of the KEC model

Commensurate with the three phases discussed under Section 3, there are internal "I" and external expenditures – Outsourced "O" categories. These two categories involve tasks, each task has associated with it Knowledge "K", Energy "E" and Capital "C" elements.

For a product.

For each internally executed task i for task 1 to n_I

$$Sum_{iI} = k_i + e_{i\cdot} + c_i \tag{1}$$

For the outsourced tasks – (at the provider l) task j1 to n_j

$$Sumj = k_j + e_j + c_j \tag{2}$$

For the product the Internal SUM

$$SUM_I = \sum_{I\ 1\ to\ ni} Sum_i \tag{3}$$

& for the External – one adds-up Summations of each provider for the total providers l to N

$$SUM_O = \sum_{I\ \ to\ 1=N} \left[\sum_{I\ to\ j=n1} \right]. \tag{4}$$

The reader gets the logic is add the contributions of KEC for each of the two categories. Because the external providers could be several there is the need for the addition of the sums from the various providers/suppliers.

The use of Eqs. (1) through (4) should yield the Internal Sum and the Outsourced Sum.

In [7], demonstrative calculations were presented based on labor prices and energy prices, i.e. the joules estimates for the knowledge and the energy that entered into various tasks for internal and outsources were given for demonstrative examples.

This paper is meant to apply the same logic in calculations for the Capital parts, meaning the tasks in phases 1, 2 leading to the estimation of the capital costs.

The author acknowledges that the estimation of the external (outsourced) capital represents considerable challenges. Nevertheless, the approach of the KEC helps in addressing the typical do it internally or outsource it. **Table 2** with parts 1, 2 and 3 is a demonstrative example discussed under subsection 5.1.

		Internal			Outsourced			
Phase 1	**Project planning/development**	**K**	**E**	**C**	**1O1**	**1O2**	**1O3**	**1O4**
1.1	Engage a consultants							
1.2	Completing estimates for purchases, equipment, appliances, computers and software	X	X	X	S			
1.3	Completion of list of required licenses	X	X	X		S		
1.4	Establishing required office space	X	X	X				
1.5	Establishing required parking space	X	X	X	S			
1.6	Decide – Buy. Or Rent of space	X	X	X	S			
1.7	Decide on electronic/remote – technology	X	X	X	S			
1.8	Estimate operating expenses – Manpower, cleaning, utilities	X	X	X	S			
1.9	Establish the equity	X	X	X	S			
1.10	Secure Loan	X	X	X			S	
1.11	Complete Financial Plan	X	X	X			S	
1.12	Other							

Part 2

		Internal			Outsourced			
Phase 2	**Project EPC and plant completion**	**K**	**E**	**C**	**2O1**	**2O2**	**2O3**	**2O4**
2.1	Search and selecting a proper office space	X	X	X				
2.2	Purchase of Medical Equipment	X	X	X				
2.3	Purchase of furniture	X	X	X				
2.4	Purchase of appliances	X	X	X				
2.5	Purchase of computers and software	X	X	X				
2.6	Applying for permits and getting licenses	X	X	X				
2.7	Search and hiring of staff	X	X	X				
2.8	Concluding utilities and internet contracts	X	X	X				
2.9	Contract with Accountant	X	X	X				
2.10	Contract with Lawyer	X	X	X				
2.11	Contract with Insurance	X	X	X				
2.12	Select and complete the purchase	X	X	X				
2.13	Receive the purchased items				YES	Yes		
2.14	Installation of purchased equipment	X	X	X		Yes	Yes	YES
2.15	Complete necessary training	X	X	X	YES			
2.16	Plan publicity campaign and inauguration	X	X	X				
2.17	Plan and implement all operating procedures	X	X	X				
2.18	Other							

Part 3								
		Internal			**Outsourced**			
Phase 3	**Operation**	**K**	**E**	**C**	**3O1**	**3O2**	**3O3**	**3O4**
3.1	Scheduling appointments for the patients	X	X	X				
3.2	Receiving the patients, completing paperwork	X	X	X				
3.3	Examination of patients	XXX	X	XX				
3.4	Issuance of visit report and updating patient medical Record	X	X	X				
3.5	Completing Medicine/pharmacy instructions	X	X	X				
3.6	Specify required Lab work	X	X	X				
3.7	Specify follow up	X	X	X				
3.8	Administration	X	X	X				
3.9	Cleaning							Yes
3.10	Accounting				Yes			
3.11	Legal					Yes		
3.12	Maintenance						Yes	
3.13	Other							

"X" meaning applicable, "Yes" designates outsourced from provider. "S" designates external support.

Table 2.
Demonstrative Example phases 1, 2 and 3 (Subsection 5.1).

It is important to note that the application of the model involves use of data, the required data come from historical data of the.

5.1 Simple example

The logic outlined above should be sufficient to follow the suggested approach. A simple additional illustration example is presented below, covering the three phases of Section 3. The emphasis is on the calculations of the Internal and Outsourced expenses. The profits are touched upon with guidance from Section 4.

The selected application is the case of general practice doctor setting her first office "general practice" after previous 5 years working at a hospital to serve local community at City CT in the USA.

She had to address the finances of the three phases of Section 3. The aim is to estimate and plan, secure funds for phase 2 and monitor cash flow for phases 2 and 3. This is typically would be done using in USD $ for this example. The proposed KEC model could be seen as an additional tool that provide advantages as it goes beyond the surface for the $. The KEC model exposes the K and E contributions (Ref. 2) and in this paper C as it also in turn relates to K &E.

Let us discuss the estimation of C for an entry c_i for an internal activity; a previous application of KEC model should have included the estimation of the share of capital that goes in the task being addressed for the life time of the investment. From that the

share of the capital to the units in the task related to the product is calculated. The process involves a lot of details but the details reveal.

Insights that could be valuable in planning and altering some perceived ways for undertaking some activities.

The calculations for the outsourced K & E have the difficulty of getting the details from the provider. The C for an Outsourced c_o faces even more difficulties. The fact that for large number of outsourced activities, the challenges are multiplied. The difficulties are compounded if the provider is not using the KEC model approach.

In **Table 2** – Parts 1, 2 and 3 the tasks for each phase are shown with the internal K, E and ~ C depicted in the left of the data entry three columns, On the right hand side the outsourced contributions are shown in four columns. The entries correspond to four different providers. The contributions are marked by yes when applicable. The yes represents the sum of the KEC for that provider for this task. Please note the naming of the provider starts with the phase, then the last is numerical sequential number for the providers of this phase.

Before leaving this section, one addresses profits with the various considerations referred to under section 4. The enterprise has the flexibility to introduce the profits at various stages as it decides on the profit centers and how it wants to get the performance indicators.

6. Concluding remarks

The paper (chapter) introduces expands the KE model of [7], being a novel approach that the author proposed for cost estimation based only on two parameters the knowledge and the energy. This is an alternative method that if developed further lead to the full dependence on the historical data in cost estimation.

The comparison of the P&S markets and the electricity system underlines how the two are converging and that supports the notion of [7] that knowledge can be presented by the same units of energy "Joules'. The attempt to expand the KE model of [7] is useful as it sheds light on the fact that the Capital is built on the enterprise's activities in terms of K &E. The exercise presented in Section 4 points to the challenges of obtaining the suitable data for outsourced services or products. The KEC while is in infant stage could provide detailed insights and could be useful in facilitating many enterprise reviews/decisions. The KEC model could provide a tool for assessing the profit centers among different divisions of a large enterprise.

The advantage of the KE and the KEC is they move from use of money and depend on a Joules, as money has many factors that lead the estimator to make some judgmental calls. The use of a common unit Joules will enable AI (Artificial Intelligence) cost estimation software to be more reliable as it will reduce the variability in the data associated with multitude of factors of the collected historical data.

Author details

Hemmat Safwat
Energy Development Services, USA

*Address all correspondence to: hhsafwat@gmail.com

References

[1] Bureau of Economic Analysis (US Government). Production Account (KLEMS)/Data for Construction and Manufacturing Industries. Available from: https://www.bea.gov/data/special-topics/integrated-industry-level-production-account-klems, https://www.bea.gov/data/gdp/gdp-industry [Accessed: September 24, 2023]

[2] Labor Department (US Government). Labor Wages. Available from: https://www.dol.gov/agencies/whd/government-contracts/construction/faq/conformance [Accessed: September 24, 2023]

[3] Construction Rates. Available from: https://www.enr.com/Cost-Data-Dashboard [Accessed: September 24, 2023]

[4] Project Management Institute. Available from: https://www.pmi.org/pmbok-guide-standards/about/current-projects [Accessed: September 24, 2023]

[5] Schwat B. Project Management, Resource Management, Project Cost Estimation: How to Estimate Project Cost. Available from: https://www.projectmanager.com/blog/cost-estimation-for-projects [Accessed: September 24, 2023]

[6] Safwat HH, Oweiss IM. Economics: New Horizons, Shifting the Paradigm, Word Association, ISBN: 1-891231-71-5. 2002

[7] Safwat HH. Business Economics – Knowledge and Energy. Word Association, ISBN: 978-1-63385-444-4; 2022

Chapter 6

Deployment of Accounting Analytics Models for Workforce and Project Management

Kevin Ow Yong, Fei Gao (Phoebe), Michelle Zou and Janet Tan

Abstract

We provide several innovative industry solutions and analytical tools for our industry partner, HANDS Enterprise Solutions, to better assess their cost structure and improve their HR policies using various big data analysis and data visualization tools. Based on our analysis, we identify several areas of weakness in their HR policies, highlight salient points to buttress their internal control policies, and provide policy recommendations for future improvement and analysis. Overall, we have improved the quality of the company's claims submission. The productivity improvement is applicable for both their consultants and staff, and the improvement in cost control can be observed at both the project and employee levels.

Keywords: big data analysis, data visualization, work efficiency, productivity, project management, internal control

1. Introduction

Traditional accounting has primarily focused on providing factual and retrospective reports. While this approach helps executives analyze past outcomes and make adjustments to their strategic and operational plans, it does not necessarily assist them in predicting future events and making proactive plans.

It is crucial to find appropriate solutions that enable a thorough examination of financial data when transitioning from a historical perspective to forward-looking business intelligence (BI). Implementing a BI solution allows for the identification of patterns within consolidated data, rather than relying on fragmented and ad-hoc processes from separate information systems. This approach uncovers hidden trends and offers valuable functionality for predictive analytics. For instance, in customer relationship management (CRM) systems, improved forecasting is vital for effectively planning for capacity fluctuations that directly impact customer experience, response time, and transaction volumes.

Data analytics has become a routine practice for accountants, who use calculations such as sums, averages, and percent changes to report on sales performance, customer credit risk, cost per customer, and inventory availability. Accountants are also familiar

with diagnostic analytics, as they conduct variance analyses and employ analytic dashboards to explain historical outcomes.

In the coming years, there is a growing trend toward attempting to predict financial performance and utilizing nonfinancial performance measures as potential indicators of financial success. This presents a significant opportunity for accountants to play a more valuable role in management. Therefore, accountants should continue harnessing data analytics' power to effectively fulfill their responsibilities.

2. Analytical tools and solutions

2.1 Predictive analysis in accounting processes

Predictive analytics and prescriptive analytics play a crucial role in providing actionable insights to companies, making it essential for accountants to enhance their proficiency in these areas to add value to their organizations. Predictive analytics involves integrating data from various sources, such as enterprise resource planning, point-of-sale, and customer relationship management systems, to forecast future outcomes based on statistical patterns discovered in historical data using regression-based models. A common application of predictive analytics is calculating a credit score to assess the likelihood of timely credit payments in the future. On the other hand, prescriptive analytics employs advanced optimization techniques, including self-optimizing algorithms, to generate recommendations on the most favorable courses of action to be taken.

The specific analytics skills required for accountants may vary depending on whether they are responsible for producing or consuming information. Analytics production entails sourcing relevant data and conducting analyses, making it a more suitable task for junior-level accountants. Analytics consumption, on the other hand, involves utilizing insights derived from analytics in decision-making processes and is particularly relevant for senior-level roles. Accountants do not need to completely transform into data scientists or computer engineers to leverage analytics tools. However, the audit and accounting professions must become more adept at consuming analytics. This proficiency will enable them to enhance their existing audit practices using available technologies and support their clients in undertaking data analytics activities.

2.2 Accounting analytics applications in audit processes

Audit Data Analytics (ADAs) help auditors discover and analyze patterns, identify anomalies, and extract other useful information from audit data through analysis, modeling, and visualization. Auditors can use ADAs to perform a variety of procedures to gather audit evidence, to help with the extraction of data and facilitate the use of audit data analytics, and a tool to help illustrate where audit data analytics can be used in a typical audit program.

Governance, risk and control, and compliance monitoring systems commonly used by larger companies include systems developed by Oracle, SAP, and RSA Archer. Oracle and SAP have application-side business intelligence systems centered on business warehouses. Lavastorm, Alteryx, and Microsoft's SQL server provide advanced tools for specialists such as business analysts and, increasingly, for non-specialists. All these platforms are currently the preserve of large systems integrators, larger and mid-tier firm consultancies, and specialist data analysts. It seems likely though, that

over time these systems will move in-house or be provided as managed services. It also seems likely that companies such as CaseWare and Validis currently provide data analytics services to larger and mid-tier firms, enabling those firms to offer data analytics services to their clients.

Some businesses already similarly analyze their own data for auditors. As these business analyses become deeper, wider, and more sophisticated, with a focus on risk and performance, it seems likely that they will align at least in part with the risks assessed by external auditors.

Data analytics is rooted in software originally developed in the early 2000s for data mining in the banking and retail sectors and for design and modeling in financial services and engineering. What is astonishing about this process is the volumes of data that can be handled efficiently on an industrial scale, and the speed of calculations being performed in a fraction of a second. The type of tasks such software can perform, and the connections it can make, dwarf what was previously possible. These technological improvements have facilitated the advances that we have seen in data analytics software.

2.3 Current applications

By using accounting analytics procedures, accountants and auditors can produce high-quality, statistical forecasts that help them understand and identify risks relating to the frequency and value of accounting transactions. Some of these procedures are simple, others involve complex models. Auditors using these models will exercise professional judgment to determine mathematical and statistical patterns, helping them identify exceptions for extended testing. Auditors commonly use data analytics procedures to examine:

- Receivables and payables aging
- Analysis of gross margins and sales, highlighting items with negative margins
- Analysis of capital expenditure versus repairs and maintenance.
- Matching of orders and purchases
- Testing of journal entries

While data analytics techniques may not completely replace traditional audit procedures and techniques, they can serve as powerful facilitators that enable auditors to perform procedures and analyses that were previously unfeasible. For instance, the three-way match process is a fundamental audit procedure. Traditionally, auditors would sample test this procedure, as it is neither practical nor expected for them to verify every transaction document. However, data analytics techniques now empower auditors to analyze all recorded transactions, potentially identifying a specific class of transactions with unmatched items. Additionally, data analytics tools enable auditors to trace revenue transactions to debtors, analyze subsequent cash receipts, and examine payments made after the period ends. By cross-referencing delivery dates extracted from underlying documents, auditors can determine if payments correspond to goods delivered before or after the period ends and identify any unrecorded liabilities.

The auditing and accounting professions have invested significant resources in understanding the impact of various data visualization techniques on decision-making and analytical procedures. As technology evolves and data sizes and volumes continue to grow, new ways of presenting information are emerging. Therefore, it is essential for accounting and auditing research to explore these newer data visualization techniques.

The primary objective of data visualization is to assist users in gaining better insights, drawing more accurate conclusions, and ultimately developing hypotheses. This is achieved by leveraging the user's perceptual abilities during the data analysis process, as well as applying their flexibility, creativity, and general knowledge to the vast datasets available in modern systems. Data visualization offers several advantages, such as presenting data concisely, facilitating faster exploration of large datasets, and providing intuitive tools that do not require an understanding of complex mathematical or statistical algorithms.

Constant advancements in software development aim to assist users in effectively managing the growing volume of data generated by businesses. Accounting firms and private businesses are increasingly adopting new business intelligence (BI) tools like Tableau, Power BI, and QlikSense. Auditors have started utilizing visualizations as a means to examine multiple accounts across multiple years and identify potential misstatements. These tools can be applied in risk analysis, transaction and controls testing, analytical procedures, supporting judgments, and providing valuable insights. Many data analytics tasks can now be easily performed by auditors with minimal or no involvement from management, emphasizing the importance of independent analysis. Detailed analyses offer audit evidence and insights, while higher-level routines aid in risk analysis to detect issues.

Data visualization tools also hold great potential in enhancing communication during audit engagements. They enable the summarization and presentation of information engagingly and sufficiently. By incorporating visual presentations, essential information can be conveyed at a glance, making reports easier to read and understand. The inclusion of visualizations can strengthen the impact of opinions by providing factual representations rather than relying solely on descriptive statements to support them. Introducing visualization techniques allows auditors to focus on key figures that effectively convey the intended message. Working with data is essential in external audits, ensuring auditors develop a comprehensive understanding of their clients and effectively plan high-quality audits.

With the rapid pace of innovation, data visualization is likely to become an integral aspect of the roles of many accountants and auditors. To fulfill their responsibilities of reporting on the past and providing timely assurance and insights about the future of businesses, accountants and auditors need to effectively utilize vast amounts of data. Employing dynamic accounting analytics and visualization tools becomes crucial in enhancing the impact of their opinions and recommendations. Therefore, the accounting profession must embrace and implement dynamic reporting and visualization techniques that address the challenges posed by big data, ultimately producing results that have a meaningful influence and impact.

3. HAND enterprise solutions

HAND Enterprise Solutions (HAND) is a leading global software solutions provider working to deliver IT strategy, ERP solution implementations, and global

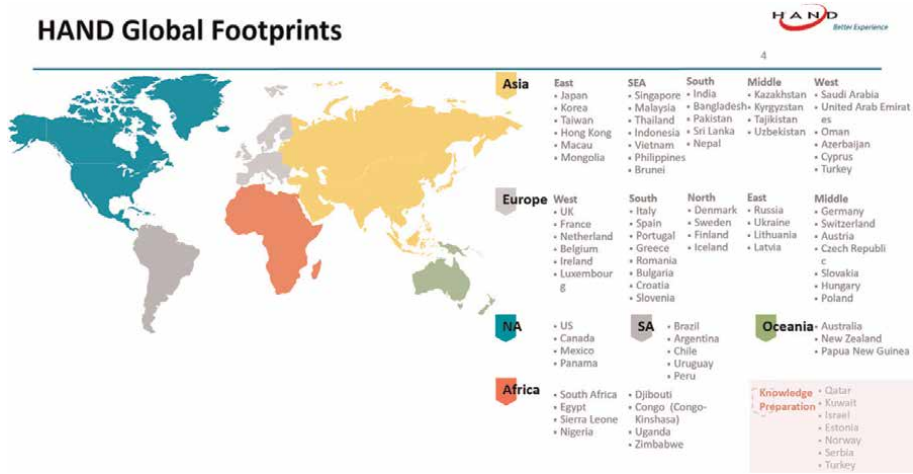


Figure 1.
HAND global footprints.

technical support. The company leverages its offshore and onshore teams from around the world to provide its customers with the most competitive, convenient, and reliable experience. HAND is publicly listed on the ChiNext, a NASDAQ-style board of the Shenzhen Stock Exchange (stock code: 300170).

The company has end-to-end IT delivery solution capabilities with 23+ years' experience in enterprise IT solutions design and building up, and 30+ industrial and packaged solutions, focusing on the traditional areas while keeping pace with innovations in the niche market.

HAND has 10,000+ professional IT consultants, 4,000+ enterprise customers, and 7,000+ successful project cases delivered and supported. The Group operates 11 major domestic bases, 5 overseas subsidiaries (e.g., U.S., Japan, Singapore), 10 participating holding companies, and global IT partners (refer to **Figure 1**).

HAND is recognised as the Best SaaS ERP Solutions Provider of the year 2017 in Asia by ORACLE. With a track record of over 80+ live projects in ORACLE Cloud, their customers value HAND for their rapid deployment capability and cost-effectiveness for ORACLE ERP projects.

HAND is also one of the world's leading SAP partners. As an SAP Platinum Partner, their experts effectively deploy, develop and support this market-leading software. HAND offers implementation and consulting services for SAP products including S/4HANA, S/4HANA Upgrades, Hybris solutions, and SAP Cloud-for-Customer (C4C).

Though the digital infrastructure has enabled the company to build up a sheer volume of financial and operational data, there is a lack of accountancy domain specialists to guide the firm to adopt a structured approach to make use of big data and analytics techniques to enhance their contribution to businesses. By integrating accounting profession expertise into big data analytics, we help the company and its clients to:

1. Create a dashboard for easier visualization of the trends of financial and non-financial data to better understand the company's cost behavior on a project or consultant basis.

2. Use predictive models and other sources of data to improve project expenses budgeting and forecasting.

3. Use more sophisticated outlier and exception analysis to improve internal control and risk management.

4. Improve the efficiency and quality of internal audit activities through the analysis of whole data sets.

3.1 Industry-specific solutions

Expenses management software is developed to replace rudimentary processes in the approval and reimbursement of expenses claims. Such software automates these mundane tasks with built-in controls, reduce human errors and integrate interface with the accounting system to facilitate expense monitoring and reporting.

As an example, HAND Enterprise Solutions use Helio, an expense management apps to simplify and automate the receipt to reimbursement process for their employees' claims on project-related expenses. Employees can submit travel bookings, T&E expenses, transportation, meals & accommodation, and miscellaneous expense claims. This software helps businesses in ensuring compliance such as external compliance with tax policy or tracking internal compliance with company policies, and cost control by designing built-in features to detect or mitigate violations in the apps. Specifically, data from transportation and meal claims with apps from on-demand or sharing companies such as DIDI is fed into their accounting system to streamline the reporting process. Such integration with other applications affords seamless data transfer, saving the hassle of toggling between different systems to manually import, export, or data entry.

3.1.1 Expenses management software ranking

According to Capterra [1], a software review site that provides user reviews and ratings for expense tracker apps designed for businesses. The most popular and highest-rated products on expense tracker apps are summarized in **Table 1**.

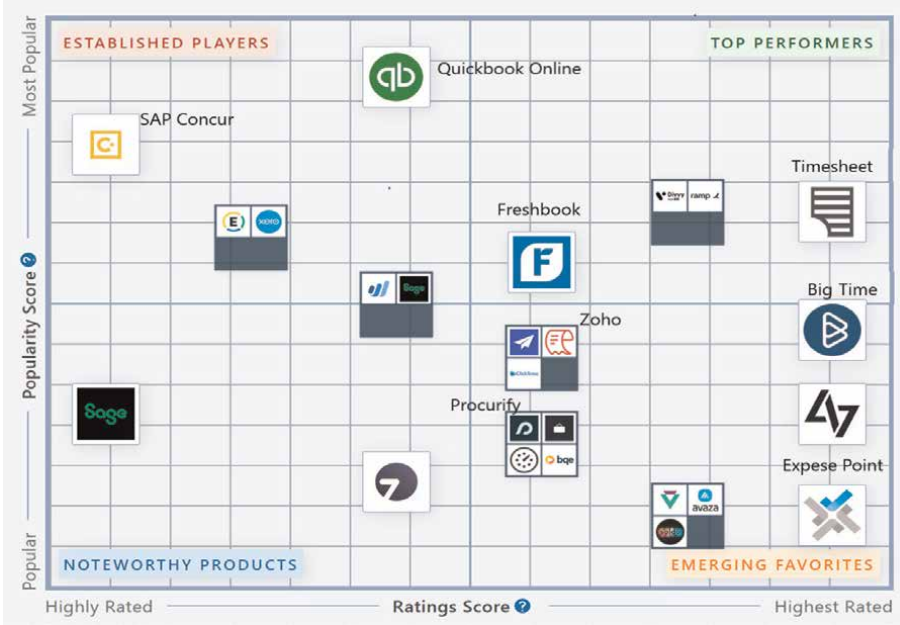
Of these products featured in Capterra, another market review report on expenses tracker apps by Gartner [2] listed the following:

SAP Concur is popular as it caters to small businesses to Fortune 500 clients [3]. It was reviewed as a mature tracking product. Concur was acquired by SAP [4] in 2014 and therefore able to integrate easily into the established SAP ERP & extended suite which consists of SAP Analytics Cloud Solutions in the Financial Planning Module and Machine Learning Platform. Helio is the Chinese and ASEAN version of SAP Concur.

SAP Analytics Cloud (SAC) is a business intelligence (BI) platform that offers data analytics, planning, and predictive capabilities. However, it is not a self-service BI tool like Tableau or MS Power BI.

3.2 Improving Helio

Under the application of the new Internet technology, the traditional accounting information system based on accounting vouchers has been greatly expanded around the accounting information system, there are many other relevant data information



Source: Capterra [1].

Table 1.
Top expense tracker software apps.

that can be obtained. This provides a new idea and tool for every commercial enterprise to adopt the new big data analysis method, strengthen enterprise control and reduce unnecessary costs. Based on big data, quantitative analysis, refining, and architecture of the data model will in turn provide a reference control model for the vast majority of enterprise managers.

Aside from big data analysis for cost behavior analysis and cost control purposes, to fully harness the power of data analytics, future projects and studies can analyse incoming data, such as sales records, marketing patterns, and growth metrics of the company, create dashboards for easier visualisation of the trends, deploy data analytics to support the making of critical business decisions that include inventory planning, payment and collection cycles reviews, revenue and cash flow prediction, new product development, investigation of supplier or production issues, formulation of product pricing and promotion strategies, developing a balanced scorecard encompassing both financial and non-financial performance metrics.

Our research team helps HAND develop models using big data analytics and machine learning techniques to innovate HES specialized products: EasiShare, a secured document management system, and Helios, an expense tracker App. Helio is the Chinese and ASEAN version of SAP Concur. Helios aims to innovate integrated travel and expense management services and solutions for organisations of all sizes, industries, and locations. Our models will be used to help HES to develop four major products: (1) Expense products, (2) Travel products, (3) Invoice products and, and (4) Data insights product.

3.3 Suite of services

Helio will be the pilot product with user testing from HAND itself first, once successful and completed, will be licensed, customized and sold to HAND's existing clients in terms of consultancy service and as Business Intelligence products (a fully developed product to be installed, implemented, and evaluated at clients' user end). The models we aim to develop from this project will improve the management control system for both HAND and its clients from the following perspectives:

a. Expense control: easily track, analyse, and report business travel spending that enables a seamless flow of data to bring a new level of control over and visibility into business expenses; integrate company expense policies and custom auditing software to improve compliance and visibility; the App is mobile and web-based that will automate, accelerate and improve expense management from start to finish.

b. Budgeting control: empower the budgeting process by capturing and consolidating data for a holistic view of employee spending across the organization and projects, controlling and adjusting budgets to changing business needs, and improving the accuracy and timeliness of spend.

c. Internal audit: certify each expense again the company's policy; identify non-compliant expenses before reimbursement; ensure all employees are compliant; consult on best practices.

d. Location control: identify risks and assess their impact; pinpoint employees' locations and know their travel plans to easily monitor how events and incidents are impacting employees and projects

3.4 Data cleaning

Our industry partner provided several large datasets tracking information on claims as well as projects (in progress and finished), linking each claim to each employer, the corresponding project, and detailed categories. We first cleaned the data by removing missing, duplicated, and inconsistent data, and study the summary statistics of the dataset to have the big picture. In the summary statistics tables, we included a number of observations and frequencies in percentage under each claim category. To understand the claim data better, we also categorize the detailed claims according to the distance between the current location and the claim location, and when the distance is too far, whether there is a reason being provided.

By conducting a comprehensive analysis of claim information, we can gain valuable insights into the overall claim pattern. This deep dive into the data enables us to identify any recurring trends or anomalies that may have gone unnoticed otherwise. Such an in-depth examination of claim information can also reveal any potential issues or areas for improvement in the claims process, leading to more effective and efficient handling of claims in the future. In essence, this detailed analysis provides us with a holistic view of the claims landscape, allowing us to make informed decisions and take appropriate actions as necessary. Upon scrutinizing the data patterns, we have put forth the risk categories that require further analysis in the following session.

3.5 Risk Identification

We propose potential alerts (risk triggers) in the system for further investigation. The basis of proposed alerts is based on the information from the various reasons provided by HAND about suspicious claims or potential violations of fraudulent claims. Discussed the weakness of the internal control during the employees' claim procedure. They find that claims on mileage, petrol and accommodation are the most occupational frauds, and we observe similar patterns in our data. Fernandhytia and Muslichah [5] identified the positive relationship between internal control and accounting fraud, governed by the shared individual morality and ethical values. With the rich dataset provided, we are extending the literature by providing more detailed analysis with features such as when the employees make the claim, reasons for the claim, and the locations when they submit the claims.

We first study the integrity and authenticity of the various claims by analyzing the physical distance from the project that the staff is supposed to work on.

Figure 2 shows the portion of the observation on the aggregate level at each Distance to the Project level. Our preliminary results suggest that 79% of the claims are within 1 km of the project that the staff is supposed to work on, and 18% of the claims are within 10 km of the project that the staff is supposed to work on. Hence, 3% of the claims are made from 10 km and further from the project that the staff is supposed to work on. To analyze the reasons for employee expense claims at various distances from project locations, we use different cut-off points for distance ranges. The analysis shows that for shorter distances, most claims had no reason specified, while for longer distances, "Others" and "Urgent Travel" were the most cited reasons. At the aggregate level, most claims were made at the project location, while for longer distances, claims were flagged for further investigation if there were no valid reasons provided.

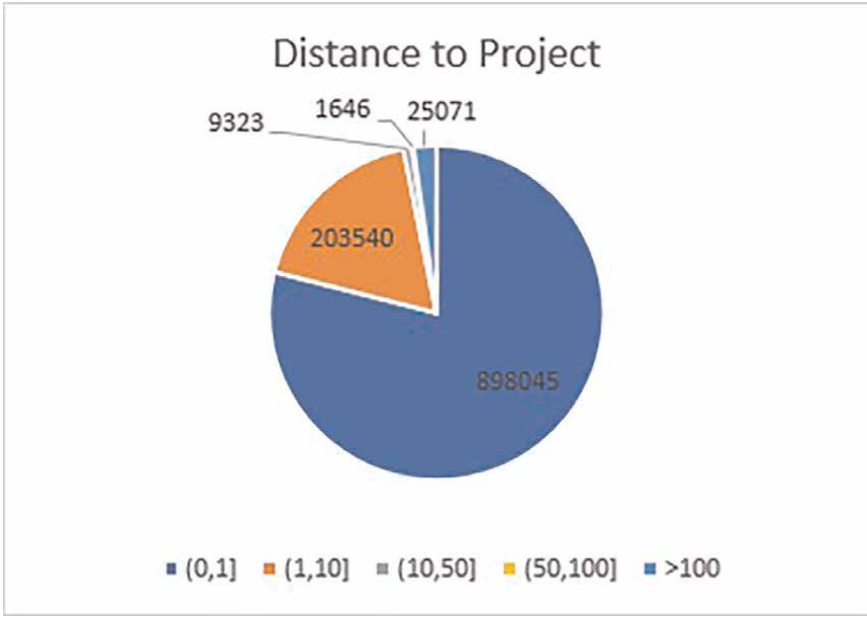


Figure 2.
Observations at each distance to the project level.

Besides the number of observations, we examined the distribution of employee expense claims in local currency under different distance to project categories. We find that the median was lower than the mean, indicating extremely large claims that shifted the distribution to the right tail. For larger claims made within the project duration, employees tended to claim without providing a reason if the distance was small. The distribution of claims for distances greater than 1,000 km was also examined, with claims under (10,50] being relatively larger. For small claims made within 1 km, employees generally did not provide a reason. The total claim amount in local currency was found to be distributed differently for each distance to the project level.

With the analysis above, we identify 12 different alerts. To make the analysis robust, we explore different alerts identifications:

1. *tooFar50* is defined as one if *Distance.to.Project.Location>50*, and zero otherwise.

2. *tooFar100* is defined as one if *Distance.to.Project.Location>100*, and zero otherwise.

3. *NoReason50* is defined as one if *Distance.to.Project.Location>50* and the reason is missing, and zero otherwise.

4. *OtherReason10* if *Distance.to.Project.Location*>10 and the reason is Others, and zero otherwise.

5. *LocationErrorTooFar10* is defined as one if the reason is Phone Location or the reason is Office Location, and *Distance.to.Project.Location>10*, and zero otherwise.

6. *LocationErrorTooFar100* is defined as one if the reason is Phone Location or the reason is Office Location, and *Distance.to.Project.Location>100*, and zero otherwise.

7. *UrgentTravelTooClose* is defined as one if the reason is Urgent Travel and *Distance.to.Project.Location<10*, and zero otherwise.

8. *Late* is defined as one if the claim is submitted after the close of the project.

9. *MileageLessOne* is defined as one if *Mileage*<1, and zero otherwise.

10. *IsWeekend* is defined as one if the expense is occurred during weekends, and zero otherwise.

11. *IsHoliday* is defined as one if the expense is occrurred during the Chinese Public holidays, and zero otherwise.

12. *ExpPerKMtooLarge* is defined as one if ExpPerKM>10, and zero otherwise.

In our risk analysis, we are focusing on the extreme values, and therefore the summary statistics include more details in the distribution tails, including minimum, 1%, 10%, 25%, 50%, 75%, 90%, 99% and maximum values, both in number of observed risks and the dollar amount.

3.6 Risk prediction

Although the frequency of alerts are low, we oberved a trend that staff who received alerts previously has a higher changce to be alerted again. To test this hypothesis, we use logit regression in the following model:

$$P(x_t = 1) = 1/\left(1 + e^{-a-bx_{t-1}}\right) \tag{1}$$

where x_t represents the alert (dummy variable) at time t while x_{t-1} represents the previous claim submitted by the staff, with staff and year-month fixed effects being controlled. In predicting the future risks (dependent variable), we use the previous observed variables (independent variables) as controls. On average, the staff that has previously being identified by the alert has a higher chance to repeat the same alert in the future, statistically significant at 1% for most of the risks being identified.

While we find the immediate previous alerts help us to explain the same future alert, we explore the past period and check if the pattern of claim persists longer. To test this hypothesis, we use logit regression in the following model:

$$P(x_t = 1) = 1/\left(1 + e^{-a-b\left(\sum_{i=1}^{10} x_{t-i}\right)/10}\right) \tag{2}$$

where $\left(\sum_{i=1}^{10} x_{t-i}\right)/10$ represents the moving average of the past 10 claims the same staff submitted, with staff and year-month fixed effects being controlled. We find that on average, the staff that has previously (previous 10 claims) being identified by the alert has a higher chance to repeat the same alert in the future.

We continue to test the likelihood that the past alerts' positive impact on the future alert using the alert created from expense data. The following alerts are identified from expense data:

1. *MileageLessTwo* is defined as one if *Mileage*<2, and zero otherwise.

2. *ExpPerKMtooLarge* is defined as one if *ExpPerKM*>10, and zero otherwise.

3. *IsWeekend* is defined as one if the expense is occurred during weekends, and zero otherwise.

4. *IsHoliday* is defined as one if the expense is occurred during the Chinese Public holidays, and zero otherwise.

Similarly, we find that on average, the staff that has previously being identified by the alert has a higher chance to repeat the same alert in the future.

3.7 Cost seasonality

We use the following parameters to understand the seasonality effect based on both calendar and project durations:

1. *Cost* is defined as the claim amount in percentage of the total project cost.
2. *TSduration* is defined as the date of last claim of the project minus the date of the first claim of the project in the sample.
3. *Dur1* is defined as one if the claim happens during the first 1/3 of the duration of the project.
4. *Dur2* is defined as one if the claim happens during the 2/3 of the duration of the project.
5. *Du3* is defined as one if the claim happens during the last 1/3 of the duration of the project.
6. *lastQ* is defined as one if the claim happens during the last quarter of the year.
7. *Oct* is defined as one if the claim happens in Oct.
8. *Nov* is defined as one if the claim happens in Nov.
9. *Dec* is defined as one if the claim happens in Dec.
10. *Cdur1* is the claim amount in the first 1/3 of the project.
11. *Cdur2* is the claim amount in the second 1/3 of the project.
12. *Cdur3* is the claim amount in the last 1/3 of the project.
13. *PCdur1* is the percentage amount in the first 1/3 of the project.
14. *PCdur2* is the percentage amount in the second 1/3 of the project.
15. *PCdur3* is the percentage amount in the last 1/3 of the project.
16. *StaffNO* is the total staff number of the project.
17. *Cost/staff/day* is the total claim amount divided by total number of staffs divided by the *TSduration*. We removed the projects that has a duration less than 30 days.

