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Disruptive Business Model Innovation and Digital Transformation

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Abstract

Background: Innovating how organisations run their business is a strategic decision to create more value for customers using or consuming the product and/or service provided. In addition to the incentive of everybody embracing digital transformation, digital technologies, and digital innovation, which frame changes of operating business models today, disruptions, i.e., another incentive that occurs suddenly and impacts globally, all force businesses to adapt and change. **Objectives:** This research aims to provide a conceptual model that can be used for organisations to evaluate and propose feasible options for responding to disruptions that influence the businesses' strategic innovation initiatives while assisting decision-makers in choosing the most appropriate option. **Methods/Approach:** Considering internal and external factors that influence digital transformation, the conceptual framework is designed to assess readiness and willingness to transform and create opportunities for future success digitally. **Results:** A conceptual framework was developed, tested, and demonstrated in a case study. The case study organisation rated positively the composition of steps to be perf readiness and willingness and choose the most feasible option to change. **Conclusions:** The digital environment and the influence of disruptions force organisations to change. The conceptual framework developed in this research helps the management choose the most feasible change option about the real as-is and the desired to-be state.

Keywords: Digital Transformation, Business model innovation, Disruption, Framework, Assessment, Case study

JEL classification: O33, O32, O31, M15, L86
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Introduction

The complexity of organisations and their environment is rapidly increasing, creating constant innovative change in business activities, resulting in products and services aligned with the new customer and stakeholder's needs. Digital, Business Model, Digital Business Model, Digital Technology, Digital Innovation, Digital Transformation, and Digital Entrepreneurship are seven terms identified within the literature as the ones affecting innovation and change the most (Bican & Brem, 2020).

Disruptions, as situations or events that cause an interruption of the usual flow of processes, have the potential to be the driving force of innovation and change, with consequences that are difficult to predict, as evident from the latest global Covid-19 pandemic and the way it has significantly changed the world.

Business models describe what benefits a company provides to customers and partners and how those benefits are transformed into revenue (Schallmo et al., 2017). They illustrate selected aspects of how the company transforms resources and builds relationships with other market participants (Becker et al., 2021). Often, business models are considered as one-page canvas-like blueprints describing (new) value propositions, as well as supportive and constructive elements contributing to delivering the designed value.

Business model canvas (Osterwalder et al., 2015), as the most used and cited business model framework, is divided into nine building blocks or elements, grouped into four sections: customer (relationships with customers, customer segments and channels), organisation (key partners, activities, and resources), value (innovations of services or product through possibilities new technologies provide) and finance (costs and revenue streams). Operationalization of the business model canvas (Osterwalder et al., 2015) and other canvas-like frameworks has been made in Business process modeling Billboard (vom Brocke et al., 2021).

Business model innovation comprises changing one or several business model elements or their interconnections (Foss & Saebi, 2017). It can be driven by the goal to adapt to a new customer need (customer-driven), by enhancement or use of new emerging technology or a mainstream technology in an evolutional manner (technology-driven), or the need or necessity to improve usual workflows and structures which support the workflows (organisational development driven) (Hrustek et al., 2019).

The global COVID-19 pandemic has revealed a new driver of change, namely a disruption (Kutnjak, 2021), which can appear suddenly, can have a disruption or great impact on the way business is done, which affects an organisation in a vortex (Loucks et al., 2016) similar behaviour within an industry and seeks for the fast or agile response. Disruptions can cause supply uncertainties and pose risks for input resource shortage, delays, overstocking, and negative financial results (Chen & Liu, 2021). Crises often create space for new business models that "encompass new capabilities, new value propositions, and new value demonstrations, and address new customer needs" (Ritter & Pedersen, 2020, p. 216). In the past, many disruptions have affected businesses and their usual business models (like the financial crisis 2008) and caused massive responses in the industry or industries affected. Still, they didn't have such a global effect as the latest health-related one. In addition, d, as a radical change and innovation opportunity raised from digitally enabled channels, digital transformation ned possibilities beyond what was considered possible or feasible (Brown, 2019). Hence, the newest crisis requires a global and faster adjustment.

Digital transformation is a concept that has marked the innovation process in the last 5-7 years (Pihir et al., 2018) significantly since it experienced rapid enrichment through new approaches, frameworks, and methods. Digital technologies have a

great impact on organisational strategic goals achievement. Service providers of information and communication technologies have to "focus on business model experimentation" to harmonise "their organisation's strategies with disruptive and/or innovative digital transformation" (Clohessy et al., 2017). Successful digital transformation has proven elusive despite all efforts, as only one in six organisations sees the expected results (Gale & Aarons, 2018). Meanwhile, according to a survey by Gale and Aarons on a sample of 135 managers in US Fortune-level organisations, over 88 percent of companies have major initiatives to become digitally transformed in the next three years (Gale & Aarons, 2017).

Motivated by the previously described context, this paper proposes a conceptual framework that can help organisations influenced by disruptions of any kind to identify their current position, their intentions, and capabilities to change, and after that, to direct the change efforts into the most suitable and promising mode of change towards digital transformation as a final desired state of operations.

To develop the conceptual framework, existing influence factors were gathered, classified into internal and external factors, revised in the context of disruptions and uncertainty, and then used to design a balanced assessment instrument for assisting organisations in assessing their readiness and willingness to transform, position themselves in the operating ecosystems and decide on feasible response options. This balanced exploration of readiness and willingness concerning exploitation opportunities represents an addition to existing frameworks and models, which mainly cover some of those elements separately.

The structure of the paper is as follows. After the introduction, methods, research design, and theoretical background are presented. The next section brings the resulting conceptual framework proposition. After the proposed conceptual framework, empirical research was conducted on a demonstrative case study. The next chapters present an evaluation of the case study, discussion, and implications. The paper concludes by summarising the main results, limitations, and further research possibilities.

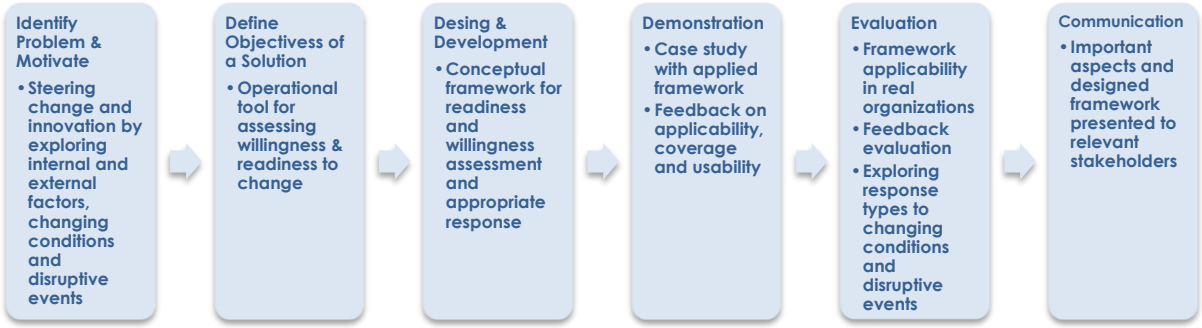
Methodology

This research is based on a problem-solving approach using the Design Science Research (DSR) methodology. Following vom Brocke et al. (2020), the research design was performed through six activities: 1) Problem identification and motivation, 2) Objectives Definition, 3) Design and development of a framework, 4) Demonstration through a case study, 5) Evaluation of the framework based on case study and feedback, and 6) Communication to relevant stakeholders, i.e., researchers and professionals.

The paper is structured by following this methodology. First, the problem and motivation are presented in the introduction section. This second section briefly explains methods and research design, stating the research objective. The following sections present the design and development of the research through the background of the research topic and the conceptual framework proposition. Next, the paper demonstrates the application in a real case study, its evaluation, discussion, implications, limitations and further research, and conclusions, which are given at the end.

The applied DSR Methodology Process Model is depicted in Figure 1.