There are 5790 projects under the cost analysis, and we find that the average percentage cost of the first 1/3 is 39.67%, which is slightly higher than the second 1/3 of the project window (26.89%) and the third 1/3 of the project (33.23%). We examine the percentage costs during different project windows in the following model controlling for staff and year fixed effects:

$$\frac{Claim}{Cproj} = a + b * window + controls, \tag{3}$$

where window is identified as which 1/3 part of the project, whether it is done during the last quarter, or in October, November, or December. We find that in

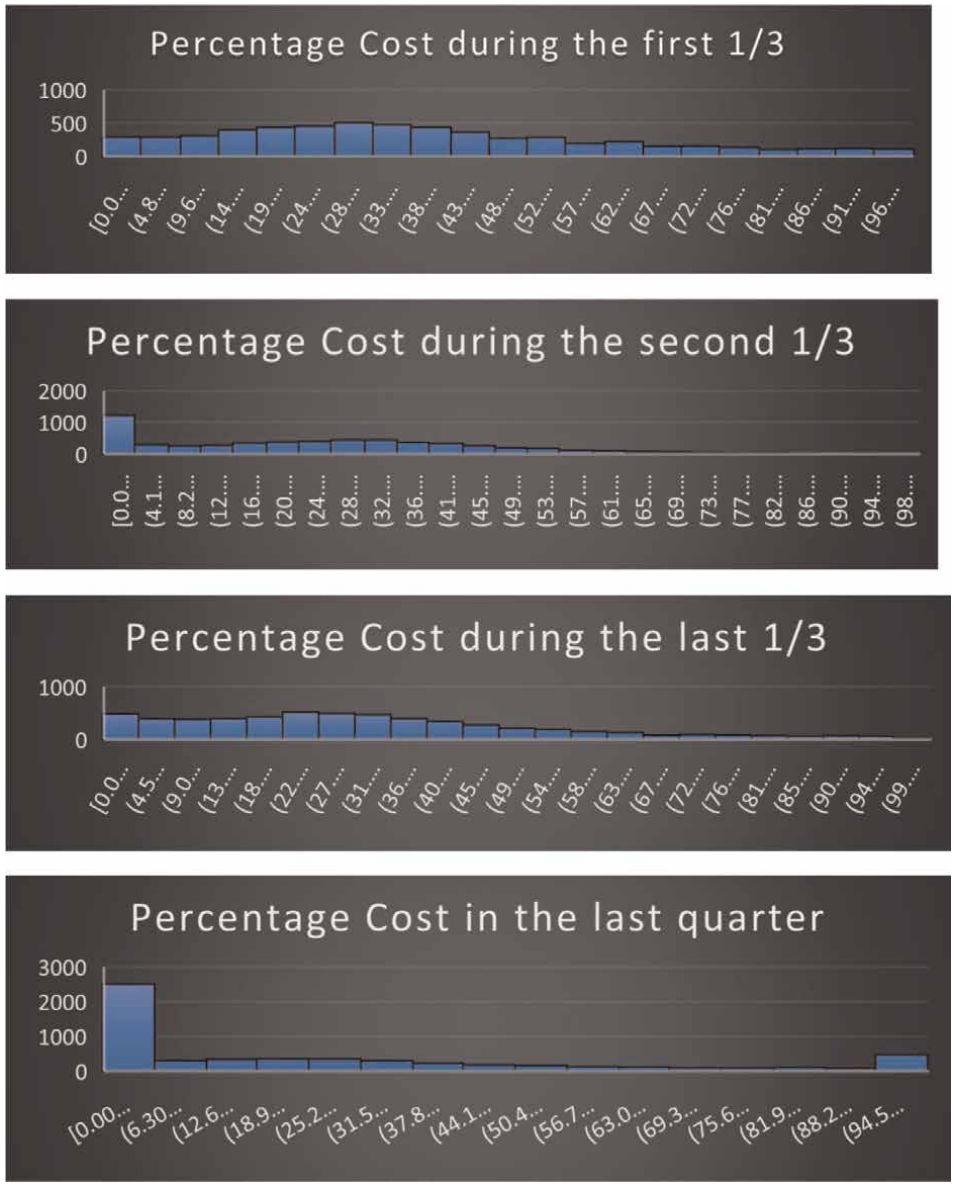


Figure 3.
Cost seasonality distribution.

general, the first 1/3 reports a relatively higher percentage costs compared to the rest periods. In the last quarter of the project, the percentage claim tends to be less. Towards the year end, there are no significant results except that the claim tends to be less in Oct.

Figure 3 shows the distribution of the percentage cost during each of the identified periods. The mode of the first 1/3 of the project window is larger than the second and third 1/3 of the projects. The percentage costs in the last quarter are polarized, where we observe heavy tails on both sides of the distribution.

3.8 Limitations

While we endeavor to optimize the raw datasets provided to us by HAND, we noted that there are some limitations to our study. The most important data limitation is that revenue information pertaining to the individual projects is not given to us due to confidentiality reasons.

This constraint limits our analyses to cost analyses; we are unable to glean data-driven insights from profitability analyses or to compare their profit margins with the costs incurred for each individual project. We also note that there is a delay in the time it takes for us to obtain the data to run our analyses. This is due to unforeseen circumstances such as the covid-19 pandemic and system integration issues. Some of the data items are also missing, and the data quality is generally not optimal and requires some data cleansing effort. In terms of the breadth of the dataset, the time series of the data is limited to 8 calendar quarters (i.e., 1Q 2020-4Q 2021). In addition, not all data items are provided. Finally, we are not able to obtain data from 1Q 2022 onwards due to the Shanghai lockdown from the covid-19 pandemic. Hence, we are unable to conduct some of our forecasting tests as we originally envisaged.

Notwithstanding these data limitations, our data analyses help to shed light on some of the cost measures that the company can focus on to optimize their cost control procedures and trim unnecessary costs.

4. Conclusion

To enhance cost structure assessment and optimize HR policies, we offer HANDS Enterprise Solutions, our industry partner, a range of innovative industry solutions and analytical tools. Leveraging big data analysis and data visualization tools, we conduct a thorough analysis that identifies areas of weakness in their HR policies. We emphasize key points to strengthen their internal control policies and provide recommendations for future enhancements and analysis. As a result, we have significantly improved the quality of the company's claims submission process. The productivity enhancements extend to both their consultants and staff, while the improvements in cost control are evident at both the project and employee levels.

Aside from big data analysis for cost behavior analysis and cost control purposes, we believe that future projects and studies can analyse incoming data, such as sales records, marketing patterns, and growth metrics of the company, create dashboards for easier visualization of the trends, deploy data analytics to support the making of critical business decisions that include inventory planning, payment and collection cycles reviews, revenue and cash flow prediction, new product development, investigation of supplier or production issues, formulation of product pricing and promotion strategies, developing a balanced scorecard encompassing both financial and non-financial performance metrics.

We also believe that there is great potential to expand this IT solution across different industries. Specifically, we are optimistic that we can use artificial Intelligence and big data solutions in corporate finance transaction services, utilising real-world settings to explore opportunities for regulators to maximising the impact of big data and to focus their resources more effectively and identify which companies warrant further investigations.

Acknowledgements

This research is supported by HAND Enterprise Solutions.

Author details

Kevin Ow Yong*, Fei Gao (Phoebe), Michelle Zou and Janet Tan
Singapore Institute of Technology, Singapore

*Address all correspondence to: kevin.owyong@singaporetech.edu.sg

References

[1] Capterra. 2022 Expense Report Software. Capterra. n.d. Available from: https://www.capterra.com/expense-report-software/shortlist/ [Accessed: April 16, 2023]

[2] Gartner. Expense management software reviews. n.d. Available from: https://www.gartner.com/reviews/market/expense-management-software [Accessed: April 16, 2023]

[3] GetApp. User reviews. n.d. Available from: https://www.getapp.sg/software/411/concur-expense

[4] SAP. SAP Analytics Cloud Help. n.d. Available from: https://help.sap.com/viewer/product/SAP_ANALYTICS_CLOUD/1.0.0/en-US [Accessed: April 16, 2023]

[5] Fernandhytia F, Muslichah M. The effect of internal control, individual morality and ethical value on accounting fraud tendency. Media Ekonomi Dan Manajemen. 2020;**35**(1):112-127

Chapter 7

Taxation and the Challenge of Fiscal Sustainability in a Resource-Rich Developing Country: A Re-evaluation of the Nigerian Perspective

Oluwatosin Olushola, Pa Lamin Beyai and Alexander Anagbado

Abstract

Taxation plays a pivotal role in the fiscal management and financing of the public sector by the government. This study is dedicated to a comprehensive exploration of taxation and its implications for fiscal sustainability, particularly in the context of a resource-rich developing nation, with a specific focus on Nigeria. In our investigation, we harnessed the power of the Autoregressive Distributed Lag (ARDL) model alongside other robust econometric tools such as the Augmented Dickey-Fuller unit root test and the ARDL bounds test of cointegration. The empirical findings of this study underscore the substantial influence of taxation on Nigeria's economic growth over the entire period under consideration. While petroleum profit tax exhibited a dampening effect on economic growth, companies' income tax and value-added tax contributed positively. Significantly, the impact of value-added tax on overall productivity eclipsed that of companies' income tax. The recommendations emphasize strengthening tax collection institutions for better compliance. The government should also focus on establishing an efficient tax system that widens the tax base, which can be achieved by formalizing informal businesses. This approach is crucial for increasing tax revenues, enhancing fiscal sustainability, and restructuring Nigeria's economy.

Keywords: taxation, fiscal sustainability, economic growth, resource-rich-country, Nigeria

1. Introduction

1.1 Background to the study

A resource-rich nation like Nigeria has a great deal of potential for sustainable growth and economic transformation. The potential for tax revenue as a key source of

financing crucial development initiatives has been reduced by the enormous endowments in natural resources, particularly with regard to oil and gas resources. The Nigerian economy has been exposed to vulnerabilities that pose a serious threat to fiscal sustainability due to the country's heavy reliance on oil revenues and the high volatility of its price on the global market. These factors, along with supply-side issues caused by domestic unrest, have made the Nigerian economy vulnerable [1].

One of the most reliable methods of funding public spending has been shown to be taxation. However, in resource-rich nations like Nigeria with a horrendously low tax to GDP ratio, a weak institutional framework for tax administration, and a high rate of tax evasion, the government has over the years relied on debt (domestic and external) to finance both capital and recurrent spending, with significant implications for fiscal sustainability and sustainable development financing [2].

Fiscal sustainability refers to the use of fiscal policy tools, such as government spending and taxation, to fund or finance economic activities so that the country's financial health is such that current government expenditure or liabilities do not exceed the amount the government will need to have in its treasury in the future to achieve the desired economic growth [3]. If it is maintained indefinitely and unchanged, a sustainable fiscal strategy would, over the long term, make the government financially solvent. It refers to the government's capacity to uphold its current tax, spending, and other policies over the long term without jeopardising the ability to pay off its debts or meet its obligations [3, 4].

Fiscal sustainability has drawn so much attention especially in developing countries, and this huge attention is attributed to the fact that most developing countries mostly experience significant fluctuations in their revenue generation thereby resulting to notable fiscal constraint in their development plans [4]. A commitment to fiscal sustainability increases the confidence level of the private sector (which comprises-firms, markets and individuals) regarding the overall direction of government policy. Tax revenue generation and government expenditure are two yardsticks for measuring fiscal sustainability in Nigeria [5].

The political, economic and social development of any country depends on the amount of revenue generated for the provision of infrastructure in the given country, and a well-structured tax system would boost the generation of income for this purpose. Fiscal sustainability is the ability of a government to maintain public finances at a credible and serviceable position over the long term. Ensuring long-term fiscal sustainability requires that governments engage in continual strategic forecasting of future revenues and liabilities, environmental factors and socio-economic trends in order to adapt financial planning accordingly [6]. High and increasing debt levels are harmful to governments' fiscal positions and can cause a vicious cycle of growing debt, reducing the potential for economic growth as funds are diverted away from productive investments. A sustainable fiscal policy is a policy that can be pursued however long without any major interventions in tax and spending patterns [4, 7].

The predominance of informal sector activities in Nigeria has significant effects on the complexity and efficacy of the tax administration structure, leading to low tax revenue and weak tax penetration. As a result, the government is more dependent on income from the exploitation of natural resources like oil and gas, which have a propensity for significant volatility in relation to commodity pricing on the global market. In order to finance important development initiatives, the nation therefore turns to borrowing, which carries a significant danger of increasing the debt burden and jeopardising fiscal sustainability. The main objective of this study is to examine Nigeria's fiscal sustainability with reference to the effects of taxation on economic

growth in Nigeria. The majority of earlier studies on the topic used contemporaneous models, which severely restricted the ability to assess the dynamic properties connected to variables of interest. This chapter will bridge this research gap by using an analytical framework known as the autoregressive distributed lag model, which has the built-in ability to incorporate the dynamic characteristics of the variables under consideration. With an emphasis on Nigeria's tax potentials in connection to fiscal sustainability and financing for sustainable development, this chapter investigates the role of taxes in Nigeria's financing of sustainable development.

1.2 Issues with Nigerian taxation and fiscal sustainability

Despite its vast potential and endowment of abundant natural and human resources, Nigeria has one of the lowest tax-to-GDP ratios in Africa. Nigeria's tax-to-GDP ratio dropped by 0.4 percentage points from 6.0% in 2019 to 5.5% in 2020. Comparatively, over the same time period, the average for the 31 African countries dropped by 0.2 percentage points, reaching 16.0% in 2020. The average for the 31 African countries has risen by 1.6 percentage points since 2010, rising from 14.4% in 2010 to 16.0% in 2020. In Nigeria, the tax-to-GDP ratio fell by 1.7 percentage points over that time, from 7.3% to 5.5% [8].

Nigeria has low tax revenue to GDP ratio when compared to other African countries of a similar size, with the majority of government income coming from the oil and gas industries [9]. Despite the fact that tax systems differ greatly between nations, according to them, the main goal of any tax system is to maximise revenue and economic growth while minimising distortions. In recent years, the public debt service burden has grown while the economy of Nigeria has continued to generate below-average tax receipts. The sustainability of state finances is seriously threatened by the costs associated with dealing with the present economic downturn and the demand to increase spending on SDG-related initiatives. Taxation and the financing of fiscal deficits through taxes are two of the most sustainable approaches to guarantee appropriate debt levels and fiscal sustainability [2]. The relationship between taxation and fiscal sustainability in Nigeria must therefore be examined, with an emphasis on how it might affect the achievement of sustainable development goals (SDGs).

Fiscal discipline must be strengthened in the process of managing public finances and the accompanying institutional processes in order to increase transparency in the administration of financial resources and ensure the correction of the public deficit and debt. Nigeria's capacity to achieve the SDGs will be greatly influenced by the sustainability of the public finances, the efficiency of fiscal control, and a solid institutional framework that enables decision-makers to desist from irresponsible fiscal behaviour. As a result, the focus of fiscal responsibility is on the laws, rules, and practises that have an impact on how fiscal policy is created, approved, implemented, and monitored. In order to achieve this, it defines three crucial concepts that have a broad impact: numerical fiscal laws, independent fiscal institutions, and medium-term budgetary frameworks [10].

One of the most important factors in attaining fiscal sustainability in Nigeria is taxation, yet there are too many loopholes in the Nigerian tax code, making it impossible for it to be fair and successful in accomplishing its sustainability goal. In order to achieve the necessary economic growth while taking into account the taxation challenges the nation faces, this research focuses on the impact that tax income and government spending have had on establishing a financially sustainable Nigerian

economy over the period of 2001–2020. But the objective is to make it apparent how important it is for tax revenues to rise and for government spending to rise as well, while making sure that the money raised from both sources is used in the right ways to achieve the required economic growth.

Nigeria's low tax to GDP ratio has been attributed to a number of factors, including but not limited to inadequate tax revenues (an inefficient tax system that is concealed by enduring institutional problems) and tax administration corruption, which encouraged a generalised persistent weakness in tax collection. One aspect of Nigeria's fiscal weakness is the abundance of natural resources, which makes tax collections in resource-rich countries seem unimportant. Other aspects include tax avoidance and evasion, inadequate tax authority assessment, a lack of trust between taxpayers and the government, a small tax base, a sizable informal sector, lenient penalties for tax defaulters, and a lack of trust between taxpayers and the government.

According to [10], Nigeria would exceed the 3% ceiling imposed by the Fiscal Responsibility Act with a fiscal deficit in 2022 of $6.39 trillion, or 3.46% of GDP. But it's important to keep in mind that, given that the budget deficit has climbed from 953.6 billion in 2015 to 3.61 trillion in 2022, a rise in the deficit would surely result in a rise in future debt servicing. Future financial costs could rise as a result, resulting in even greater deficits.

To close the fiscal gap in 2022, the Federal Government of Nigeria (FGN) anticipates borrowing 2.57 trillion dollars from domestic and foreign sources, 1.16 trillion dollars through multilateral and bilateral loan drawdowns, and 90.7 billion dollars from privatisation earnings. When revenue projections are uncertain or outside funding is insufficient, the FGN may also utilise the CBN's Ways and Means facility (WMF). Government debt as a proportion of GDP is forecast to increase from 35.7% in 2021 to 36.7% in 2022 as a result of the increased borrowing. This will dramatically raise the nation's debt load and put its ability to service debt in jeopardy [11].

1.3 Taxation, theoretical underpinnings

1.3.1 Benefit principle

In the philosophy of taxation from public finances, there is a notion known as the benefit principle. The benefit approach was initially devised by two Swedish economists, Erik Lindahl (1891–1960) and Johan Gustaf Knut Wicksell (1851–1926), to evaluate the effectiveness of taxation and fiscal policy [12]. Taxes for public goods are based on the principal's political willingness to pay for the advantages obtained. According to this principle, the state should tax people in proportion to the benefit that has been given to them. A person should contribute to the government more the more benefits they receive from governmental actions. As a result, the benefit-received principle of taxation says that individuals and organisations should pay taxes in a way that is similar to how they would pay for other products and services. The road tax is a good illustration. Therefore, people who gain from using the roads for transportation pay the tax for their upkeep and development. The Benefit Principle of Taxation has three basic explanations or applications: 1. It acknowledges that taxes are levied with the intention of financing government services by requiring taxpayers to pay a share of the benefits from government spending. 2. According to the benefit principle, taxes are thought to have a comparable purpose to pricing in private transactions. Since resources would be allocated through the public sector, this might result

in a solution that is economically efficient. 3. It quantifies the benefits that people obtain from specific special taxes, such as the tax on gasoline and the tax on improvements, among others [12, 13].

1.3.2 The theory of optimal taxation

According to the widely accepted theory of optimum taxation put forth by Frank P. Ramsey in 1927, a tax system should be chosen to maximise a social welfare function within a set of limitations [14]. The social planner is often portrayed in the literature on optimal taxation as a utilitarian, meaning that the social welfare function is based on the personal utility of each member of the society. Numerous models that concentrate on different facets of the tax system are included in the field of optimal tax theory. Three characteristics unite these many models. First, each model outlines the government's revenue requirements as well as a list of practical levies, like commodities taxes. Lump-sum taxes, which would not produce any economic distortion, are often excluded from the models. Second, each model describes how people and businesses react to taxation. In other words, people have preferences for certain types of goods and activities, businesses use certain production technologies, and people and businesses engage under certain market structures (often perfect competition). Third, the government has an impartial role in assessing various tax structures. In the most basic models, the government seeks to maximise revenue generation while minimising the excess burden brought on by the tax system [14].

1.3.3 Domar's approach to fiscal sustainability

The first economist to address fiscal sustainability in the context of an expanding economy was Domar (1944). Domar's stability condition is the name given to Domar's notion of fiscal sustainability. He referred to a stabilising debt-to-GDP ratio or deficit-to-GDP ratio when defining fiscal sustainability. According to Domar's condition, for fiscal policy to be sustainable, national output growth (n) must outpace the cost of governmental borrowing (r), or the growth rate of public debt if no new borrowing is made. However, any deficit might result in a fiscal policy that is inherently unsustainable if borrowing costs are higher than growth rates in the nation's GDP. Domar's method is unusual in that it makes it easier to determine the necessary primary surplus (PS) or deficit to maintain the debt-to-national production ratio at a specific level, given a growth-interest rate difference. This method assumes that r and n's behaviour is exogenously determined and unrelated to the management of fiscal policy [15].

1.3.4 Solvency approach

The inter-temporal budget constraint (IBC) of the government serves as the foundation for the solvency method. The present-value budget constraint approach is another name for this. This method holds that a fiscal policy is sustainable if the government can pay off all outstanding debt by producing PSs from future budgetary results. Technically speaking, fiscal sustainability calls for the stock of public debt to be at least equal to the discounted value of predicted future primary budgetary surpluses in a dynamically efficient economy [16]. According to [17], a government is considered to be solvent if its assets are greater than its liabilities. Solvency is guaranteed as long as net worth is positive.

1.3.5 Ricardian equivalence approach

In the 19th century, David Ricardo created this hypothesis. They view taxes and public debt as two methods of funding governmental expenses [17]. While the deficit or the national debt are taxes on future generations, current taxes are a burden on the current generation. Deficit or debt are therefore implicit taxes, and the replacement of taxes by public debt is nothing more than a change in the schedule of taxes. Public debt is the deferral of taxes, which will result in larger tax burdens in the future. Thus, taxes and debt have an impact on both the wellbeing of the present and future generations. The generational welfare neutrality of these two fiscal devices is the fundamental component of Ricardian equivalence. Fiscal policy is unsustainable from a generational welfare perspective if taxes and debt financing have unequal or non-neutral effects on present and future generations. As a result, the generational accounting technique and the Ricardian equivalency approach to budgetary sustainability can both be understood in roughly the same ways. The RET is predicated on certain assumptions. The two main assumptions are (a) fully foresighted and charitable economic agents, and (b) an ideal capital market, in which lending and borrowing rates are the same for diverse agents like the public and private sectors. Taxes are not distorted, and both the market interest rate and each agent's personal subjective discount rate between present and future spending decisions are identical. The Ricardian approach states that fiscal policy is sustainable if the method used to finance government spending has no negative effects on generational welfare neutrality.

2. Review of the Nigerian tax system

2.1 The Nigerian national tax policy

A revised National Tax Policy (NTP) was approved by the Federal Executive Council on February 1, 2017. The central objective of the tax policy is to establish fundamental rules that will direct the Nigerian tax system's orderly growth in the direction of achieving its overall goals. In this regard, the Policy emphasises the Fundamental Objectives found in Chapter 2 of the Federal Republic of Nigeria's 1999 Constitution and reaffirms the necessity of administrative and tax policies that foster economic development [7]. The Policy outlines important policy concepts to address the issues the Nigerian tax system is facing. It outlines the rights and obligations of key stakeholders and acknowledges the contributions they played in the creation of an efficient tax system. The Policy also emphasises the importance of good Tax Administration in the goal of a fair and equitable tax system [18].

The National Tax Policy (NTP) affirms the necessity of tax legislation and administrative procedures for promoting economic development in Nigeria and outlines essential principles to direct the tax system's orderly development. The Nigerian Tax Plan (NTP) is a plan that establishes broad guidelines for taxation and related issues in Nigeria. It provides a set of guidelines, norms, and operating principles that would regulate taxes in Nigeria and that all participants in the tax system can accredit. It is a clear statement of the principles guiding tax administration and revenue collection [19].

In an effort to ingrain a solid and effective tax system in Nigeria, the National Tax Policy (NTP) was initially released in 2012. Four years later, among other developments, the rapidly shifting business environment and the continued low tax to Gross

Domestic Product (GDP) ratio required new approaches to continue achieving government goals of fostering an enabling environment, streamlining the tax code, and ensuring ease of compliance. One of the most important aspects of the NTP is its progressive transition to indirect taxation, purposeful efforts to improve the ease of paying taxes ranks, expansion of the tax base, and use of technology, intelligence, and inter-agency cooperation. The Federal Ministry of Finance has established an office of tax simplification and a committee to implement tax policy. The federal and state legislatures have also established taxation committees. Special tax courts have also been established.

2.2 Fiscal sustainability commission

In a bid to foster fiscal discipline and ensure fiscal sustainability in, the Nigerian Fiscal Responsibility Commission was created by the Fiscal Sustainability Act of 2007 [9]. The commission's statutory responsibilities include the following: to monitor and enforce the fiscal responsibility act's provisions and, in doing so, to advance the economic goals outlined in Section 16 of the Constitution; and to disseminate standard practises, including international good practise, that will lead to greater efficiency in the allocation and management of public expenditures, revenue collection, debt control, and transparency in fiscal matters [9]. In order to encourage efficient tax revenue collection and foster fiscal sustainability in Nigeria, the Fiscal Sustainability Act has established a number of institutional instruments, such as:

2.2.1 Medium term expenditure framework

In accordance with the Fiscal Sustainability Act's requirements, the Medium-Term Expenditure Framework (MTEF) must include a Macro-Economic Framework that outlines the macroeconomic projections for the next three fiscal years, the underlying assumptions used to make those projections, as well as an assessment and analysis of the macroeconomic projections for the previous three fiscal years. A Fiscal Strategy Paper (FSP) outlining the Federal Government's medium-term financial goals, taxation, recurrent (non-debt) expenditure, debt expenditure, capital expenditure, borrowings and other liabilities, lending and investment, as well as the Federal Government's strategic economic, social, and developmental priorities for the next three fiscal years is also anticipated to be included in the MTEF [20].

The MTEF is also anticipated to include an expenditure and revenue framework that details estimates of total revenues for the Federation for each fiscal year based on the predetermined commodity, projections of tax revenues and reference prices, as well as projections of total expenditures and total tax expenditures for the Federation over the course of the next three fiscal years. According to the Fiscal Responsibility Act, the Minister must submit the Medium-Term Expenditure Framework to the Federal Executive Council for review and approval by the end of the second quarter of each fiscal year. The Federal Executive Council's approved Medium-Term Expenditure Framework will go into effect once a resolution of each house of the National Assembly has been approved. The National Assembly-approved Medium-Term Expenditure Framework will be published in the Gazette [21].

A MTEF may be amended at the president's request. However, any modification to the MTEF shall only be made to remedy obvious errors and significant, in the President's opinion, changes to the fiscal indicators. The MTEF must also serve as the foundation for the estimates of revenue and spending that must be created and

presented to the National Assembly, as well as for the sectoral and compositional distribution of the estimates of expenditure, according to the Fiscal Sustainability Act [22].

3. Methodological approach

3.1 Review of the literature

Numerous studies have been conducted on the connection between taxation and economic expansion. Some of these studies contend that tax policies significantly and favourably affect the pace of output growth, whilst others have found an adverse relationship between the two variables. Using an overlapping generation's model with exogenous growth settings, [23] examined expenditure- and tax-based consolidations under the rule of reductions in debt-to-GDP ratios to the target level and the consequences of these consolidations on fiscal sustainability and welfare. According to the study, tax-based consolidation must proceed more quickly than expenditure-based consolidation in order to guarantee budgetary sustainability. In terms of welfare, governments may choose several types of consolidation depending on the quantity of outstanding debts in relation to capital, the efficiency of the economy, the levels of taxation, and the degree to which people benefit from public goods and services. More importantly, it might also depend on whether governments prioritise social welfare or equity in the allocation of welfare among generations. In contrast, fiscal consolidation cannot last much longer than 30 years from the perspectives of both social welfare and equitable distribution of welfare across generations.

Anthony [24] used a multivariate framework to study the 1970–2019 fiscal policies and public debt sustainability in Nigeria. To ascertain the long-term relationship between the variables, the autoregressive distributed lag (ARDL) bounds test is used. The findings of the ARDL test show that the variables employed in this study have a long-term association. In particular, the outcome demonstrates that budget deficit affects public debt positively and significantly over the short and long terms, but interest rates, real gross domestic product, and inflation rate were statistically insignificant across all time periods and had no effect on public debt. In order to ensure that allocative efficiency is attained in the budgeting system, it was advised that the budgeting process in Nigeria at the federal and state levels be reviewed.

In Cosimo [25] the fiscal sustainability of the six Gulf Cooperation Council (GCC) nations was examined from 1990 to 2017. Mixed results are obtained from panel unit root tests when government revenues, expenses, the main balance, and debt are subject to cross-sectional dependence. However, cointegration tests show that there is a long-term relationship between government revenues and expenditures, although the relationship between the primary deficit of the government and debt remains debatable. Saudi Arabia is at risk and must keep its debt under control, according to panel assessments of the cointegrating relationship. However, Bahrain and Qatar appear to be up against the most difficult obstacles. The findings of causality tests indicate that the GCC governments make decisions about their revenues and expenditures at the same time, supporting the theory of fiscal synchronisation. According to the study, the GCC region should take into account three general factors. First, countries will also need to raise their non-oil tax collection in order to address budgetary crisis. Second, it's likely that governments will have to scale back as future

economic pressures might be lessened with more non-oil tax revenue. Third, nations ought to reconsider their approach to saving.

Using annual data on public revenues and expenditures, all expressed as a ratio of GDP, [25, 26] evaluated the sustainability of fiscal policy in Nigeria from 1961 to 2016. The study uses the cointegration approach of ARDL bounds testing to identify an equilibrium relationship between the variables. A data analysis approach called Autoregressive Distributed Lag (ARDL) is also used to assess how well the Nigerian government complies with the budget restriction equation. The findings indicate that there is no equilibrium between public revenue and expenditure, which excludes sustainability in Nigeria's public finances. Therefore, it is sensible for the government to increase the revenue base, lower tax rates, and exercise fiscal restraint in order to prevent spending money ineffectively.

Using state-level data for India from 1980 to 1981 to 2017–2018, [27] analysed budgetary sustainability. The findings, which were obtained using cointegration and dynamic ordinary least squares techniques, indicate that the majority of states have excellent budgetary sustainability. States in the north, west, and south are more financially stable than states in the east. Financial sustainability was also discovered by the investigation for both the income and capital accounts. In terms of policy, state governments should review their spending habits to cut down on non-developmental spending, especially in those states with weak sustainability.

A research on Japan's fiscal sustainability was done in 2020 by [28] they claim that Japan has the highest debt to GDP ratio among advanced countries and is at the forefront of the demographic ageing process in terms of both speed and magnitude. Furthermore, it is predicted that public pension, healthcare, and long-term care (LTC) costs will rise at a much faster rate than revenues, further straining the economy. In order to control the earnings and labour supply profiles of heterogeneous agents and their cohort shares, the study developed an accounting model that is populated with overlapping generations of people and incorporates social insurance programmes in detail. It also uses the most recent estimates of Japanese microdata and government demographic projections. According to the findings, if existing policies are not changed, Japan will continue to experience significant deficits in the areas of public health, pensions, and necessities, and its debt to GDP ratio will soar to previously unheard-of heights with rising interest costs.

Fiscal sustainability in the Caribbean was studied by [29]. They said that for small economies with high debt and increased vulnerability to climate change, fiscal sustainability continues to be a major concern. They used the model-based fiscal sustainability test in 16 Caribbean nations between 1980 and 2018 to fulfil the study's goals. The findings suggest that fiscal policy in the Caribbean adopts corrective measures to counterbalance a growth in the debt-to-GDP ratio since the coefficient on lagged government debt is positive and statistically significant. However, nonlinear estimations reveal that the quadratic debt parameter is negative, indicating that the fiscal policy response is insufficient to ensure sustainability at greater levels of debt. The empirical findings show that conservative fiscal policies must be maintained, and growth-promoting structural reforms must be put in place in order to create fiscal buffers and guarantee debt sustainability with a high likelihood even in the event of long-term negative shocks.

The sustainability of Sri Lanka's fiscal imbalance and state debt was examined by [30]. The study uses a symmetric ARDL (autoregressive distributive lag) technique to estimate a government's intertemporal budget constraint in order to determine if the fiscal imbalance is sustainable. Additionally, it uses an asymmetric ARDL technique to

estimate a fiscal reaction function to assess the sustainability of public debt. This technique allows for differing primary budget balance responses depending on whether regressor shocks are positive or negative. The estimations are based on annual data from 1961 to 2018. The findings show that Sri Lanka's fiscal management is incompatible with strong form sustainability, which calls for making sure that spending does not increase faster than income. However, estimate of the fiscal reaction function uncovers solid proof of the inequalities in fiscal policy. There is growing evidence that Sri Lanka's fiscal policy is pro-cyclical, with strong stabilisation tendencies during economic booms but weak stabilisation tendencies during recessions. Authorities are observed to undertake fiscal consolidation in response to increases in the debt-to-GDP ratio, which suggests a weak form of sustainability.

Olufemi [31] conducted research on Nigeria's budgetary sustainability in relation to the nation's economic performance. A fiscal sustainability equation is created and the conditions for creating sustainability are determined using the framework of an intertemporal budget constraint for the government. The empirical methodology uses the dynamic OLS (DOLS) regression method, the unit root test, and the cointegration test to examine the viability of the fiscal position from 1961 to 2016. The DOLS regression result in particular supports the empirical evidence of weak sustainability. Similar to this, the results regarding the relationship between budgetary sustainability and economic performance show a weak reaction from the latter. The evidence from this study generally did not significantly differ from earlier investigations in this body of literature. This study's key policy recommendation is that Nigeria's government make sure there is a stronger, systemic connection between tax and spending policies and the development of the public debt.

3.2 Model specification and estimation technique

We used a Autoregressive Distributed Lag (ARDL) model to capture the relationship between taxation and economic growth in Nigeria for the period 2001–2020. Included in the model are; gross domestic product as the dependent variable; and companies income tax (CIT) revenue, petroleum profit tax (PPT) revenue, value added tax (VAT) revenue as the explanatory variables.

3.2.1 Petroleum profit tax (PPT)

Companies involved in the production and transportation of petroleum products are subject to the petroleum profit tax (PPT). It relates to parts of oil mining, prospecting, and exploration leases that are related to rents, royalties, margins, and profit-sharing arrangements. PPT serves as a tool through which the government restricts the number of players in the petroleum business and takes ownership of public assets in addition to generating cash for the government. The PPT is, in a sense, a tool for wealth redistribution between the wealthy and industrialised economies who control the knowledge, expertise, and technical know-how, as well as the capital required to develop the oil and gas sector in Nigeria and other developing countries.

3.2.2 Companies income tax (CIT)

The profit or gain of any company that is incurred in, derived from, imported into, earned in, or received in Nigeria is subject to companies income tax (CIT). The tax rate, which was previously 30% and applied to the company's gross or chargeable

profits, was lowered to 20% under the new (2010) tax law. It should be noted that oil marketing and oil service businesses are subject to education tax at a rate of 2% on the assessable profit.

3.2.3 The value added tax (VAT)

The Value Added Tax Act Cap V1, LFN 2004 governs value added tax (VAT) in Nigeria (as amended). It is a consumption tax that is paid when products are bought and services are provided. The final consumer is responsible for a multi-stage tax. Except for those expressly exempted by the VAT Act, all products and services, whether domestically produced or imported, are subject to taxation. 7.5% is the VAT rate.

The functional specification of the model used for the purpose of this study is stated as:

$$\text{GDP} = \text{f}\ (\text{CIT}, \text{PPT}, \text{VAT}) \tag{1}$$

The Autoregressive Distributed Lag Model of the functional specification in Eq. (1) is written as:

$$GDP_t = \alpha_0 + \sum_{i=1}^{p} \lambda_i GDP_{t-i} + \sum_{i=0}^{q_1} \beta_{1i} CIT_{t-i} + \sum_{i=0}^{q_2} \beta_{2i} PPT_{t-i} + \sum_{i=0}^{q_3} \beta_{3i} VAT_{t-i} + \mu_t. \tag{2}$$

Where:
GDP = Gross Domestic Product.
CIT = Companies Income Tax.
PPT = Petroleum Profit Tax.
VAT = Value Added Tax.
α_0 to β_3 = the parameters to be estimated.
μ_t = Stochastic error term.
p and q are optimal lag order, where.
p = lag length of the dependent variable.
q_1 = lag length of CIT.
q_2 = lag length of PPT.
q_3 = lag length of VAT.
β_{1-3} = parameters of the independent variables.
γ_i = parameters of the lagged values of the dependent variable included as independent variables.
$\sum$ = summation sign.

A-priori expectation

By theoretical expectation, the coefficients of CIT, PPT and VAT are all expected to be positive.

$$\alpha_0 > 0; \gamma > 0; \beta_1 > 0; \beta_2 > 0; \beta_3 > 0;$$

An Autoregressive Distributed Lag (ARDL) model was specified as part of the quantitative analytical technique used to analyse the data collected for the aim of this study. The data were subjected to diagnostic studies to ascertain their stationarity status as well as the trend trajectory of the data in an effort to prevent the occurrence

of spurious regression. Unit root tests, bounds tests for cointegration, and trend analysis are some of the investigations that were conducted. The Breusch-Pagan-Godfrey test for heteroscedasticity, the Cumulative Sum Test (CUSUM) for model stability, and the Breusch-Godfrey LM Test for Serial Correlation are all used as post estimation diagnostic tests.

The model's and the estimating technique's justification depends on how well they measure the dynamic aspects of taxation and economic growth in Nigeria throughout the time period under consideration. In order to accomplish the study's stated aims, it is believed that the model is appropriate. The ARDL model permits the integration of both the current and lagged values of the variables taken into consideration for this study when analysing the effects of one variable on another. A second argument in favour of the model is that it is straightforward to use.

3.3 Nature and sources of data

The nature of data for this research is secondary data obtained from the National Bureau of Statistics (NBS) and Federal Inland Revenue Service (FIRS) covering the fiscal period 2000–2020. The quarterly time series data regarding gross domestic product (GDP) was obtained from the NBS while the quarterly time series data regarding CIT, PPT and VAT were obtained from the FIRS.

4. Regression results and analysis of taxation trends

4.1 Analysis of tax trends in Nigeria

This section shows the trend of selected tax variables in Nigeria considered for analysis from 2001 to 2020. From **Figure 1**, companies' income tax (CIT) shows a fairly stable movement pattern from the first quarter of 2001 to second quarter of 2008. However, an upward but wave-like oscillatory pattern can be observed in the trend from 2009 to 2020. This trend pattern shows a relatively unstable contributions of companies income tax revenue during recessions and economic downturns. This is attributable to the fact that companies' profits are also affected by macroeconomic shocks and unfavourable government policies. It is therefore important to maintain a

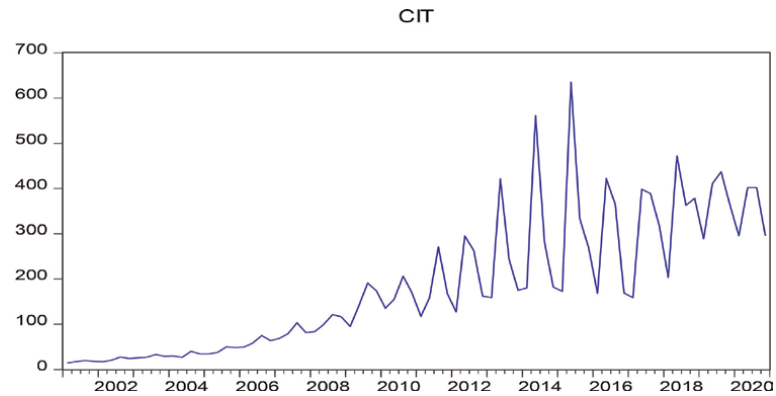


Figure 1.
Trend of companies' income tax measured in billions of Naira (2001–2020). Source: Authors' computation based on data from Federal Inland Revenue Service (FIRS).

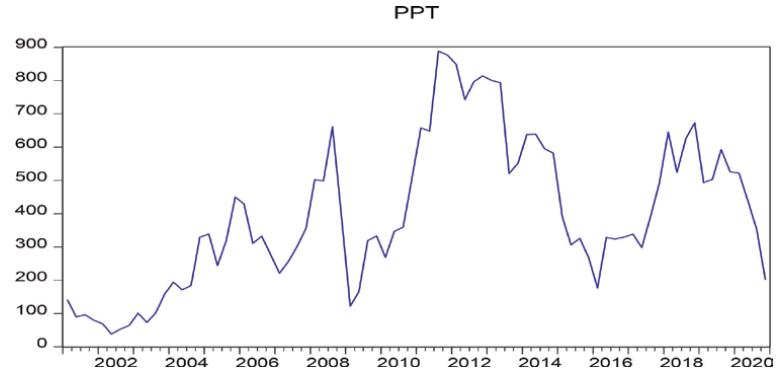


Figure 2.
Trend of petroleum profit tax measured in billions on Naira (2001–2020). Source: Authors' computation based on data from Federal Inland Revenue Service (FIRS).

conducive and business friendly environment for companies to thrive, while ensuring effectiveness of the companies income tax administration framework.

From **Figure 2**, the trend of petroleum profit tax shows a highly unstable trajectory throughout the entire period under consideration. This movement pattern can be attributed to the high volatility associated with commodity prices in the international market. Petroleum profit tax revenue increases when crude oil price rises in the international market, and falls sharply with falling crude oil prices. This is an indication that reliance on such tax revenue to finance critical development projects necessary for economic transformation, may not be sustainable. It is therefore imperative to focus more on the non-oil tax revenue in order to engender fiscal sustainability.

The trend trajectory of value added tax is depicted in **Figure 3**. The trend pattern shows a relatively stable and upward trajectory throughout the entire period of study. The trend pattern is an indication that non-oil tax revenue such has VAT are imbued with the potential for sustainable financing of government expenditure without compromising fiscal sustainability. The consistency in the trend trajectory of VAT is a testament to the enormous revenue potentials of a broadened tax base and the efficacy of collection systems.

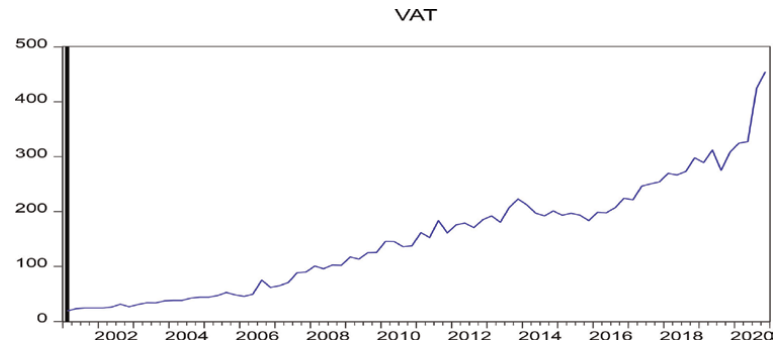


Figure 3.
Trend of value added tax measured in billions of naira (2001–2020). Source: Authors' computation based on data from Federal Inland Revenue Service (FIRS).

4.2 Regression results and discussions

The Augment Dickey Fuller (ADF) unit root test was used to evaluate the time series properties of the data used for the regression analysis in an effort to prevent the phenomenon of spurious regression, which is frequently linked with non-stationary time series data. The unit root test has a decision rule that states that we reject the unit root null hypothesis when the absolute value Augmented Dickey-Fuller (ADF) t-statistics is greater than the critical value at 5% level of significance and the probability value (p-value) corresponding to the test statistic is less than 0.05, indicating that the time series data under consideration is stationary. However, if the p-value is higher than 0.05, the unit root hypothesis is not rejected and it can be concluded that the time series data is not stationary at 0.05 level of significance.

The summary of ADF unit root tests shown in **Table 1** demonstrates that CIT, PPT, VAT, and GDP are all stationary at first difference. The p-values for all of the ADF-statistics were less than 0.05, and their absolute values were all higher than the absolute 5% critical values. This suggests that all variables are integrated to order one I (1). In other words, while the time series data with respect to the time series data under examination are not stationary at level, they are all stationary at the first difference. It is crucial to look at the variables for cointegration Source: Author's computation because they are not stationary at level.

The F-statistics is 7.344302, which is higher than the upper critical bound value of 3.67 at 5% level of significance according to the findings of the ARDL Bounds test of cointegration shown in **Table 2**. Because of this, we accept the alternative hypothesis that there is Cointegration at 5% level of significance and reject the null hypothesis that there is no Cointegration at this level of significance. This suggests that the factors being thought about have a long-term link. Since cointegration has been established,

Variable	ADF-statistics	5% critical value	P-value	Order of integration
GDP	−3.593576	−2.900670	0.0081	1(1)
CIT	−26.08183	−2.900137	0.0001	1(1)
PPT	−7.957927	−2.899115	0.0000	1(1)
VAT	−9.848912	−2.899115	0.0031	1(1)

Source: Author's computation.

Table 1.
ADF unit root test results.

Statistics	Values	Significance levels	1(0) Lower critical bound value	1(1) Upper critical bound value
F-Statistics	7.344302	10%	2.37	3.20
		5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Source: Author's Computation.

Table 2.
Auto-regressive distributed lag bounds test of cointegration.

we can now estimate the model's long-run form and the error correction model, which gauges how quickly equilibrium shifts between the short-run and long-run.

Based on the results of the long run model presented in **Table 3**, the estimated coefficient of petroleum profit tax (PPT) is negative and statistically insignificant at 5% level of significance. The P-value corresponding to the t-statistic is 0.0082 which is less than 0.05, implying a rejection of the null hypothesis that the coefficient of PPT is not statistically significant. A unit increase in petroleum profit tax will result in a decrease in economic growth on the average by 8.571372 units, holding companies income tax and value added tax constant. This outcome indicates that petroleum profit tax has a negative and significant impact on economic growth in the in the long run. This results shows that petroleum profit tax has a negative influence on the long run growth path of the economy.

Companies' income tax (CIT) shows a positive but statistically insignificant relationship with economic growth. The P-value corresponding to the t-statistic is 0.1262, which is greater than 0.05, implying a no rejection of the null hypothesis that the coefficient of CIT is not statistically significant at 5% significance level. A unit increase in companies income tax will result in an increase in economic growth by 26.18403 units, holding petroleum profit tax and value added tax constant. Hence, companies income tax has a positive but insignificant impact on economic growth in the long run.

Value added tax (VAT) shows a positive and statistically significant relationship with economic growth. The P-value corresponding to the t-statistic is 0.0000, which is lower than 0.05, implying a rejection of the null hypothesis that the coefficient of value added tax is not statistically significant and the acceptance of the alternative hypothesis that the coefficient of value added tax is statistically significant at 0.05 significance level. A unit increase in value added tax will result in an average increase in economic growth by 120.7390 units, holding petroleum profit tax and companies income tax constant. This implies that value added tax has a significant positive impact on economic growth in the long run.

The error correction model is examined to evaluate the short run dynamics between the dependent and independent variables and its speed of adjustment to equilibrium. Its results are presented in **Table 4**. The short-run form is represented as the first differenced variables. From the results of estimated Error Correction Model presented **Table 4**, the estimated coefficients of petroleum profit tax (PPT) shows that the current value has a negative and insignificant impact on economic growth, while the lagged coefficients have positive impact on economic growth. Only the second and third lagged coefficients are statistically significant, indicating the presence of delays in the transmission of the effects of petroleum profit tax to economic

Variable	Coefficient	Standard error	T-statistics	P-values
PPT	−8.571372	3.131866	−2.736825	0.0082
CIT	26.18403	16.87352	1.551783	0.1262
VAT	120.7390	27.09763	4.455705	0.0000
C	−981.9481	1017.499	−0.965061	0.3385

Source: Author's Computation based on output from E-VIEWS10 software.

Table 3.
ARDL Long Run Form regression results.

Variable	Coefficient	Std. error	t-statistics	P-values
D(GDP(−1))	0.048913	0.102040	0.479351	0.6335
D(GDP(−2))	−0.372648	0.095016	−3.921972	0.0002
D(GDP(−3))	−0.213931	0.103797	−2.061062	0.0438
D(PPT)	−0.991867	1.205642	−0.822688	0.4141
D(PPT(−1))	3.090010	1.250695	2.470634	0.0164
D(PPT(−2))	1.600954	1.279585	1.251151	0.2159
D(PPT(−3))	4.136915	1.240565	3.334703	0.0015
D(CIT)	3.148992	2.378288	1.324058	0.1907
D(CIT(−1))	−4.398355	3.133672	−1.403579	0.1658
D(CIT(−2))	−0.302398	2.798384	−0.108062	0.9143
D(CIT(−3))	−6.337973	2.581409	−2.455237	0.0171
D(VAT)	9.939373	7.757969	1.281182	0.2052
D(VAT(−1))	−26.98527	10.10646	−2.670100	0.0098
CointEq(−1)*	−0.268736	0.042893	−6.265304	0.0000
R-squared	0.751638	Mean dependent var		4781.114
Adjusted R-squared	0.699562	S.D. dependent var		9803.505
S.E. of regression	946.2699	Akaike info criterion		20.20353
Sum squared resid	55,516,463	Schwarz criterion		20.75862
Log likelihood	−620.8947	Hannan-Quinn criter.		20.38447
Durbin-Watson stat	1.958871			

Source: Author's Computation.

Table 4.
Error correction model regression results.

growth in Nigeria. Hence, petroleum profit tax has a positive and significant effect on economic growth in nigeria in the short run with some time lags required for the impact to fully take effect.

The current value of companies income tax is positive but not statistically significant while the third lag coefficient is negative and statistically significant at 5% significance level. This implies that the impact of companies income tax on economic growth in Nigeria is associated with some delays in the short run. Also, the current value of value added tax (VAT) is positive but not statistically significant in the short run while the second and third lag coefficients are negative and statistically significant at 5% significance level. This implies that the impact of value added tax on economic growth in Nigeria is also associated with some delays in the short run.

Also, the results of the Error Correction Model presented in **Table 4** indicates that the error correction term is negative and statistically significant at the 5% level of significance. The estimated ECM coefficient (−0.268736) measures the speed of adjustment towards an equilibrium relationship. It indicates that about 27% of the disequilibrium is adjusted each quarter. This also implies a long run causal

relationship. The adjusted R^2 shows that about 70% of the total variations in economic growth in Nigeria is explained by all the explanatory variables explicitly captured in the regression model. This implies that the regression model has a good fit.

The CUSUM test is used to determine the appropriateness and stability of the estimated model. It is used to test whether the model is stable and appropriate for any long run decisions. The basis of the test is that if the plot of the CUSUM test stays within the 5% critical bounds, the null hypothesis that all the parameters are stable cannot be rejected. If either of the parallel lines are crossed or the cumulative sum goes outside the boundaries of the two critical lines, then the null hypothesis of parameter stability is rejected at the 5% significance level.

From **Figure 4**, the plots are confined within the 5% critical bounds which prove that the residual variance is stable. Thus, the null hypothesis that all parameters are stable cannot be rejected at 5% level of significance, implying that the model is stable.

The economic implication of the long run result is that both companies income tax and value added tax have a long run positive impact on economic growth while petroleum profit tax has a negative impact on economic growth. Hence, measures targeted at enhancing the efficacy of non-oil related taxed have tremendous potential to boost growth of the economy in the long run. With reference to the petroleum profit tax, the estimated coefficient is negative and statistically significant at 5% level of significance. This is an indication that overreliance on oil revenue has a negative long run impact on economic growth in Nigeria.

The results of the estimated Error Correction Model, which measures the dynamics of change from short run to the long run, shows that there are delays associated with the transmission of taxation to economic growth in the short run. Also, the Error Correction Term (ECT) shows that the speed of adjustment from short run to long run equilibrium is −0.268736. This is an indication that the model converges towards equilibrium in the long run and about 27% of the disparity between short run and long run equilibrium is adjusted each period.

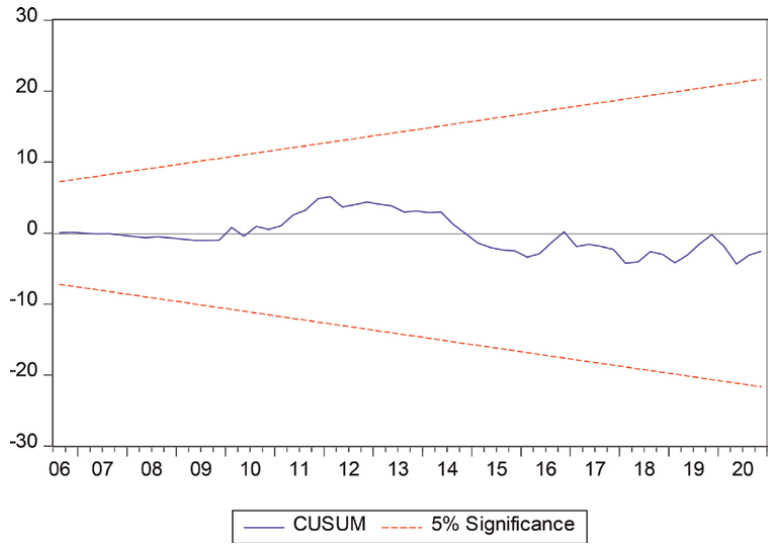


Figure 4.
Cumulative sum test for model stability.

5. Conclusions and policy recommendations

In this chapter, we looked at taxes and the issue of fiscal sustainability in a resource-rich developing nation, paying specific attention to how taxes affected Nigeria's economic growth from the first quarter of 2001 to the fourth quarter of 2020. Value added tax (VAT), petroleum profit tax (PPT), and companies income tax (CIT) received particular attention (VAT). According to the study's empirical results, taxes have a big impact on Nigeria's economic growth over the long and short terms. However, certain tax provisions are more successful than others at promoting growth. The results of the autoregressive distributed lag model demonstrate that while oil-related tax components, such as the petroleum profit tax, had significantly negative long-term effects on Nigeria's economic growth, non-oil tax components, such as companies' income tax and value added tax, had long-run positive effects on the country's economy. Additionally, compared to corporate income tax, value added tax had a substantially higher impact on overall productivity in the Nigerian economy among the non-oil tax components. Therefore, it should be highlighted that this result is illuminating for both policy and planning in terms of improving Nigeria's taxes systems. Therefore, policy actions aimed at increasing tax revenues and taxation capacity can aid in raising the country's productivity, which will then favourably impact economic growth. Based on the findings from the empirical investigations in this study, the following policy recommendations are designed:

In order to improve the performance of corporate income tax as it relates to its contribution to economic growth in Nigeria, the government should ensure the establishment of an efficient tax system with a focus on widening the tax net. The Nigerian government should ensure the formalisation of enterprises operating in the informal sector in order to increase tax revenues from the Companies Income Tax, according to the study's conclusions. This can be done by encouraging business registration with the use of specific grants and government benefits.

Incentives should be offered as well to encourage tax payer compliance. Concessionary tax rates for individuals and corporate organisations that were able to file their tax returns within the required timeframe can be used to include these incentives into the administrative tax systems. Government should also implement specific socio-welfare measures to encourage Nigerians, including individuals and businesses, to voluntarily comply with their tax duties. Because of this, fiscal deficits will be lower and more sustainable.

Government officials should be held accountable and transparent for managing the funds obtained from the various forms of taxation. This is done to ensure that citizens, who should be able to benefit from paying taxes, receive the maximum benefits of taxation. Further strengthening of the regulatory agencies in charge of tax collection is necessary in order to ensure taxpayer compliance. Above all, tax income should be fairly allocated to enable economic progress, particularly in Nigeria's need for basic infrastructure and social amenities.

Author details

Oluwatosin Olushola[1*], Pa Lamin Beyai[2] and Alexander Anagbado[1]

1 Veritas University Abuja, Nigeria

2 United Nations Development Programme (UNDP), Sierra Leone

*Address all correspondence to: kreativetosin@gmail.com

IntechOpen

References

[1] Odhiambo O, Olushola O. Taxation and economic growth in a resource-rich country: The case of Nigeria [Internet]. Taxes and Taxation Trends. InTech; 2018. DOI: 10.5772/intechopen.74381

[2] Olushola O, Ojijo O, Beyai P. Capital markets, economic growth and sustainable development financing: A case study of Nigeria. Journal of Economics and Sustainable Development. 2016;**7**(22):121-132

[3] Adam A. Approaches of public finance sustainability taking into account the current economic context. Financial Studies. 2015;***19***(1):93-101

[4] Saibu O. Public spending, fiscal sustainability and macroeconomic performance in Nigeria. NDIC Quarterly. 2018;**33**(4):33-48

[5] NBS. Q4, GDP Report. National Bureau of Statistics. 2021

[6] OECD. Fiscal Sustainability in Government at a Glance. Paris: OECD Publishing; 2013. DOI: 10.1787/gov_glance-2013-11-en

[7] Federal Ministry of Finance. National Tax Policy. Abuja: Federal Ministry of Finance; 2017

[8] OECD. Revenue statistics in Africa: Key findings for Nigeria. OECD 2022. Available from: https://www.oecd.org/tax/tax-policy/revenue-statistics-africa-nigeria

[9] Fiscal Responsibility Commission. Fiscal Responsibility Act. Abuja: Federal Republic of Nigeria; 2007

[10] Cavallo A, Pietro D, Antonio R. The common framework for national fiscal policies and the euro area fiscal union. In: Fiscal Policies in High Debt Euro-Area Countries. Berlin: Springer; 2018

[11] Macroeconomic Review 2022. Available at: https://assets.kpmg.com/content/dam/kpmg/ng/pdf/2022-macroeconomic-review.pdf

[12] Erik L. Studies in the Theory of Money and Capital. New York: Routledge; 1939

[13] Wicksell KW. Interest and Price: A Study of the Causes Regulating the Value of Money. London: Macmillan and Co. Limited; 1936

[14] Joseph E. In praise of frank Ramsey's contribution to the theory of taxation. Economic Journal, Royal Economic Society. 2015;**3**(583):235-268

[15] Domar E. The burden of debt and national income. American Economic Review. 1944;**34**(4):798-827

[16] Buiter W, Patel U. Debt, deficits and inflation: An application to the public finance of India. Journal of Public Economics 1992. 1992;**47**(2):171-205

[17] Rajaraman I, Bhide S, Pattainaik R. A Study of Debt Sustainability at State Level in India. Mumbai: Reserve Bank of India Bulletin; 2005

[18] Omotosho B, Bawa S, Doguwa S. Determining the optimal public debt threshold for Nigeria, central Bank of Nigeria. Journal of Applied Statistics. 2016;**7**(2):1-25

[19] Folorunso B, Falade O. Relationship between fiscal Deficit and public debt in Nigeria: An error correction approach. Journal of Economics Behavioral Studies. 2013;**5**(6):346-355

[20] Oyeleke O, Ajilore O. Analysis of fiscal deficit sustainability in Nigeria economy: An error correction approach. Asian Economic and Financial Review. 2014;**4**(2):199-210

[21] Ebi B, Ayodele O. Tax reforms and tax yield in Nigeria. International Journal of Economics and Financial. 2017;**7**(3): 768-778

[22] Olushola O, Anagbado AC. Fiscal federalism and regional agitations in Nigeria. In: Ugwuoke WO, Adegoriola AE, editors. Fiscal Federalism and Infrastructural Development in Nigeria. Kabod Publishing. pp. 94-113

[23] Noritaka M. The pace of fiscal consolidations, fiscal sustainability, and welfare: An overlapping generations approach. Journal of Macroeconomics. 2023;**75**(3):20-39

[24] Anthony I. Fiscal policy and sustainability of public debt: The Nigerian experience. Journal of Jilin University (Engineering and Technology Edition). 2022;**42**(3):1-18

[25] Cosimo M. Fiscal sustainability in the GCC countries. International Journal of Economic Policy Studies. 2022;**16**(2): 389-408

[26] Dauda G, Gbadebo S. Fiscal policy sustainability in Nigeria: ARDL bounds testing technique. Asian Journal of Empirical Research. 2020;**10**(3): 74-80

[27] Badri N, Vaseem A. What do we know about fiscal sustainability across Indian states? Journal of Economic Modelling. 2020;**87**(3):307-321

[28] Selahattin İ, Sagiri K, Tomoaki Y. Fiscal sustainability in Japan: What to tackle? Journal of the Economics of Ageing. 2020;**14**(3):3-17

[29] Serhan C, Vibha N. Riding the storm: Fiscal sustainability in the Caribbean. International Review of Applied Economics. 2020;**34**(3):384-399

[30] Anuruddhi S. Sustainability of the fiscal imbalance and public debt under fiscal policy asymmetries in Sri Lanka. Journal of Asian Economics. 2020;**66**(5): 15-31

[31] Olufemi M. Public spending, fiscal sustainability and macroeconomic performance in Nigeria. NDIC Quarterly. 2019;**33**(2):33-48

Chapter 8

Taxing Energy as Innovation Driver in the European Union

Mª Gabriela Lagos-Rodríguez

Abstract

A significant European Union's concern is overcoming dependence on fossil fuels and generating sustainable and environmentally friendly growth. Public decisions must be adopted to ensure this objective considering the widespread agreement about promoting energy change implies a technological transformation derived from R&D. This chapter is focused on the relationship between energy taxation and environmental R&D. The question is whether European taxation's role is suitable for promoting energy change. The main conclusion is that beyond the fact that green taxes are a low percentage of the total collection, their configurations are more designed to internalise pollution's cost than favour R&D. Despite energy taxation has been directed at the fundamental objective of revenue collection, it is necessary that public tax policies should be designed considering their role as a driver of environmental R&D. Taxes on traditional energy sources should adapt their structure considering the level of CO_2 emissions as well as the impact of investment tax credits on the Corporate Income Tax should be assessed as drivers of environmental R&D. A limitation of this study is the lack of available data to link these incentives to the patents on green energy sources which constitutes an objective to achieve in future research.

Keywords: environmental taxation, innovation, energy taxation, carbon taxation, renewable energy

1. Introduction

This chapter focuses on environmental taxes' role in achieving the EU's goal of net zero emissions by 2050. It is claimed that taxation is a representative instrument of public policies, which means that taxation measures have the potential to contribute decisively to accomplishing important political and economic goals. The purpose of this document is fixed on how the main corporative taxes configuration can orientate private investment through environmental research and development (R&D). A proper context needs to briefly analyse to support the relationship between taxation and the new energy consumption model. According to our aim, the framework also requires an overview of the amount of green taxes European countries have created and what they are their imposable objects. However, the primary approach is to analyse if we can stand a real impact between tax incentives related to R&D on new sources of green energy or, at least, on more

efficient processes of its consumption. This chapter offers an analysis of the role of taxes as instruments that should guide the behaviour of taxpayers. In other words, beyond the collection figures obtained and the variety of taxes created, the question raised is whether they promote investment in R&D, specifically in the new technologies that will make it possible to achieve the goals of the European 2030 Agenda.

In recent decades, we have become accustomed to terms such as climate change, global warming, or greenhouse gases, and we have witnessed efforts of diverse kinds that international institutions and states have put in place to try to curb these phenomena that deteriorate our environment. Yet, without going into the weight of human action in environmental destruction, the fact is that its impact is undeniable, and corrective measures for production processes and consumption decisions that generate pollution have proliferated, with greater or lesser success in their results.

There is extensive literature on taxation and different aspects of environmental policies, which has provided multiple policy directions concerning the role of environmental taxes. However, on the whole, the studies conclude that environmental taxes play a relevant role in mitigating greenhouse emissions. Moreover, in-depth empirical analyses emphasise that we should consider that implications obtained from the interdependence among environmental taxes, environment, energy consumption, and economic growth are different across developed, developing, and emerging countries.

The analysis of public intervention through tax regulations usually focuses on the penalisation of environmental pollution; however, one of the most outstanding aspects of fiscal action is its capacity to promote technological innovation and the development of processes that make it possible to overcome the adverse effects that our economic model generates, i.e., the so-called eco-innovation. As Jaffe & Stavins state, the success or failure of environmental protection depends mainly on the impact of public policies on technological development [1].

The research and development of these innovative technologies, or their adaptation to production processes, requires superior levels of investment and the assumption of significant risks. Therefore, innovation to protect the environment is crucial in public policies and taxation. The generation of new sources of clean energy is where incentives for R&D and innovation provided for in corporate taxes can be applied. Still, in a complementary manner, environmental taxes should contribute to sustaining and strengthening them, hence the relevance of their analysis.

In addition to penalising environmentally damaging behaviour, taxation offers instruments to promote fewer polluting procedures or activities. In this sense, promoting renewable energies is the ideal solution for an environmentally friendly energy transition. There is an agreement that consuming clean energy is the key to sustainable economic development and the progressive disappearance of greenhouse gases. However, the truth is that for this change process to occur, a substantial technological effort is necessary to ensure levels of energy supply that allow economic activity to continue.

The climate outlook for the planet could be more promising, and policy focus on tax measures should impact this process. Despite the progress achieved in public policies other than fiscal measures, the fact remains that environmental taxes are still the main instrument for public action, especially those levied on greenhouse gas emissions and the consumption of hydrocarbon derivatives. The link between the use of fossil energy sources and the widespread consumption

of oil derivatives, and the emission of carbon into the atmosphere is a critical element that all experts have highlighted. In the above context, taxation on CO_2 emissions and fossil fuel consumption has emerged as a crucial instrument in the fight against climate change. More than a few international institutions and states have found in this type of taxation the most immediate solution to act on the consumption of the fuels that currently underpin the production processes of the world economy.

Despite the progressive introduction of this type of tax, data from the Organisation for Economic Cooperation and Development (OECD) and the European Union (EU) show a significant gap between the objectives set at successive international conferences [2] and the current reality. Therefore, it is worth considering whether the configuration of these taxes is appropriate and whether they encourage the development of technological innovations that lead to lower pollution levels. The ease of application of taxes, especially indirect taxes, is an essential incentive for their establishment, as is the revenue they bring in. Still, their pressure can be much greater than the savings expected from research, acting as a barrier to innovation. This is the central aspect of the relationship between these taxes and eco-innovation, from which the assessments and findings of this contribution will be drawn.

2. The change in energy model and technological innovation

It is almost a rhetorical exercise to highlight the importance of promoting renewable energies that allow for an effective transition towards an environmentally friendly energy model. However, many scientific, political and economic bodies have considered this process vital for decarbonising our atmosphere. Furthermore, other expected positive effects are improving the energy supply and security and the incentive of national employment [3].

According to OECD data for 2022, the world economy's dependence on fossil fuels is still very high (78%), although it varies by region. One element to highlight is that, in areas where the volume of CO_2 emissions has been reduced, economic growth has been maintained due to technological changes that have led to the application of new energy sources and greater efficiency in using traditional ones.

Despite variations in energy intensity across countries, dependent on various factors (economic structure, level of income and public policies, for instance), the impacts of COVID-19 have been similar. Even though pandemic lockdowns have led to lower global energy consumption, renewables have continued to grow. Without research and its application to production processes, this situation is possible, which shows the positive effect of R&D in changing the energy model of the economy. However, a comprehensive analysis of public action highlights inconsistencies, such as the significant increase in government support for the production and use of fossil fuels, mainly through additional incentives that benefit the oil and gas sector, such as tax provisions that give beneficial treatment to capital expenditures for fossil fuel production.

Europe is one of the regions of the world that has made the most outstanding effort to use renewable energies and to adapt its economy to energy change. As we can see from **Table 1**, the average European related to renewable energies is around 20% of total energy consumption.

TIME	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
EU-27	16.0	16.7	17.4	17.8	18.0	18.4	19.1	19.9	22.0	21.8
BE	7.1	7.7	8.0	8.1	8.7	9.1	9.5	9.9	13.0	13.0
BG	15.8	18.9	18.1	18.3	18.8	18.7	20.6	21.5	23.3	17.0
CZ	12.8	13.9	15.1	15.1	14.9	14.8	15.1	16.2	17.3	17.7
DK	25.5	27.2	29.3	30.5	31.7	34.4	35.2	37.0	31.7	34.7
DE	13.5	13.8	14.4	14.9	14.9	15.5	16.7	17.3	19.1	19.2
EE	25.6	25.4	26.1	29.0	29.2	29.5	30.0	31.7	30.1	38.0
IE	7.0	7.5	8.5	9.1	9.2	10.5	10.9	12.0	16.2	12.5
EL	13.7	15.3	15.7	15.7	15.4	17.3	18.0	19.6	21.7	21.9
ES	14.2	15.1	15.9	16.2	17.0	17.1	17.0	17.9	21.2	20.7
FR	13.2	13.9	14.4	14.8	15.5	15.8	16.4	17.2	19.1	19.3
HR	26.8	28.0	27.8	29.0	28.3	27.3	28.0	28.5	31.0	31.3
IT	15.4	16.7	17.1	17.5	17.4	18.3	17.8	18.2	20.4	19.0
CY	7.1	8.4	9.1	9.9	9.8	10.5	13.9	13.8	16.9	18.4
LV	35.7	37.0	38.6	37.5	37.1	39.0	40.0	40.9	42.1	42.1
LT	21.4	22.7	23.6	25.7	25.6	26.0	24.7	25.5	26.8	28.2
LU	3.1	3.5	4.5	5.0	5.4	6.2	8.9	7.0	11.7	11.7
HU	15.5	16.2	14.6	14.5	14.4	13.6	12.5	12.6	13.9	14.1
MT	2.9	3.8	4.7	5.1	6.2	7.2	7.9	8.2	10.7	12.2
NL	4.7	4.7	5.4	5.7	5.8	6.5	7.4	8.9	14.0	12.3
AT	32.7	32.7	33.6	33.5	33.4	33.1	33.8	33.8	36.5	36.4
PL	11.0	11.5	11.6	11.9	11.4	11.1	14.9	15.4	16.1	15.6
PT	24.6	25.7	29.5	30.5	30.9	30.6	30.2	30.6	34.0	34.0
RO	22.8	23.9	24.8	24.8	25.0	24.5	23.9	24.3	24.5	23.6
SI	21.6	23.2	22.5	22.9	22.0	21.7	21.4	22.0	25.0	25.0
SK	10.5	10.1	11.7	12.9	12.0	11.5	11.9	16.9	17.3	17.4
FI	34.2	36.6	38.6	39.2	38.9	40.9	41.2	42.8	43.9	43.1
SE	49.4	50.2	51.2	52.2	52.6	53.4	53.9	55.8	60.1	62.6

Source: own elaboration based on Eurostat (2023).

Table 1.
Share of energy from renewable sources in the European Union.

As a result, Europe is in a better relative position than other areas, especially Southeast Asia, which leads to greenhouse gas emissions. According to data from the European Commission, in 2021, seven countries (China, India, Russia, Iran, Saudi Arabia, Brazil and Türkiye) are responsible for more than 1% of global CO_2 emissions. The biggest concern is that some of these countries have increased their emissions. But then, Türkiye shows an amount superior to 7% from 2019 to 2021. On the contrary, the EU27 and other countries (United States, Japan, South Korea, Indonesia, Canada, South Africa, Mexico and Australia) emitted fewer greenhouse gases in 2021

than in 2019. However, despite the progress made, there still needs to be more scope for adopting renewable energy sources in European countries [4].

With significant differences between the Nordic and Benelux states, the fact is that the average for the Union of 27 countries is just shy of 20% of total energy consumption from renewable sources. However, it needs to be closer to the Commission's proposed target of 53% of the total energy demand supplied in the form of electricity by 2050. Moreover, according to the Commission's forecast, 80% of this electricity will come from renewable sources derived from solar plants and onshore and offshore wind, significantly reducing energy dependence on hydrocarbon-producing countries. The Commission's calculations foresee the release of between two and three trillion euros that could be used to modernise the EU economy. The advantages, therefore, are not only environmental, but the energy transition is a new model of economic competitiveness that will improve the relative position of the states that carry it out.

Governments may increase their spending to help private actors through discretionary stimuli. According to the classical equivalence proposition, the more debt-financed public expenditure, the greater the savings to the private sector, so the stimulus effect on aggregate demand will be neutralised. However, in the short-term, increases in public expenditure can encourage private investments, especially during recessions. **Table 2** illustrates how most European countries target renewables in their public energy-related research spending.

TIME	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
EU-27	2.08	2.1	2.11	2.12	2.12	2.15	2.19	2.22	2.3	2.26
BE	2.28	2.33	2.37	2.43	2.52	2.67	2.86	3.16	3.35	3.22
BG	0.6	0.63	0.79	0.95	0.77	0.74	0.75	0.83	0.85	0.77
CZ	1.77	1.88	1.96	1.92	1.67	1.77	1.9	1.93	1.99	2.
DK	2.98	2.97	2.91	3.06	3.09	2.93	2.97	2.93	2.96	2.81
DE	2.88	2.84	2.88	2.93	2.94	3.05	3.11	3.17	3.13	3.13
EE	2.12	1.72	1.43	1.47	1.24	1.28	1.41	1.63	1.75	1.75
IE	1.56	1.57	1.52	1.18	1.18	1.25	1.17	1.23	1.23	1.06
EL	0.71	0.81	0.84	0.97	1.01	1.15	1.21	1.28	1.51	1.45
ES	1.3	1.27	1.24	1.22	1.19	1.21	1.24	1.25	1.41	1.43
FR	2.23	2.24	2.23	2.23	2.22	2.2	2.2	2.19	2.3	2.21
HR	0.74	0.8	0.77	0.83	0.85	0.85	0.95	1.08	1.24	1.24
IT	1.26	1.3	1.34	1.34	1.37	1.37	1.42	1.46	1.51	1.49
CY	0.44	0.48	0.51	0.48	0.52	0.54	0.61	0.71	0.84	0.87
LV	0.66	0.61	0.69	0.62	0.44	0.51	0.64	0.64	0.69	0.69
LT	0.89	0.95	1.03	1.04	0.84	0.9	0.94	0.99	1.14	1.11
LU	1.21	1.23	1.22	1.25	1.27	1.24	1.17	1.18	1.09	1.02
HU	1.25	1.38	1.34	1.34	1.18	1.32	1.51	1.47	1.59	1.65
MT	0.8	0.74	0.69	0.72	0.56	0.55	0.58	0.56	0.65	0.63
NL	1.92	2.16	2.17	2.15	2.15	2.18	2.14	2.18	2.31	2.25
AT	2.91	2.95	3.08	3.05	3.12	3.06	3.09	3.13	3.2	3.19

TIME	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
PL	0.88	0.88	0.94	1.	0.96	1.03	1.21	1.32	1.39	1.44
PT	1.38	1.32	1.29	1.24	1.28	1.32	1.35	1.4	1.61	1.66
RO	0.46	0.39	0.38	0.49	0.48	0.5	0.5	0.48	0.47	0.47
SI	2.56	2.56	2.37	2.2	2.01	1.87	1.95	2.04	2.14	2.14
SK	0.79	0.82	0.88	1.16	0.79	0.88	0.84	0.82	0.9	0.93
FI	3.4	3.27	3.15	2.87	2.72	2.73	2.76	2.8	2.91	2.98
SE	3.23	3.26	3.1	3.22	3.25	3.36	3.32	3.39	3.49	3.36

Source: own elaboration based on Eurostat (2023).

Table 2.
Gross domestic expenditure on R&D (EU-27).

Public intervention in areas such as innovation and the environment is justified by several classic economic problems that determine market failure in their production. Without going into well-known sites, incomplete information, externalities, and economies of scale are typical cases where the market cannot set a fair price for goods or services. As far as the environment is concerned, there is neither a price attached to the emission of pollution nor enforceable property rights for the damage caused; when it comes to innovation, the market can neither ensure the success of its research nor all the funding it needs nor, of course, that it can exclusively receive the benefits generated by its inventions [5]. This situation corresponds to a double scenario of underproduction [6]. Therefore, it justifies the intervention of the public sector with measures that encourage innovation and discourage pollution.