Figure 1
DSR Methodology Process Model (vom Brocke et al., 2020)



Source: Author's illustration

This research proposes a conceptual framework that aims to contribute to a body of knowledge and arrange concepts and constructs for assessing readiness and willingness to respond to changing conditions in the operating environment and disruptive events. Since this research relies on a longitudinal literature review and experience gathered in over a decade-long project activity of authors, it is somewhat subjective. However, the intention to publish a paper in this early stage is an important step for future research since, according to (Gale & Aarons, 2017), most US Fortune-level companies plan digital transformation in the following years, which will surely motivate others within the same or within accompanying industries, to follow. According to existing literature and team research experience in digital transformation, ICT-enabled process improvement projects, business process management, and organisational change initiatives, the authors propose a conceptual framework for achieving the objective of this paper. This conceptual framework will help organisations guide their change after a disruptive event and decide which feasible direction to go. Based on earlier referenced methods, a conceptual framework will be further researched in real case study examples and examined in more detail. A conceptual framework is proposed for the CEO (Chief Executive Officer) and strategic management level supported by the CIO (Chief Information Officer) and/or CTO (Chief Technology Officer) and/or CDO (Chief Digital Officer) if delegated.

The authors intend to gather relevant opinions and develop an elaborate research design. Since this paper demonstrates one case study, future research will be performed in more detail on several case studies for further evaluation.

For this first evaluation of the framework, the interpretive stance (Conboy et al., 2012); (Goldkuhl, 2012) is applied and will be followed by conducting an exploratory field study with selected organisations (Miles et al., 2014; Walsham, 1995; Yin, 2017; Rashid et al., 2019). A semi-structured interview using a data collection instrument (based on Tables 1-3) has been conducted to demonstrate and evaluate the framework.

Our further approach will be based on grounded theory methodology (Glaser & Strauss, 1998; Mason, 2006; Urquhart, 2013). Therefore, we build up our constructs and elaborate interview questions. In the end, we apply a grounded theory coding approach to fully describe the conceptual framework after more case studies have been performed.

Theoretical Background

Based on the literature review, presented in the following parts of the paper, a baseline of impact factors is gathered and presented as internal and external factors influencing digital transformation as a most demanding organisational change in the recent digital age.

Internal Factors Influencing Digital Transformation

This study comprises 6 Digital Transformation initiatives within Croatia gained by various internal factors that influence organisations' digital transformation. A positive fact is that internal factors can be influenced, controlled, and governed. Traditional internal factors influencing and shaping organisational capabilities can be (conservatively) seen as "Mission, Vision, and Goals; Strategy; Technology; Size; Life Cycle of the organisation; People; Products and Location" (Sikavica, 2011, p. 216). A more contemporary view on those traditional internal factors, identified by analysing scopes, methodologies, and readiness assessment tools in the literature describing maturity frameworks, considers them as pillars, i.e., building blocks for whatever an organisation can generate, products, services, or general value for customers.

According to (Pihir et al., 2019), Digital Transformation Pillars are a) Strategy orientation; b) Customer centricity; c) ICT and process infrastructure; d) Talent, capability, and capacity strengthening, and e) Innovation culture and organisational commitment. In light of Digital Transformation, they could be seen as agility characteristics because Digital Transformation Pillars help boost digital transformation and support successful Business Change. These pillars (Pihir et al., 2018) were identified on an extensive evaluation of several digital maturity models assessing digital transformation and digital maturity. The pillars comply with the existing wide range of global and regional methodologies through some of the matches within three key elements from Digital Maturity Model - TM Forum (TM forum, 2020), four dimensions of the Digital Maturity Model 5.0 – Forrester (Forrester, 2018); Digital Maturity Assessment Tool - Government of South Australia (Government of South Australia, 2022); Key pillars of digital transformation - Chief information Officer (CIO) Report (Evans, 2017) and five areas of the Framework for digital maturity of schools – CARNet (e-Schools, 2018).

Pillars of digital transformation from (Pihir et al., 2018) should be seen as internal factors of an organisation's maturity for digital transformation:

Strategy orientation refers to an organisation's vision, which needs to be oriented on value propositions, streams, and chains. The role of the management is to design, model, lead, and direct all the efforts in achieving the vision in long and short terms, as well as constructing and deconstructing appropriate internal environment devoted to accomplishing goals.

Customer centricity is a digital transformation keystone in the focus on customers. Understanding the pains and gains of customers, predicting and shaping expectations, managing customer journeys, rethinking the value propositions, and establishing customer communities that will advocate, recommend, and communicate the market value. Knowledge engineering and creative design thinking methods and techniques application should be oriented on empathy mapping to harvest benefits from targeting relevant stakeholders (Pileggi, 2021).

ICT and process infrastructure refers to the infrastructural resources, including technology, data, and business processes, that must be aligned with the strategy orientation and customer-centricity. The infrastructure is only potential until it is put into use. It can be seen as a prerequisite for agility in coping with external environmental challenges. Still, it can help deliver results only as good as governed and streamlined with the organisational or business objectives.

Talent, capability, and capacity strengthening include talents, skills, capability, and capacities to build new knowledge and know-how that become essential due to the development of technology-intensive societies. Rapid technology growth fundamentally redefines how an organisation needs to keep its competitiveness and generate contemporary competencies to pursue new endeavours. These resources determine the extent of exploitation and exploration opportunities concerning industry, environment, customers, and other factors.

Innovation culture and organisational commitment enable exploitation when the maturity of current assets is at a stage where the acceptable return is profitable, with or without minor innovation. Exploration is more resource-intensive and demands more creativity, innovation potential, and commitment to building a playground (Tomičić Furjan et al., 2019) for testing the feasibility of ideas, ventures, or value propositions. The role of organisational culture is to provide a motivating environment for supporting the atmosphere where trial and error are welcome, building the potential to become innovative and gaining agility for responding to new disruptions.

The expectation that most organisations face nowadays is that they need to be agile. In this case, agility refers to being ready to respond to disruptions and challenges with high adaptability, flexibility, evolutivity, and innovation. Here, it is important to emphasise that agility is very much dependent on the industry the organisation is operating in. Some industries are more technology-intensive than others, and even in the same industries, the same technologies can have different significance in the level they are implemented in business processes. The maturity of technologies within industries is therefore not necessarily similar by its potential to contribute to the value of products or services; some technologies can already be considered mainstream in some cases (like robotics in automotive industries), while they could have emerging importance in others (like Artificial intelligence in education). Nevertheless, the internal influence factors are only as valid as the environment of an organisation is ready to perceive its ability to deliver the value proposed.

External Factors Influencing Digital Transformation

Various external factors influence the digital transformation of organisations. The most important are technological changes, competitive pressure, ecosystem dynamics, regulatory framework, and innovation infrastructure.

Technological changes have a significant impact on socio-economic trends and how organisations work. A well-known relationship between technology and economic activity is given by the Kondratieff cycles (K cycles) (Kondratieff, 2015). Today, we have many research papers on technological change and the response to economic activity. It is generally accepted that the fast adoption of new or disruptive technology can give a significant market advantage. However, many authors also warn that there are obstacles related to technology adoption (Oliveira & Martins, 2011), such as the organisation's maturity level, the agility of business processes, risks associated with technology adoption, etc. This means that besides awareness of technology change, organisations must continuously increase their capacities for technology adoption and change management (Ritchie & Brindley, 2005).

Competitive pressure is an essential part of market relationships. Competitive advantage has many components. Companies compete in business models, organisation of business processes, technology use and adoption, etc. Competitive pressure pushes organisations to take risks, embrace changes and stretch their limits. Generally accepted variables of competitive pressure are market share, time to market, quality of product or service, flexibility and adaptation to customer needs,

and cost efficiency. Companies face increasing market concentration, with considerable productivity and profitability gaps between the top companies in each sector and all others. Every organisation must constantly evaluate its market position and find new ways to adapt (Thong & Yap, 1995). In that respect, companies adopt dual strategies, which allow them to excel in traditional business while embracing new and unexplored business models.

Ecosystem dynamics and ecosystems gained popularity with the smart industry and digital platforms paradigms (Immonen et al., 2014; Makris et al., 2018). Many smart products are supported by large ecosystems, such as mobile phones, smart cars, gaming consoles, etc. (Makris et al., 2018).