However, actions encouraging specific objectives usually channel resources towards certain economic agents' investments, activities, or decisions. Governments must weigh the effect of diverting resources towards the proposed goals regarding other expenditure items that will reduce their funding and the degree of efficiency achieved. Economic studies on promoting innovation in improving the environment show that public action is more efficient than public spending. The OECD concludes that invention significantly impacts policies to reduce environmental damage: not only does it reduce the cost of measures, but the environmental outcome is achieved earlier. The OECD's recommendation is to undertake solid short-term investments that encourage the introduction of new technologies to achieve significant long-term results.

Consistent with the above approach, the European Commission has promoted an action plan that seeks greater competitiveness in the European economy and is based on ensuring sustainable consumption and production patterns following the prescriptions of other international organisations [7]. The new circular economy model aims to abandon the current model (Take-Make-Waste) for a regenerative growth model based on the efficient use of natural resources, with technological progress being the ideal means to make this possible. One of the most significant interests is research into new sources of clean energy, such as that generated in the oceans or using hydrogen as a raw material in industrial processes. These alternatives, together with the maintenance of nuclear power plants and the development of new biofuels that can be used in the so-called diffuse sectors, will, according to the Commission's estimates, make it possible to achieve the goal of zero net emissions by 2050 [8].

In any case, public sector action in environmental protection can be carried out through different means, which are not mutually exclusive, but their combination

usually yields better results. The traditional way to act is by regulating the technical conditions of specific sectors, processes, or products. Regulatory regulation, *per se*, has determined the forced change of polluting processes or fuels, requiring the abandonment of obsolete and polluting technology to reduce the environmental impact.

In addition to the regulatory function, market-based instruments make the most polluting products more expensive. Emissions trading makes it possible to use emission allowances as a marketable commodity. In this way, an economic agent who carries out a polluting activity and holds an emission permit can trade with his allowances, buying more if he needs to emit more pollutants or selling if his need is less than the allowances recognised. In either case, a global emissions ceiling is set that cannot be exceeded. The first and most significant international carbon market is the EU Emissions Trading Scheme, created in 2005 and regulated by Directive 2003/87/EC [9]. Significantly, one of its objectives is to assist industry and the energy sector in meeting the innovation and investment challenges of transitioning to a low-carbon economy using specific funding mechanisms. The Innovation Fund is a funding instrument for low-carbon technology and processes in energy-intensive industries, environmentally safe carbon dioxide capture, utilisation and storage, and innovative renewable energy and energy storage technologies. It is programmed for 2021–2030 and endowed with 10 million. It funds up to 60% of investment and operational costs and coordinates with other European funding programs for research and innovation in low-carbon technology. Another instrument is the Modernisation Fund, which finances investments to modernise the electricity sector in carbon-dependent regions in ten low-income Member States. A tool can also be adapted at the market level to set a certain level of acceptable pollutant emissions in a sector, whereby operators exceeding this level are penalised. Those that fall below it receive discounts or subsidies—Feebates. It can be configured as a zero-sum mechanism that encourages internal competition and, ultimately, the overall reduction of recorded emissions.

Finally, states have established taxes on certain economic activities and products whose justification can be found in protecting the environment. The harmonised definition of such taxes is that environmental taxes are those whose tax base consists of a physical (or similar) unit of some material that has a proven and specific negative impact on the environment.

In recent decades, taxation has been extended to the different areas of protection of the natural environment, dealing with water consumption and purification, solid waste treatment and emissions of gases and other products that pollute the atmosphere. However, the two main categories of environmental taxation are energy taxes and transport taxes, classic forms of indirect taxation oriented towards environmental protection. The evolution of this category of taxes has reflected the progressive concern to limit the polluting impact of our productive activity, at least from the declarative point of view, although the collection object. Nevertheless, what had inspired the birth of a large part of these taxes has not been abandoned.

3. Taxation as a driver of energy transition through technological innovation

From an economic perspective, taxes levied on activities that generate pollution act as correctors of market inefficiency that does not compensate for a negative externality. Therefore, the premise that "the polluter pays" is nothing more than the recognition of the corrective action of the public sector through its taxation powers. The tax paid by those who cause environmental damage is configured as a compulsory payment to discourage their behaviour. In correspondence with the levy, the polluting

agent will introduce corrective measures that allow him to reduce the fiscal cost he bears, which he will also pass on as an increase in the price of the product or service that generates the negative externality, discouraging its consumption.

We typically accept three types of environmental taxes. There are some whose goal is to cover the costs of ecological services against pollution; another kind of tax has the primary function of providing revenues, and incentive taxes are designed to modify producers' and consumers' behaviour. According to the Final Report of the European Commission [10], there were 142 taxes identified that target greenhouse gases emission, considering that the data excludes taxes under the Energy Tax Directive. Taxes on vehicles is also one of the most common types of taxation employed. Countries usually charge by the purchase and registration of the vehicle, as well as create a circulation tax. However, the carbon taxes, in conjunction with the emissions trading systems, are relevant instruments to reduce the impact of greenhouse gases. Carbon taxes often have significant distributional effects on their political sustainability. Because of that, carbon taxes can also be designed to be neutral, meaning that introducing or increasing the carbon tax in environmental tax reforms will lead to reductions in other taxes. Furthermore, taxes are often offset in recycling measures that return carbon tax revenues to households and businesses to mitigate the harmful effects of their distributional consequences.

It is irrelevant whether the result of this type of tax collection is linked to expenditure related to protecting the natural environment. In other words, not the earmarking of revenues for this purpose is decisive, but rather the configuration of the taxable event to penalise the polluting action. International reports suggest that revenues from this tax should not be earmarked for environmental activities but rather reducing other taxes that discourage work and investment. However, on the other hand, an incorrect configuration could lead to undesired direct effects that aggravate the problem of pollution.

The advantages of environmental taxation [4] are its efficiency in internalising costs, as well as in promoting technological innovation and changing consumption habits. The boost to technological development and innovation increases their efficiency if it occurs through a tax because the tax continues to operate, linked to the positive impact on the environment once the technological breakthrough has occurred. Moreover, suppose the product is taxed to penalise its polluting nature. In that case, it will influence the consumption decision through the price and provide an incentive to behave environmentally soundly.

Among the disadvantages of environmental taxation are the undesirable effects of its use for tax collection purposes. The financial needs of the public sector can lead to an abuse of this type of taxation, the action of which can be directed at the will of the legislator towards specific sectors to the detriment of others. Another, not minor, problem is their introduction and modification according to the economic situation and the consequent loss of legal certainty. The stability of tax regulation is essential for operators to plan their activity rationally and, above all, to make technology investments that can improve products or production processes. Overly intense taxation of a polluting sector can discourage innovative investments that can reduce its environmental impact, hence the importance of coordinating taxation to avoid this risk. On the other hand, a profusion of exemptions and deductions can undermine the tax's natural effect on the polluting product's price so that its introduction will serve only the environmental purpose but other economic policy objectives, such as the protection of certain activities.

Regarding the percentage of total tax revenues obtained by European States, **Table 3** shows that the relative importance of environmental-related taxes is relatively low. Treasuries barely collect from 4–10% of their tax revenues, and, related to the European level, the data shows how their implementation has been moderate.

Time	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
EU-27	6.2	6.2	6.2	6.2	6.2	6.1	6.0	5.9	5.6	5.5
BE	5.6	5.5	5.6	5.7	6.0	6.0	6.0	6.1	5.8	5.7
BG	10.2	10.2	10.0	10.2	10.2	9.4	8.8	9.9	9.9	9.1
CZ	6.4	6.0	6.2	6.0	6.0	5.7	5.4	5.7	5.4	5.1
DK	8.7	9.0	8.2	8.6	8.6	8.0	8.2	7.0	6.7	6.0
DE	5.5	5.4	5.2	5.0	4.8	4.6	4.5	4.4	4.3	4.4
EE	8.6	8.1	8.3	8.2	8.9	8.7	8.3	9.6	7.2	6.8
IE	8.4	8.6	8.3	8.2	8.0	7.8	7.0	6.4	6.1	5.5
EL	9.2	10.2	10.3	10.5	9.8	10.2	9.5	9.8	9.7	10.0
ES	4.9	5.8	5.5	5.7	5.5	5.4	5.3	5.1	4.7	4.6
FR	4.4	4.5	4.5	4.7	4.9	5.0	5.1	5.1	4.8	4.8
HR	7.1	7.8	8.7	9.1	9.3	9.4	9.4	9.2	8.9	8.8
IT	8.0	7.9	8.3	7.9	8.3	8.0	7.9	7.7	7.1	6.9
CY	8.2	8.6	9.1	9.2	9.1	9.0	8.6	7.4	7.0	6.5
LV	10.3	10.8	11.3	11.8	11.7	11.2	10.9	9.6	9.8	9.0
LT	6.1	6.2	6.3	6.4	6.5	6.5	6.6	6.2	6.2	5.8
LU	6.1	5.7	5.2	5.1	4.7	4.5	4.3	4.4	3.6	3.8
HU	6.5	6.3	6.3	6.4	6.5	6.4	6.2	6.2	6.0	5.9
MT	8.9	8.2	8.7	9.1	8.6	8.4	8.2	8.3	7.7	6.5
NL	9.1	9.1	8.9	9.0	8.7	8.6	8.6	8.6	8.0	7.8
AT	5.8	5.6	5.6	5.5	5.6	5.7	5.4	5.4	5.0	5.0
PL	8.1	7.6	8.1	8.2	8.1	7.9	7.7	7.2	7.1	7.8
PT	6.9	6.5	6.7	7.0	7.6	7.6	7.4	7.3	6.7	6.6
RO	7.2	7.5	8.7	8.8	9.3	7.8	7.6	8.1	7.3	7.4
SI	10.1	10.5	10.3	10.3	10.3	9.8	9.1	8.9	7.9	7.3
SK	8.3	8.2	8.0	7.7	7.6	7.5	7.3	7.3	7.1	6.7
FI	7.0	6.7	6.6	6.7	7.1	6.9	6.9	6.6	6.5	5.8
SE	5.7	5.5	5.2	5.1	5.0	4.8	4.8	4.8	4.7	4.5

Source: own elaboration based on Eurostat (2023).

Table 3.
Share of environmental-related tax revenues (% of total tax revenues).

The setting of environmental taxes can be determined based on the amount of pollution generated, or an indirect criterion based on the consumption of the product that produces the polluting emissions can be used as a benchmark. The corrective capacity of the first tax type is higher and, therefore, preferable to eliminate or reduce environmentally harmful activity. However, indirect taxes on the consumption of specific products are easier to apply, which is why this is the predominant form of environmental taxation.

Taxes applied to discourage the consumption of polluting energies, coal, petroleum products and natural gas, have become widespread and represent an essential source of resources for the treasury. Fuel taxation is simple to implement, has low collection costs and can be passed on to final consumers so that consumption restrictions are passed on to those who ultimately spend energy. However, both indirect taxes on

the consumption of these products and the higher direct taxes borne by companies dedicated to the exploitation of hydrocarbons increase the price of energy supplies to individuals and companies and, in short, generate a disincentive effect on their use.

However, it should be pointed out that, in the absence of alternative energy sources not penalised by taxation, the consumption of oil or coal derivatives is not so much an option as an obligation for their recipients. In economic terms, we are dealing with an inelastic demand, which determines a change in the price of production and consumption. Still, not a lower impact on the volume produced or consumed. In this way, rather than discouraging the production and consumption of these fuels, what is delivered are perverse effects well known in economics, particularly an increase in inflation and the relative worsening of those with less economic capacity. It is well known that indirect taxation is not adapted to the conditions of the taxpayer, which is why the portion of income spent on this type of taxation is higher for those with lower income. One of the most affected aspects of environmental fiscal policy requirements is to prevent their implementation from generating a worse income redistribution, especially in developing countries [11]. If these taxes are not designed with a broader redistributive approach, considering their coordination with other tax measures and direct aid concessions, the result is regressive. They are more detrimental to lower incomes, especially if they need transport from areas with poorer infrastructure.

Revenues from taxes aimed at penalising activities that generate climate change come mainly from specific taxes on energy products, gains from the auctioning of tradable CO_2 emission allowances and taxes on the use of roads and motor vehicles, as shown in **Figure 1**.

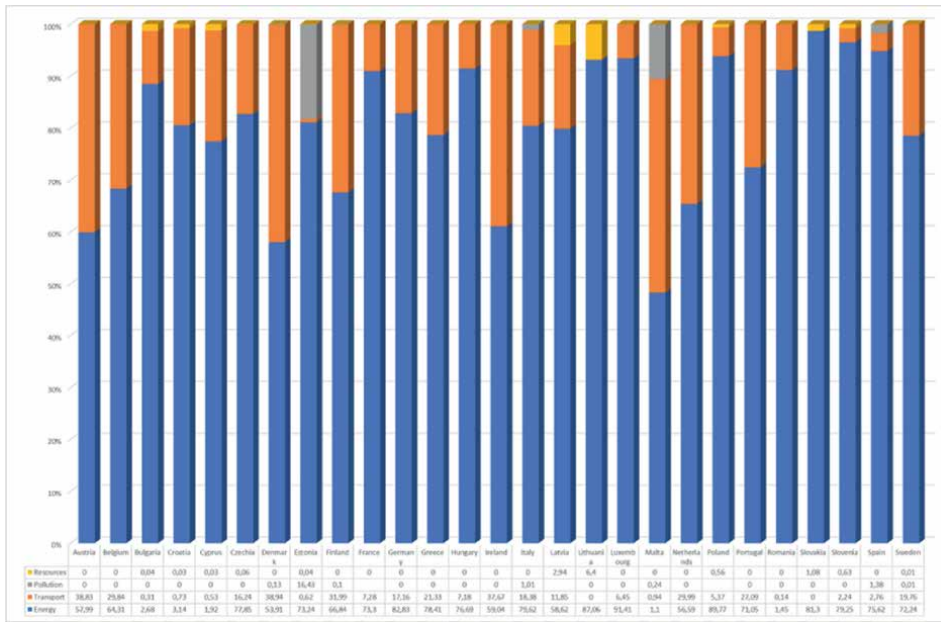


Figure 1.
Climate change-related tax revenue by taxable base (% total environmental-related tax revenue). 2020. Source: OCDE (2022).

The selection of countries presented represents the reality of European Union members. As is evident, the primary tax effort of states is focused on taxing energy, mainly motor fuels and transport. Generally, the trend is downward in the revenue volume they contribute, both in absolute terms and concerning GDP.

Although the situation cannot be generalised to all states, the causes of this reduction can be found in a combination of global factors. The most relevant, from the perspective of the structure of these taxes, is that the tax rates applied, usually defined in physical units, are set in nominal terms. As the tax cannot be adjusted for inflation, these rates decrease in real terms over time. In short, and as Gago et al. [12] state, practically all existing energy taxes in the world are below the optimal level from an environmental point of view, with one of the factors that explain this situation being the problems in the design of these taxes [13]. In the same sense, Sanz & Rodríguez [14] point out that some environmental taxes have not been designed, considering the impact of energy consumption on the environment.

Likewise, different tax sovereignties have jointly taxed certain taxable events, or else the sources of taxation have been distributed in correlation with the competencies that each one holds. In this sense, environmental tax policy can generate free-rider behaviour in tax asymmetry. As we have noted, the fiscal cost can be a barrier to innovation due to the pressure it exerts on the price of products, which can result in an advantage for those countries that do not impose this type of tax or apply relevant exemptions and deductions on them. Border tax adjustments linked to the carbon content of imported products have been suggested [15], and it has been found that, in terms of carbon dioxide emissions, countries that have made a more significant effort in environmental control have increased carbon imports more than those that have not implemented these policies [16].

The risks of increasing taxation on these energy sources are high, so alternatives are being sought to avoid their negative consequences and encourage a reduction in consumption. These objectives must be met before the fact is that most of our energy consumption in Europe comes from fossil fuels, which is why tax measures on this type of consumption are the central area of environmental action for states. It is obvious that ecological tax protection is not limited to the introduction of environmental taxes but is also expressed in the provision of incentives to promote certain activities that are beneficial to our natural environment—such as the R&D deduction in corporate taxation—or in the introduction of the ecological element in the structure of current taxes. Concerning the relationship between corporate taxation and its adequacy to promote innovation, as stated in different studies, taxation on corporate and personal income negatively affects quantity, quality, location, and innovation [17]. However, most governments introduce tax incentives in corporate income tax to promote innovation investments business. By lowering the effective tax burden, companies benefit from a tax advantage that encourages innovation investments. Countries try to address these investments to reduce the carbon footprint and focus innovation on developing environmentally friendly technologies.

Measuring the effectiveness of taxation on innovation is very complicated, which is why indirect indicators are used, such as the one shown in the following **Figure 2**, which shows the evolution of patents related to the environment.

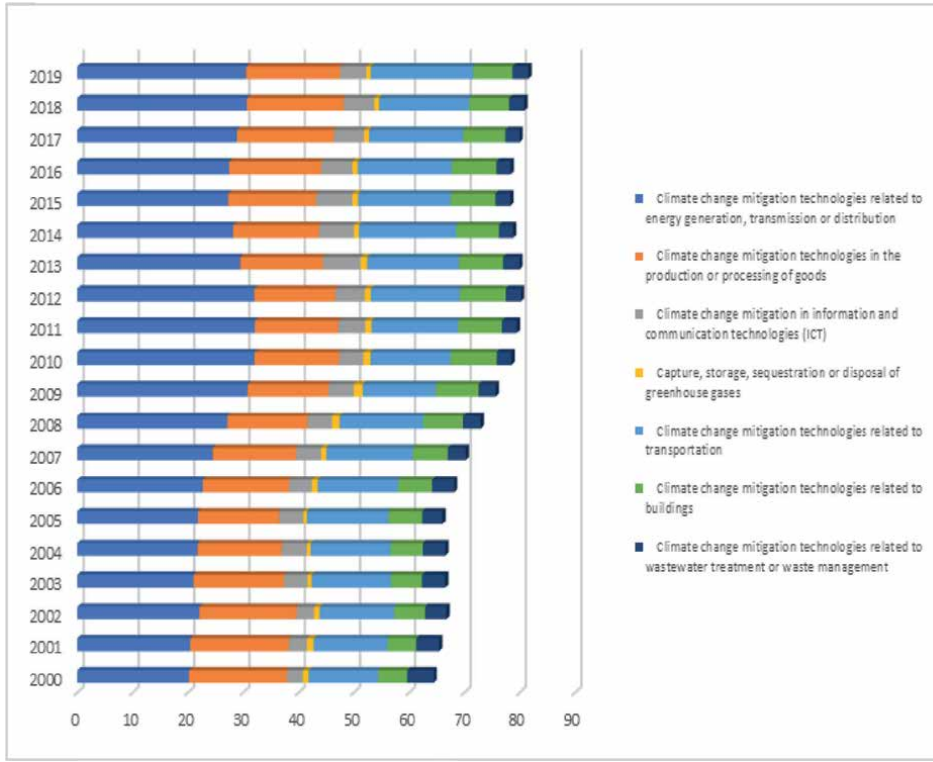


Figure 2.
Evolution of environment-related patents. 2010–2018. Source: OCDE (2022).

Although some environmental innovation needs to be better reflected in the generation of new patents, the graph above shows the sensitivity of ecological innovation to economic policy measures, and **Table 4** shows accurately.

Time	**2019**
BE	172.8
BG	9.0
CZ	53.1
DK	401.4
DE	3985.1
EE	2.3
IE	47.3
EL	13.8
ES	227.5
FR	1457.0
HR	2.1
IT	579.5

Time	2019
CY	3.8
LV	3.5
LT	3.5
LU	14.6
HU	21.3
MT	3.0
NL	425.5
AT	359.9
PL	61.7
PT	24.5
RO	10.2
SI	17.6
SK	13.2
FI	207.9
SE	392.7

Source: OCDE (2023).

Table 4.
Environmental-related patents by country 2019.

Data show a remarkable disparity between European countries, with Germany and France as clear leaders. If the above information is disaggregated, we can see that most patents are related to developing technologies for mitigating climate change, followed by those on producing and processing goods and those on transportation [18]. Of particular note is that patents related to capturing and storing greenhouse gases, which should be most relevant to reducing the climate change impact, are the scarcest (**Figure 3**).

Market failures concerning environmental innovation are generally addressed more efficiently by complementary technological instruments rather than by setting the ecological tax above marginal environmental damages [19]. About this type of analysis, the OECD [20] concludes that the application of more restrictive standards on pollutant gas emissions has a higher impact on patent generation than those implemented for fuel efficiency, and, with some caveats, they also see a positive effect to petrol prices and patent generation. This effect is consistent, therefore, with the pressure that higher fuel prices put on the need for innovation and provides scope for governments to take fiscal action in this area. However, although it would be possible to act by reducing the taxation of energy from renewable sources or the consumption of ecological products, its capacity to incentivise technological innovation is reduced. In other words, the optimal type and amount of innovation to help solve global environmental challenges are not likely to be achieved through environment-related taxes alone [21].

Lower innovation can be seen as an undesirable consequence of taxation, given its elasticity concerning taxes [22]. We should expect that the higher the tax burden, the less innovation will occur. Therefore, tax policy could be designed to encourage or stimulate innovation [23]. A standard measure to improve private innovation is to provide R&D tax credits for investment in a Corporate Income Tax. These credits are either volume based or only for an increment in R&D. The first option means that the tax credit is attainable over

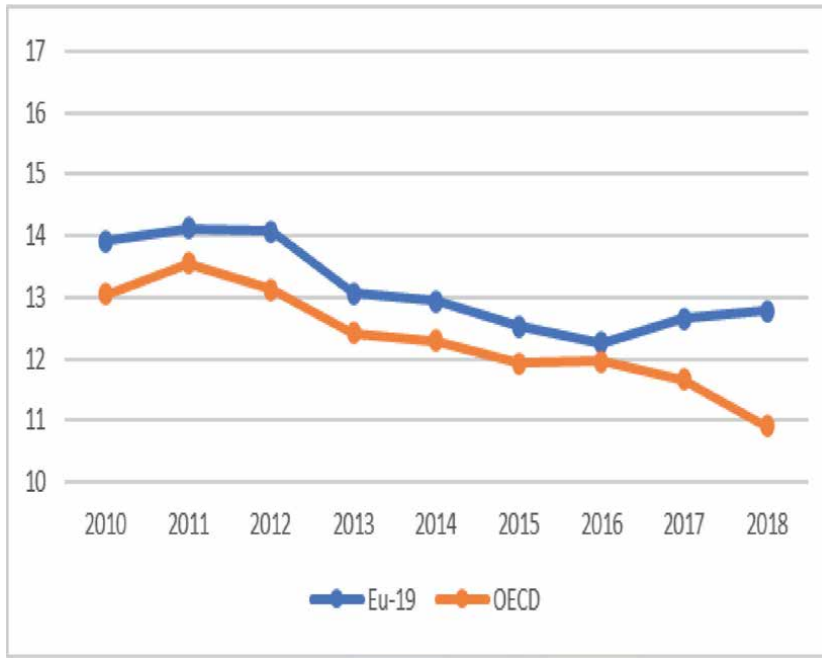


Figure 3.
Percentage of environment-related patents on climate change mitigation. 2000–2019. Source: OCDE (2023).

the total amount of R&D invested in a fiscal year. The advantage of this kind of incentive is that it is easier to administer, but, on the other hand, firms obtain a fiscal profit for R&D investment that could have taken place without public aid. Therefore, if the incentive is provided only in case of an increment in R&D, the companies that benefit from such a system have committed to ameliorating their rate of R&D spending over time. Even though this incentive could be considered more accurate, there are still some questions to solve. Increment-based schemes encourage enterprises to adapt their R&D investments to maximise fiscal benefits. Firms with cycling R&D behaviour increase the total amount of R&D tax credits [24]. Another problem with incremental R&D incentives is that firms may take advantage of corporative transformations like mergers.

Many countries are setting up R&D tax credits whose positive impact is less intense than we expect (OECD, 2008). According to the study, tax credits should focus on the larger industries which are structurally more R&D intensive. However, as Palazzi points out, reducing a Corporate Income Tax rate could be better for economic growth than a R&D tax credit.

4. Conclusions

Given the diversity of this topic, it is difficult to draw firm and comprehensive conclusions about the role of environmental taxes in the overall ecological policy of individual countries. Yet, ecological taxation plays a somewhat more critical role in Europe than in other areas. This leads, in part, but very imperfectly, to higher tax revenues as a percentage of the total collection. However, as well as had been shown in this chapter, it barely reaches 5%. Consequently, there is a long way to go on green taxation, especially on promoting the development of private R&D investments linked to environmental protection.

An important aspect to highlight is that different consequences can be expected depending on the type of tax. Environmental levies should be divided into energy and transportation taxes, which have great potential as a source of income and are driven at least partly by global concerns such as climate change. In this category, designing a careful incentive policy is crucial to maintain effectiveness as an instrument to achieve global climate goals. A relevant concern about energy prices due to higher tax rates on energy sources must stand. Despite significant revenues that could be obtained, the harmful impact on industrial competitiveness would explain competitive tax behaviour between countries, which, as well as settled in the literature, means lost in the global collection. Therefore, a coordinated environmental tax policy avoids the negative results of fiscal competition. Moreover, this energy and transportation taxation has an undesirable regressive effect on the lowest incomes that cannot be accepted without consideration in European democratic society.

About a carbon tax, in the same sense, that European Commission has proposed, a border adjustment mechanism is needed to tax greenhouse emissions associated with products manufactured in countries where these emissions are not charged. Moreover, taxation on some energy sources—mineral oils, coal, and electricity—should adapt their configuration considering the level of CO_2 emissions, not only modifying their tax rate but also calculating their tax base according to their environmental performance.

The main conclusion is obvious but relevant: environmental taxation and carbon pricing are two essential instruments in the fight against climate change that can be oriented towards promoting investment in R&D related to low-carbon technologies. It is, therefore, important that the necessary regulatory measures are adopted to make both objectives compatible. This goal cannot be done through a single tax figure; the tax system must be oriented to comprehensively achieve the bases for the desired change in the economic model. Not only should governments be able to allocate resources to public investments but also to improve private R&D investments.

Taxation systems must be capable of attracting capital to encourage renewable energy projects. To achieve this objective, the corporate income tax should include incentives linked to promote energy efficiency investments. Some European countries have an incentive that may eliminate, in whole or in part, the taxation on fixed assets used for renewable energy production. Energy credits can be an excellent stimulus for capital-intensive technologies such as wind power or solar energy. Examples of these technology tax credits are the Investment Tax Credit (ITC) and the Production Tax Credit (PTC). However, it may also be desirable to encourage firms to take effective environmental management measures.

Notwithstanding anything above, the influence of the tax system on innovation goes beyond the incentives that can be applied to corporate income tax. Therefore, the motivation for investment in R&D cannot be relegated to corporate taxation, ignoring the effects that other taxes can have on it. Remember that taxes are one more component of company expenses and that a relative change in the price of production factors is an incentive for innovation. A specific innovation aimed at reducing the cost of the element that has become more expensive, i.e., tax policy, can "put a price" on the environment that is consumed/polluted and direct the company's innovative effort towards reducing its polluting activity.

In this area, taxes on the consumption of certain products alter the firm's profit and are, *per se*, an incentive to introduce technological change. In particular, excise taxes on energy, especially on hydrocarbon derivatives, compel the firm to reduce its consumption or to look for new, untaxed sources. For a company to decide to invest in research and development of new technology, it must expect that future savings

will allow it to make a profit. Therefore, although the excise tax makes a factor more expensive and acts as a spur to innovation, complementary mechanisms are needed to enable the company to reduce its tax bill in the research and development period, which requires coordination with the corporate tax.

From international experience, energy taxation has been directed at the fundamental objective of revenue collection and needs to consider its role as a driver of environmental and technological innovation. However, obtaining additional resources derived from these figures does not in itself lead to an improvement in environmental protection. Even if these revenues were earmarked to reverse the problems generated by pollution, they would continue being consumed, and new production processes would only be adopted if new technologies developed cost savings. When we go into the case of Europe, the environmental tax trend is stable. Although tax revenues increased, this dress was less than the increase in total revenue collected. In addition, countries such as Denmark, Germany and Portugal experienced declining environmental tax revenues in recent years.

Indeed, it is vital to care about energy taxation, avoiding problems in their structure, particularly in sectoral allowances, reductions, and nominal rates that have eroded the price signal they should have generated. The lack of a significant impact on price results in lower investment in clean and low-carbon technologies. It also presents visibility problems for the consumer, who needs to adequately value their choice to consume a polluting product instead of an environmentally sustainable one. On the other hand, the tax with the most significant potential impact, the one levied on gas emissions, needs to be better regulated. Its low rates prevent it from acting as a powerful incentive for energy innovation.

Despite the relevance of taxation, our environmental taxes are not designed to favour innovation and are, at best, only oriented towards internalising pollution's cost.

The challenge facing public decision-makers is not an easy one: on the one hand, and they are under pressure to act to decarbonise our economy; on the other, they must ensure that their companies are not disadvantaged by the opportunistic behaviour of those who do not bear the cost of reducing the use of fossil fuels—which will necessarily require broad international agreement. Taxation can be a good solution as long as it does not lead to distortions in income redistribution and is not such as discouraging innovative efforts in search of business savings. Instead, the solution requires that direct and indirect taxation act in a coordinated manner be genuinely effective and achieve the dual objective of discouraging carbon emissions and favouring technological innovation.

Author details

Mª Gabriela Lagos-Rodríguez
Castilla-La Mancha University, Centre of Fiscal Studies-European School of Advanced Fiscal Studies, Albacete, Spain

*Address all correspondence to: gabriela.lagos@uclm.es

References

[1] Jaffe AB, Stavins RN. The energy-efficiency gap. What does it mean? Energy Policy. 1994;**22**(10):804-810. DOI: 10.1016/0301-4215(94)90138-4

[2] United Nations: COP 27: UN Climate Change Conference. XXVII United Nations Climate Change Conference. 2022. Available from: https://unfccc.int/cop27/auv

[3] European Commission. A clean planet for all. Europe's long-term strategic vision for a prosperous, modern, competitive and climate-neutral economy. 2018. 773 final

[4] OECD. Taxation, Innovation and the Environment. Paris: OCDE Publishing; 2010:32-61. DOI: 10.1787/9789264087637-en

[5] Eurostat: Share of renewable energy in gross final energy consumption by sector. 2021. Available from: https://ec.europa.eu/eurostat/web/products-datasets/-/sdg_07_40

[6] Jaffe AB, Newell RG, Stavins RN. A tale of two market failures: Technology and environment policy. Ecological Economics. 2005;**54**:164-174. DOI: 10.1016/j.ecolecon.2004.12.027

[7] United Nations. Transforming our world: the 2030 Agenda for Sustainable Development. General Assembly Resolution. 25 September 2015. Available from: https://www.unfpa.org/resources/transforming-our-world-2030-agenda-sustainable-development

[8] European Commission. Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC. Available from: https://eur-lex.europa.eu/legal-content/ES/TXT/PDF/?uri=CELEX:32003L0087&from=ES

[9] European Commission. A new Circular Economy Action Plan for a cleaner and more competitive Europe, COM. 2020. 98 final. Available from: https://eur-lex.europa.eu/resource.html?uri=cellar:9903b325-6388-11ea-b735-01aa75ed71a1.0018.02/DOC_1&format=PDF

[10] European Commission: Taxation in support of green transition: an overview and assessment of existing tax practices to reduce greenhouse gas emissions. Final Report. November 2020. Available from: Taxation in support of green transition - Publications Office of the EU (europa.eu)

[11] Alvaredo F, Chancel L, Piketty T, Saez E, Zucman G. World Inequality Report 2018. World Inequality Lab; 2018:27-28. DOI: 10.4159/9780674984769

[12] Heine D, Norregaard J, Parry IWH. Environmental tax reform: Principles from theory and practice to date. IMF Working Paper. Whasington D.C. 2012; 12/180. Available from: https://www.imf.org/en/Publications/WP/Issues/2016/12/31/Environmental-Tax-Reform-Principles-from-Theory-and-Practice-to-Date-26049

[13] Gago A, Labeaga JM, López-Otero X. Cómo utilizar la fiscalidad energético-ambiental para una transición ecológica justa en España: una propuesta enfocada a los carburantes. Centro de Políticas Económicas de ESADE. Madrid. 2021

[14] Sanz J, Rodríguez D. El PNIEC y su principal reto pendiente: la reforma fiscal medioambiental. Presupuesto y Gasto Público. 2019;**97**:03-120

[15] Trachtman J. WTO law constraints on border tax adjustment and tax credit mechanisms to reduce the competitive effects of carbon taxes. National Tax Journal. 2017;**70**:469-493

[16] Aichele R, Felbermayr G. Kyoto and carbon leakage: An empirical analysis of the carbon content of bilateral trade. The Review of Economics and Statistics. 2015;**97**(1):104-115. DOI: 10.1162/REST_a_00438

[17] Akcgit U, Stantcheva S. Taxation and innovation. 2018;**3**:14-18

[18] OECD. Patents on environment technologies (indicator). 2023. DOI: 10.1787/fff120f8-en

[19] IMF/OECD. Tax Policy and Climate Change: IMF/OECD Report for the G20 Finance Ministers and Central Bank Governors. April 2021. Available from: https://www.imf.org/external/np/g20/pdf/2021/040721.pdf

[20] OECD. Patents on environment technologies (indicator). 2021. Available from: Environmental policy - Patents on environment technologies - OECD Data

[21] OECD. Climate Change, Environment at a Glance Indicators. 2022. DOI: 10.1787/5584ad47-en

[22] Palazzi P. Taxation and innovation. In: OECD Taxation Working Papers. Paris: OCDE Publishing; 2011. p. 9. DOI: 10.1787/5kg3h0sf1336-en

[23] De Mooij R., Keen M, Parry I. Fiscal Policy to Mitigate Climate Change. A Guide for Policymakers. International Monetary Fund. Whasington D.C. 2012. DOI: 10.5089/9781616353933.071

[24] Zachman G. Green growth and green innovation. In: European Investment Bank: Investment and Growth in the Time of Climate Change. Whasington D.C. 2012. pp. 259-225

Chapter 9

Challenges of Digital Tax Administration Transformation in Indonesia

Siti Kurnia Rahayu and Andri Kusdianto

Abstract

The purposes of this chapter are to identify how digital transformation can enhance the efficiency, transparency, and cost-effectiveness of tax administration, leading to increased tax revenue and reduced compliance costs in Indonesia. The results of study indicate that the digital transformation of tax administration in Indonesia is currently in the acceleration stage. The tax authority (DGT) has set a policy for digital transformation in the tax administration system to reduce compliance costs and improve administrative process efficiency, as well as optimize budgetary functions. DGT has developed big data processing from taxpayers and external parties for analysis purposes used by authorities for compliance risk management, business intelligence, surveillance, audit, and more. The challenges of digital transformation in tax administration in Indonesia are the integration of information system applications in DGT. Another challenge is the difference in interests between authorities, technological platform differences, and the willingness level of each authority toward the adoption of integrated automation processes in all sectors in Indonesia. Therefore, it is crucial to build collaboration in the development of an integrated information system and strategic adjustments to business processes. National enterprise architecture-related policies are highly needed to achieve strategic digital transformation objectives.

Keywords: digital tax administration transformation, compliance risk management, business intelligence, big data analytics, directorate general of taxes (DGT)

1. Introduction

Digital transformation as a series of ongoing processes in tax reform is marked by the concept of a digital transformation campaign for tax administration starting from Tax Administration 1.0, Tax Administration 2.0, and Tax Administration 3.0. Tax Administration 1.0 era where the tax administration process is done manually, then the Tax Administration 2.0 (e-administration) stage, the era of digitizing most of the tax administration processes, and then the Tax Administration 3.0 stage where the paradigm of the taxpayer and the tax administration system is interconnected, and the decision function is carried out by utilizing technology [1]. In the current era of tax administration, digital administration processes are driven by data input

from taxpayers, then analyzed to assess risks for audit purposes and other processes, which are developed gradually in stages. Digital transformation in tax administration reform is a major component in increasing capacity, efficiency, and managing big data and complex taxpayer activities with the hope that the speed and scope of tax administration will become wider and increase [2]. The digital transformation of tax administration is implemented in stages as a continuous process due to financing factors, vision, strategy, politics, and regional adoption of information system applications. Utilization of specific technologies that are implemented allows the emergence of risks and challenges that depend on several factors, including baseline, capacity, depth and breadth of technology, and infrastructure penetration. So that digital transformation in tax reform implementation must be strategically planned with a road map [3].

Digital transformation applied to tax administration in Indonesia is a series of processes that are sustainable in the long term. The Directorate General of Taxes (DGT) establishes policies to increase the efficiency and effectiveness of the tax administration process to meet the demands of tax revenues and provide services to taxpayers by utilizing data, ICT systems that are always developing dynamically, and continuous automation. Digital transformation in tax reform in Indonesia has the same goal as the main objective of digital transformation in tax administration according to ADB [2], namely to (i) increase efficiency, speed, and transparency; (ii) reduce compliance costs and tax administration costs; (iii) tax revenues increase.