A business ecosystem is a dynamic group of largely independent economic players that create products or services that together constitute a coherent solution (Pidun et al., 2019), meaning that it is a governance model that is complementary to other ways of organising the creation of a product or service, such as a vertically integrated organisation, a hierarchical supply chain, or an open-market model. Each ecosystem can be characterised by a specific shared interest (delivery of better product or service) and a particular number, although rapidly changing, group of participants with different roles (such as producer, supplier, orchestrator, complement). This organisational structure can quickly provide access to technologies and knowledge that may be too expensive or time-consuming to build within a firm. Once launched, ecosystems can scale much faster than individual businesses because their modular structure makes it easy to add partners. In a sense, they are designed to scale up with very low risk involved for participants. Ecosystems are flexible and resilient; their modularity enables many participants and a high capacity to evolve. Ecosystems also have their downsides, and many fail (Pidun et al., 2020), but still, they are an unavoidable form of a modern business environment.

The regulatory framework might be vital for the large-scale adoption of certain technologies (EU SCAR AKIS, 2019). These are mainly technologies that interfere with some older technologies that are partly regulated (such as electronic invoices or cryptocurrencies) or introduce market changes that are considered dubious or unfair (such as the Uber business model or the use of Artificial Intelligence in certain cases). In that sense, regulators play an important role in implementing and using certain technologies. The regulatory framework can make a significant difference in the overall economy of the country and the rise of its business activity. Of course, many technologies are neutral to the regulatory framework, and companies seek a stable and lightweight regulatory framework.

Innovation infrastructure has many forms, but most notably, it is present in government-sponsored innovation hubs and governmental incentives for innovative products and services (OECD, 2019). These incentives are essential for reducing the risk related to adopting new technologies and giving access to knowledge and technologies beyond the capabilities of many firms. Nations worldwide invest public resources in research activities by universities, research institutes, and companies. Public resources are essential to generate new knowledge and reduce private research risks. Such an approach is extremely important for SMEs striving in daily operations without the capacity for research and development. However, they can develop skills through different educational programs, innovation hubs, competence centres, and vocational training activities. Innovation hubs serve as a one-stop-shop where firms, particularly SMEs, can access services related to testing, attracting investors, skills and training, networking, and the innovation ecosystem. Another initiative striving to increase innovation potential is related to producing and using open data, which can create new opportunities for companies to learn from other's

work efforts (Corrales-Garay et al., 2020). Also, developing data lakes and working towards creating and implementing open data strategies for producing or using other company's data can lead to de-silofication in organisations, as shown through multiple case study analyses (Enders et al., 2020). The willingness to pay for other companies and public sector data to create a test polygon for new ideas and innovations has been identified (Enriquez-Reyes et al., 2021). One of these incentives' most important side effects is the development of an experimentation culture necessary for the modern business environment. Low-risk experimentation is crucial for initiatives based on new technology implementation. In that respect, the business community needs a playground for testing the feasibility of ideas. As support for developing a digital transformation playground within an organisation, demonstrative operational methodologies can be applied (Tomičić Furjan et al., 2019).

Conceptual Framework Proposition

While operating with internal capabilities for agility and under various external factors in a changing environment, organisations must continuously re-evaluate their position and need for a response. Five distinct environments (classical, adaptive, visionary, shaping, and renewal) according to three dimensions of the business environment (predictability, malleability, and harshness) can help choose a general strategy archetype for response (Reeves & Haanaes, 2015). At the same time, the strategic response needs to be incorporated into the business model, which, as a framing concept, needs to be translated into operational business processes. With the exponential technology growth, disruptive events, industry-specific competitiveness, and increasing customer centricity, the borders of appropriate distinct responses are blurring. Rethinking relationships within ecosystems and across value chains call for diversity in managing the change, resulting in strategic and BPM ambidexterity (vom Brocke & Mendling, 2018), dual strategies, digital twinning, everything-as-a-Service, everything-as-a-Platform, and similar business paradigms.

Yet for some organisations, industries, and even some economies, no response is a feasible option, meaning that not all organisations, industries, or economies feel the same competitive pressure to change their business models and digitally transform. Digital Transformation case studies can be found in (Tomičić Furjan et al., 2020).

Sometimes, doing nothing or continuing business as usual is a proper response. In this case, the business model stays the same; only operational processes can undergo minor adjustments to changing environments (e.g., during the global health disruption, bakery employees needed to wear facial masks while baking products in a small bakery or while selling bread, while everything else stays the same, would be seen as the continuation of operating within a same business model). Change is unavoidable for all others for whom continuation is not their operating reality.

The questions which arise in the case of inevitable change are the following:

1) To what extent is my organisation ready to change? The answer to this question can be found in many maturity assessment frameworks that evaluate maturity in various dimensions, thereby, the readiness to change. A variety of self-assessment tools helps organisations identify what they can achieve, describing the As-Is state. Still, it does not help in sketching the future. This describes the readiness of an organisation to perform some change.
2) What are we trying to achieve? The focus of change can be put on defining new value propositions, redefining process outcome priorities, developing improved customer journeys, designing new services or products, rethinking operating models, constructing or deconstructing value chains, implementing digital

technologies, boosting resilience, joining or creating ecosystems and other types of change. The only restriction should be put on the feasibility of change, meaning that the change should shape the desired To-Be state in an inspiring manner, but at the same, be feasible to achieve and not put the organisation in front of a chasing-a-unicorn-quest, which obviously cannot be realised for whatever reasons. This describes the willingness to initiate the change.

Previously described internal and external influence factors might be a starting point for positioning an organisation's readiness and willingness when faced with the need to respond. Positioning is intentionally used instead of evaluating because evaluations are often seen as a structured, systematic measurement or determination, whic requiringous instruments and criteria. On the other hand, positioning should encourage organisations to frequently perform rethinking-sprints and not obey only continuous indicator measurement loops.

As a visualisation of conceptual framework application, Figure 2 shows the general process flow, how to use it, and references instruments for steps performance.

Figure 2
Visualisation of Conceptual Framework Application

Source: Author's illustration

Step 1 - Internal and External Factors Assessment

In Table 1, the internal influence factors are gathered. In Table 2, external factors are listed, forming an instrument to assess the position regarding the two questions of what an organisation can do and what the organisation can achieve.

Based on the positions identified on a simplified scale of poor-medium-high, organisations can build awareness of the smallest and largest gaps and select a feasible option of change based on that.

Table 2 is a component of an assessment instrument aiming to help an organisation understand its readiness and willingness to adapt to external changes in the business environment. Each row refers to a different external influence factor, and the corresponding questions prompt introspection about the organisation's current state and desired future. The organisation can then rate its readiness for change and desired achievement level using a three-point scale (poor, medium, high).

For example, Change of Technology (EXT1) refers to how ready the organisation is to adapt to new technologies. The questions focus on the degree of exposure to technological changes, potential disruptors, and the organisation's capacity to incorporate new technologies into daily operations.

In addition to the continue as is option, four distinct options of change (shown in Fig. 3) arise, which can be selected based on the gap analysis from Tables 1 and 2.

Table 1
Readiness and Willingness Assessment Instrument - Internal Factors

Internal influence factors	To what extent is my organisation ready to change?			What are we trying to achieve? Enter the description in the selected row…
INT1: Strategy orientation	Do we have a clear vision of the value propositions, streams, and chains? Do we have stakeholder support?			poor medium high
	poor	medium	high	
INT2: Customer centricity	Do we properly manage customer journeys and experiences? Do we apply creative techniques to design new types of customer relationships? How strong is our customer community? Do we have tools for modelling and managing customer expectations?			poor medium high
	poor	medium	high	
INT3: ICT and process infrastructure	IS our BPM governance aligned with our strategy focus? Is there some technology that could act as a toxic legacy? How strongly do we manage our data?			poor medium high
	poor	medium	high	
INT4: Talent, capability and capacity strengthening	Do our resources fit more an exploitation or exploration approach? To what extent is our operating industry technology-intensive? Are the skills needed transferable, rare, or unique?			poor medium high
	poor	medium	high	
INT5: Innovation culture and organisational commitment	Does our culture offer a playground for testing the feasibility of ideas? Are we committed to innovation and agility?			poor medium high
	poor	medium	high	

Source: Authors

Table 2
Readiness and Willingness Assessment Instrument - External Factors

External influence factors	To what extent is my organisation ready to change?	What are we trying to achieve? *Enter the description in the selected row…*
EXT1: change of technology	Is my current operating industry highly exposed to technology change? Are there emerging technologies that might disrupt my industry? Do I have the capacity to introduce new technologies in daily operations? poor | medium | high	poor medium high
EXT2: competitive pressure	Do we have a significant competitive advantage in the market? To what extent can we predict future competitive potential? poor | medium | high	poor medium high
EXT3: ecosystem dynamics	Is there an adequate ecosystem that we can participate in? Do we have ecosystem management capabilities and business processes? To what extent does the digital vortex influence my value chain? poor | medium | high	poor medium high
EXT4: regulatory framework	Is the regulatory framework relevant for using competitive technologies in my industry? Do we have a favourable regulatory framework? Are there any regulatory Initiatives we can join? poor | medium | high	poor medium high
EXT5: innovation infrastructure	Can we rely on the assistance of digital innovation hubs, competence centres, education programs, and vocational training? Do we have access to services related to testing, attracting investors, skills and training, networking, and the innovation ecosystem? Are we open to the experimentation culture? Do we have a business community acting as our playground for testing the feasibility of ideas? poor | medium | high	poor medium high

Source: Authors

Step 2 - Gap Identification & Context Analysis Rules Evaluation

After the first step of readiness and the willingness assessment, the gaps should be analysed by their value (poor-medium-high) and context. If most marks are set to poor in readiness and willingness, continuation without change is a feasible option.

If the willingness marks are high, but most readiness marks are poor across internal and external influence factors, then terminal change is more appropriate. This case can be interpreted as the following situation: the assessed organisation is operating in an industry where significant disruptions are happening, where the expectations of customers are growing increasingly, but at the same time, the organisation does not have appropriate knowledge or skills, neither the infrastructure, organisational culture or the assistance from external stakeholders to change. Terminating the current business model means cutting your losses and/or suspending your business activity. This is a feasible option when, e.g., no resources are available, during global disruptions and lockdowns when the industry maturity curve is declining or reaching the zero-demand point. The business model needs to be terminated because the business environment has changed so severely that operations are no longer feasible. This response type to changing conditions and disruptive events is a feasible option when an organisation has, to some extent, recognised the uncertainty level of a clear-enough future (Courtney et al., 1997), forecasting that the organisation will not be able to deliver expected value.

If the internal willingness marks are high, but most external factors are poor, temporal change could be an appropriate response. This option would be feasible for organisations operating in an industry with the most significant external factors. An example of this type of change can be found in the restaurant-service industry, where due to the health disruption of Covid-19, many organisations switched to delivery but are aiming to roll-back to location-based food service with the experience of going to a restaurant. Temporally changing the business model requires introducing new value propositions through new distribution channels that were not operational before or through technology-supported operations, switching to substitute resources, activities, or products/services for a certain period. The business model needs an exploitation change, which will occur for a certain period. After the period has surpassed, the change can be rolled back to the previous state, meaning trusted business ways. This response type is feasible when an organisation has recognised the uncertainty level of alternative futures (Courtney et al., 1997), opting for a few discrete possibilities manageable for a certain time to deliver the expected value. According to (Courtney et al., 1997), the most appropriate managerial implication would be to reserve the right to play.

If the readiness-willingness gap is 1 for most internal factors and not greater than 1 for some external factors, and the willingness marks are mostly high, the transitional change could be feasible. The transition timeout could allow the organisation to gain additional strengths and build its capacities for the desired transformational change. The duration of the transitional change can vary, depending on the factors that endanger the change. If the missing link is infrastructure, the transition phase can last shorter; if the largest gap is in talent, capability, and capacity, strengthening the duration of boosting this factor would take longer. This change option is often seen in dual-strategy approaches and technology-based industries. Transitional efforts to gain capabilities to reposition are applicable when the organisation is aware that new-normal and technology-driven paradigms are becoming essential but is not ready to lead yet.

Due to changing conditions related to customers, ecosystems dynamics, or regulatory initiatives related to the use of competitive technologies in the operating industry or environmental requirements, the business model needs substantial improvements. Still, the explorational capacities are not scaled enough. This change approach is intensive on resource allocation because improvements must be implemented. At the same time, the organisation can try to achieve internal

capabilities to transform in the future. Unlike the temporal change, the transitional approach does not aim to roll back but to prepare for future potential. Also, this response type is a feasible option when an organisation faces the uncertainty level of a range of futures (Courtney et al., 1997), offering a range of options in gaining capacities for future desired transformational change in delivering the expected value. Managerial implications for this response type would fit the Adapt to the future strategic posture, according to (Courtney et al., 1997), and it could lead to shaping the future at some further point.

If the gap between readiness and willingness is 0 or not greater than 1 and the most willingness marks are set high, the organisation is ready for the transformational change. In this case, the organisation has what it takes to transform and can set the aim of responding to changing conditions and disruptive events more comprehensively. Transform and leading on the change is feasible as a response in cases when an organisation is mature enough to make a breakthrough, when customer experience management is a priority of technology-supported improvement designs when the organisation is ready to reinvent its business model and inspire others in its ecosystem to realise the joint vision or when favourable regulatory frameworks and initiatives are in place which the organisation can join. This response type is a feasible option when an organisation faces the uncertainty level of true ambiguity (Courtney et al., 1997), opening the space of action for shaping the future strategic reply or leading the design of expected value and creating new scenarios of delivering it.

Step 3 - Readiness and Willingness Assessment Calculation

As an overview of a possible application of the proposed conceptual framework, step 3 allows for readiness and willingness assessment using Table 3 as a readiness and willingness assessment instrument. The rules presented in Table 3 summarise the most important rules that have arisen from the current research and will be revised in future research. The rules describe internal and external decision factors and can be answered as Yes (the rule applies) or No (the rule does not apply) questions.

Step 4 - Selecting the Options for Change

Decision factors and rules from Table 3 are intended to help organisations identify which type of change could be feasible. The rules describing the Gap factors are more general than the additional internal and external factors rules.

Depending on the real case elements describing the context of the operations, the most appropriate type of change is the one with the most Yes (Y) decisions. The list of rules is not finite. Therefore, specific rules can be added if conflict or inconclusive results are obtained using this framework.

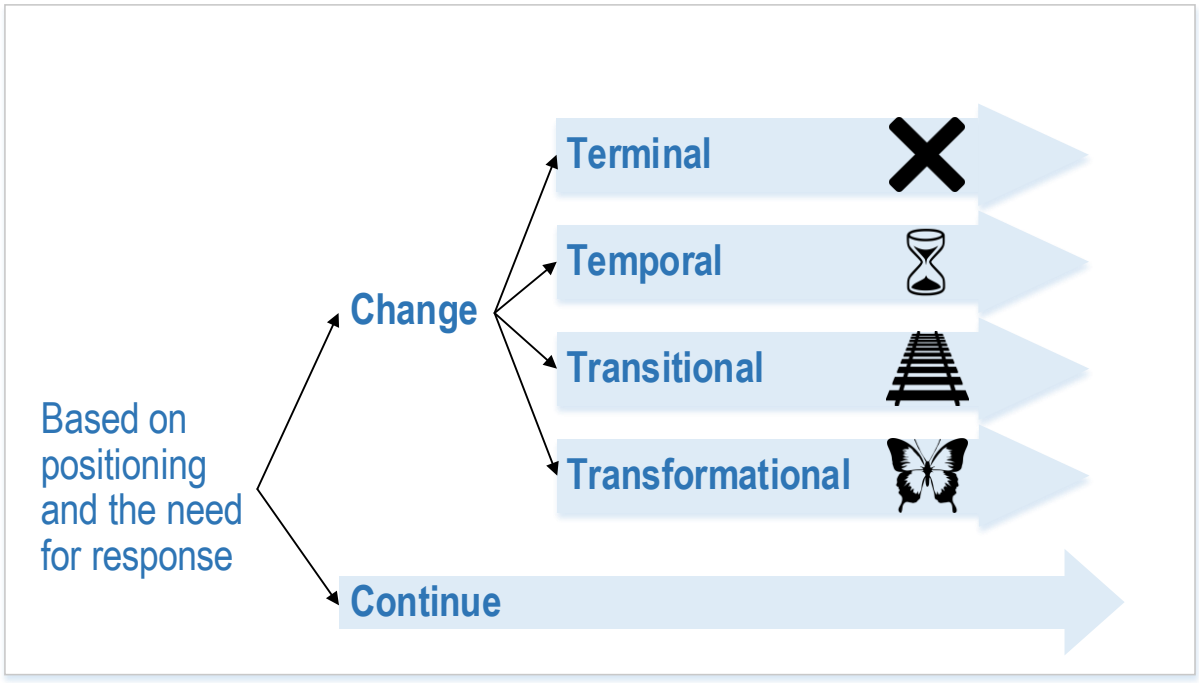
Figure 3 presents the response types to changing conditions and disruptive elements. The ultimate goal is to transform to thrive in the competitive environment, but this can be achieved in a one-step or more-than-one-step approach since there is no one-fits-all option for change.