The journey of tax reform in Indonesia began with the modern tax regime as a reform journey of the Tax Law starting in 1983, namely the change in the official assessment system to a self-assessment system, and in 1991–2000 with the stipulation of the basic principles of taxation and simplification of tax types. Furthermore, in 2000–2008, namely Tax Reform I as bureaucratic reform with the stipulation of the vision, missions, and blueprint in 2000–2001, and in 2002–2008 the stipulation of modernization of taxation and amendments to the Tax Law. Then Tax Reform II where in 2009–2014 a program was launched to improve internal control and in 2014–2016 as institutional transformation with institutional arrangement and management of human resources. Tax reform in Indonesia is currently entering Tax Reform III. In 2016, Bureaucratic Reform and Institutional Transformation with the Acceptance Theme Strategic Initiative were established. Then in 2017–2018 the Tax Reform Program with consolidation, accelerations, and continuity of tax reform. Furthermore, in 2018–2024 through the Renewal of the Tax Administration System (PSAP), it consists of an organization (ideal organizational structure), human resources (professional, competent, credible, and with integrity), IT and database (dependable and reliable IT and database), business process (simple, effective, efficient, accountable, IT-based, and comprehensive business processes)—Legacy and CoreTax, and laws and regulations (legal certainty, accommodating economic dynamics, reducing compliance costs, expanding the tax base and increasing tax revenue). IT and databases, as well as business processes, are embodied in the Tax Administration Core System Renewal Project (PSIAP). The Roadmap for Development of the Core Tax Administration System (SIAP) begins in 2021 and is targeted for post-implementation in 2024. SIAP Deployment is targeted for October 2023. To provide optimal benefits for tax revenues, SIAP cannot stand alone and requires the support of other institutional information systems that are realized through SIAP interoperability.

Planning, strategy, and implementation of digital transformation are linked to the larger tax agenda; therefore, it is important to utilize the *Tax Administration*

Diagnostic Assessment Tool [2]. TADAT can set the basis for reform plans, as it measures tax administration in terms of effectiveness and productivity, as well as being responsive to the needs of taxpayers [4].

Since 2016, DGT has used TADAT with an assessment focusing on 9 Performance Outcome Areas-POAs. In 2016, DGT programs included tax amnesty, TADAT self-diagnostic, formation of a tax reform team, and the Coretax strategic initiative as part of RBTK (KMK 974/2016). In 2017–2018, the establishment of a tax reform program [5], improvement of existing business processes toward Coretax, preparation of Coretax requirements and roadmaps, establishment of Presidential Decree 40 of 2018 concerning PSAP, establishment of KMK-767 concerning IS PSAP and repeal of KMK-360, improvement of existing business processes toward Coretax and preparation of KAK and RUP for PSIAP procurement. In 2019–2020 implementation of the IS work program in PSAP, reorganization of KPDJP and vertical units, Stamp Duty Law, Job Creation Law, improvement of existing business processes toward Coretax, formation of the PSIAP team and determination of selected vendors (PA, SI, PMQA, and CM). In 2021, the development of the click, call, counter (3C) system, implementation of the IS PSAP work program, improvement of existing business processes toward Coretax, system development (design, build, test, data migration), Tax Regulations Harmonization Law, self-diagnostic TADAT (per June 2021). In 2022, implementation of the Harmonization of Tax Regulations Law, implementation of a voluntary disclosure program, implementation of a carbon tax, implementation of the IS PSAP work program, improvement of business processes toward Coretax, system development (build, test, and data migration), benefit realization analysis. In 2023, regarding income tax, goods and services, Land and Building Tax, renewal of DGT SIKKA, implementation of IS PSAP work program, improvement of existing business processes toward Coretax, system development (test, data migration), PSIAP implementation (deployment), and TADAT self-diagnostic (2023). In 2024, RPP Land and Building tax rates, reorganization of KPDJP and Kanwil, reorganization of contact center and UPDDP, implementation of IS PSAP work program, and support and maintenance. Year 2025–2026 post-implementation and TADAT Self-diagnostic (2026).

DGT in utilizing information technology in tax reform, although there is an increase in the efficiency and effectiveness of tax administration, still faces challenges. Voluntary tax compliance is still a major challenge, a fully digital tax administration process does not always provide a high level of compliance. Tax gaps persist and this is a major tax challenge. Another challenge that DGT must face is the burden of compliance. Administratively fulfilling tax obligations is a burden for taxpayers and tax compliance costs for taxpayers are still high. Apart from that, in terms of verification at the end of the period due to the tax collection system. Tax audit causes a level of uncertainty for taxpayers because it has implications for cash flow management, tax debt, and taxpayer compliance costs increase in response to tax audit verification. Another challenge is that the understanding of taxation is a separate part of government administration. Differences in systems and approaches used by various government agencies in Indonesia create difficulties in data integration. This can cause problems for taxpayers because they must use multiple identities to access the online system and for tax officials in integrating taxpayer data nationally.

The increasing number of interconnections of information systems with the use of new technologies in the future will enable taxpayers to be able to use various information systems in business and in fulfilling obligations to the Indonesian government to enable voluntary tax compliance to be built naturally. DGT must be able to adapt the tax administration process to be integrated with the information system used by

taxpayers. In addition, DGT must also be able to make the tax administration process system part of the digital platform. Taxation must be integrated with other government services and functions supported by a single digital identity across all administrative services and processes nationwide.

The results of research [6] conducted a technology usage review in tax administration, covering data collection, analysis, law enforcement, and public service. However, this article has identified several gaps in their research, including the insufficient exploration of the human aspect as technology users, inadequate examination of regulatory and policy aspects, neglect of technology usage in developing countries, and insufficient discussion of comprehensive taxation system development. The study of this chapter aims to address several objectives: firstly, to examine digital transformation in tax administration reform, particularly the process in Indonesia and other countries, and identify the goals of this transformation; secondly, to explore the history of tax reform in Indonesia and how digital transformation has played a role in this journey; and finally, to provide insights into how digital transformation can enhance the efficiency, transparency, and cost-effectiveness of tax administration, leading to increased tax revenue and reduced compliance costs. The study of the chapter is a valuable addition to the existing literature on tax administration, offering valuable insights into the challenges and opportunities presented by digital transformation in the Indonesian context. It underscores the need for ongoing reform efforts to achieve effective and efficient tax administration, emphasizing the importance of digital transformation in this regard. The study notes that digital transformation is essential for increasing capacity, managing big data, and improving efficiency in tax administration. It also highlights that digital transformation is a continuous process that requires a strategic plan, considering various factors such as financing, vision, strategy, politics, and regional adoption of information system applications.

2. Method

The study of this chapter used a qualitative research approach, aiming to gain a complete understanding of the process and stages of digital transformation in tax administration reform in Indonesia. The research was designed to capture the meaning on the ground through direct interactions between the researcher and the key informants, who are the CRM and BI developers at the DGT Indonesia, as well as document analysis. The data sources were purposively selected based on their knowledge of the required data. Data collection was conducted from October 2022 to January 2023, using structured interviews and document reviews. The researcher used the triangulation method to ensure data validity, which involved comparing and verifying information from multiple sources. Data analysis was carried out using a qualitative verification strategy, which involved simplifying the data and focusing on the main research problem. The research used the DMAIC method to identify and solve problems.

3. Results and discussion

3.1 Digitization of tax administration in Indonesia

The digital transformation strategy is at the core of the national agenda to increase tax revenues in Indonesia, so it becomes the main task in establishing a balanced

digital strategy. Digital transformation is a comprehensive process that includes infrastructure, governance, business, people, and ecosystem pillars based on political, economic, social, technological, environmental, and legal analysis and circular flow models [7]. The breadth and speed of change of digital transformation are important for the government to pay attention to because it raises many public policy challenges through the development of ICT as part of the infrastructure (dependence on communication networks, big data, software, and hardware) to support policy development and implementation [8]. Digital dynamics is a challenge for policymakers in the increasingly complex field of taxation to be able to design, develop and implement policies that provide certainty and clarity and can facilitate efforts to increase tax revenues. The development of digital economic activities requires the government to be able to ensure proper tax treatment, impact the tax burden on taxpayers, and simplify the tax administration process. Voluntary tax compliance can be enhanced by digitized tax administration capabilities in providing taxpayer and third-party information in the context of cross-border access.

The tax digital transformation strategy has been stipulated in the DGT Strategic Plan and in the Road Map for the Development of the Tax Administration Core System (SIAP), which will begin in 2021. And as support for the achievement of the tax digital transformation strategy is supported by infrastructure pillars that are at the upper middle level, commitment to DGT in the development of information systems, DGT business processes and business and industrial developments, human skills and competencies as actors and Indonesian ecosystems that are influenced by political, economic, social, technological conditions, environmental, and legal analysis. Based on the Digital Transformation Index (DTI) study by Park et al. [7], Indonesia entered the accelerated stage. DTI in this study implemented three stages of digital maturity, namely foundation, adoption, and acceleration, and Indonesia obtained a DTI score of 47.19, and grade level B entered the accelerated stage.

To establish the basis for development projects, Indonesia needs to assess the stages of its digital transformation journey with reference to the "Digital Maturity" scheme developed by the Tax Administration Forum. This scheme divides the digital transformation process into Level 1, e-files; Level 2, e-accounting; Level 3, e-match; Level 4, e-audit; and Level 5, e-assess [9]. In this context, Indonesia can determine its presence on the digital maturity scale at the start of the project, plan the final goal, and determine progress according to the mapping at a certain time. Based on the index, it can be determined that Indonesia is in development on a level 3 scale, namely the development stage of sending additional accounting data from third parties and the government can access it, then matching data across all tax types and possibly all tax payments in real time. E-accounting is being developed for a pilot in 2020. Standardization of data gathering, and historical data reconciliation is still in progress. For data analysis that is currently under development are automatic generation of calculations and/or penalties, audit trails with external data, and audit trails with internal and external data both feed into the generation of outliers in the system.

Progress along the digital transformation path can also be measured by the number of budget funds provided in financing digital program planning each period. The budget commitment demonstrates the government's commitment to implementing the transformation program and is also the basis for measuring progress [1]. The development of DGT's Core Tax System ecosystem infrastructure requires funds of IDR 44.01 trillion and has been approved by the DPR as the Indonesian legislative body for the 2022 fiscal year. The Indonesian government's commitment to the digital transformation journey is demonstrated by this funding and approval by the DPR.

With an assessment of these indicators, the journey of digital transformation in Indonesia can support tax reform in accordance with its objectives. Digitalization that has been applied to tax administration in Indonesia has covered every function of tax administration operations.

DGT has responded well to the dynamics of changes in the ICT landscape in the development of digitization of tax administration in Indonesia. Technological waves that have an impact on digital tax administration are basic, consolidated, and optimal [1]. The tax authorities in Indonesia have gone beyond the initial wave of ensuring that tax information has been digitized (analog process to digital process). The implementation of e-filling for taxpayers has been implemented properly and provides DGT with accurate data in verifying taxpayer reporting. The consolidation wave was characterized by a rapid evolution of new ICT applications [1]. DGT uses basic analysis, data warehouse, and new information sources related to taxpayers through policies in the form of data handling rules that can enable process automation. Improvement in the efficiency and speed of the tax administration process in Indonesia occurred in this wave and this is the final point because it can reduce compliance and tax administration costs as well as smooth data flow but cannot fully automatically support the tax audit process. The third wave, namely optimization, shows a significant shift in control and managerial elements. Tax administration will be able to control the design of information flow and optimize data flow. Predictive analytics, machine learning, and deep neural networks can enable computers to optimize systems [1]. DGT has designed and developed an information system on this element with the use of technology while it is important to control the technology used. This shift in managerial terms indicates the heads and managers of the tax authority to plan the goals and operations of the tax authority where the machine can optimize the data for decision-making [1]. DGT has not fully experienced this significant shift, because the implementation of advanced technology has not been equipped with blockchain technology or AI technology. DGT also has not fully integrated DGT software into other organizational systems in capturing tax-related transactions in real time. This is a challenge for DGT to define a new approach in digital tax management in the future.

The Indonesian tax authority (DGT) continues to make progress with the use of modern technology in most aspects of tax administration, increasing efficiency and service standards to taxpayers. Core IT systems (Core Tax Systems) are developed in-house, by developers, or through a combination of both, custom-developed and using commercial off-the-shelf packages [1]. Core Information Technology Systems is specially developed by developing a series of programs into a system by internal or external experts, where skilled and comprehensive analysis, design, and development teams are obtained from external parties. This process uses the traditional "waterfall approach," which requires detailed design confirmation prior to system construction and requires a level of knowledge of the ideal future system and procedure. Teams can develop new systems that are adapted extensively to defined business needs [10]. DGT continues to focus on developing a strong information system for the core functions of the tax administration process, using in-house system development. Development of Core Information Technology Systems in Indonesia since 2018 using solutions developed in-house.

Tax administration is an important process in producing tax information for decision-making. Processes in tax administration include taxpayer registration, tax payment, tax reporting, tax audit, and collection that are built systematically and comprehensively. The large and complex volume of data related to the tax

administration process that must be managed by DGT requires a comprehensive and well-integrated information technology infrastructure and information system. The challenge for DGT is to develop *Core Information Technology Systems* to be able to realize effective and efficient tax administration.

Indonesia's tax digitalization journey began in 2001, with the view that modernization and digitization are the keys to increasing voluntary taxpayer compliance. 2001–2008 was a period of digitalization of DGT business processes, such as SPT payment and reporting, as part of the tax base expansion program. 2009–2016 was a period of expanding efforts to digitize taxpayers and the initial steps of digitizing internal business processes such as data analysis. 2017–2024 is the period for delivering IT systems to manage all administrative processes (Core Tax System) to support fundamental transformations in tax administration and to transform back-end digitization efforts.

The tax administration in Indonesia started the digitization process by automating the basic functions of electronic registration and filing and is on the way to digital transformation to enable real-time transaction data to flow into the online tax administration system. In 2011, the e-registration system was implemented. E-registration with tax authorities integrated within the electronic process of starting a business through other government ministries in 2013, has been able to support the effectiveness of management of tax reporting and payment records in tax audit trails and changes in taxpayer information as well as supporting online access to initial registration and updating of details. This element in the digital journey, once functional, is a major step toward a seamless and continuous flow of data that will increase compliance rates and significantly lower compliance and administration costs.

Increasing the availability of data that has been analyzed is able to direct the implementation of the operational process of tax administration in Indonesia in services for taxpayers that facilitate understanding and reporting of tax obligations. It is also possible to encourage changes in taxpayer behavior toward voluntary compliance. Providing independent services for taxpayers in the form of *e-filling*, *e-billing*, *e-SPT,* and others through the introduction of a web-based mobile application as DGT's effort to provide an easy communication channel for taxpayers. This has shown a shift in the design of most of the tax administration processes in Indonesia toward a user-centered design even though it has not been fully integrated into e-government initiatives with limitations on the protection and security of taxpayer data. DGT's era I tax reform was the beginning of a tax technology revolution where DGT focused on *e-filling* to ensure accuracy and as a first step in digitizing data. The main timeline of DGT's digitization journey related to taxpayer services began with the launch of an electronic payment application (MP3) in 2002. In 2004, e-Filing of the annual income tax return through a third-party Application Service Provider (ASP). Then in 2008 the online and chat Kring Tax was launched to answer taxpayer questions. Furthermore, in 2012 further development for e-Filing of the Annual PPh SPT through the DGT website was launched. E-billing, which facilitates electronic tax payments by generating a 15 digits ID billing code for tax payments, was implemented in 2013. In 2014, DGT created the DGT Online website for submitting SPT and e-Invoice Tax (E-Faktur Tax, FP) for Pilot VAT. In 2016, the e-Billing application is required to be used by taxpayers and e-Tax Faktur (e-Tax Faktur, FP) for VAT. Electronic Tax Withholding Proof (E-Bupot) for 2017 PPh deductions. During this period DGT started experimenting with using third-party data to be able to monitor taxpayer compliance.

Increased use of data from third parties available for use by DGT coupled with advances in data analysis with analytical techniques according to the needs of tax

administration. Information can be used as a source of verification of taxpayer tax reporting and payments and can minimize the tax compliance burden due to the use of ICT (*compliance by design*). The information system that has been built by DGT can support tax reporting verification activities, including the operation of assessing tax reporting and payment, tax audits, tax collection, and tax investigations. DGT has developed a risk management system so that audit selection is centered on using analytical results to select the highest-risk cases. The extension of the assessment and auditing techniques implemented by DGT required matching, filtering, and storing data and then the use of predictive technologies (and machine learning technologies), which can perform risk assessment operations using a variety of sources and formats.

3.2 Technology used by DGT

DGT has adopted ICT with updates that are tailored to the needs and used in the tax administration process that has supported all stages of the tax administration operational cycle. DGT adopting ICT is intended to achieve the goal of reducing compliance costs to increase tax compliance. The use of *e-faktur* in Indonesia and the use of data matching technology on transaction invoices have been able to detect the possibility of fictitious invoices to increase VAT collection. Indonesian tax authorities have started to collect digital invoice data, although it is not optimal.

The technology used in developing administrative information systems and taxation ICT operational solutions in Indonesia, DGT uses a custom built, commercial off the Shelf, and software as a service (cloud-based) approach. The use of innovative technology in the form of Cloud Technology has been implemented in the development of tax administration, while DLT/Blockchain and Artificial Intelligence have not been used. As for the use of innovative technology in the form of Data Science/ Analytic Tools, Application Programming Interfaces (APIs) have been implemented. DGT has not used Robotics Process Automation, Whole of Government Identification Systems, Digital Identification Technology (e.g., Voice), and Virtual Assistants.

DGT has also utilized the types of electronic services provided for taxpayers in the form of information on the website, tools, and calculators on the website, access to integration of taxpayer accounts, online services (e-filling), electronic invoicing systems for businesses, access to taxpayer data from third parties, and digital mailboxes. DGT offers a website with general tax-related information, which is quite complete and easy to navigate. DGT offers tools and calculators for use by taxpayers. DGT has an integrated system of taxpayer accounts that can show the entirety of taxpayers, most of which benefit businesses that usually have tax-related responsibilities. DGT provides services that enable taxpayers to make online tax transactions. DGT provides an electronic tax collection system to support DGT business processes. DGT can also obtain taxpayer information from third parties. DGT has provided modern and comprehensive electronic services for taxpayers.

3.3 Considerations for the development of tax administration

Dynamic technological developments have given the tax administration process the opportunity to re-evaluate not only how the tax authorities can carry out their functions but also what functions are still needed and what new activities can be carried out in achieving tax administration goals. The use of innovative technology in tax administration focuses on retrieving, decoding, and executing data that can be useful in assisting existing tax administration functions. The main target is to increase the

available data sources and enable matching of these data sources with taxpayer data [1]. The resulting key processes include (i) digital data collection; (ii) tax governance framework; (iii) Extended application of advanced analytics; (iv) utilization of online taxpayer services [1].

In Indonesia, tax administration focuses on *e-filing* and gathering digital financial reporting information. DGT has also begun to base its allocation of scarce resources on risk management principles to achieve higher levels of tax compliance. Data analysis is currently used by the tax administration in Indonesia mostly for tax audit case selection and non-compliance detection. Tax administrations are starting to implement techniques that identify potentially risky taxpayers or returns. Digital analytical processes are also used in several tax administration functions and activities; thus the use of advanced analytics will be further expanded. DGT has also made efforts to increase the use of online services for taxpayers. Providing taxpayers with a single platform and/or online tax application by DGT in the *e-billing application* can lower costs and provide a better understanding for taxpayers.

DGT's focus to date has been on automating current processes and increasing their scope and efficiency. Indonesia's tax administration process in the future will develop better, involving process rethinking and digital infrastructure reimagining to achieve goals. Technological innovations enable changes in tax administration and result in the need to reconsider options in tax administration, which are already embedded in the tax regime, by not being included in future designs. This requires a clear vision of the goal of tax administration in the long term. The tax administration will eventually include elements of the tax ecosystem that are connected to each other due to digitalization in all fields. Data collection is an important part of the verification function, embedding taxes into natural systems can help simplify the data collection process with the effectiveness of validating data checks. In addition, data collection does not only come from taxpayer reports but can be in the form of transferring data into the taxpayer's natural system by relying on intermediaries or third parties. With big data that can be analyzed properly, tax administration can become a data-based tax audit. Tax risk can be managed properly so that taxpayer behavior can change toward voluntary compliance and increased control of tax payments. Data security, data management, and data governance have become key for future tax authorities. Complexity increases as data sources increase, along with the complexity of the data management system.

3.4 Risk management in tax digital transformation

The tax administration function that can run according to its vision requires careful planning and effective implementation, where development projects are built based on digital transformation goals and require major changes with parallel distribution to reduce risk [1]. Issues that have the potential to become risks can be identified in the transformation of tax administration in Indonesia including: (i) a comprehensive digital strategy; (ii) innovative resources, infrastructure, and designs; (iii) the adoption rate of e-filling and data analysis and process automation; (iv) exchange of data with other bodies; (v) appropriate change management and enabling administrative processes. While the general risks in digitalization that every tax administration faces [11] are to help tax authorities reduce the risk of (i) inheritance systems. It is necessary to input data from the old system into the new system; (ii) complexity. Simple system design can create a reliable digital equivalent; (iii) limitations of the digital system. A system must be designed to ensure data is not

missed in the automatic data flow; (iv) security and privacy. There must be regulations for the protection of the security of taxpayer data; (v) costs incurred in developing digitization; (vi) audit systems development that focuses on a technology-neutral approach; (vii) political risk. Political support is needed in developing the project.

The approach to addressing these risks [12] includes (i) careful planning in a technology road map; (ii) an operating model that supports the technology and enables long-term application in decision making; (iii) design of technology initiatives in building a technology road map through an assessment with the right methodology; (iv) design of interventions that pay attention to internal and external change management in the initial engagement of key stakeholders as management support; (v) HR management that is in line with the implementation of the technology road map; (vi) Manage expectations on digital initiatives such as clear return on investment; (vii) actual learning to make decisions in advanced planning.

DGT applies the Enterprise Risk Management (ERM) framework in providing a methodological structure for tax compliance risk management (CRM) using the ISO 31000:2018 risk management approach. Taxpayer compliance risk is all *likelihood* or uncertainty *that* can have *consequences* on the main target of the tax authority, namely optimal tax revenue [13]. In implementing DGT's compliance risk management, it utilizes innovative technology which is implemented in stages in the framework of digital innovation testing. DGT also has broad autonomy in managing HR qualifications. DGT has a formal organizational unit to encourage innovation in the development of risk management systems, namely the Directorate of Technology and Information, and the Directorate of Information and Communication Technology Transformation.

DGT works closely with private sector collaborators on a user-centric approach to designing digital tax systems. DGT focuses its approach to technology development on taxpayers to encourage the use and help users maximize the benefits of this technology. DGT has partnered well with the private sector to reduce development costs. Since 2005, third-party ASPs have been able to facilitate the submission of corporate income tax returns electronically. Currently, eight ASPs are available to all taxpayers. ASP adds value by integrating various digital services provided by DGT into one platform and enabling a more user-friendly experience. DGT's transformation to the point where a new approach is optimized has become a long and gradual process of building systematic capabilities. The adoption of a technology approach should always be driven by level of capability, business needs, and priorities, not just data and technology availability.

In implementing risk management at DGT, three things need to be developed, namely, risk culture, system and structure, and the whole framework. Risk management at DGT consists of taxpayer risk management which is Client risk (Third Party) from the point of view of the company and institutional risks related to strategic risk, operational risk, HR risk, financial risk, budget risk, and others. The two cannot be separated in terms of DGT's efforts to treat taxpayers and qualified human resources according to the required placement.

The Industrial Revolution 4.0 ushered in the development of Big Data Analytics at DGT, where organizational efficiency is achieved using technology-based smart assistance systems that can replace routine tasks to be able to focus on creative and valuable activities for employees [14]. The development of BDA at DGT began in 2014 through the development of a Compliance Risk Management (CRM) risk machine to increase taxpayer compliance, and at the same time to fulfill the performance indicators of the Tax Administration Diagnostic Assessment Tool Field Guide (TADAT),

specifically on POA 2 (Effective Risk Management), namely The DGT is declared to have implemented ERM if the DGT is able to manage all tax risks effectively. DGT's risk management has been regulated in the Director General of Tax Decree Number KEP-702/PJ/2019 concerning risk management within the Directorate General of Taxes which mostly regulates institutional risk management.

DGT has developed BDA starting by utilizing internal data and external data. Data warehouse is a place to collect data, processed and analyzed by data scientists. Infrastructure support that is specifically managed by the Directorate of Information and Communication Technology (ICT) is a supporting facility related to storage servers and the provision of applications. The BDA implementation process at DGT is divided into several parts starting from analytical activities which include determining the context, identifying risks and/or variables, exploring data, modeling, mockup user interfaces, deployment, monitoring, and evaluation. Furthermore, the analytical methods and techniques used are Data Matching, Natural Language Processing (NLP), Classification, Clustering, Social Network Analysis (SNA), and Graph Data Science which produce products such as CRM, Smart web, and ATP. BDA at DGT was developed by the Directorate of Tax Data and Information (DIP) with duties and functions covering data governance and management, individual analysis, and CRM & BI development.

DGT has used a solution approach in ICT development and operations: custom-built, commercial off-the-shelf, and software as a service (cloud-based). While status with Use of Innovative Technologies includes the implementation of Cloud Technology, and for DLT/Blockchain and Artificial Intelligence it has not been implemented. DGT implements Data science/Analytics tools and implements Application Programming Interfaces-API. For RPA, Whole Government Identification Systems, Digital Identification Technology, and Virtual Assistants are not used in system infrastructure development.

CRM is a structured process for the systematic identification, assessment, rating, and treatment of taxpayer compliance risks [15]. The development of CRM as a risk *framework* managed by DGT began in 2004 [16], and the development of CRM-based taxpayer compliance began in 2005 through the establishment of a taxpayer monitoring mechanism by an account representative (AR). In 2008, AR was equipped with a Web-Based Taxpayer Profile Application (Approweb) as a tool to carry out the supervisory function in mapping taxpayers' potential activities. The development of CRM in 2012 was marked by an increase in the quality of *Total Benchmarking,* namely the *Behavioral Benchmarking Model* (BBM) (SE-40/PJ/2012). BBM is one of the tools to explore potential taxpayers by mapping the risk of non-compliance by corporate taxpayers. In addition, DGT has implemented CRM in the billing function based on *aging.*

The development of comprehensive risk-based taxpayer compliance (CRM) began to be developed in 2013. CRM became one of the sixteen DGT institutional transformation strategic programs with assistance from McKinsey as a consultant. CRM developments that have been carried out by DGT: (i) In 2019 implemented: (a) CRM Extensification Function (aimed at providing a compliance risk map in the taxpayer registration process), (b) CRM Inspection and Supervision Function (aimed at mapping taxpayers and giving priority to taxpayers taxes to be supervised or audited), and (c) CRM Billing Function (aimed at increasing the effectiveness and efficiency of disbursing tax arrears); (ii) In 2021 DGT has implemented CRM, namely (a) CRM Tax Education Function (aimed at determining a list of extension targets), (b) CRM Transfer Pricing (producing a map that illustrates taxpayer compliance in applying the principles of fairness and customary business for transactions involving

influenced by special relations and other international tax transactions); (iii) In 2022 DGT implements: (a) CRM Law Enforcement Function (aimed at providing early warning detection of indications of tax crime), (b) CRM Appraisal Function (aimed at optimizing the role of assessment in order to increase taxpayer compliance), (c) CRM Service Function supports voluntary compliance by providing nudging notifications using a different language according to the risk profile of the taxpayer. The use of language in notifications adopts the behavioral insight. (d) The CRM Objection Function aims to allocate objection files based on the competence and workload of the Objection Reviewers so that the objection process can be made shorter; (e) CRM Integration, linking 11 DGT business processes, and using the Integrated Compliance Approach concept, (an approach to assessing tax compliance as a whole from taxpayers; (v) In 2024, DGT will integrate several BI in CRM Integration, so that DGT's vision is Data-Driven Organization (DDO) achieved.

CRM processes are aligned with the Data-Driven Organization model. The availability of consolidated master data generated through data management and data governance supported by adequate analytics capabilities is a key factor in determining the success of the CRM process, especially at the risk identification, risk analysis, and risk evaluation stages. CRM is formed by relying on processed data so that it can form a map of taxpayer compliance and provide input on the appropriate treatment for each taxpayer's risk position as a prescriptive analysis from a data analytics point of view.

Digital transformation at DGT in the future will lead to a natural digital system. In this concept, the tax administration system is integrated with the daily economic activities of taxpayers, and taxpayer data is automatically stored in DGT's data storage. The natural digital system products include e-Reg, Online NPWP validation, e-Faktur, e-Bupot 23/26, e-Bupot Unification, e-Billing, and improvements to e- Filing. The implementation of natural digital systems can also be seen in the development of the Extensible Business Reporting Language (XBRL) for submitting electronic-based financial reports. With the implementation of natural digital systems, taxpayer activities can be detected from the start to minimize the possibility of non-compliance and taxpayer fraud. Starting with the launch of e- Filing, the development of BDA at DGT is expected to lead to the implementation of natural digital systems that are integrated with CRM.

Development of Business Intelligence (BI) at DGT is carried out based on the Data Management Body of Knowledge (DMBOK) namely data governance design guidelines at DGT, which consists of the areas of Data Architecture, Data Modeling and Design, Master Data and Reference, Data Storage and Operations, Integration and Interoperability, Enterprise Data Warehouse and Business Intelligence, Documents and Content, Metadata, Data Security, and Data Quality.

Business Intelligence used by DGT is a process in DGT's efforts to add value to data and insights used in decision-making. Types of Business Intelligence in the form of descriptive analytics that have been produced by DGT are "Acceptance Dashboard" and "Smartboard". Descriptive analytics is a form of analytics and reporting on historical data. Meanwhile, the type of Predictive Analytics that has been implemented by DGT is "Ability to Pay", namely BI which can predict the ability of taxpayers to pay taxes. Predictive analytics uses machine learning technology, algorithms, and Artificial Intelligence. The BI type of prescriptive analytics implemented in DGT is a CRM risk engine.

BI development at DGT applies the Cross-Industry Standard Process for Data Mining (CRISP-DM) approach. This model was developed by a consortium consisting of NCR System s Engineering Copenhagen, DaimlerChrysler AG, SPSS Inc., and

OHRA Verzekeringen en Bank Group. BI developments that have been carried out by DGT: (i) In 2021, DGT has implemented Business Intelligence, namely (a) Smart Web (a data visualization in graphical form that aims to identify beneficial owners and group members of a group company and also visualize related transactions whether reported in the notification letter (SPT) or not), (b) Ability to Pay (aimed at predicting the ability to pay off the taxpayer), (c) Middle WP Dashboard (aimed at monitoring taxpayers to be more effective and efficient), (d) Smartboard (aimed at assisting in monitoring and prioritizing supervisory follow-up in the remaining time of the year and determining strategies for achieving revenue based on the potential of each work unit); (ii) In 2022 DGT will implement 8 Business Intelligence products for reception and human resources (HR). Business Intelligence is one of the supporters of CRM Integration implementation. (iii) In 2023, DGT develops (a) Reception BI, (b) HR BI, (c) organization BI, (d) Regulation BI.

3.5 Tax digital transformation challenges

Implement *Compliance Risk Management* and *Business Intelligence* in responding to the challenges of BDA development, by establishing CRM and BI in 2023 to become DGT's backbone to increase voluntary taxpayer compliance. The challenge faced by DGT in this regard is to ensure that all business processes can be integrated and structured with each other. SIAP Update (PSIAP) as a DGT program is heavily influenced by the readiness of CRM and BI in processing data and visualizing it into valuable information in each advanced business process such as extensification, monitoring and auditing, billing, law enforcement, service, objection, appraisal, and international taxation.

The challenges faced by DGT in implementing integrated CRM are data quality and model maturity. Data quality is still a challenge for CRM development. Infrastructure is DGT's challenge in CRM development with the start of using national data. The volume, breadth, and complexity of data require adjustments in infrastructure capacity to be able to keep up with data capacity in CRM development.

Another challenge faced by DGT is the current CRM development process, which is the loss of qualified human resources due to mutation/promotion by bringing their CRM knowledge, thus requiring the recruitment of new human resources to be retrained. With *technical assistance* from AIPEG and ATO (Australian Tax Office) assisting DGT in continuing development. DGT's CRM team was formed to address HR issues due to the characteristics of the task force which were still not solid. The establishment of the Taxpayer Compliance Risk and Data Science Sub-Directorate (RKWPSD) under the DIP Directorate as DGT's data support directorate, is DGT's effort to apply international *best practice* in CRM development. The DIP Directorate must be able to meet the needs and manage the expectations of stakeholders to maintain *user engagement* with the products it produces. DIP is preparing a CRM, BI, and TAM (Taxpayer Account Management) "home" when the *Core Tax* Administration System (CTAS) has been implemented. Adequate capacity of a special dedicated unit as a CTAS manager needs to be prepared.

The challenge of implementing CRM is a matter of adaptation to the risk culture by vertical units. Future business process designs that require the use of CRM/BI/Taxpayer Account Management (TAM) as a starting point for supervisory actions may be hampered by possible resistance from field staff. DGT implements change management and coercion programs to overcome resistance to this cultural change. DGT has issued a policy that "forces" vertical units to do things according to CRM's

directions. This policy is expected to prevent the election of supervised taxpayers based on the subjective considerations of Account Representatives but with elections originating from machine scoring.

DGT's vision and urgency to become a Data-Driven Organization is pursued through various programs related to data collection, management, and utilization. The data managed is internal data originating from the registration, payment, and reporting functions of taxpayer SPTs, which need to be managed according to Data Governance principles so that they can be used optimally. External data was obtained from Agencies, Institutions, Associations, and other parties (ILAP). The right data in accordance with the actual situation (guaranteed single source of truth) and data needs that can be fulfilled through the integration of data exchange between DGT and ILAP are important. DGT has started to build an Evidence and Information System (IBK), which can directly connect DGT with data providers. The challenge is the readiness of the data provider. Currently, what has been initiated in cooperation with several banking companies. DGT is currently piloting a host-to-host integrated system with State-Owned Enterprises (BUMN). Pertamina, Indonesia's state-owned oil and gas company, 2018 provided DGT with real-time access to its information systems, including data on purchases and sales, payroll, and transactions with third parties. State-owned electricity distribution company PLN and PT Telekomunikasi Indonesia followed suit.

The reliability of BDA results is strongly influenced by quality internal data and external data and in accordance with the rules of Data Governance. The role of data governance in improving CRM and BI at DGT: (i) setting the roles involved, which consist of data governance in identifying and defining, the person in charge of each process of data management, escalation, and resolution of problems related to data; (ii) process arrangements related to data management to ensure data is collected, stored, accessed, and processed in accordance with the rules and best practices; (iii) regulating the flow and formation of data, and ensuring the availability and formation of data are in accordance with the needs of CRM and BI development; (iv) technology-related arrangements in accordance with the needs and capabilities of the organization. A data warehouse is needed that can guarantee a single source of truth for all data flows between units.

Most organizations, including organizations in the government sector, understand that if all the data in their business processes can be integrated, then the organization can apply BDA to increase the added value of the organization and obtain significant information including feedback as material for BDA improvement. The challenges in system integration with other authorities in Indonesia are differences in interests between authorities, differences in technology platforms, and the level of willingness of each authority to adopt integrated automation processes in all sectors in Indonesia. It is very important to build collaboration in the development of integrated information systems and strategic adjustments to business processes. Policies related to national enterprise architecture are urgently needed to achieve digital transformation strategic goals.

4. Conclusions

The digital transformation strategy is at the heart of the national agenda to increase tax revenues in Indonesia, which has been stipulated in the DGT Strategic Plan and in the Road Map for the Development of the Tax Administration Core

System (SIAP) which will begin in 2021. Based on the 'Digital Maturity' Index scheme developed by the Tax Administration Forum, it can be determined that Indonesia is in development at a level 3 scale, namely the 2020 E-accounting development stage. Standardization of data gathering and historical data reconciliation are still in progress. For data analysis that is currently under development are Automatic generation of calculations and/or penalties, audit trails with external data, and audit trails with internal and external data both feed into the generation of outliers in the system.

Indonesia's tax digitization journey began in 2001. 2001–2008 was the period of DGT's business process digitization. 2009–2016 was a period of expanding efforts to digitize taxpayers and the initial steps of digitizing internal business processes. 2017–2024 is the period for delivering IT systems to manage all administrative processes (Core Tax System) to support fundamental transformations in tax administration and to transform back-end digitization efforts. The development of DGT's Core Information Technology Systems has been carried out since 2018 using solutions developed in-house.

The technology used in developing administrative information systems and taxation ICT operational solutions in Indonesia, DGT uses a Custom Built, Commercial Off the Shelf and Software as a service (cloud-based) approach. The use of innovative technology in the form of Cloud Technology has been implemented in the development of tax administration, while DLT/Blockchain and Artificial Intelligence have not been used. As for the use of innovative technology in the form of Data Science/Analytic Tools, Application Programming Interfaces (APIs) have been implemented. DGT has not used Robotics Process Automation, Whole of Government Identification Systems, Digital Identification Technology (e.g., Voice), and Virtual Assistants. DGT has also utilized the types of electronic services provided for taxpayers in the form of information on the website, tools, and calculators on the website, access to integration of taxpayer accounts, online services (e-filling), electronic invoicing systems for businesses, access to taxpayer data from third parties, and digital mailboxes.