Table 3
Readiness and Willingness Assessment Tables

Decision factors		Rules	Change			
GAPS	Readiness/ willingness	Willingness marks are high, but most readiness marks are poor across internal and external influence factors	Y	N	N	N
		Internal willingness marks are high, but most external factors are poor	N	Y	N	N
		The readiness-willingness gap is 1 for most internal factors and not greater than 1 for some external factors, and the willingness marks are mostly high.	N	N	Y	N
		The gap between readiness and willingness is 0 or not greater than 1, and most willingness marks are set high.	N	N	N	Y
INTERNAL	INT1: Strategy orientation	The organisation is aware that the new normal is in place	N	N	Y	Y
		Mature enough to make a breakthrough	N	N	Y	Y
	INT2: Customer centricity	Customer experience management is a priority	N	N	N	Y
		Changing conditions related to customers	N	N	Y	N
	INT3: ICT and process infrastructure	Technology-driven paradigms are becoming essential	N	N	Y	N
		Technology-supported improvement designs are in place	N	N	N	Y
	INT4: Talent, capability, and capacity strengthening	No resources are available	Y	N	N	N
		Substitute resources available	N	Y	N	N
	INT5: Innovation culture and organisational commitment	Explorational capacities are not scaled enough	N	N	Y	N
		Reinvent its business model.	N	N	N	Y
EXTERNAL	EXT1: Change in technology	The industry maturity curve is declining or reaching the zero-demand point	Y	N	N	N
		Technology-supported operations available	N	Y	N	N
	EXT2: Competitive pressure	The business model needs substantial improvements	N	N	Y	N
		The business environment has changed so severely that operations are no longer feasible	Y	N	N	N
		Global disruptions and lockdowns	Y	N	N	N
	EXT3: Ecosystem dynamics	Changing conditions and environmental requirements	N	N	Y	N
		New distribution channels that were not operational before	N	Y	N	N
	EXT4: Regulatory framework	Regulatory initiatives related to the use of competitive technologies in the operating industry	N	N	Y	N
		Favourable regulatory frameworks and initiatives are in place that the organisation can join	N	N	N	Y
	EXT5: Innovation Infrastructure	Equipped but not ready to lead yet	N	N	Y	N
		Inspire others in its ecosystem to realise the joint vision	N	N	N	Y

Source: Authors

Figure 3
Response Types to Changing Conditions and Disruptive Events



Source: Author's illustration

Case Study

Case study description

To demonstrate the application in a real environment, an initial evaluation has been performed by applying this conceptual framework in a real case study. Tables 1, 2, and 3 were used as a data collection instrument as a questionnaire sent to a CIO equivalent position in a mid-sized Croatian IT company. The company is known for its progressive and proactive approach to developing information systems, with experience in digital transformation initiatives in the IT sector. The person who participated in the data collection is an experienced IT professional with leadership experience and a strong collaboration orientation with customers and employees.

Case study results

The response is shown in tables 4, 5, 6, 7, and 8. Results indicate that the company's ultimate goal is transformation, as stated in the questionnaire, along with notes that, as a company, they feel quite ambitious and self-critical, so probably some companies in a similar situation would rate themselves better. Still, they intend to raise the bar for themselves and their partners to be more competitive and their customers and employees more satisfied.

Table 4
Readiness and Willingness Assessment Instrument - Internal Factors – Case Study

Internal influence factors	To what extent is my organisation ready to change?	What are we trying to achieve?
INT1: Strategy orientation	High	High: Clear vision and stakeholder support.
INT2: Customer centricity	Medium	High: We want to develop our customer community, especially new market segments.
INT3: ICT and process infrastructure	Medium	High: We need to manage our data in an integrated, secure, and reliable way.
INT4: Talent, capability, and capacity strengthening	Medium	High: We must develop a fully organisational culture based on innovation, talent development, and high ethical values.
INT5: Innovation culture and organisational commitment	High	High: We need to extend our best practices to our ecosystem.

Source: Authors

Table 5
Readiness and Willingness Assessment Instrument - External Factors – Case Study

External influence factors	To which extent is my organisation ready to change?	What are we trying to achieve?
EXT1: Change of technology	Medium	High: We must find new funding and partnerships for future readiness improvement.
EXT2: Competitive pressure	Medium	High: We have the ambition to be the regional leader in our main domains/industries
EXT3: Ecosystem dynamics	Medium	High: Our goal is to orchestrate our business community sustainably and with benefits for all major stakeholders.
EXT4: Regulatory framework	Medium	High: There is a relevant regulatory framework, and we are part of new regulatory initiatives.
EXT5: Innovation infrastructure	Poor	Medium: Our company has a business opportunity to participate in innovation ecosystem initiatives and communities.

Source: Authors

Table 6
Readiness and Willingness Assessment Table -Case Study -Gaps

	Decision factors	Rules	Change			
			Terminal	Temporal	Transitional	Transformational
Gaps	Readiness/ willingness	Willingness marks are high, but most readiness marks are poor across internal and external influence factors	Y	N	N	N
		Internal willingness marks are high, but most external factors are poor	N	Y	N	N
		The readiness-willingness gap is 1 for most internal factors and not greater than 1 for some external factors, and the willingness marks are mostly high.	N	N	**Y**	N
		The gap between readiness and willingness is 0 or not greater than 1, and most willingness marks are set high.	N	N	N	Y

Source: Authors

Table 7
Readiness and Willingness Assessment Table – Internal factors

	Decision factors	Rules	Change			
			Terminal	Temporal	Transitional	Transformational
Internal factors	**INT1: Strategy orientation**	The organisation is aware that the new normal is in place	N	N	**Y**	**Y**
		Mature enough to make a breakthrough	N	N	**Y**	**Y**
	INT2: Customer centricity	Customer experience management is a priority	N	N	N	**Y**
		Changing conditions related to customers	N	N	**Y**	N
	INT3: ICT and process infrastructure	Technology-driven paradigms are becoming essential	N	N	**Y**	N
		Technology-supported improvement designs are in place	N	N	N	**Y**
	INT4: Talent, capability, and capacity strengthening	No resources are available	Y	**N**	**N**	**N**
		Substitute resources available	N	**Y**	N	N
	INT5: Innovation culture and organisational commitment	Explorational capacities are not scaled enough	N	N	**Y**	N
		Reinvent its business model.	N	N	N	**Y**

Source: Authors

Table 8
Readiness and Willingness Assessment Table – External factors

	Decision factors	Rules	Change: Terminal	Change: Temporal	Change: Transitional	Change: Transformational
EXTERNAL	EXT1: change of technology	The industry maturity curve is declining or reaching the zero-demand point	Y	**N**	**N**	**N**
		Technology-supported operations available	N	**Y**	N	N
	EXT2: competitive pressure	The business model needs substantial improvements	N	N	**Y**	N
		The business environment has changed so severely that operations are no longer feasible	**Y**	N	N	N
		Global disruptions and lockdowns	**Y**	N	N	N
	EXT3: ecosystem dynamics	Changing conditions and environmental requirements	N	N	**Y**	N
		New distribution channels that were not operational before	N	**Y**	N	N
	EXT4: regulatory framework	Regulatory initiatives related to the use of competitive technologies in the operating industry	N	N	**Y**	N
		Favourable regulatory frameworks and initiatives are in place that the organisation can join	N	N	N	**Y**
	EXT5: innovation infrastructure	Equipped but not ready to lead yet	**N**	**N**	Y	**N**
		Inspire others in its ecosystem to realise the joint vision	N	N	N	**Y**

Source: Authors

Table 9
Number of potential decisive marks

Decision factors	Rules	Change: Terminal	Change: Temporal	Change: Transitional	Change: Transformational
Sum of potential decisive marks in Tables 6, 7, and 8		**2/3**	**3/6**	**8/10**	**7/10**

Source: Authors

The potential decisive marks in Tables 6, 7, and 8 are assessed with company representatives, and their value is presented in blue-coloured cells. Based on the number of Yes answers in potential decisive marks (which can have a decisive Yes or No value for the appropriate response type, depending on the question), the recommendation is a close call between transitional (8/10) and transformational (7/10) response type to changing conditions and disruptive events.

Considering the gap analysis, the final recommendation of transitioning would be more appropriate: although the company shows an appropriate level of maturity for

transformational change, the external factors set such environmental conditions, which impact the overall mark to the transitional response type.

Evaluation of the Case Study

The case study shows that the framework helped rethink the complex factors impacting the response to changing conditions and disruptive events. In the free-form feedback information, the participant stated that the framework confirmed most of the company's existing strategic determinants and business thinking, and they would like to consider the issue of generational challenges and the issue of dual strategy operations. The dual strategy operations are feasible since applying the proposed framework was a close call. Therefore, 2 scenarios of change emerged as possible paths to go. Previous and ongoing global disruptions have impacted, and still do, the business environment so severely that transitional change at this point would be a less risky decision. In similar cases of operating in highly disruption-sensitive ecosystems, we recommend applying complementary methods and techniques for analysing the industry's and business environment's potential. In this case, the recommendation is to opt for the transitional change while bridging gaps for the next step of transformation; sensible CIO, CEO, or CXO can also choose the option of Transformative change. Still, in that case, more efforts are required in the readiness score, meaning that the executives need to rethink to what extent the organisation is ready to change and at what cost.

The suggestion for improving the framework from the case study participants is to develop an interactive tool for the framework application, both for availability for ease of use but also for additional benefits (tracking, automatic processing of results, tracking trends in case of multiple consecutive fillings by the same entities, etc.).

Discussion and Implications

This research aimed to develop and present a conceptual framework that should help organisations steer change or innovation endeavours to the most feasible option when faced with intense disruption and uncertainty in their operating environment. The following approach was applied: (1) already well-known models, concepts, and frameworks were reviewed; (2) internal and external factors influencing digital transformation readiness and willingness were explored; (3) a 4-step conceptual framework was designed; (4) an assessment instrument was created to assist organisations in assessing their readiness and willingness, positioning and deciding on response options, and finally (5) the framework was tested through a case study. Each part of this journey brought us new insights. First, already known models, concepts, and frameworks are oriented towards assessing the readiness, i.e., capabilities or complex dynamics within ecosystems. This led us to the second important insight: the need to classify internal and external factors influencing digital transformation readiness and willingness. Those factors were explored and modified for bringing into equation disruptions and uncertainty when weighing alternatives for exposing organisational existing and future operational business models to different response needs. Third, the importance of balance between readiness and willingness while unveiling disruptions and uncertainty gave us insights into the complexity, which we tried to minimise by designing the 4-step conceptual framework. Fourth, developing an assessment instrument that assists organisations in assessing their readiness and willingness aims to enable organisations to take the right position before deciding on response options. This revealed to be an opportunity to do a reality check - if performed objectively – and admit that both can be feasible options: to Continue (do nothing) or (in a Terminal, Temporal, Transitional, or Transformational manner). Fifth, the case study

revealed that the assessment instrument was useful in positioning organisational readiness and willingness and steering the response. Still, it also allowed the participating organisation to identify complementary opportunities for exploitation and growth related to their view on internal and external capabilities and challenges. All these insights gained through this journey added to the basic contribution of our approach to assisting organisations in uncovering feasible response types of action while dealing with intense disruption and uncertainty in their operating environment.

Relations to Previous Findings

The results of exploring our newly developed framework comply with existing digital maturity models for assessing digital transformation and digital maturity (Evans, 2017; Forrester, 2018; Government of South Australia, 2022; TM forum, 2020; e-Schools, 2018) through pillars of Digital transformation identified in (Pihir et al., 2018). The pillars became an essential part of the framework as internal influence factors, which can be evaluated through questions and statements offered in the framework. External influence factors, gathered mainly from previous projects and research experience of the authors and described in the same section, together with the internal ones, give a unique complementary and balanced but upgradeable set of factors for readiness and willingness assessment under disruptions and uncertainty. Therefore, our framework emphasises the balance between what an organisation is ready to achieve concerning what it is willing to achieve while considering the dynamics in the operational environment. That is why it is not only supposed to give the as-is state but can be used to show feasible directions or paths towards an appropriate response concerning exploitation opportunities.

Implications for Academia and Practice

Regarding possible implications, the contribution of this research is twofold. Regarding potential academic implications, both the research journey and empirical results add to understanding the ecosystem's complexity and dynamics. At this point, the proposed conceptual framework is intended to be a tool for discussing the business context at the high level of organisational and business processes governance to draft a general strategic direction towards digital transformation when faced with intense disruption and uncertainty in the operating environment. Existing methods like Business model canvas (Osterwalder et al., 2015) or the BPM Billboard (vom Brocke et al., 2021) can be applied for translation into initiatives or projects. Besides adding to research on digital transformation, the applied Design Science Research methodology is inspired by customer centricity, knowledge engineering, and creative design thinking methods and techniques for guiding new initiatives towards identifying problems and motivating solutions which are addressing those problems while reducing the complexity to a small number of internal and external factors presented in Table 3.

Implications for practice arise from the empirical part of this research, namely from the case study, illustrating the application of the proposed framework. The case study participants supported our assumption that although considering various factors within a complex environment, capability, and future vision can be explored well-enough by applying a reduced but balanced set of questions and statements, offering to concentrate on important opportunities and challenges. The case study showed that the proposed framework could be used to assess the position of what an organisation is capable (or ready) of what can be achieved (willingly) in a feasible manner. Managerial implications on selecting feasible strategic directions are related to two main strategic directions. The less probable case of optioning is to change nothing and continue with current business models because the operating industry is

not affected enough to cause the need for a response. For other more probable cases, the need for a response is genuine, and organisations can estimate the need for a response by rethinking changing conditions and disruptive events and then select one out of four options: terminal change, temporal change, transitional change, or transformational change. Each strategic direction impacts resource allocation as one of the most important managerial jobs, addressing the scope of response and timing. Therefore, an operational instrument for assessing when and what to do seems worth presenting.

Conclusion

Summary of research

This paper proposed a conceptual framework for steering change or innovation endeavours while considering organisational readiness and willingness to change when faced with disruptions. The framework application process is designed to assess the readiness (To which extent is my organisation ready to change?) and willingness (What are we trying to achieve?) when initiating a future digital transformation.

Internal and external factors that affect the digital transformation process in organisations are gathered from previous research and literature review. These internal and external factors have been identified as influence factors for selecting response types to changing conditions and disruptive events. Depending on the organisation's willingness and readiness, but also depending on the ecosystem and industry context of operations, besides doing nothing and continuing with current business models, for other more probable cases, feasible response types can be described as terminal, temporal, transitional, and transformational change. The framework helps management select appropriate organisational change options that could lead an organisation towards digital transformation. Therefore, the proposed conceptual framework is designed to support organisations in the balanced exploration of readiness and willingness about exploitation opportunities in environments under disruptions and uncertainty.

Limitations

The case study shows that the framework helped build awareness of the limiting and encouraging factors of the operating environment in performing projects and initiatives related to digital transformation. Certainly, the limitation of this research is its reliance on expert and professional experiences forming an understanding of the market's behaviour, industry vortex strengths, and technology impact, as well as of the assessment instrument and its interpretation into feasible options of change.

Another limitation of this framework is its interpretability because a whole variety of marks and their interpretation lies in the background of this framework, especially since this is not an operational calculation of marks but seeks a deeper understanding of markets and industries. The next limitation of the proposed model framework is that in case of close results, it does not have to provide a single concrete solution but often can help clarify the readiness or willingness issues. To deal with this or similar situations, complementary methods and tools can be applied to guide the decision more straightforwardly. In case of a disruption that happens kind of doubt, the Digital Vortex (Loucks et al., 2016) can help evaluate options within a specific industry. In the resource availability gap, the Blue ocean strategy method (Kim & Mauborgne, 2021) can give insights into how the competition deals with similar challenges.