DGT applies the Enterprise Risk Management (ERM) framework in providing a methodological structure for tax compliance risk management (CRM) using the ISO 31000:2018 risk management approach. The development of BDA at DGT began in 2014 through the development of a Compliance Risk Management (CRM) risk machine to increase taxpayer compliance, and at the same time to fulfill the performance indicators of the Tax Administration Diagnostic Assessment Tool Field Guide (TADAT), specifically on POA 2 (Effective Risk Management). DGT has developed BDA starting by utilizing internal data and external data. Data warehouse is a place to collect data, processed and analyzed by data scientists. Infrastructure support is specifically managed by the Directorate of Information and Communication Technology (ICT). BDA implementation at DGT is divided into several parts starting from analytical activities which include determining the context, identifying risks and/or variables, exploring data, modeling, mockup user interfaces, deployment, monitoring, and evaluation. Furthermore, the analytical methods and techniques used are Data Matching, Natural Language Processing (NLP), Classification, Clustering, Social Network Analysis (SNA), and Graph Data Science which produce products such as CRM, Smartweb, and ATP.

DGT has used a solution approach in ICT development and operations: custom-built, commercial off-the-shelf, and software as a service (cloud-based). While status with Use of Innovative Technologies includes the implementation of Cloud Technology, and for DLT/Blockchain and Artificial Intelligence it has not been implemented. DGT implements Data science/Analytics tools and implements Application

Programming Interfaces-API. For RPA, Whole of Government Identification Systems, Digital Identification Technology, and Virtual Assistants are not used in system infrastructure development. CRM developments that have been carried out by DGT from 2019 to 2022 include CRM Extensification Function, CRM Inspection and Supervision Function, CRM Billing Function, CRM Education Taxation Function, CRM Transfer Pricing, CRM Law Enforcement Function, CRM Appraisal Function, CRM Service Function, CRM Function Objection, and CRM Integration, connecting 11 DGT business processes, and using the Integrated Compliance Approach concept. The development of Business Intelligence (BI) at DGT is based on the Data Management Body of Knowledge (DMBOK). BI developments that have been carried out by DGT from 2021 to 2023 include SmartWeb, Ability to Pay, Intermediate WP Dashboard, Smartboard, BI Acceptance BI, HR BI, organization BI, and Regulation BI.

The challenge faced by DGT in this regard is to ensure that all business processes can be integrated and structured with each other. Data quality is still a challenge for CRM development. Infrastructure is DGT's challenge in CRM development with the start of using national data. The volume, breadth, and complexity of data require adjustments in infrastructure capacity to be able to keep up with data capacity in CRM development. Another challenge is the current CRM development process, which is the loss of qualified human resources due to mutation/promotion by bringing their CRM knowledge, thus requiring the recruitment of new human resources to be retrained. In addition, there are issues related to adaptation to the risk culture by vertical units. Future business process designs that require the use of CRM/BI/Taxpayer Account Management (TAM) as a starting point for supervisory actions may be hampered by possible resistance from field staff. The reliability of BDA results is strongly influenced by quality internal data and external data and in accordance with the rules of Data Governance. A data warehouse is needed that can guarantee a single source of truth for all data flows between units. The challenges in system integration with other authorities in Indonesia are differences in interests between authorities, differences in technology platforms, and the level of willingness of each authority to adopt integrated automation processes in all sectors in Indonesia. It is very important to build collaboration in the development of integrated information systems and strategic adjustments to business processes. Policies related to national enterprise architecture are urgently needed to achieve digital transformation strategic goals.

5. The limits of the study and the further research

The study has limitations in examining digital transformation in taxation administration while considering the roadmap of taxation reform in Indonesia, with a focus on Tax Reform III and the Taxation Administration System Renewal (from 2018 to 2024) and considering the specific risks and challenges of utilizing information technology.

Further research based on this study could include (1) digital maturity analysis to assess the performance of the Indonesian tax authority in implementing IT in taxation administration; (2) evaluation of digital transformation success to evaluate the success of digital transformation in taxation administration in Indonesia; and (3) risk analysis and risk management to analyze the effectiveness of risk management systems implemented in the Directorate General of Taxes (DJP), particularly in terms of tax compliance.

Author details

Siti Kurnia Rahayu[1] and Andri Kusdianto[2]*

1 Universitas Komputer Indonesia, Bandung, Indonesia

2 Directorate General of Taxation, Indonesia

*Address all correspondence to: andri.kusdianto@pajak.go.id

IntechOpen

References

[1] OECD (Organisation for Economic Co-Operation and Development). Tax Administration3.0: The Digital Transformation of Tax Administration. 2020. Available From: http://www.oecd.org/tax/forum-on-tax-administration/publications-and-products/taxadministration-3-0-the-digital-transformation-of-tax-administration.pdf

[2] ADB. Asian Development Bank. Launching A Digital Tax Administration Transformation What You Need to Know. 2022. DOI: 10.22617/TCS210343. Available From: https://www.adb.org/sites/default/files/publication/792586/digital-tax-administration-transformation.pdf

[3] Sanger C. Tax Authority Approaches to Digital Tax Administration: EY Global Presentation. 2020;**5**:25-30

[4] IMF (The International Monetary Fund). TADAT-Tax Administration Diagnostic Assessment Tool (TADAT). 2019. Available From: www.tadat.org/home and https://www.tadat.org/assets/files/TADAT%20Field%20Guide%202019%20-%20English.pdf

[5] Ministry of Finance of the Republic of Indonesia. KMK-Keputusan Menteri Keuangan Nomor. 260/KMK.03/2017 Tentang Program Reformasi Perpajakan

[6] Singer S, Jokovic B. Economic themes. Digital transformation in tax administration: A literature review. Economic Themes. 2020;**58**(3):369-386

[7] Park J, Jun S, Kim JY. United Nations ESCAP, Information and Communications Technology and Disaster Risk Reduction Division: Methodology for Data Analysis of Digital Transformation (Version 1). Bangkok; 2022

[8] OECD (Organisation for Economic Co-Operation and Development). Tax and Digitalisation. 2018. Available From: https://www.oecd.org/tax/beps/tax-and-digitalisation-policy-note.pdf

[9] Barr R. Digital Adminsitration Maturity. EY. 2021. Availble from: https://www.ey.com/en_gl/tax/digital-tax-adminsitration-maturity

[10] IMF (International Monetary Fund). Use of technology in tax administration Core information technology systems in tax administration. In: Technical Notes and Manual No. 17/02. Washington DC; 2017. p. 3

[11] ICAEW. Digitalisation of Tax: International Perspectives. 2019 https://www.icaew.com/-/media/corporate/files/technical/technology/thought-leadership/digital-tax.ashx

[12] EY Forbes. Data & Advanced Analytics: High Stakes, High Rewards. 2017. Available From: https://i.forbesimg.com/forbesinsights/ey_data_analytics_2017/EY_Data_Analytics_Report.pdf

[13] British Standar-BS ISO 31000:2018. Risk Management Guidelines. 2018. Available From: www.iso.org

[14] Kagermann H, Lukas WD, & Wahlster W. Industrie 4.0: Mit dem Internet der Dinge auf dem Weg zur 4. Industriellen Revolution. 2011. Available From: http://www.vdi-nachrichten.com/Technik-Gesellschaft/Industrie-40Internet-Dinge-Weg-4-industriellen-Revolution

[15] OECD (Organisation for Economic Co-Operation and Development). Compliance Risk Management:

Managing and Improving Tax Compliance. 2004. Available from: https://www.oecd.org/tax/administration/33818656.pdf

[16] Directorate General Taxation. Ministry of Finance of the Republic of Indonesia. Kebijakan Pemeriksaan Pajak (Seri Pemeriksaan Pajak 01-03). Surat Edaran Nomor. SE-01/PJ.7/2003

Chapter 10

Dimensions of Organizational Commitment and Its Impact on Organizational Learning and Innovation in Agribusiness

María Del Carmen Martínez Serna
and Javier Eduardo Vega Martínez

Abstract

The proposal of this study is to analyze a model in which the effect of each of the dimensions of organizational commitment (OC) on organizational learning (OL) and its influence on innovation (INN) is examined. A questionnaire was applied to managers of 347 agribusiness small and medium-sized enterprises (SMEs) from the three states of the Bajío zone of the Mexican Republic. A quantitative study was carried out, for which a model that presents the different relationships proposed as hypotheses was validated, and with the use of structural equations the results were known. The findings show that affective commitment and continuance commitment have a positive and significant effect on OL, however, normative commitment was found to be non-significant on OL. The last hypothesis of the influence of OL on INN was positive and significant. The findings show that in the agribusiness SMEs examined, the feeling of belonging of employees in the organization should be promoted to a greater extent, as well as the desire to remain in the organization due to the benefits and guarantees that the company offers them to promote learning and the INN in them.

Keywords: organizational commitment, organizational learning, innovation, agribusiness, México

1. Introduction

Today every company faces important challenges, especially with the changes that happened in a vertiginous way due to the health crisis due to COVID-19. As a result, companies had to make changes almost immediately and in some cases, they are still processing actions related to innovation (INN) in the way they serve their market. INN requires as a background a high level of commitment and collaboration on the part of all members of the company at different levels, from top management to operational levels.

It is important for management to encourage all employees to give their ideas in order to create innovations within the company. In organizations, it is necessary to know which of the different strategies to promote commitment within the company influences in generating changes that allow breaking the established routines that provoke innovative ideas.

On the other hand, the agribusiness sector is an important sector in Mexico and requires support in its management in order to give the necessary impulse to generate new and better products, as well as the generation of more employment and more entrepreneurial actions.

In terms of organizational management, it is relevant to know what type of commitment to promote in employees to provoke more organizational learning (OL) and thereby increase innovation, since there is literature that has addressed the issue of organizational commitment (OC), examining the influence of the concept in its entirety. However, it is relevant to know specifically how each of its dimensions contributes to the generation of OL and INN.

The objective of this study is to analyze to what extent the dimensions of OC influence OL within the organization and how this influences agribusiness innovation.

From the literature examined on Innovation, it is found that Schumpeter [1, 2] was one of the initiators of the study on the topic of innovation, and regarding the concept, he points out that it is the process of incorporating new goods and services into the market, new production methods, the creation of a new market, a new source of raw material supply, a new form of management, which in turn classifies it into incremental and radical innovation. The incremental innovation considers developing aspects for the improvement of products, processes, and management systems and the radical ones break with what has been defined so far in the organization since they make stronger changes than the first ones.

For its part, the Organization for Economic Cooperation and Development (OECD) updates its concept of innovation by stating that "An innovation is a product, process (or combination of both) that differs significantly from previous products and processes, and that has been made available to potential users (products) or implemented in the organization (processes)" [3], currently INN is one of the effective strategies used in changing environments and situations [4], in turn, product innovation can help companies gain customers and market acceptance, maintain competitiveness and improve performance and profitability [5].

There are studies that indicate that OL is a strong element for innovation to occur in companies. The positive influence of the OL construct with the INN construct has been analyzed and discussed in various studies [6–9], especially because the OL prepares the organization for the continuous change that is required and manages to integrate knowledge in the company [10], it also allows transforming the knowledge of the people who belong to the organization individually in the knowledge that is incorporated into the company [11]. Obtaining knowledge through OL allows companies to have advantages over the competition [12], thereby developing an innovative process that allows exploiting the development of new products [7]. This is why the improvement of skills, knowledge, and aptitudes is a reflection of the OL that also allows innovation processes [8].

On the other hand, if the people within the organization share the same vision, the top management must make it known and promote it in such a way that everyone in the organization goes after the same objectives and that the top management maintains an open mentality to accept that all the collaborators within the company feel free to propose new ideas for the improvement of processes, products and

management systems or any new idea that allows an improvement for the company and that on the part of management there is a commitment to continually learn that allows the necessary changes to face the challenges of the environment, this will provide an environment conducive to innovation within organizations.

Some results of studies on the relationship of OL with INN is that of Gomes et al. [9] in which they find that OL acts as a facilitator for INN to be generated concluding that the management of managers should be more proactive and creative, continuously promoting new ideas. There is also the research of Fonseca [7] who concludes that the level of OL implementation makes change more possible. For their part, Atitumpong and Badir [13] conclude in their empirical study that OL within the organization is related to innovative work behavior. On the other hand, Abbas et al. [8] point out as a result of their study that recognizes the critical part of OL in initiating and sustaining INN.

In the same order of ideas, as a precedent to OL within the company, is that people commit themselves. OC is the psychological link of the employee with the company and determines the degree of his connection with the organization [14]. It also determines worker behaviors in unwritten contracts [15]. It can be of three types [16], the first is the "affective" and is defined as "the feeling of belonging to the organization" [17], which has to do with the personality and experience of the employees. It includes social exchange processes that benefit the organization [18]. The second is "continuance" considered as the desire to remain in the organization because the employee sees benefits and guarantees that other companies do not give them and needs to remain in it [19]. The employee evaluates the investments in wasted effort and time in the event of leaving the organization [20]. The third is "normative" commitment, in which employees remain as a result of a sense of obligation since they are forced to remain [19], either out of loyalty or feeling a duty to provide correspondence [20].

OC has been linked to various variables of organizational results [20] with the implementation of innovations [21, 22] with job performance [23] and with the implementation of changes [21].

Regarding the relationship between OC and OL, it has been found that there are antecedent variables that can influence different types of commitment and that in turn cause a variation in other constructs, including OL [24], furthermore, to the extent that there is commitment at the different levels of an organization, the greater the ability to learn may be [25].

In the literature there are studies that demonstrate that there is an influence between OC and OL within the organization since the former supports questioning the values of the organization and promoting the rupture of the daily routines established in the company, this causes a change and generates learning [6, 26], evidence is also confirmed in the relationship between affective and continuance commitment with the OL [27].

It is then expected that regardless of the type of commitment that the employee manifests within the organization (affective, continuance, or normative), there is a bond with the organization and the desire to remain in it, this will allow their behaviors to influence participation in sharing the vision of the institution and with its actions to achieve it in the indicated future, it is also expected that it will be influenced by having an open mind on the part of all members of the organization to share knowledge and ideas for improvement since they will be committed to continuously learn that leads them to present beneficial proposals for the organization.

In order to fulfill the objective of the study and after having presented the evidence in literature on the antecedents of the OC dimensions on the OL and its relationship with INN, the following hypotheses are presented.

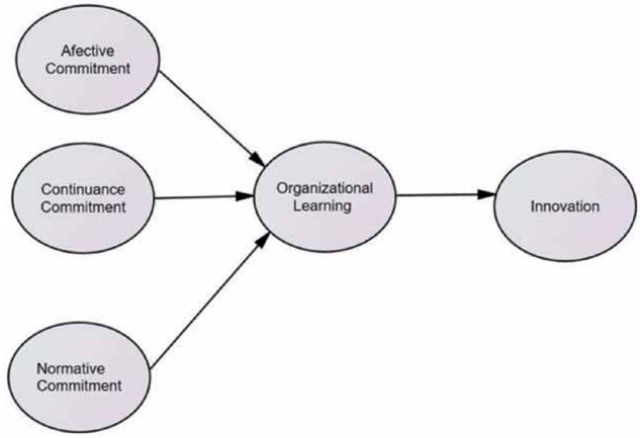


Figure 1.
Conceptual model.

H1: Affective commitment has a significant and positive influence on organizational learning.

H2: Continuance commitment has a positive and significant influence on organizational learning.

H3: Normative commitment has a positive and significant influence on organizational learning.

H4: Organizational learning has a positive and significant influence on innovation.

Figure 1 shows the conceptual model that is evaluated in this study and on which the structural analysis will be performed to test the study hypotheses.

2. Methodology

The target population for the development of the study was the small and medium-sized enterprises (SMEs) in an area of the Bajio region of Mexico belonging to the agribusiness sector. For the selection of the total population, manufacturing, commerce, and service SMEs were identified from the National Statistical Directory of Economic Units [28], which was a total population of 4891 SMEs in the three states in which the study was conducted and on which the sample of 347 agribusiness SMEs was determined (with an error of +/−5% and a confidence level of 95%), of which corresponded to 110 SMEs in Aguascalientes, 141 in Guanajuato and 96 in Jalisco.

The information was obtained through a questionnaire applied personally to the managers or owners of each agribusiness SME in the sample selected for the Bajio region of Mexico.

The measurement of the scales for each of the study variables was based on a careful review of the literature. All the study variables were operationalized using multi-item scales. For the OC variable, the scale with 18 questions proposed by Allen and Meyer [14] was used, which includes three dimensions corresponding to the three types of commitment, affective, continuance, and normative, each with six questions. For the OL variable, an adaptation of the scale suggested by Sinkula et al. [29] was applied, with three dimensions, commitment to learning, shared vision, and open-mindedness, with a total of 18 questions, with six questions for each dimension.

Finally, to measure the INN variable, a scale adapted by the Spanish Association of Accounting and Business Administration [30] and used by García-Pérez de Lema et al. [31] was used, the said variable is subdivided by products/services, processes, and management [30].

To confirm the reliability of these measures, Cronbach's Alpha was analyzed, where the values ranged from 0.758 to 0.888. According to the literature, the

Construct	Item	Standardized load	Average load	Alpha Cronbach	CRI	IVE
Commitment to learning (COA)	COA1	0.645	0.820	0.850	0.860	0.682
	COA3	0.923***				
	COA4	0.882***				
Shared vision (VIC)	VIC1	0.869***	0.820	0.888	0.890	0.681
	VIC2	0.902				
	VIC3	0.806***				
	VIC5	0.710***				
Open mindedness (MEA)	MEA1	0.725	0.800	0.875	0.880	0.650
	MEA3	0.860***				
	MEA4	0.897***				
	MEA5	0.727***				
Affective commitment (CA)	CA1	0.872	0.770	0.850	0.860	0.602
	CA2	0.842***				
	CA3	0.722***				
	CA6	0.647***				
Continuance commitment (CC)	CC3	0.660	0.780	0.810	0.830	0.626
	CC4	0.947***				
	CC5	0.739***				
Normative commitment (CON)	CON1	0.867	0.770	0.812	0.820	0.601
	CON2	0.797***				
	CON3	0.646***				
Products and services (PS)	PS1	0.839***	0.850	0.843	0.840	0.730
	PS2	0.869				
Process (PC)	PC3	0.830***	0.780	0.758	0.760	0.616
	PC4	0.737				
Management systems (SG)	SG5	0.762***	0.830	0.865	0.870	0.688
	SG6	0.855***				
	SG7	0.867				
Chi2/df = 1.771 (p = 0.000); RMSEA = 0.047; IFI = 0.958; CFI = 0.957; NFI = 0.908						

*Source: Authors (2023).*** $p < 0.001$.*

Table 1.
Reliability and validation convergent.

	COA	VIC	MEA	CA	CC	CON	SG	PC	PS
COA	1								
VIC	0.647	1							
MEA	0.523	0.579	1						
CA	0.305	0.325	0.361	1					
CC	0.276	0.245	0.270	0.503	1				
CON	0.162	0.262	0.214	0.508	0.572	1			
SG	0.360	0.364	0.296	0.194	0.197	0.176	1		
PC	0.381	0.412	0.305	0.253	0.166	0.192	0.824	1	
PS	0.296	0.274	0.218	0.223	0.105	0.185	0.813	0.796	1

Source: Authors (2023) according to the results of the HTMT criterion in AMOS.

Table 2.
HTMT analysis discriminant validity.

reliability of the scales is confirmed as long as values greater than 0.7 are obtained [32]. In this case, the criterion is met.

Confirmatory factor analysis (CFA) was carried out to evaluate the measurement model using the Analysis of Moment Structures (AMOS) software version 25, where a good fit was confirmed with a Chi2/df = 1.771 below the criterion level which indicates that it should be less than 5 [33] and all the indexes adhered to the criteria indicated by the theory RMSEA = 0.047, less than 0.05 according to Hair et al. [34]; IFI = 0.958; NFI = 0.908; CFI = 0.957, following Byrne [35] these values indicate a good fit due to the fact that they are close to 1.

The reliability of the scale was also verified using the composite reliability index (CRI) [36] and the index of variance extracted (IVE) [37]. In all the measures of the constructs, these indices were above the values according to the evaluation criteria, resulting in higher values of 0.7 for the CRI and 0.5 for the IVE. This confirmed the reliability of the constructs used in the instrument (see **Table 1**).

To check the convergent validity, it was verified that all the questions of the factors were significant and that the average is above 0.7 [38], which was fulfilled in all the items of the factors of the model because they presented values between 0.770 and 0.850, which suggests a good convergent validity [39]. See **Table 1**.

To check the discriminant validity, the Heterotrait-Monotrait Ratio of Correlations (HTMT) test was used, which is a real estimate of the correlation of two constructs. If it were perfect, values close to one mean a lack of discriminant validity [40]. The HTMT analysis performed in AMOS 25 indicates that there are no warnings or validity problems for the model used in this study ($\leq$0.824) since the values are below the level (0.90) allowed in the theory [41]. See **Table 2**. In general, the result of the HTMT analysis is acceptable, which supports the discriminant validity between the variables.

3. Results

After verifying the validity and reliability of the study variables and the measurement model, structural equation modeling was developed to test the hypotheses,

	Hypothesis			Path (t)	P	Results
H1	Affective commitment	→	Organizational learning	0.283 (4.124)	***	Support
H2	Continuance commitment	→	Organizational learning	0.165 (2.644)	**	Support
H3	Normative commitment	→	Organizational learning	0.094 (1.437)	0.151	Not supported
H4	Organizational learning	→	Innovation	0.462(6.276)	***	Support
Model fit measures of the general model: Chi2/df =2.245 (p = 0.000); RMSEA = 0.060; IFI = 0.926; CFI = 0.925; NFI = 0.874.						

Source: Developed by the authors (2023). ** *p < 0.01.*
*** *p < 0.001.*

Table 3.
Results of structural analysis.

using the AMOS statistics program version 25, with maximum likelihood estimation as the technique for testing the model. The model fit is satisfactory (Chi2/df = 2.245; RMSEA = 0.060; IFI = 0.926; CFI = 0.925; NFI = 0.874).

We proceeded with the analysis of the study hypotheses, finding that hypothesis 1 is accepted since the results show a path coefficient of 0.283 with a t-value = 4.124, which confirms that affective commitment influences OL in a positive and significant. Hypothesis 2 has a path coefficient of 0.165 with a t-value = 2.644, this confirms the acceptance of hypothesis 2 since continuance commitment influences OL in a positive and significant way. In hypothesis 3, the results indicate a path coefficient of 0.094 with a t-value = 1.437, this shows that there is a positive, but non-significant, relationship between normative commitment and OL, so this hypothesis is not accepted. In hypothesis 4, the results indicate a path coefficient of 0.462 with a t-value = 6.276, therefore, there is a positive and significant relationship between the OL and INN, so hypothesis 4 is accepted. See **Table 3**.

4. Conclusions

The most outstanding contribution that can be pointed out as conclusions is the fact of being able to know how the influence of OC on OL, measured separately in each of its dimensions, was evaluated in order to know which of them influences to a greater extent to promote the strategic orientation of learning within a sector with very particular characteristics such as agribusiness, In this sense, the affective commitment and continuance are the necessary antecedent to promote OL, which has relevant implications in management, since it is necessary to promote the development of a link between the employee and the organization derived from the employee feeling that he/she is treated fairly by his/her employer, and at the same time it will be necessary to encourage the employee to recognize that staying in the company gives him/her guarantees and benefits that are difficult to find in other organizations.

The normative type of commitment, which is determined by the moral obligation of the worker to remain in the company, does not have a significant influence on the processes of change necessary to bring about more innovation through learning.

On the other hand, it is verified in the sample analyzed that OC generates the changes in routines necessary to develop higher levels of INN within agribusinesses.

For future lines of research, it is advisable to analyze more closely the behaviors that are generated in each type of commitment on the part of the worker in order to establish the most appropriate policies within the company that will lead to greater permanence and better levels of innovation. In other words, to move from evaluation to the generation of management elements that support the sector.

Acknowledgements

We acknowledge the Autonomous University of Aguascalientes for the facilities and funding for the development of this research.

Conflict of interest

The authors declare no conflict of interest.

Author details

María Del Carmen Martínez Serna* and Javier Eduardo Vega Martínez
Autonomous University of Aguascalientes, Aguascalientes, Mexico

*Address all correspondence to: mcmartin@correo.uaa.mx

References

[1] Schumpeter JA. The Theory of Economic Development. Cambridge, MA: Harvard University Press; 1934

[2] Schumpeter JA. Capitalism, Socialism and Democracy. Cambridge, MA: Harvard University Press; 1942

[3] Gault F. Innovation indicators and measurement: An overview. In: Gault F, Arundel A, Kraemer-Mbula E, editors. Handbook of Innovation Indicators and Measurement. 2nd ed. UK: Edward Elgar Publishing; 2023. pp. 2-10

[4] Sukanthasirikul K, Phornlaphatrachakorn K. Product innovation accounting, customer response capability and market success: An empirical investigation in Thailand. The Journal of Asian Finance, Economics and Business. 2021;**8**(10):65-76. DOI: 10.13106/jafeb.2021.vol8.no10.0065

[5] Hien LM, Tram NTA, Ha LTH, Van PTT. Consumer behavior and purchasing intention toward the country of origin labeling products: An empirical study in Vietnam. Journal of Asian Finance, Economics, and Business. 2021;**8**(8):565-572. DOI: 10.13106/jafeb.2021.vol8.no8.0565

[6] Serna M, Md, Vega Martínez JE, Eternod Domenechb V. The influence of organizational commitment and learning orientation on innovation in SMEs. Contaduría y Administración. 2018;**63**(3):1-19. DOI: 10.22201/fca.24488410e.2018.1411

[7] Fonseca ED. Accident and innovation in construction industry: Learning by doing to prevent accidents and improve the production. Safety Science. 2021;**142**:105389. DOI: 10.1016/j.ssci.2021.105389

[8] Abbas J, Zhang Q, Hussain I, Akram S, Afaq A, Shad MA. Sustainable innovation in small medium enterprises: The impact of knowledge management on organizational innovation through a mediation analysis by using SEM approach. Sustainability. 2020;**12**(6):2407. DOI: 10.3390/su12062407

[9] Gomes G, Seman LO, Berndt AC, Bogoni N. The role of entrepreneurial orientation, organizational learning capability and service innovation in organizational performance. Revista de Gestão. 2022;**29**(1):39-54

[10] Tu Y, Wu W. How does green innovation improve enterprises' competitive advantage? The role of organizational learning. Sustainable Production and Consumption. 2021;**26**:504-516. DOI: 10.1016/j.spc.2020.12.031

[11] Basten D, Haamann T. Approaches for organizational learning: A literature review. SAGE Open. 2018;**8**(3):1-20. DOI: 10.1177/2158244018794224

[12] Tan FZ, Olaore GO. Effect of organizational learning and effectiveness on the operations, employees productivity and management performance. Vilakshan-XIMB Journal of Management. 2021;**19**(2):110-127

[13] Atitumpong A, Badir YF. Leader-member exchange, learning orientation and innovative work behavior. Journal of Workplace Learning. 2018;**30**(1):32-47. DOI: 10.1108/JWL-01-2017-0005

[14] Meyer JP, Allen NJ, Smith CA. Commitment to organizations and occupations: Extension and test of a three-component conceptualization.

Journal of Applied Psychology. Aug 1993;**78**(4):538-551

[15] Li Y, Liu Z, Qin K, Cui J, Zeng X, Ji M, et al. Organizational trust and safety operation behavior in airline pilots: The mediating effects of organizational identification and organizational commitment. Journal of Air Transport Management. 2021;**92**:102018. DOI: doi.10.1016/j.jairtraman.2021.102018

[16] Rameshkumar M. Employee engagement as an antecedent of organizational commitment–a study on Indian seafaring officers. The Asian Journal of Shipping and Logistics. 2020;**36**(3):105-112. DOI: 10.1016/j.ajsl.2019.11.003

[17] Salas-Vallina A, López-Cabrales Á, Alegre J, Fernández R. On the road to happiness at work (HAW): Transformational leadership and organizational learning capability as drivers of HAW in a healthcare context. Personnel Review. 2017;**46**(2):314-338. DOI: 10.1108/PR-06-2015-0186

[18] Schwarz G, Newman A, Yu J, Michaels V. Psychological entitlement and organizational citizenship behaviors: The roles of employee involvement climate and affective organizational commitment. The International Journal of Human Resource Management. 2021;**34**:1-26. DOI: 10.1080/09585192.2021.1962388

[19] Feizi M, Ebrahimi E, Beheshti N. Investigating the relationship between transformational leadership and organizational commitment of the high school teachers in germy. International Journal of Organizational Leadership. 2014;**3**(1):17-30

[20] Chiang M, Núñez A, Martín MJ, Salazar M. Compromiso del Trabajador hacia su Organización y la relación con el Clima Organizacional: Un Análisis de Género y Edad. Panorama Socioeconómico. 2010;**28**(40):90-100

[21] Fuentes CL, López DD, Moya FO. Compromiso organizacional como estrategia de cambio en hospitales públicos de Colombia y Venezuela. Revista Espacios. 2020;**41**(22):316-327

[22] Iqbal S, Ehsan S, Rizwan M, Noreen M. The impact of organizational commitment, job satisfaction, job stress and leadership support on turnover intention in educational institutes. International Journal of Human Resource Studies. 2014;**4**(2):181. DOI: 10.5296/ijhrs.v4i2.5906

[23] Loan L. The influence of organizational commitment on employees' job performance: The mediating role of job satisfaction. Management Science Letters. 2020;**10**(14):3307-3312. DOI: 10.5267/j.msl.2020.6.007

[24] Guzmán GC, Velasco MV, Dávila AA, Carrillo AA. Compromiso organizacional: Antecedentes y consecuencias. Conciencia Tecnológica. 2020;**60**:6

[25] Villar-Vargas M, Araya-Castillo L. Consistencia entre el enfoque de liderazgo y los estilos de liderar: Clave para la transformación y el cambio. Pensamiento & Gestión. 2019;**46**:187-221. DOI: 10.14482/pege.46.3801

[26] Cegarra-Navarro JG, Wensley AK, Martinez-Martinez A, Garcia-Perez A. Linking organisational commitment with continuous learning through peripheral vision and procedural memory. European Management Journal. 2020;**38**(6):874-883. DOI: 10.1016/j.emj.2020.05.003

[27] Atak M, Erturgut R. An empirical analysis on the relation

between learning organization and organizational commitment. Procedia-Social and Behavioral Sciences. 2010;**2**(2):3472-3476

[28] Instituto Nacional de Estadistica y Geografia (INEGI). 2017. Available from: www.beta.inegi.org.mx/app/mapa/denue/

[29] Sinkula JM, Baker WE, Noordewier T. A framework for market-based organizational learning: Linking values, knowledge, and behavior. Journal of the Academy of Marketing Science. 1997;**25**(4):305-318

[30] Española A, de de Contabilidad y Admistración de Empresas (AECA). La innovación en la empresa: Factor de supervivencia. Principios de organización y sistemas. Madrid, España: AECA; 1995

[31] García-Pérez de Lema D, Gálvez-Albarracín EJ, Maldonado-Guzmán G. Efecto de la innovación en elcrecimiento y el desempeño de las Mipymes de la Alianza del Pacífico. Un estudio empírico. Estudios gerenciales. 2016;**32**:326-335. DOI: 10.1016/j.estger.2016.07.003 0

[32] Nunnally JC, Bernstein IH. Psychometric Theory. 3rd ed. New York: McGraw-Hill; 1994

[33] Bentler PM. EQS Structural Equations Program Manual. Los Angeles: BMDP Statistical Software; 1989

[34] Hair JF, Anderson RE, Tatham RL, Black WC. Análisis multivariante. Vol. 491. Madrid: Prentice Hall; 1999

[35] Byrne B. Structural Equation Modeling with EQS: Basic Concepts, Applications, and Programming. 2nd ed. New York: Lawrence Erlbaum Associates Publishers; 2006

[36] Bagozzi RP, Yi Y. On the evaluation of structural equation models. Journal of the Academy of Marketing Science. 1988;**16**(1):74-94

[37] Fornell C, Larcker D. Structural equation models with unobservable variables and measurement error: Algebra and statistics. Journal of Marketing Research. 1981;**18**(3):382-388

[38] Hair J, Anderson R, Tatham R, Black W. Multivariate Data Analysis. 4th ed. New Jersey: Prentice-Hall International Inc.; 1995

[39] Sethi V, King WR. Development of measures to assess the extent to which an information technology application provides competitive advantage. Management Science. 1994;**40**(12):1601-1627

[40] Hair JF, Sarstedt M, Ringle CM. Rethinking some of the rethinking of partial least squares. European Journal of Marketing. 2019;**53**(4):566-584. DOI: 10.1108/EJM-10-2018-0665

[41] Henseler J, Ringle CM, Sarstedt M. A new criterion for assessing discriminant validity in variance-based structural equation modeling. Journal of the Academy of Marketing Science. 2015;**43**(1):115-135. DOI: 10.1007/s11747-014-0403-8

Chapter 11

Analysis of Technologies Maturation Level to Face the Future Challenges of the Rail Sector

Garazi Carranza Ruiz de Loizaga, Oihane de la Rua Losada and Olatz Amorrortu

Abstract

Technologies play a key role in driving innovation in the rail sector, addressing key aspects such as sustainability, efficiency, passenger experience, and freight transport. The implementation of new propulsion systems and advanced materials in pursuit of sustainability, together with the adoption of smart operation and advanced manufacturing, contribute to optimizing resources, and reducing environmental impact. Data and analytics-based solutions enable more effective management of operation, predictive maintenance and safety, and improving service reliability and safety. In addition, passenger-oriented applications and services, such as digital ticketing and real-time information, enrich the user experience. Technology is also revolutionizing freight transport, optimizing the operation and infrastructure for more efficient and sustainable movement of goods. Together, these technologies are shaping a more advanced and efficient future for the rail sector.

Keywords: rail, railway, innovation, technologies, sustainability, efficiency, passenger experience, freight

1. Introduction

Innovation has played a transformative role in the rail sector at both Spanish and European level. In Spain, there has been a strong drive toward the modernization and improvement of rail infrastructure, as well as the implementation of advanced technologies to optimize operational efficiency and enhance the passenger experience. Furthermore, in Europe, innovation has been a driving force in promoting the interoperability and connectivity of rail systems between member countries, thus fostering greater integration and facilitating cross-border transport.

Technological innovation has had a significant impact on the railway sector, both from an economical and operational perspective. This transformation has generated several benefits and has boosted an economical growth in different European regions. For example, the implementation of new technologies in the rail sector has boosted job creation. Innovation has led to the emergence of new roles and required skills, which has opened up job opportunities in areas such

as information technology, engineering, project management, and software development.

On the one hand, the adoption of innovative technologies has led to greater efficiency in rail operations. For example, the implementation of traffic management systems and capacity optimization have led to better planning and utilization of resources, reducing costs, and improving profitability. On the other hand, more efficient and sustainable solutions have also been implemented, leading to a reduction in operating costs. For example, the introduction of energy management systems has led to a more efficient use of energy, reducing energy costs. In addition, improved planning and optimization of services have increased the profitability of railway companies.

In summary, technological innovation has had a significant economic impact on the European rail sector, driving growth, operational efficiency, employment generation, and the promotion of mobility. These developments have contributed to strengthening Europe's position as a leader in the rail industry worldwide and have generated economic benefits at company, regional, and national levels.

Progress in key areas, such as applications and services, materials, energy and energy management, models (Industry 4.0), data and electronics, and connectivity, have significantly contributed to the evolution of the railway sector in Spain and Europe, being the backbone for a promising future in terms of efficiency, sustainability, and technological development.

2. Objective

The study analyzes the challenges faced by the railway sector in the technological field, analyzing the involvement of technologies when it comes to providing solutions. These technologies have been analyzed according to their degree of maturity in the Basque innovation ecosystem, with the aim of knowing the state of technological advances in the region in the railway field, identifying strengths, and opportunities for development in the field of innovation in the railway sector. The study has been carried out under the RIN-Rail innovation network project, funded by the Basque Government in the Elkartek 2022 program (KK-2022/00027).

3. Theoretical background

There is concern about the environmental and social problems caused by the generalization of a transport model based on fossil fuels. Transport accounts for a quarter of the European Union's greenhouse gas emissions and is increasing. To achieve climate neutrality, a 90% reduction in transport emissions is needed by 2050 [1, 2].

The railway sector is undergoing a transformation due to the incorporation of new technologies, which is changing the way companies operate, manage, and produce. This evolution based on technological innovation seeks mainly to provide a better travel experience, greater safety, more efficient operations, less environmental impact, and more competitive and profitable companies. In this sense, the rail sector, as one of the most energy-efficient modes of transport, has significant advantages compared to other modes of transport. Being responsible for 9% of passenger transport and 7% of freight transport [3], it accounts for less than 0.4% of the GHG

emissions of the entire transport sector. Rail is set to be a key driver for the decarbonisation of the transport industry.

Additionally, after the COVID-19 crisis, a global recovery of the rail supply market is expected with a growth of 3% per year until 2027, reaching an annual volume of approximately 211 billion euros in 2027 [4]. This is why rail is destined to become the backbone of European mobility.

Innovation in the rail sector covers a wide range of areas, from infrastructure and rolling stock to rail technology, automation, digitalization, energy and sustainability, safety, and risk management. The evolution that the sector has undergone in recent years covers a variety of areas and technologies.

In the area of infrastructure and transport systems, efforts have been made in ensuring the interoperability between the different rail networks, facilitating cross-border transport, and promoting European integration. Projects have been carried out to modernize and renovate railway stations and signaling systems to improve safety, capacity and efficiency.

In the rolling stock and technology area, the sector is working on the development of lighter and more aerodynamic trains, using advanced materials such as aluminum alloys, and carbon fiber. This has made possible the reduction of energy consumption and carbon emissions. More efficient propulsion systems have also been introduced, such as electric motors and hybrid systems, as well as the adoption of energy recovery and regenerative braking solutions. Furthermore, more efficient energy storage technologies, such as high-capacity batteries and large-scale energy storage systems, are being explored.

In terms of improving passenger comfort and experience, focus has been given to the development of ergonomic seating, air conditioning quality, in-flight entertainment, and Wi-Fi connectivity with the aim of enhancing the travel experience. New traffic management and control solutions have also been developed, implementing advanced traffic management and control systems to improve train safety, capacity, and punctuality. Additionally, innovations in signaling focused on making signaling systems more efficient and accurate, such as the communication-based train control system (CBTC) and the European signaling system (ETCS).

The use of data and analytic technologies has also gained importance in recent years. Data collection and analysis, including sensors and real-time monitoring systems, are used to optimize route planning, predict maintenance, and improve operational efficiency. Technological developments have also focused on safety systems. For example, advanced security technologies, such as obstacle detection systems, surveillance cameras, and intrusion detection systems, have been implemented. Risk management strategies have also been strengthened, and cyber-attack protection systems have been developed to ensure the safety of railway operations.

All of these advances have improved efficiency, sustainability, and the passenger experience and continue to drive the transformation of the rail industry globally. To address these advances, there are a number of innovative technologies that are transforming the way services are operated and delivered.

IoT has revolutionized the railway sector by enabling the connection of devices and sensors to collect real-time data. This enables the monitoring and control of railway infrastructure, including tracks, trains, and signaling systems. IoT is also used to improve safety, perform predictive maintenance, and optimize operational efficiency.

This requires technologies, such as big data and advanced analytics. The collection and analysis of large volumes of data generated by railway systems have provided

valuable information for decision-making and operations optimization. Advanced analytics techniques, such as machine learning and artificial intelligence, can identify patterns, predict problems, and improve the efficiency of rail services.

Focusing on the train maintenance tracking, inspection, and cleaning areas, the sector is applying robotic systems. Robots and drones can perform faster and more precise inspections, helping to identify and solve problems efficiently. In addition, automation has been implemented in train operation, allowing for greater precision in control and a reduction in human intervention.

Aligned with the key enabling technologies, it should be highlighting the blockchain technology, aiming to improve traceability and security in asset management, such as tickets and financial transactions. By decentralizing and immutably recording transactions, integrity and transparency in railway processes can be ensured.

In the area of renewable energy and storage systems, energy sources, such as solar and wind power, are being adopted to power railway systems. In addition, advanced energy storage systems, such as high-capacity batteries and hydrogen systems, are being developed to optimize energy use and improve sustainability.

In the skills area, augmented reality (AR) and virtual reality (VR) have been used to improve employee training and education, as well as to provide interactive experiences for passengers. These technologies allow the visualization of information in real time, simulations of emergency situations, and the creation of interactive interfaces for navigation in stations and trains.

All these innovative technologies are driving efficiency, safety, sustainability, and passenger experience in the rail sector. As their development progresses and they become more widely integrated, they are expected to continue to transform the industry and generate new benefits in the future.

4. Methodology

In 2022, a consultation was made with MAFEX—Spanish Rail Industry member companies. The objective was to align the sector's offer to the challenges and opportunities of the market from the technological point of view, considering both the deployment of current technologies and the development and adoption of emerging technologies, all with a medium- and long-term perspective. The purpose of this consultation was to define the keys to the future competitiveness of the sector, identify the relevant technologies, and analyzing and prioritizing the technologies identified. During the consultation, 35 companies participated in and the results were subsequently validated with the 118 members of MAFEX. MAFEX members account for 83.45% of exports, representing more than 8% of the industrial GDP at state level.

As a result of the analysis, these four major key areas have been identified for the competitiveness of all the agents and companies that are part of the railway sector: (1) efficiency, (2) sustainability, (3) passenger experience, and (4) freight.

To meet the challenges in these four lines of research, six technological enablers have been defined: (i) applications and services, (ii) materials, (iii) energy and energy management, (iv) models (Industry 4.0), (v) data, and (vi) electronics and connectivity.

A total of 59 technologies were identified, divided into the six technology areas mentioned above (**Figure 1**).

Figure 1.
Technology areas and technologies involved. Source: Own elaboration.

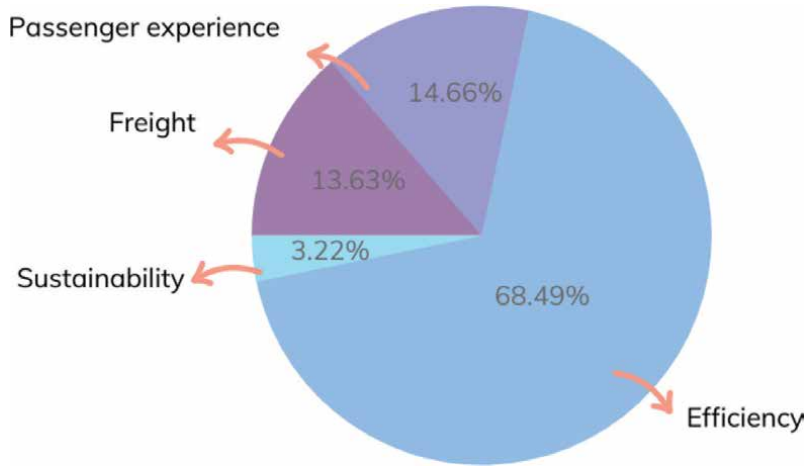


Figure 2.
Capacities in each of the identified thematic areas. Source: Own elaboration.

5. Results of the analysis

According to the analysis, in the area of sustainability, a priority is set on the implementation of new propulsion systems. In terms of efficiency, the key challenges are related to new materials and the increasement of the capacity along with intelligent operation, advanced manufacturing, and Industry 4.0. The study concludes the user experience as another important area, where improvements are sought in comfort and infotainment, payment and access methods, and integrated mobility. Finally, in the freight area, the driving factors are focused on optimizing both operation and infrastructure.

According to the analysis (see **Figure 2**), efficiency is the thematic area with the greatest impact on the sector, with 68.49%. User experience is the second most attended area, with 14.66%, and freight is at 13.63% (**Figure 3**).

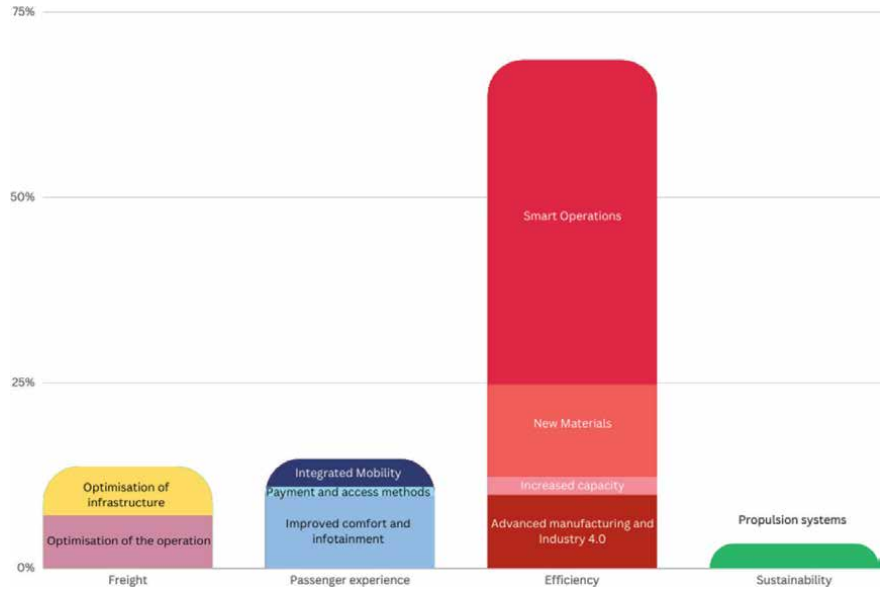


Figure 3.
Capacities in the driving factors in each of the thematic areas. Source: Own elaboration.

In terms of efficiency, in addition to being one of the main thematic areas, the importance of the intelligent operation driving factor is prioritized showing that 43.75% of rail entities have solutions and capacity to face the challenges of this topic.

Rail apps and services have enabled passengers to access real-time information on train schedules, delays, and cancelations. This gives them greater control and allows them to plan and manage their journeys more effectively. In addition, the apps offer the ability to easily and quickly purchase tickets, select seats, access additional onboard services, and receive personalized updates during the journey. All of this has contributed to a more convenient and satisfying travel experience for passengers.

Passenger-focused apps and services have also made it easier to manage capacity on trains. By providing real-time information on train occupancy, rail operators can accurately track demand and adjust supply accordingly. This enables them to optimize seat allocation and improve efficiency in resource utilization, avoiding situations of over-occupancy or under-utilization of trains.

Applications and services have also contributed to improving operational efficiency in the rail sector. By enabling digital ticket purchasing and travel management, the need for manual processes has been reduced and administrative procedures have been streamlined. In addition, the implementation of artificial intelligence and machine learning solutions has made it possible to predict demand, optimize route planning, and minimize waiting times, leading to greater efficiency in the operation of rail services.

The development and use of data in rail innovation have had a significant impact on several aspects of the industry. Some of the most relevant impacts are presented below (**Figure 4**).

In terms of milestones, the analysis pieces of evidence show that the actual rail capacity is focused on the areas related to the *monitoring of infrastructure* (7.37%) and *monitoring of rolling stock* (6.30%), as well as in the *optimization of maintenance cycles*

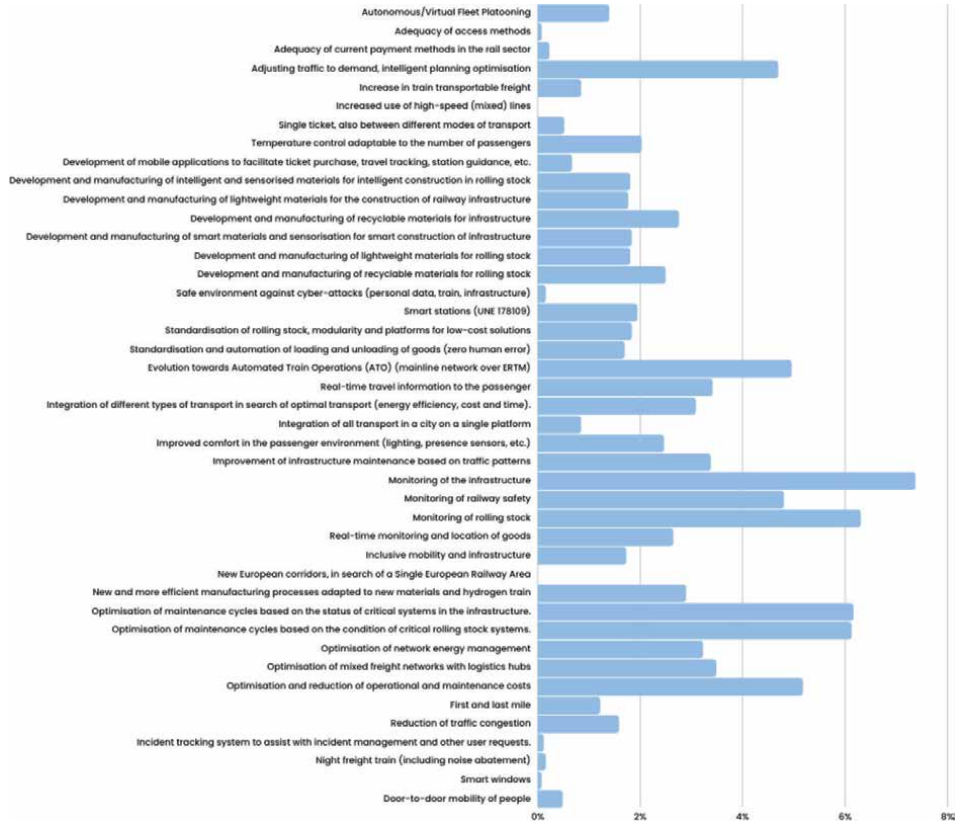


Figure 4.
Milestones and capacities. Source: Own elaboration.

based on the status of critical systems. These milestones focus on efficiency and sustainability, reflecting a trend toward the implementation of advanced technologies to improve system performance and reliability.

Furthermore, the milestones that have shown lower capacity focus on *increasing the use of high-speed lines* and the *opening of new European rail corridors*. While these milestones may be important for improving integrated mobility and connectivity between countries, their implementation may require significant investments in infrastructure and additional resources.

The development of passenger-oriented applications and services has spurred innovation in the rail sector. Companies have had to adapt and adopt new technologies to remain competitive. This has led to the implementation of solutions such as augmented reality, virtual reality, facial recognition, and integration with digital payment systems, which have further enhanced the passenger experience and driven technological evolution in the sector.

From the results obtained, it can be seen that the development of the use of data in rail innovation has generated significant impacts on the optimization of the operations, predictive maintenance, safety, passenger experience, and strategic planning. These advances enable more informed decision-making, improve operational efficiency, and contribute to a more satisfying and safer travel experience. As data collection and analysis continue to advance, more opportunities for continuous improvement and innovation in the rail industry are expected to emerge.

In addition, in optimization of the operation, data analytics enables rail operators to collect and use real-time information on train performance, train occupancy, timetables, and other relevant factors. This enables them to make more informed decisions and optimize the operation of rail services. As an example, they can adjust train schedules and capacity to meet demand, optimize resource allocation, and improve the punctuality of services.

In the field of predictive maintenance, the collection and analysis of data on the performance of railway equipment and components enables the identification of patterns and anomalies that may indicate impending problems. This facilitates the implementation of predictive maintenance strategies, where failures are detected before they occur and appropriate maintenance is performed. As a result, unplanned train downtime is reduced, resources are optimized, and service reliability is improved.

Data analysis contributes to better safety management in the railway sector. Data can be used to identify incident patterns, analyze causes, and establish appropriate prevention measures. In addition, machine learning algorithms can be used for real-time monitoring of anomalous events and behaviors that may represent safety risks, enabling a faster and more efficient response to emergency situations.

In the area of passenger experience, with the use of data analytics, operators can more easily understand passengers' needs and desires, providing personalized recommendations, offers, and services tailored to each individual. This improves passenger satisfaction, strengthens loyalty and generates a more engaging travel experience.

Finally, it should be noted that analysis of historical and real-time data allows rail operators to make more informed and strategic decisions in network planning and expansion. They can identify demand patterns, evaluate the profitability of new routes and services, and perform simulations to assess the impact of different scenarios. This facilitates informed decision-making and helps maximize the efficiency and profitability of investments in rail infrastructure and services.

The study confirms that the railway sector has undergone a major transformation in recent years, largely thanks to the incorporation of innovative technologies. In this sense, it is interesting to analyze how the railway sector is dealing with enabling technologies to address the challenges mentioned above.

Figure 5 shows that the electronics and connectivity and data technology areas account for 68.34% of the total capacities the rail industry offers to face the future challenges. The development of electronic technology and connectivity has positively impacted rail innovation by improving operational efficiency, safety, passenger experience, capacity, and demand management. These advances have driven the digital transformation of the rail industry, enabling more efficient, reliable, and connected services. As technology continues to evolve, further advances and benefits are expected in the rail industry.

The electronics and connectivity solutions enable, as well as the implementation of advanced control and supervision systems in the railway sector, improving efficiency and operational safety. These systems allow real-time monitoring and control of the operation of trains, infrastructure, and other equipment. This facilitates early problem detection, predictive maintenance, and informed decision-making to improve efficiency and operational safety.

Connectivity also helps on the remote monitoring and maintenance of railway systems. Sensors and connected devices can collect data and send real-time information about the condition of trains and infrastructure. This enables continuous monitoring and proactive maintenance, resulting in reduced downtime and improved service availability and reliability.

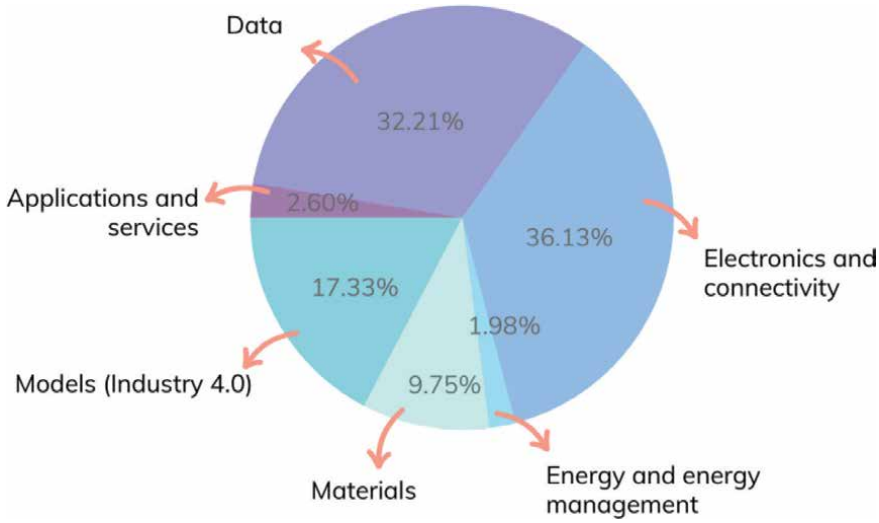


Figure 5.
Technology areas and capacities. Source: Own elaboration.

Furthermore, the solutions based on electronics and connectivity have brought a number of benefits for passengers. The availability of Wi-Fi, charging points for mobile devices, and entertainment systems have improved the travel experience and passenger comfort. In addition, connectivity makes it possible to provide real-time information on schedules, delays and other relevant data, allowing passengers to stay informed, and plan their trip more efficiently.

The results of the analysis show how these technological areas are related to the implementation of solutions based on electronics, connectivity, and data analysis, allowing the improvement of efficiency, safety, and sustainability of railway systems. Video surveillance systems, obstacle detection sensors, and real-time communication systems make it possible to respond quickly in emergency situations. In addition, connectivity facilitates communication between rail operators, security agencies, and responsible authorities in the event of incidents or crisis situations. Additionally, real-time information systems and data analysis algorithms help predict and manage passenger demand, optimizing the allocation of resources and avoiding situations of over-occupation or under-utilization of trains.

Also as shown in **Figure 5**, the technology areas of applications and services (2.60%) and energy management (1.98%) have shown the least capacity. These areas involve solutions that require greater investment in research and development to be able to offer effective solutions. More efficient propulsion systems have been implemented, such as electric motors and hybrid systems, which take advantage of the energy generated during regenerative braking. In addition, advanced algorithms and control systems have been developed to optimize energy consumption and minimize losses. Energy management has driven the development and implementation of energy storage solutions in the rail sector. High-capacity batteries and large-scale energy storage systems are used to store and efficiently utilize regenerative energy and energy from renewable sources. This helps to improve grid stability and ensure a constant supply of energy, even at times of high demand.

Moreover, energy management has contributed to the reduction of emissions in the railway sector. The adoption of cleaner and more efficient technologies has led

to a decrease in greenhouse gas emissions and other pollutants. In addition, renewable energy sources, such as solar and wind power, are being explored to power rail systems, further reducing the carbon footprint. Energy management has also had an impact on the development of charging infrastructures for electric trains. Fast charging and inductive charging systems have been implemented, enabling more efficient and faster recharging of trains. This improves the availability and efficiency of electric trains and facilitates the transition to the electrification of the rail network.

The analysis evidences how energy management technology has enabled better monitoring and control of energy consumption in real time. Intelligent energy management systems collect and analyze data on the energy consumption of trains, infrastructure, and other equipment. This makes it possible to identify energy saving opportunities, detect anomalies, and optimize energy use throughout the rail network.

In summary, the development of energy management technology is showing a positive impact on rail innovation by improving energy efficiency, reducing emissions, facilitating intelligent energy management, implementing storage solutions, and optimizing freight infrastructure. These advances not only improve the sustainability of the rail sector but also contribute to reduced operating costs and increased reliability of energy supply. As progress continues to be made in this area, more opportunities for continuous improvement and innovation in the rail sector are expected to be generated.

According to the analyzed data (see **Figure 6**), it can be observed that the technologies most applied by the entities are based on sensors, artificial intelligence, and data analytics, with percentages of 6.93, 6.3, and 5.72%, respectively. They are closely followed by edge computing, with 5.20%. Interestingly, a group of technologies is at the same level, with 5.17% usage, including actuators, predictive algorithms and control, big data, and positioning systems. However, other technologies, such as

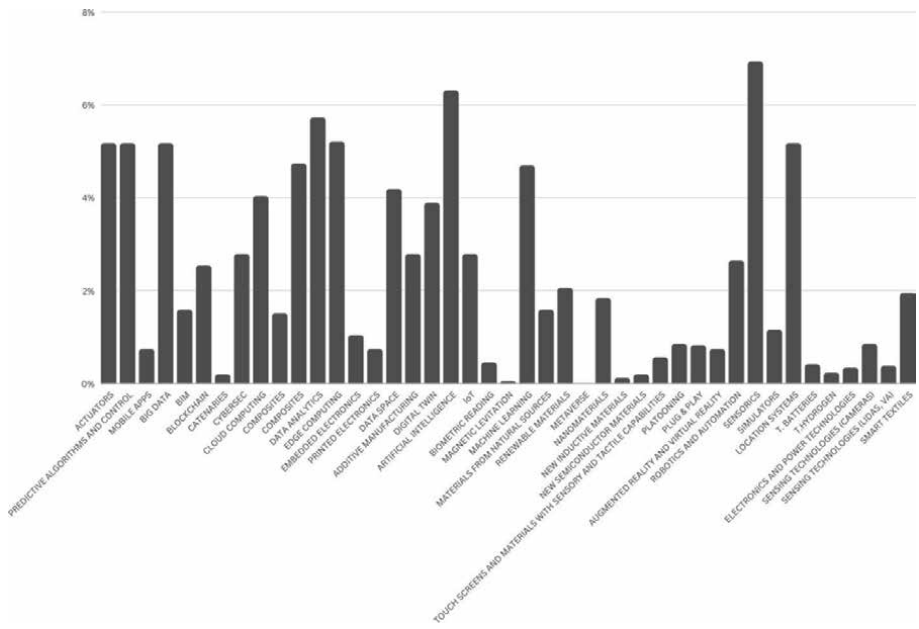


Figure 6.
Technologies and capacities. Source: Own elaboration.

metaverse and magnetic levitation, with 0 and 0.04%, respectively have not been deeply explored in the rail sector. Also in this group are new inductive materials and catenaries, with 0.11 and 0.18%, respectively.

6. Conclusions and future research

Europe aims to provide an integrated high-capacity rail network by removing barriers to interoperability and providing solutions for full integration, covering traffic management, vehicles, infrastructure, and services [5].

It is clear that innovation and technological development contribute to the development of the railway sector. Digitalization and automation are key factors that provide solutions to reduce rail costs, increase capacity and improve flexibility, making rail an attractive, accessible, competitive, efficient, and sustainable mode of transport that contributes to social cohesion and the mobility of passengers and freight.

The analysis carried out highlights a clear direction toward technological development in the rail sector, with a focus on crucial areas such as sustainability, efficiency, passenger experience, and freight transport. The strategic priorities identified in the study demonstrate the sector's capacity to adapt to a constantly changing environment, where the adoption of innovative technologies plays an essential role in the evolution and sustained growth of the industry.

In the area of sustainability, emphasis is placed on the importance of implementing new technological developments that reflect the rail sector's firm commitment to reducing environmental impact. The introduction of technologies, such as electric propulsion and energy recovery systems during braking, demonstrates a clear focus on energy efficiency and reduced emissions.

At the same time, in terms of efficiency, there is a strong determination to optimize resources and processes, which translates into a more efficient and profitable operation. The application of automation technologies and real-time data analysis enables accurate monitoring of infrastructure and trains, facilitating more efficient management of resources, and informed decision-making to minimize waiting times and maximize transport capacity.

Improving the user experience stands as a key pillar, driving improvements in comfort, entertainment, payment and access methods, and integrated mobility. This evolution holds the promise of generating more convenient and pleasurable travel experiences for passengers, thereby raising overall customer satisfaction. At the European level, this approach is helping to increase the percentage of passengers opting for rail transport.

In the field of freight transport, the search for efficiency in freight management is supported by innovative technologies such as real-time monitoring of the location and status of goods, traceability systems, and intelligent loading solutions. These tools streamline the logistics chain and enable more efficient distribution of goods, reducing costs, and delivery times.

However, there are numerous enabling technologies to be developed. The study shows that the sector has not exploited sensing technologies, blockchain, or the metaverse. There are several applications, such as the development of smart information windows, the use of night train for freight, smart stations, or door-to-door travel that could benefit from these developments.

It is, therefore, necessary to highlight the railway sector's continuous adaptation to changing demands through the strategic adoption of innovative technologies. The

evolution toward sustainability, efficiency, improved passenger experience, and freight transport reflects the industry's strong readiness to meet current and future challenges. With continued investment in research and development, it is anticipated that the rail sector will continue to transform and strengthen its ability to deliver efficient, safe, and high-quality services, consolidating its position as a vital and innovative part of the modern transport infrastructure.

Acknowledgements

We thank respondents who provided insight through the consultation sessions and give us the opportunity to analyze the results offering conclusions.

Funding

The study has been carried out under the RIN-Rail Innovation Network project, funded by the Basque Government in the Elkartek 2022 program (KK-2022/00027).

Availability of data and material

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Author details

Garazi Carranza Ruiz de Loizaga*, Oihane de la Rua Losada and Olatz Amorrortu
MAFEX-Spanish Rail Industry, Spain

*Address all correspondence to: garazi@mafex.es

References

[1] Ministerio para la Transición Ecológica y el Reto Demográfico. Objetivos de reducción de emisiones de gases de efecto invernadero. [Internet]. 2023. Available from: https://www.miteco.gob.es/es/cambio-climatico/temas/mitigacion-politicas-y-medidas/objetivos.aspx

[2] European Commission. Green deal. 2019. Available from: https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF

[3] Tattini J, Teter J. Tracking report. IEI—International Energy Agency; 2020

[4] Berger R. World Rail Market Study. Belgium: Commissioned by UNIFE; 2022. Conducted by Roland Berger

[5] European Commission. Europe's Rail Joint Undertaking Master Plan. 2022. Available from: https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_Master-Plan.pdf

Chapter 12

Operational Framework for Rural Tourism Destination Management and Marketing Organizations

Akram Abdulraqeb Sultan Al-Khaled

Abstract

Malaysia is recognized as a country that has all kinds of tourist attractions within it. Malaysia is famous for its urban tourism, ecotourism, rural tourism, rainforest tourism, island tourism and also culture tourism. The facet of tourism which is the focus of this research is cultural tourism. Cultural tourism is also affected by matters relating to cultural tourism sustainability. Tourism activities in Malaysia, both concerning cultural tourism development as well as the consumption of tourism services and products can have detrimental consequences on the sustainability of cultural tourism in Malaysia. There are studies that have shown that badly managed cultural tourism activities can cause significant detriment to the heritage sites, thus resulting in the cultural tourism activity becoming unsustainable. Examples of these sites include Genting Highlands and Taman Negara, both of which are experiencing an erosion of their cultural value due to the degradation of the environment. This can then have dire consequences on the culture, tourism and the environment.

Keywords: rural tourism practice, sustainable development, local communities, rural tourism, destination management

1. Introduction

Malaysia is recognized as a country that has all kinds of tourist attractions within it. Malaysia is famous for its urban tourism, ecotourism, rural tourism, rainforest tourism, island tourism and also culture tourism. The facet of tourism which is the focus of this research is cultural tourism. Cultural tourism is also affected by matters relating to cultural tourism sustainability. Tourism activities in Malaysia, both concerning cultural tourism development as well as the consumption of tourism services and products can have detrimental consequences on the sustainability of cultural tourism in Malaysia. There are studies that have shown that badly managed cultural tourism activities can cause significant detriment to the heritage sites, thus resulting in the cultural tourism activity becoming unsustainable. Examples of these sites include Genting Highlands and Taman Negara, both of which are experiencing an erosion of their cultural value due to the degradation of the environment. This can then have dire consequences on the culture tourism and the environment. For example, the disaster at the Genting Highlands in 2022 was the result of heavy rainfall and landslides, which

caused widespread damage and casualties. This event highlighted the risks associated with natural disasters and the need for preparedness and planning to mitigate their impact. Climate change is expected to increase the frequency and intensity of extreme weather events, such as heavy rainfall and landslides, which may increase the risk of similar disasters in the future. It is also important to consider the role of climate change in exacerbating such natural disasters, as the changing climate can cause increased frequency and intensity of extreme weather events. Therefore, it is essential that culture tourism management is carried out in a very strategic, responsible and sustainable way through the implementation and execution of effective public policies. This is to ensure that the culture tourism products and services in Malaysia are delivered to the consumers in a sustainable way. There are many justifications for this kind of a topic that investigates cultural heritage sites and the importance of preserving them through effective policies. These sites accentuate the fact in sustaining the culture that surrounds these sites and protects their sense of what they really are. The preservation of these sites provides a very strong connection to the past, to certain social values, beliefs, customs and traditions. It allows for an identification of oneself with others and deepens the sense of unity, belonging and national pride of societies. The main objective of this study is to examine the kind of policies needed to bring about the preservation of cultural heritage sites in Malaysia. The findings that are expected to be made consist of insights that can give an idea about a set of multipronged policies that can result in the preservation of cultural heritage sites. The implication of this study is that it will result in important cultural heritage sites being given protection through a set of laws and policies that preserve these sites.

Rural tourism is a kind of tourism that involves traveling and enjoying leisure activities in the countryside far, from the hustle and bustle of cities and crowded areas. It allows people to explore and experience the way of life the beautiful landscapes, unique traditions and rich culture [1]. Through rural tourism visitors, can connect with nature, immerse themselves in customs and get a true taste of how people live in rural communities. It is a part of promoting tourism by supporting economic growth, preserving cultural heritage and fostering environmental conservation in rural areas [2].

Community-based tourism (CBT) has been presented as an alternative means to traditional mass tourism in developing countries, and is developed as a community development tool that aids communities in seizing the tourism management and development and delivering benefits to the communities which are generated by tourism activities [3]. Furthermore, CBT as a community development tool helps to fortify and empower remote communities by assisting in tourism resource management and ensuring community participation [4].

Rural tourism provides a fulfilling adventure for both visitors and the local community. By highlighting the charm of areas, preserving traditions and promoting sustainable methods, rural tourism can play a significant role in advancing economic growth and protecting the environment [5]. To fully unlock its potential, it is essential to foster cooperation among important stakeholders involved, such as government entities, local communities, non-profit organizations and private businesses. This collaboration ensures that rural tourism benefits all parties while safeguarding the beauty and cultural heritage for generations [6].

Rural tourism presents an enriching adventure for both travelers and local communities. It showcases the breathtaking beauty of various rural areas, while also preserving their heritage and promoting sustainable practices [7]. This harmonious blend can be a catalyst for development and environmental conservation. To fully

unlock its potential, it requires collaboration among stakeholders including government bodies, local communities and NGOs. Rural areas boast landscapes, ecosystems and a tranquil ambiance [8]. Travelers yearn for moments of serenity, fresh air and an escape from the paced lifestyle. Rural communities are often guardians of traditions, local customs, folklore and artistic expressions that magnetize tourists seeking to immerse themselves in different ways of life [9]. Rural tourism offers visitors experiences without filters–a chance to engage with locals and gain insight into their activities like farming, handicrafts and traditional culinary practices [10].

Rural tourism has the potential to make a significant contribution to the economic growth of rural areas. When visitors are attracted to these areas, it supports not only businesses but also brings in income and creates job opportunities. Various stakeholders benefit from tourism-related activities, including accommodation providers, restaurants, transportation services artisans who create handicrafts and tour guides [11]. Additionally, the arrival of tourists often leads to improvements in infrastructure such as roads, communication facilities and hospitality services. These developments further enhance the region's attractiveness and overall living standards [12].

Ensuring the long-term viability of rural tourism necessitates embracing practices such as waste management, conservation of natural resources and fair distribution of economic benefits. Rural tourism often relies on the involvement of communities, which play a vital role in hosting tourists, providing accommodations, organizing guided tours and showcasing cultural events [13]. The experiences in tourism can differ depending on cycles, seasonal festivities and traditional celebrations. This allows visitors to witness and take part in one-of-a-kind events [14]. Collaborating with local business organizations and individuals is essential to ensure that rural tourism benefits everyone involved while preserving the cultural treasures for generations [15].

Malaysia's charm goes beyond its cities and it extends to the captivating rural landscapes that truly capture the essence of the country. To truly grasp tourism in Malaysia, it is essential for tourists to be capable of immersing themselves in the tapestry of cultures, traditions and natural beauty that defines this country [1]. Rural tourism is intricately intertwined with the lives of communities and their pristine surroundings. Within this particular rural tourism sphere, various institutions such as homestays, community-based tourism projects, agricultural tourism and ecotourism initiatives play a role in offering a sustainable travel experience [11].

It must be pointed out here that homestay programs hold a place within Malaysia's rural tourism sector. Facilitated by Malaysia's Ministry of Tourism, Arts and Culture these programs provide visitors with an opportunity to first-hand experience the lifestyle by living with local families and participating in their daily activities. These programs go beyond benefiting the tourism industry and they also promote exchange, boost local economies and contribute to overall rural development [16].

Community-based tourism projects are another component that supports communities while simultaneously preserving their environment and culture. These projects often involve villages working collaboratively with residents. These projects empower communities to effectively mobilize their resources in a seemly fashion while offering visitors an opportunity to immerse themselves in the authentic local culture [12].

In Malaysia's tourism scene, agricultural tourism, also known as agro-tourism plays a very important role in the Malaysian tourism industry. It allows tourists to delve into the country's side and experience first-hand the beauty of tea plantations and vast paddy fields. These initiatives, supported by the Ministry of Agriculture and Agro-Based Industry, provide income for farmers but also promote sustainable farming practices [16].

Ecotourism projects often intertwine with community-based efforts that focus on preserving and appreciating environments. They offer nature-centered experiences such as jungle trekking, wildlife observation and exploration of parks. Through these activities, they aim to raise awareness about conservation and educate tourists about biodiversity [17].

The operational framework of these rural tourism institutions is carefully designed to prioritize sustainability, foster local development and ensure visitor satisfaction [18]. The Malaysian government regulates these initiatives through ministries by providing guidelines that maintain authenticity and sustainability while encouraging the growth of rural tourism [16]. Striking a balance between preserving culture, traditions and natural surroundings while meeting evolving tourist expectations is very important in ensuring the success of rural tourism in Malaysia [19].

Besides that, it is essential to emphasize the importance of collaboration among the government, private sector and local communities. This collaboration ensures that everyone shares responsibility and reaps benefits [9]. The government oversees regulations and it also provides support to the private sector and this is by investing in marketing initiatives and the local communities contribute by offering experiences that have both economic and social advantages through tourism activities [5].

One of the strategies employed by these organizations involves capitalizing on the cultural and natural resources found in rural areas [2]. By focusing on these qualities, rural tourism establishments can create experiences that cater to a wide range of tourist's interests. These experiences can range from immersing themselves in cultures to exploring nature or engaging in agritourism and eco-adventures [20].

Malaysia's rural tourism institutions form a network comprising bodies, private entities and local communities working together to provide genuine, sustainable and one-of-a-kind tourism experience. The operational framework governing them ensures a balance between meeting tourists' needs while supporting economies, preserving culture and environment as well as fostering rural development [1].

2. Organized or casual leisure farm or agricultural site visits and perceptions

Malaysia can be described as a country known for its diversity and natural beauty and it is famous for its cities, stunning beaches and lush rainforests. However, the charm of areas often goes unnoticed. In recent years, rural tourism in Malaysia has become increasingly popular as it provides visitors with an opportunity to immerse themselves in the traditional and agrarian way of life [18].

Organized leisure farm visits are often arranged by tour operators and these tours are known to provide tourists with itineraries that showcase different aspects of rural life. These visits are carefully curated to ensure that tourists engage in activities that reflect traditions offering them a rounded experience [14]. One of the attractions of organized leisure farm visits is the chance to participate in agricultural practices. Visitors can get involved in planting crops, harvesting produce or even taking care of livestock, hence allowing them to fully immerse themselves in the rhythm of life. These hands-on experiences create a connection, with both the land itself and the people who rely on it for their livelihoods [17].

During these organized tours, tourists also have the opportunity to learn about crafts and skills that are deeply rooted within rural communities. Local artists often showcase crafts like weaving, pottery and wood carving, hence providing tourists a glimpse into the artistic heritage that has been passed down for generations. Engaging in these activities preserves not only traditions but also helps visitors to cultivate an appreciation for the skills and craftsmanship of the local communities [21].