Future research directions

In further research, more attention should be put to identifying and resolving the limitations of the proposed framework and making this tool an easy-to-use strategic assessment tool supported by a digital tool to make the framework easier-to-use. The contribution to the operational translation of the proposed concepts from the organisational governance level into operational inputs could be implemented to develop more case studies and test the framework over longer periods, in different industries, across different organisational demographics, and among different transformational scopes. Better communication of the framework to other involved or affected stakeholders for mutual learning and improvement. In addition, the synergy of industry-public and administration-research institutions is most welcome, especially since each stakeholder can contribute to building better mutually supported initiatives.

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An Extended RFM Model for Customer Behaviour and Demographic Analysis in Retail Industry

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Abstract

Background: Customer segmentation has become one of the most innovative ways which help businesses adopt appropriate marketing campaigns and reach targeted customers. The RFM model and machine learning combination have been widely applied in various areas. **Motivations:** With the rapid increase of transactional data, the RFM model can accurately segment customers and provide deeper insights into customers' purchasing behaviour. However, the traditional RFM model is limited to 3 variables, Recency, Frequency and Monetary, without revealing segments based on demographic features. Meanwhile, the contribution of demographic characteristics to marketing strategies is extremely important. **Methods/Approach:** The article proposed an extended RFMD model (D-Demographic) with a combination of behavioural and demographic variables. Customer segmentation can be performed effectively using the RFMD model, K-Means, and K-Prototype algorithms. **Results:** The extended model is applied to the retail dataset, and the experimental result shows 5 clusters with different features. The effectiveness of the new model is measured by the Adjusted Rand Index and Adjusted Mutual Information. Furthermore, we use Cohort analysis to analyse customer retention rates and recommend marketing strategies for each segment. **Conclusions:** According to the evaluation, the proposed RMFD model was deployed with stable results created by two clustering algorithms. Businesses can apply this model to deeply understand customer behaviour with their demographics and launch efficient campaigns.

Keywords: Customer segmentation, RFMD model, K-Means, One hot encoding, K-Prototypes, Cohort analysis, machine learning

JEL classification: C61; C63; C67
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Introduction

Customer data is a foundation for successful business strategies. Exploring data to find customer insights and supporting decision-making increases business interest. Instead of applying marketing strategies for all customers who interact with the business in the same way and collectively, clustering customers helps businesses to identify target customers (Dawane et al., 2021), from which they can understand the characteristics of each segment and devise appropriate business strategies. Therefore, applying clustering methods to identify potential customers is today's leading trend. Combining machine learning algorithms with user data is a perfect example of customer segmentation that can help businesses identify customer segments that are difficult to detect through intuition and manual data inspection (Kumar, 2023).

RFM has found extensive utilisation as a method for analysing customers in various contexts (Ha & Park, 1998). The model is a behavioural prediction model used to analyse and predict customer behaviour (Yeh et al., 2009). RFM combined with clustering algorithms is an effective method many businesses apply to search for optimal customer segments. RFM is also applied in many fields based on customer clusters. Many studies have proposed extended models, incorporating new variables or applying various analytical techniques to differentiate customer groups in more detail and from multiple angles. Some extended RFM models include the RFMV model (Variety of products) by (Moghaddam et al., 2017), incorporating variables on products that customers frequently purchase and return to or incorporating variables such as Category to segment according to the characteristics of transactions performed by customers in the RFMC model, the study by (Allegue et al., 2020). Several other studies have delved deeper into the application of techniques in the clustering process to achieve clear analysis: the AHP technique in the RFM scoring process in the study by Liu and Shih (2005a) and Liu and Shih (2005b) or the basic clustering methods in the RFM segmentation, such as K-means, Cheng and Chen (2009).

Although RFM combined with clustering algorithms is easy to understand and apply, according to the study by Wei et al. (2010), the RFM model can only help businesses group customers based on transaction variables without considering other variables. Therefore, businesses have requested a specific customer segmentation model or method to address this issue in detail. Research questions have also been raised to clarify the research direction. Businesses have not yet evaluated or analysed which customer groups they belong to, their demographic characteristics, and how these characteristics affect their buying behaviour. Is there a method or model to apply and solve this issue easily? From there, appropriate strategies can be developed for each customer segment. The objective of this article is also to answer these research questions.

This study proposes the RFMD model, which combines traditional RFM with demographic data to provide businesses with a more specific understanding of customer behaviour and demographic characteristics within each cluster. Additionally, the model is applied with two clustering techniques, K-means, and K-prototypes, to obtain results and compare the two clustering outcomes. The proposed RFMD model combined with machine learning clustering techniques aims to generate customer clusters with similar behaviour and demographic characteristics on mixed data sets. Furthermore, the study applies Cohort analysis techniques to gain deeper insights into the data and combine the clustering results to provide business recommendations. Evaluation of the clustering results using AMI and ARI indices is also applied to ensure objectivity in selecting the clustering method. With the traditional RFM model, it can be offered to understand customer behaviour and identify customer segments.

However, these factors only evaluate behavioural variables based on how customers interact with the business but cannot provide specific information about the characteristics of these customers, as argued earlier. Therefore, integrating demographic factors into customer segmentation provides a more comprehensive understanding of each customer group. The combination of behavioural analysis and demographic characteristics is necessary and helps to enrich customer segmentation, according to the study (Sarvari et al., 2016). However, in this study, RFM analysis is performed first, followed by demographic analysis to understand each cluster better, which may be time-consuming and costly. Therefore, this study proposes the integrated RFMD model to simultaneously segment all four input variables and evaluate and collect results. This model is tested using popular clustering methods with mixed data sets. The RFMD model is a new contribution to the field of science, improving existing models and applying them to many execution methods. Furthermore, the proposed RFM improvement has contributed a model for applying machine learning in science, helping to classify data and search for data groups with similar characteristics.

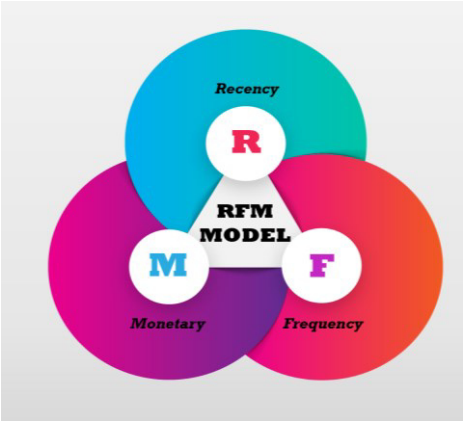
The research consists of six sections, with the introduction as the first part of the study. The next section reviews relevant research and theoretical foundations related to the research topic. Section 3 outlines the method proposed for constructing the process and model. The next section discusses the analysis, results collection, and content. In section 5, the achieved results are discussed in more detail, along with the proposed solutions. Finally, the conclusion summarises the research conducted, with limitations and implications.

Literature review

RFM models

In this section, various literature related to this paper has been reviewed, and research gaps also were discovered in articles about RFM models (Figure 1). Moreover, a series of extended RFM model studies is summarised as a diagram in Figure 2.