Furthermore, organized visits to leisure farms often include trips to markets and small-scale businesses. Tourists get to interact with farmers and entrepreneurs gaining insights into the challenges they face and the creative solutions they employ [15]. This first-hand experience helps tourists grasp the importance of agriculture in economies and improves their appreciation for the work that goes into producing the food they enjoy [17].

It is understood here that spontaneous visits to leisure farms or agricultural sites offer a relaxed and flexible experience. Unlike tours, casual visits allow tourists to explore areas at their own pace, hence granting them the freedom to choose which activities they want to participate in. Casual visitors might stumble upon farms or agricultural sites while traveling through regions leading to unexpected and delightful encounters [18]. The authenticity provided by leisure farm visits is one of their attractions. Tourists have an opportunity to directly engage with farmers and villagers without any intermediaries from the tourism industry. This direct interaction provides a chance for an authentic exchange of cultures, ideas and experiences [14].

During visits, tourists also have the opportunity to taste cuisines made from fresh produce sourced from the farms they visit. Sharing a meal with the locals offers a glimpse into their lives and culinary traditions. Such experiences promote understanding and respect, and this has the effect of breaking down barriers and fostering unity between tourists and rural communities [13].

Both organized and casual visits to leisure farms contribute to shaping the perception of tourism in Malaysia. As tourists engage in these experiences, their views on life undergo transformations as notions and stereotypes are challenged. They develop an appreciation for the richness of culture, the resilience of communities and the interdependent relationship between humans and nature [12].

One common perception that often changes is the notion that rural life is dull or stagnant. Through leisure farm visits, tourists witness first-hand the vibrancy of economies and societies. They observe how rural communities adapt to changing times, while still preserving their traditions and values. This newfound understanding challenges an urban-centric worldview by encouraging a nuanced perspective on Malaysia's ways of living [16]. The way people perceive agriculture in today's society has undergone a shift. Many city dwellers view agriculture as something disconnected from their lives. However, when they visit leisure farms, they start to understand how important agriculture is in their lives. They begin to appreciate the importance of farming practices, the need to support farmers and the value of consuming locally-grown produce [11].

Informal visits to farms or agricultural sites are incredibly important for tourism in Malaysia. These visits provide tourists with an experience that challenges their preconceived notions, encourages cultural exchange and promotes sustainable tourism [10]. Whether it is through guided tours or spontaneous encounters, these visits offer an enriching glimpse into life. As more tourists embrace tourism in Malaysia, both tourists and rural communities benefit from an increased appreciation for heritage and the significance of agriculture [22].

3. Adventurous or mountaineering/rock-climbing tours and analysis

Beyond the cities and pristine beaches, Malaysia has a captivating beauty that extends to its magnificent mountain ranges and rock formations. These awe-inspiring landscapes attract adventure enthusiasts from all corners of the globe [1]. Rural tourism in Malaysia opens up thrilling opportunities for tourists to embark on mountaineering and rock-climbing expeditions. The rural areas of Malaysia offer thrill seekers a chance to conquer some of the peaks and cliffs in the region through mountaineering and rock-climbing tours. The country is blessed with mountain ranges like Mount Kinabalu in Sabah and Gunung Tahan in Taman Negara National Park. These mountains cater to climbers of varying skill levels accommodating both adventurers and beginners seeking challenges [2].

One of the draws for mountaineering enthusiasts in Malaysia is the opportunity to immerse themselves in nature's splendor. As climbers ascend these peaks, they traverse through ecosystems encountering unique plant life and wildlife that thrive at different altitudes. The lush rainforests cascading waterfalls and sweeping vistas create a captivating backdrop for this adventure fostering an appreciation for Malaysia's biodiversity [5].

Rock-climbing enthusiasts are also drawn to Malaysia for its limestone formations that are renowned worldwide. Popular climbing destinations like Batu Caves near Kuala Lumpur and Bukit Keteri in Perlis have become well-liked among climbers due to their challenging routes and stunning scenery. The rise in mountaineering and rock-climbing tours has had an impact on communities' economies [6]. These activities create opportunities for guides, porters and support staff offering them employment options and a source of income. Consequently, rural residents who previously relied on subsistence agriculture or traditional crafts can now explore livelihoods in the tourism industry contributing to the diversification of economies [11].

Furthermore, the growth of mountaineering and rock-climbing tourism leads to investments in infrastructure and services within areas. Local communities and authorities often invest in improving trail conditions establishing climbing facilities and upgrading accommodation options to meet the rising number of adventure tourists. These investments enhance the experience for visitors and also benefit local residents by providing improved amenities and services [12]. However, adventure tourism is about associating with a new culture or a new landscape and being physically active simultaneously. It is not about being risky or pushing visitors' boundaries. In fact, it is especially crucial to know and respect their limits while they are in an unfamiliar area. Mountaineering and rock-climbing activities can potentially strain ecosystems by causing soil erosion, littering or disrupting wildlife habitats. Uncontrolled tourism can become a problem when popular routes get overcrowded which worsens the impact on the environment [18].

To tackle these concerns, it is crucial to adopt sustainable tourism practices. Local authorities and tour operators should take steps to regulate tourist activities impose limits on the number of climbers and set up waste management systems to minimize harm to the environment. Besides that, raising awareness about climbing practices and educating tourists about the importance of preserving nature plays a role in fostering a culture of sustainability among adventure-seeking tourists [20].

Moreover, engaging and empowering communities in the decision-making processes is essential for the tourism industry. By involving residents in planning and managing tourism activities, it is possible to tap into their knowledge and expertise to ensure that tourism efforts align with preserving both cultural heritage and natural

beauty [1]. The impact of mountaineering and rock-climbing tourism goes beyond environmental aspects and it also plays a significant role in shaping social connections within rural communities. As adventure-seeking tourists interact with locals during their tours, they gain insights into ways of life, customs and cultural practices specific to rural Malaysians [5]. These interactions create opportunities for cultural exchanges that foster mutual understanding and appreciation between tourists and locals. The diverse mix of Malaysia's groups and their unique cultures truly come alive during these encounters creating an enriching experience for visitors [2]. Also, mountaineering and rock-climbing tours often cultivate a sense of camaraderie among participants. Climbers from different backgrounds and nationalities unite through their shared love for adventure and nature. This feeling of community and shared moments can have a lasting impact on individuals, hence inspiring them to advocate for tourism and conservation [5].

Rural Malaysia's mountaineering and rock-climbing tours offer adventure enthusiasts an experience amidst the country's natural surroundings. These activities are capable of testing climbers' physical and mental endurance and also provide an opportunity to appreciate the diverse ecosystems and cultural heritage of Malaysia [1]. However, it is crucial to adopt practices that minimize impact while involving local communities in decision-making processes to ensure the sustainability of adventure tourism [2]. When executed properly mountaineering and rock-climbing tourism can positively contribute to the well-being of communities by fostering growth, cultural exchange and a deeper admiration for Malaysia's natural splendor [20].

4. Rural resort management and other related issues & case studies

In recent years, there has been an increase in the popularity of rural tourism in Malaysia. Many tourists are now looking for immersive experiences in the countryside of this country. To meet the demands of these tourists, rural resorts have become crucial in providing a mix of nature, culture and relaxation. Rural tourism in Malaysia has seen a surge in popularity as more and more travelers yearn for immersive experiences amidst the country's countryside. Rural resorts play a role in meeting the demands of these explorers, offering a blend of nature, culture and comfort [20].

One primary reason behind the increasing favorability of tourism in Malaysia stems from travelers longing to escape the hectic pace and technology-driven environments found in urban life. Many tourists seek solace from bustling cities, they yarn for an experience that embraces tranquility. Rural areas provide a backdrop with landscapes and close proximity to nature, and this is a perfect haven for those seeking respite [2].

Furthermore, the growth of tourism can be attributed to the growing interest in ecotourism and sustainable travel practices. Today's travelers are increasingly aware of their impact on both the environment and local communities. They are inclined to support tourism initiatives that prioritize conservation efforts while preserving cultures. Rural resorts that adopt eco practices while promoting tourism appeal greatly to this environmentally conscious demographic [5].

Rural retreats offer an array of attractions that capture the interest of travelers seeking experiences. The charm lies in the chance to engage with communities participate in age customs and witness traditional practices that have been passed down through generations. Visitors can take part in activities like planting rice, fishing or creating handicrafts allowing them to gain an understanding of the way of life [6].

The cultural immersion provided by retreats promotes cultural exchanges and fosters mutual respect between travelers and local communities. Through interactions with villagers, visitors gain insights into the customs, traditions and values upheld by Malaysians. This intercultural engagement cultivates an appreciation for diversity and nurtures an understanding of the country's rich heritage [8].

Furthermore, rural retreats serve as platforms for promoting entrepreneurship and supporting artisans and businesses. These establishments often source their supplies and ingredients locally providing a marketplace for small-scale farmers and producers. By purchasing handicrafts and locally made goods, travelers contribute to the well-being of communities while helping preserve traditional crafts [7].

The economic impact of tourism extends beyond the resort facilities themselves. The impact of tourism in areas goes beyond the resorts themselves. It has an effect on various businesses nearby including restaurants, transportation services and souvenir shops. This increased tourist spending helps to boost the economy and creates job opportunities, hence reducing the reliance on agriculture as the sole source of income [19].

Another appealing aspect that attracts tourists to resorts is the chance to engage in activities and to look for adventure. Malaysia's diverse landscapes ranging from rolling hills to rainforests and majestic mountains offer a range of possibilities for recreational pursuits [22]. Activities like hiking and jungle trekking cater to travelers looking for thrilling experiences amidst the country's beauty [10].

To ensure growth in tourism, it is vital for resort management to prioritize sustainability and responsible practices. Conservation efforts should be at the core of how rural resorts operate in order to protect the resources that initially attract tourists. Implementing eco-initiatives like waste reduction and energy conservation can help to minimize their impact [11].

Moreover, establishing connections with communities is crucial for long-term success in rural tourism. Resort management should actively collaborate with villagers by involving them in decision-making processes and ensuring that they share in the benefits brought by tourism [16]. Promoting the involvement of the community in the tourism industry can be further strengthened through training programs and initiatives to build their capacity [12].

Over the years, both the Malaysian government and non-governmental organizations have acknowledged the potential of rural tourism in driving sustainable development. To attract tourists, efforts are underway to promote tourism and upgrade infrastructure in rural areas. This includes developing facilities like eco-parks, hiking trails and cultural centers to enhance the tourist experience and encourage longer stays in regions [13].

Successful case studies of managing resorts in Malaysia demonstrate how responsible and sustainable practices can positively impact communities and the tourism industry as a whole. These examples that will be provided below would serve as models for resorts emphasizing the significance of preserving cultural heritage, protecting the environment and actively engaging with local residents [18].

The rise of tourism in Malaysia can be attributed to a growing desire for travel experiences that deeply immerse visitors. Rural resorts play a role in meeting these demands by offering a blend of nature, culture and comfort [17]. The allure of tourism lies in opportunities for immersion, outdoor adventures and supporting sustainable initiatives. Rural resorts play a role in promoting environmentally friendly practices, which have a dual impact on the economic growth of rural areas and the preservation of Malaysia's natural and cultural heritage [21]. By focusing on the

development of rural tourism, there would be a beneficial relationship between tourists and local communities paving the way for a prosperous and enduring future for Malaysia's rural regions [20].

4.1 Case study 1: eco-adventure Pahang

The Eco Adventure Retreat, in Pahang serves as an example of how a rural resort can balance tourism and environmental preservation. Through the adoption of eco practices and active engagement with the community, the resort has successfully established a sustainable tourism model that benefits both visitors and the surrounding environment [20].

A fundamental pillar of the Eco Adventure Retreats sustainability approach lies in its dedication to minimizing its carbon footprint. The resort has implemented initiatives aimed at mitigating its carbon footprint and conserving resources. For instance, they have embraced rainwater harvesting as a means to reduce reliance on groundwater and alleviate pressure on the water supply, which is particularly crucial in rural areas with limited access to water sources [23].

In line with their commitment to sustainability, solar power plays a role at the Eco Adventure Retreat. By harnessing the sunlight in the region, they generate energy to power their facilities and operations. This reliance on energy reduces not only dependency on non-renewable sources but also contributes toward efforts in combating climate change [2].

Effective waste management is another aspect of their eco practices. The management has implemented a waste management system that promotes recycling and minimizes waste sent to landfills [23]. The resort takes care to educate tourists on waste disposal with strategically placed recycling bins throughout the premises. This helps to reduce waste and make an impact on the environment contributing to a cleaner and more eco-friendly community [24].

In addition, the Eco Adventure Retreat actively participates in reforestation efforts to restore the surrounding forest areas. The resort places importance on preserving biodiversity and recognizes the valuable ecological services provided by forests [23]. By organizing tree-planting activities, the resort is able to offset its carbon emissions, and also creates a welcoming habitat for wildlife and protects the local watershed [5].

One of the resort's sustainability initiatives is educating guests about tourism. Through workshops and guided nature walks, tourists are made aware of the ecosystem they have come to explore. By sharing knowledge about flora and fauna and promoting practices, the resort empowers visitors to become conscious travelers and advocates for preserving our environment [8].

Beyond its endeavors, the Eco Adventure Retreat has formed a partnership with the local community. Understanding that community involvement is crucial for tourism, villagers are actively engaged in aspects of resort operations [23]. The Eco Adventure Retreat in Pahang Malaysia goes above and beyond to offer guests experiences. They involve artisans and performers who provide a taste of the local way of life, allowing tourists to fully immerse themselves in the community [11].

Moreover, the resort's dedication to supporting the economy is commendable. They actively source special local food and handicrafts for their gift shop which boosts economic activity in surrounding villages and also helps to preserve traditional crafts and practices. In addition to these efforts, the Eco Adventure Retreat understands the significance of giving back to the community [23]. They reinvest a portion of their revenue into community projects, such as education and infrastructure

development. This approach ensures that local residents benefit from tourism and feel a sense of pride and ownership in their heritage [16].

By engaging with the community and promoting responsible tourism among visitors, the Eco Adventure Retreat has become a shining example of sustainable rural resort management in Malaysia. Their success demonstrates that it is possible to strike a balance between catering to tourists' needs while preserving both the environment and local culture [12].

Rural resorts like the Eco Adventure Retreat play a role in driving the growth of tourism throughout Malaysia. These resorts are meeting the increasing demand for responsible travel by providing tourists with immersive experiences in the countryside [23]. The Eco Adventure Retreat sets an example of management for resorts through its eco-friendly practices and community involvement, demonstrating that tourism can have a positive impact on rural areas [13]. As more people are attracted to tourism, it is crucial for other resorts to follow suit by adopting practices and contributing to the sustainable development of Malaysia's rural regions [18].

4.2 Case study 2: agro-Tourism Farmstay Sabah

The Agro-Tourism Farmstay in Sabah showcases an approach to managing resorts by offering tourists an immersive experience in traditional farming practices. However, the resort encounters challenges that require navigation to ensure its long-term success and sustainability [25]. A major hurdle faced by the Agro-Tourism Farmstay is retaining personnel to handle day-to-day operations [26]. The resort's rural location surrounded by landscapes poses difficulties in recruiting qualified staff due to the absence of urban amenities and lower wages compared to urban areas. Potential employees might be enticed by rewarding opportunities in hospitality establishments located in cities, leaving the resort with a limited pool of talented individuals [16].

In order to address this issue, the resort management has implemented strategies focused on investing in the growth of the workforce. By providing training and skill development opportunities for residents from villages, the resort creates a pipeline of employees who have a vested interest in its success [25]. These training programs would not equip individuals with valuable skills, but also offer them promising prospects for career advancement within the resort's operations [1].

Furthermore, the resort management actively fosters a sense of ownership and pride among the community regarding the achievements of the resort. By involving the community in decision-making and providing employment opportunities, the Agro-Tourism Farmstay plays a role in supporting the economic well-being of the villagers [25]. This beneficial relationship ensures that the advantages of tourism are fairly distributed and the success of the resort becomes intertwined with the prosperity of the surrounding villages [2].

Dealing with seasonality poses another challenge for the Agro-Tourism Farmstay as visitor numbers fluctuate throughout the year like tourist destinations. During peak seasons like school holidays and festive periods, there is an influx of tourists seeking a getaway. The resort must be well prepared to accommodate these numbers while still delivering top-notch service as expected by its guests [8].

During off-peak seasons, maintaining an income to support year-round operations becomes challenging for the resort. With tourists visiting during these months, strategies need to be devised to attract visitors and generate revenue [7]. To tackle this seasonality issue, the Agro-Tourism Farmstay positions itself as a destination for

retreats and team-building activities. Corporate groups are drawn to this setting during off-peak periods, for team-building exercises and workshops [11]. To ensure a flow of visitors throughout the year and reduce the impact of fluctuations on financial sustainability, the resort cleverly markets itself as an ideal venue for corporate events [16].

Moreover, by attracting corporate visitor groups, the management creates opportunities for engagement with rural communities through various corporate social responsibility initiatives. During their stay, corporate clients can actively participate in community development projects. These initiatives benefit not only the well-being of the surrounding communities but also strengthen the resorts' bond with the local population [12].

Furthermore, to diversify its sources of revenue, the Agro-Tourism Farmstay has embraced tourism as a core concept. In addition to providing accommodation services, this resort offers tourists an experience in farming practices. Visitors can immerse themselves in activities like planting crops, harvesting produce and taking care of livestock, and this is a hands-on encounter with life [18].

The introduction of tourism enhances not only guests' experiences but also generates additional income streams for the resort. Tourists are often willing to pay for experiences while seeking eco-friendly and sustainable travel options [15]. To ensure that Agro-Tourism remains sustainable, it is crucial for the resort to find a balance between meeting the demands of tourists and preserving the environment and culture. The management of the resort should implement practices to safeguard the resources in the area ensuring that tourist activities do not cause any harm to the ecosystem [1]. Furthermore, the resort can collaborate with farmers and artisans to source produce and handicrafts that can be sold to tourists. This collaboration supports not only the economy but also promotes traditional crafts and agricultural methods [2].

Sabah's Agro-Tourism Farmstay offers an approach to managing resorts by providing tourists with an authentic experience in traditional farming practices. To overcome challenges like attracting staff and managing fluctuations in tourist arrivals, the resort has implemented strategies that prioritize community involvement, professional development for local workers and diversification of income sources [1].

By involving and investing in the development of the community, the resort fosters a mutually beneficial relationship between tourists and rural residents. Moreover, their commitment to promoting responsible practices through tourism demonstrates their dedication to a better future [2]. As tourism in Malaysia flourishes, resorts such as the Agro-Tourism Farmstay set an example for tourism showcasing how tourism can bring positive transformation to rural areas. By finding a ground between meeting the needs of tourists and preserving the environment and culture, these resorts play a vital role in fostering sustainable development in rural regions, while also sharing Malaysia's vibrant cultural legacy with the global community [25].

4.3 Case study 3: Genting Highlands case study

Genting Highlands stands as a fascinating case study of tourism in Malaysia. Situated amidst the Titiwangsa Mountains and an hour's drive away from Kuala Lumpur, this area has transformed into one of the most sought-after tourist destinations in the country. With its climate, landscapes and abundance of attractions, Genting Highlands has become a beloved retreat for both locals and international travelers [1].

In the 1960s, Genting Group, led by Malaysian entrepreneur Tan Sri Lim Goh Tong embarked on developing Genting Highlands. The grand vision was to create a resort

that offered visitors an escape from the sweltering heat and humidity of the lowlands while providing a range of leisure activities and entertainment options [27]. The journey began with the establishment of Genting Hotel and a splendid golf course soon followed by Malaysia's casino known as Casino de Genting [5].

Thanks to its strategic location and visionary leadership under Tan Sri Lim Goh Tongs guidance, Genting Highlands swiftly emerged as a prominent player in Malaysia's tourism industry. Genting Highlands has gained popularity among city dwellers looking for a getaway due to its proximity to the capital city Kuala Lumpur and easy access via constructed roads [6].

The resort's continuous expansion has added to its allure. The completion of the Genting Skyway cable car system in 1997 has provided a convenient mode of transportation from the foothills to the peak offering views of the surrounding rainforest and mountains. Moreover, the Genting Highlands Theme Park, which has undergone renovations and upgrades over time has become an attraction for families and thrill seekers alike [27].

One of the factors contributing to Genting Highlands' success as a tourism destination is its wide range of attractions and amenities. Apart from the casino and theme park, visitors can engage in outdoor activities such as shopping at the SkyAvenue mall, enjoying diverse dining options, witnessing cultural shows or indulging in outdoor adventures like nature walks and jungle trekking [27].

In addition to its array of offerings, Genting Highlands takes advantage of its setting by hosting an array of events and entertainment shows that attract international tourists. Concerts, festivals and cultural performances are regularly organized throughout the year to provide visitors with a vibrant experience [1]. Genting Highlands has successfully attracted a range of tourists due to its offerings. It caters to families in search of a fun-filled vacation, couples seeking a getaway and even gamblers looking for entertainment and gaming. This broad appeal ensures a stream of visitors throughout the year making Genting Highlands a preferred destination [9].

One of the factors contributing to Genting Highlands' success is its variety of accommodation options. The resort offers hotels and resorts that cater to budgets and preferences, ensuring that visitors from all walks of life can find lodging. From hotels with breathtaking views to affordable choices, Genting Highlands has taken care of the needs of various types of travelers. However, as Genting Highlands rapidly develops and expands, it faces challenges [27]. The growth in infrastructure and tourist facilities has had an impact on the environment resulting in deforestation and disruption to the ecosystem. Moreover, with its increasing popularity comes pressure on the community. Employment opportunities are affected as living costs for those residing nearby increase [16].

While Genting Highlands has provided job opportunities for the community, the increasing number of tourists has resulted in rising housing prices and living expenses, hence making it difficult for some residents to afford accommodation and maintain their traditional way of life [1]. Furthermore, the significant influx of tourists has raised concerns regarding waste management and environmental sustainability. The large volume of visitors generates an amount of waste. If not properly managed, this can lead to pollution and degradation of the environment. To ensure that Genting Highlands remains a tourism destination in the long run both resort management and relevant authorities must actively address these environmental issues [27].

To mitigate these effects on the environment, the Genting Group has implemented sustainability practices. They have introduced initiatives aimed at reducing waste generation and promoting recycling [2]. Additionally, they have adopted energy-saving measures to minimize their carbon footprint and conserve resources. These efforts are

crucial in preserving the region's beauty for future generations of both tourists and locals [20]. Despite the challenges faced, Genting Highlands continues to thrive as a rural tourism destination in Malaysia. The resort's ability to adapt to changing consumer preferences through expansion and innovative approaches has been vital to its success. This showcases the resilience and thinking mindset of the Genting Group [27].

Genting Highlands is a case study of tourism in Malaysia. It has come a long way from its beginnings and is now a thriving tourism hub. This success can be attributed to the leadership, strategic location and a wide range of attractions the resort offers. However, there are also challenges that need to be addressed, such as managing its impact and ensuring the well-being of the community [16]. To maintain its reputation as a tourism destination, it is crucial to strike a balance between tourism growth and preserving the environment while actively involving the community. Genting Highlands serves as an example for the tourism industry, shedding light on both the opportunities and obstacles associated with rural tourism development, in Malaysia [1].

5. Tourist behaviors and cultural impact on local rural population and case studies

In years the past few years, rural tourism in Malaysia has experienced growth, hence enticing travelers who are looking for genuine experiences in the countryside. This phenomenon has had an impact on the rural communities shaping their cultural identity and way of living [2].

5.1 Case study on Sarawak

Sarawak is situated on the island of Borneo and is renowned for its range of cultures and captivating natural attractions. Rural tourism in Sarawak attracts visitors who are eager to immerse themselves in the traditions and ways of life of various indigenous communities [28]. When tourists explore Sarawak, they actively engage in experiences, such as attending traditional ceremonies witnessing tribal dances and visiting longhouses to gain insights into local customs and lifestyles [20]. In an effort to promote tourism practices while supporting communities' economic well-being, Sarawak has introduced community-based ecotourism initiatives that allow tourists to stay with local communities [26]. Visitors can also participate in activities like jungle trekking, handicraft-making workshops and traditional cooking sessions [1].

The impact of tourism on the fabric of Sarawak is a complex issue with both positive and negative implications. On one hand, the interest and appreciation demonstrated by tourists toward Sarawak's cultures have instilled a sense of pride among the rural population. They actively celebrate their customs and practices as aspects of their identity [25]. Additionally, tourism has opened up avenues for communities through community-based initiatives [26]. The income generated from these tourism activities has played a role in supporting livelihoods while facilitating the preservation of traditional crafts and skills. However, there are concerns regarding the commercialization of indigenous culture that need to be addressed proactively [11].

Sometimes when it comes to tourists, traditional ceremonies and dances might undergo changes or simplifications which could result in them losing their authenticity and cultural significance [26]. As tourism brings in influences, younger generations within communities may become more attracted to modern ways of life, potentially causing certain cultural practices to gradually fade away over time [16].

5.2 Terengganu case study

Terengganu is situated on the coast of Peninsular Malaysia and is renowned for its unspoiled beaches, traditional Malay architecture and vibrant cultural legacy. When visiting Terengganu, tourists have the opportunity to immerse themselves in the Malay way of life. Exploring fishing villages and engaging with fishing communities are common activities for visitors in rural Terengganu [29]. They can learn about fishing techniques first-hand and savor the taste of freshly caught seafood. Alongside these experiences, cultural festivals like the Terengganu International Squid Jigging Festival attract tourists seeking a glimpse into Malay celebrations and captivating cultural performances [1].

The impact of tourism on the population in Terengganu presents both positive and negative aspects. Tourism has opened up opportunities for fishing communities in Terengganu. Visitors' interest in fishing practices and coastal experiences has become a source of income for fishermen and their families. The preservation and promotion of Malay festivals and events have also been bolstered by tourism [30]. Local communities take pride in showcasing their heritage to visitors, ensuring that cherished customs continue to thrive. However, it is important to note that tourism can disrupt fishing practices and the local way of life. In areas where over-tourism occurs, there may be degradation as well as strain on local resources [29]. Additionally, there is a risk of some tourism offerings presenting portrayals of culture purely for commercial gain, hence potentially diluting the true essence of local customs [2].

5.3 Johor case study

Johor is a state that is situated in the part of Peninsular Malaysia and it offers a blend of rural and urban tourism opportunities. The rural areas of Johor are especially appealing to visitors seeking experiences and cultural encounters [31]. Agricultural tourism has gained popularity in the countryside of Johor, where tourists can explore farms and plantations, while learning about farming practices and even engage in fruit-picking activities. Additionally, Johor is rich in heritage tourism with tourists immersing themselves in the sites and cultural landmarks it has to offer. A few notable places include the Johor Bahru Old Chinese Temple and the Royal Abu Bakar Museum [28].

The impact of tourism on the population in Johor carries both positive and negative aspects from a cultural standpoint. On one hand, agricultural tourism has provided farmers and plantation owners with income sources by opening their doors to tourists. This diversification has proven beneficial for locals who appreciate revenue streams [20]. On another note, heritage tourism plays a role in preserving sites and cultural landmarks as tourist interest encourages their conservation efforts [28]. However, it is important to note that there are instances where over commercialization of tourism can raise concerns regarding resource exploitation and environmental sustainability. Managing visitor influxes and preserving structures pose challenges for heritage sites, amidst increased tourist arrivals [31].

6. Other relevant topics

Rural tourism in Malaysia is an ever-changing industry that covers a range of subjects and factors. In addition to the mentioned themes above, there are important topics that play a role in the expansion and progress of rural tourism in the country.

Rural regions in Malaysia are known for their heritage comprising of ancient temples, traditional villages and colonial-era structures scattered across the landscape. Preserving these landmarks is important to ensure they can be enjoyed by tourists and local communities alike. To achieve the conservation efforts, it encompasses restoration, maintenance and educational initiatives aimed at safeguarding the country's legacy [20].

Rural areas thrive with entrepreneurship and the flourishing of businesses because of rural tourism. Numerous communities in regions have initiated home-based enterprises, artisanal crafts and Agro-Tourism initiatives. These endeavors have contributed to diversification and also empowered the locals [2]. Improving the abilities and knowledge of communities engaged in tourism is essential to ensure visitors have a great experience. It is important to offer training programs that focus on hospitality, customer service, language skills and cultural understanding. This will enhance the quality of tourism experiences [5].

Given the growing urgency of climate change, it is crucial to prioritize practices in rural tourism. By embracing eco methods, minimizing the carbon footprint and endorsing energy projects, it is possible to play a significant role in minimizing the negative effects of tourism on the environment [6].

Author details

Akram Abdulraqeb Sultan Al-Khaled
Faculty of Business, Berjaya University College, Kuala Lumpur, Malaysia

*Address all correspondence to: akram.abdulraqeb@berjaya.edu.my

References

[1] Lo MC, Ramayah T, Yeo AW. Harmonizing rural tourism and rural communities in Malaysia. Journal of Sustainable Development. 2016;**9**(4). DOI: 10.5539/jsd.v9n4p27

[2] Lane B, Kastenholz E, Carneiro MJ. Rural tourism and sustainability: A special issue, review and update for the opening years of the twenty-first century. Sustainability. 2022;**14**(10):6070. DOI: 10.3390/SU14106070

[3] Trejos B, Chiang LHN. Local economic linkages to community-based tourism in rural Costa Rica. Singapore Journal of Tropical Geography. 2009;**30**:373-387. DOI: 10.1111/j.1467-9493.2009.00375.x

[4] Jamal T, Stronza A. Collaboration theory and tourism practice in protected areas: Stakeholders, structuring and sustainability. Journal of Sustainable Tourism. 2009;**17**:169-189. DOI: 10.1080/09669580802495741

[5] Campillo-Alhama C, Martínez-Sala AM. Tourism marketing strategy of world heritage sites through 2.0 events. PASOS Revista de Turismo y Patrimonio Cultural. 2019;**17**(2):425-452. DOI: 10.25145/J.PASOS.2019.17.029

[6] López-Sanz JM, Penelas-Leguía A, Gutiérrez-Rodríguez P, Cuesta-Valiño P. Rural tourism and the sustainable development goals. A study of the variables that most influence the behavior of the tourist. Frontiers in Psychology. 2021;**12**:722973. DOI: 10.3389/FPSYG.2021.722973/BIBTEX

[7] Cruz Ruiz E, Bermúdez González G, Tous Zamora D. Destination image, satisfaction and destination loyalty in cruise tourism: The case of Málaga (Spain). Tourism & Management Studies. 2018;**14**(1):58-68. DOI: 10.18089/TMS.2018.14105

[8] Carlos Castro J, Quisimalin M, de Pablos C, Gancino V, Jerez J. Tourism marketing: Measuring tourist satisfaction. Journal of Service Science and Management. 2017;**10**(03):280-308. DOI: 10.4236/JSSM.2017.103023

[9] Herle F-A. The impact of destination image on tourists' satisfaction and loyalty in the context of domestic tourism. Marketing–From Information to Decision Journal. 2018;**1**(2):14-26. DOI: 10.2478/MIDJ-2018-0007

[10] Kristjánsdóttir KR, Ólafsdóttir R, Ragnarsdóttir KV. Reviewing integrated sustainability indicators for tourism. Journal of Sustainable Tourism. 2018;**26**(4):583-599. DOI: 10.1080/09669582.2017.1364741

[11] Isa MI, Rahman NA, Abdullah K, Ahmad AL, Mohamad MR, Rahmat A, et al. Development of rural tourism in Perak Tengah district based on local authority perspectives. Planning Malaysia. 2022;**20**(4):405-419. DOI: 10.21837/PM.V20I23.1175

[12] Kumar S, Valeri M, Shekhar. Understanding the relationship among factors influencing rural tourism: A hierarchical approach. Journal of Organizational Change Management. 2022;**35**(2):385-407. DOI: 10.1108/JOCM-01-2021-0006

[13] Kanwal S, Rasheed MI, Pitafi AH, Pitafi A, Ren M. Road and transport infrastructure development and community support for tourism: The role of perceived benefits, and

community satisfaction. Tourism Management. 2020;**77**. DOI: 10.1016/J.TOURMAN.2019.104014

[14] Chin CH. Empirical research on the competitiveness of rural tourism destinations: A practical plan for rural tourism industry post-COVID-19. Consumer Behavior in Tourism and Hospitality. 2022;**17**(2):211-231. DOI: 10.1108/CBTH-07-2021-0169

[15] Giambona F, Grassini L. Tourism attractiveness in Italy: Regional empirical evidence using a pairwise comparisons modelling approach. International Journal of Tourism Research. 2020;**22**(1):26-41. DOI: 10.1002/JTR.2316

[16] Amir S, Dura NH, Yusof MA, Nakamura H, Nong RA. Challenges of smart tourism in Malaysia eco-tourism destinations. Planning Malaysia. 2020;**18**(4):442-451. DOI: 10.21837/PM.V18I14.844

[17] Rosalina PD, Dupre K, Wang Y. Rural tourism: A systematic literature review on definitions and challenges. Journal of Hospitality and Tourism Management. 2021;**47**:134-149. DOI: 10.1016/J.JHTM.2021.03.001

[18] Isa MI. Evolution of waterfront development in Lumut City, Perak, Malaysia. Planning Malaysia. 2020;**18**(3):104-117. DOI: 10.21837/PM.V18I13.778

[19] Yoopetch C, Nimsai S. Science mapping the knowledge base on sustainable tourism development, 1990-2018. Sustainability (Switzerland). 2019;**11**(13). DOI: 10.3390/SU11133631

[20] Lo MC, Chin CH, Law FY. Tourists' perspectives on hard and soft services toward rural tourism destination competitiveness: Community support as a moderator. 2017;**19**(2):139-157. DOI: 10.1177/1467358417715677

[21] Hayes S, Tucker H. Using synchronous hybrid pedagogy to nurture a community of inquiry: Insights from a tourism master's programme. Journal of Hospitability Leisure Sport & Tourism Education. 2021;**29**:100339. DOI: 10.1016/j.jhlste.2021.100339

[22] An W, Alarcón S. How can rural tourism be sustainable? A systematic review. Sustainability. 2020;**12**(18):7758. DOI: 10.3390/SU12187758

[23] Janjua ZA, Krishnapillai G, Rehman M. Importance of the sustainability tourism marketing practices: An insight from rural community-based homestays in Malaysia. Journal of Hospitality and Tourism Insights. 2023;**6**(2):575-594. DOI: 10.1108/JHTI-10-2021-0274/FULL/XML

[24] Job H, Bittlingmaier S, Mayer M, von Ruschkowski E, Woltering M. Park–people relationships: The socioeconomic monitoring of national parks in Bavaria, Germany. Sustainability (Switzerland). 2021;**13**(16). DOI: 10.3390/SU13168984

[25] Kamarudin KH, Wahid SNA, Chong NO. Challenges for community based rural tourism continuity and resilience in disaster prone area: The case of Mesilou, Sabah. IOP Conference Series: Earth and Environmental Science. 2020;**409**(1):012003. DOI: 10.1088/1755-1315/409/1/012003

[26] Chin CH, Thian SSZ, Lo MC. Community's experiential knowledge on the development of rural tourism competitive advantage: A study on Kampung Semadang–Borneo Heights, Sarawak. Tourism Review. 2017;**72**(2):238-260. DOI: 10.1108/TR-12-2016-0056/FULL/XML

[27] Kean Hua A. Highlands sustainable development and tourist's satisfaction: A grounded model study. Journal of Tourism, Hospitality & Culinary Arts (JTHCA). n.d.;**10**(2):12-22. 2018

[28] Chong NO, Kamarudin KH, Abd Wahid SN. Framework considerations for community resilient towards disaster in Malaysia. Procedia Engineering. 2018;**212**:165-172. DOI: 10.1016/j.proeng.2018.01.022

[29] Afthanorhan A, Awang Z, Fazella S. Perception of tourism impact and support tourism development in Terengganu, Malaysia. Social Sciences. 2017, 2017;**6**(3):106. DOI: 10.3390/SOCSCI6030106

[30] Bachok S, Amin TATM, Rahman SAA. In pursuit of economically competitive agro-tourism sector: The case of Terengganu homestay, Malaysia. Planning Malaysia. 2018;**16**(2):164-174. DOI: 10.21837/PM.V16I6.471

[31] Saad M, Abdullah NN, Nur S, Rosman H. Developing the rural town of Panchor into a future river-based tourism destination: Host community perception. In: AIVCE-BS-1, 2020 ShahAlam. 2020. pp. 2398-4287. DOI: 10.21834/ebpj.v5i14.2236

Edited by Vito Bobek and Tatjana Horvat

Dive into a compelling exploration of contemporary business and management paradigms with the Annual Volume 2023. This edition offers a mosaic of perspectives on organizational commitment, innovation's role in competitive advantage, fiscal sustainability in dynamic economies, and the strategic implications of taxation and digital transformation. Delve into nuanced analyses covering diverse sectors, from agribusiness to rail technology, illuminating the intricate relationships between learning, innovation, and strategic agility. Uncover the evolving landscapes of energy, taxation, and economic policies, steering discussions on workforce management, rural tourism, and game theory's application to business strategy. Engaging and thought-provoking, this volume presents diverse lenses into the dynamic intersections of business, economics, and strategic management.

Taufiq Choudhry,
Business, Management and Economics Series Editor

ISSN 2753-894X
ISBN 978-0-85014-524-3

Published in London, UK

IntechOpen