Figure 1
RFM Model Illustration



Source: Authors' summary

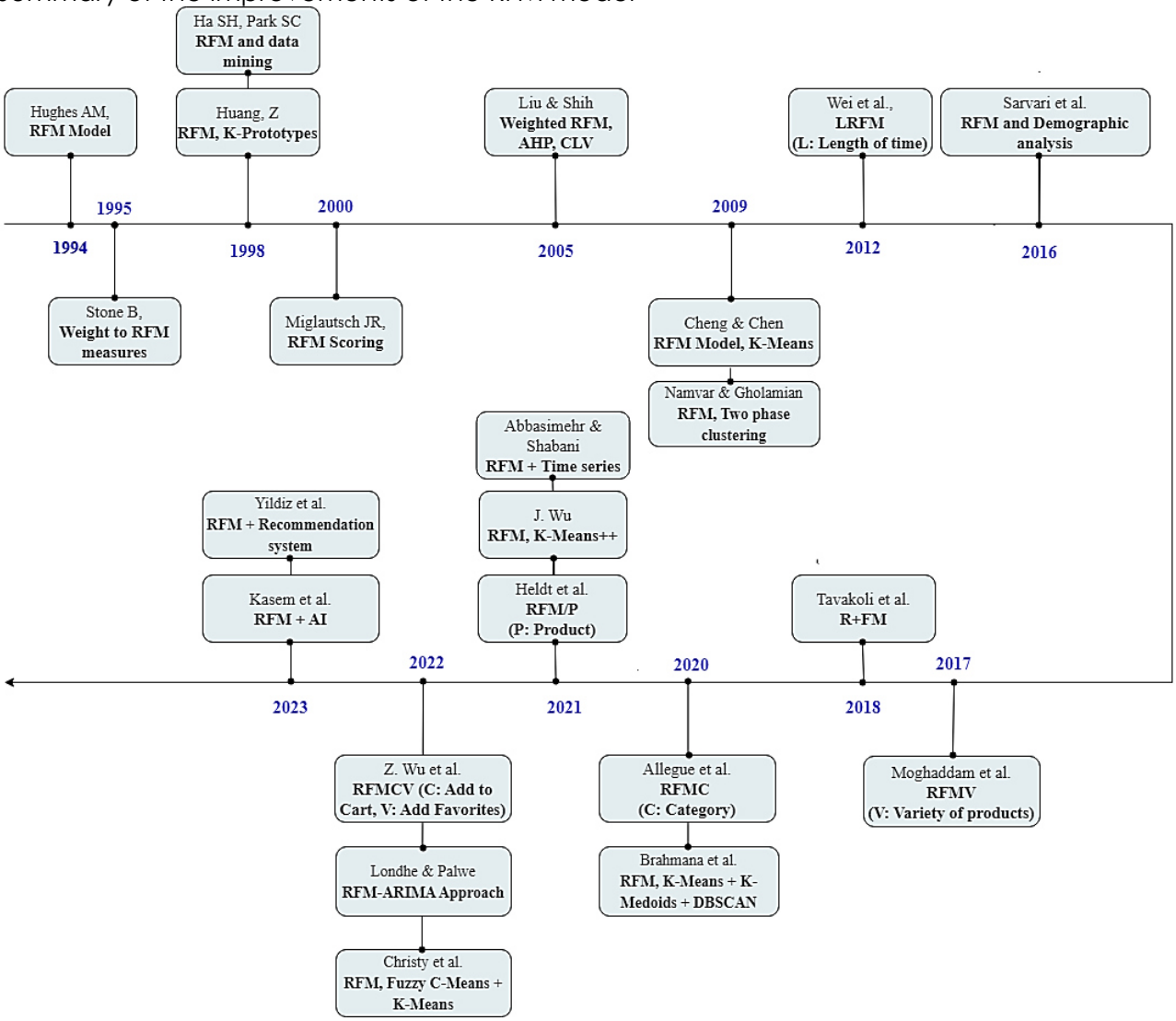
The RFM model is famous for dividing customers into segments based on analysing their past transactional data. This includes factors like the Recency of a customer's purchases, the Frequency of their buying activity, and the monetary value of their spending (Wei et al., 2010).

However, this traditional RFM model does not take advantage of additional consumer attributes and only considers transactional variables like Recency, Frequency, and Monetary (Hoegele et al., 2016). As a result, numerous research studies have been conducted to add additional variables to the traditional RFM model and apply machine learning to improve customer segmentation performance.

A summary of developments in consumer segmentation using enhanced RFM models between 1994 and 2021 was prepared. Figure 2 shows the evolution of the RFM model during the periods.

Figure 2

Summary of the improvements of the RFM model



Source: Authors' work

In the earliest period of the above timeline (from 1994 to 2000), the first concepts of the RFM model were introduced. Hughes first proposed the definition of the RFM model. In this initial RFM model (Hughes, 1994), three variables, R, F, and M, held equal significance in computing the overall score. For instance, if R, F, and M were assigned scores of 4, 5, and 3, respectively, the resulting combined score would be 12. However, Stone (1995) implied that product and industry features should be considered, and distinct weights would be assigned to each measure of RFM. In 1998, the RFM model

was first integrated with data mining technologies applied to datasets from enterprise data warehouses to boost convenience store sales in Ha and Park (1998). This time, two methods were also proposed in the research (Huang, 1998): extended K-Means for categorical variables and mixed data processing algorithms that integrate the K-Modes using the measurement method. The K-Prototypes algorithm, combining features from both the K-Means and K-Modes algorithms, not only handles categorical data but also removes restrictions when handling data from huge datasets. K-Means is only used with numerical data. RFM was also referred to as the customer quantile-based method in Miglautsch (2000), which arranges customers in decreasing order. The numbers of customers in each segment were in the same proportion.

From 2005 to 2012, many important improvements were proposed to the RFM model. In Liu and Shih (2005a) and Liu and Shih (2005b), the authors determined the weights of the three factors within the RFM model identified by the AHP technique instead of predetermining them. This approach enabled firms to evaluate customer lifetime value with the RFM model more precisely when applied in different industries. RFM model was also explored with another dimension with additional variables, for instance, variable L in the study of Wei et al. (2012). Variable L represents the duration from a patient's initial to final hospital admission. Moreover, the analysis of RFM models, which improved classification accuracy with the first use of K-Means in the study of Cheng and Chen (2009), enabled firms to successfully implement CRM tools when gaining knowledge of client segments' consumption patterns.

The third stage observed for summary, from 2015 to 2023, is when the RFM model developed with both clustering algorithms application and integration of other factors. The article of Moghaddam et al. (2017) considered the characteristic of the product category with additional variable V for the RFMV model, while the research by Heldt et al. (2021) took the product factor into account and suggested a product-specific RFM (RFM/P) model to predict the value of customer per product. Moreover, the article by Tavakoli et al. (2018) suggested using the R+FM model to help firms consider the relationship between customers and changes in their behaviour. The article by Allegue et al. (2020) also proposed an extended RFM model, which was RFMC with variable C as the feature for the Category of transactions made by the customer. Since variable C was categorical data, one hot encoding transforms the data into numeric values.

Additionally, the study by Sarvari et al. (2016) compared two clustering methods, Kohonen and K-Means, and three algorithms for generating association rules: FP-growth algorithm, Éclat algorithm, and A-priori under 42 scenarios with different RFM weights, segmentation factors, and input for Association Rule Mining. Analysis results demonstrate the importance of the demographics factor when merged with the RFM model. In 2022, for the dataset of the e-commerce platform, the extended RFM model with two variables, C and V, was proposed (Wu et al., 2022). Variable C represents the Frequency of customers adding items to their shopping carts, and variable V refers to the Frequency of customers adding items to their favourites list. Also, this year, the RFM model was combined with the ARIMA model in Londhe and Palwe (2022) to segment customers and predict sales revenue, referred to as a hybrid multi-step model. The results of these methods showed that RFM-ARIMA achieved better accuracy and was presented as a better approach to analysing customer behaviour and making precise sales revenue predictions. RFM model analysis also improved clustering efficiency with many clustering algorithms. K-Means, K-Medoids, and DBSCAN clustering algorithms—were applied in the article of Brahmana et al. (2020) using the customer transactional dataset. In addition, K-Means and Fuzzy C-Means were used, and the results were evaluated based on the comparison between their iteration number, cluster cohesion, and execution time of the clustering process (Christy et al., 2021). Besides, Wu et al.

(2021) precisely calculate customer value with an enhanced RFM model and employ K-Means++ for user segmentation on E-commerce platforms. Moreover, various techniques were combined with RFM; for example, Abbasimehr and Shabani (2021) proposed customer behaviour forecasting at the segment level with RFM and represented as a time series; Yıldız et al. (2023) presented the integration of the recommendation system with a rule-based heuristic algorithm and customer segmentation whose parameters for the clustering phase were RFM value and demographic data; RFM analysis and boosting tree were also combined in (Kasem et al., 2023) to create the customer profiling system and predict product sales.

Research gap

The reviewed customer segmentation using RFM analysis studies in general use factors related to product or transaction characteristics but have not taken advantage of many customer demographics such as age, gender, and Region. Although demographics have been considered in some studies, its data is not a main variable in customer clustering. Therefore, the demographic variable cannot demonstrate the relationship or impact on the R, F, and M variables of the RFM model in the process of clustering or customer segmentation. For example, Namvar et al. (2010) built a new customer segmentation model with two distinct clustering phases: first, customers were clustered with K-Means based on R, F, and M variables, and then with demographics data, these clusters would be partitioned into new clusters. In addition, in the study of Sarvari et al. (2016), with the transaction dataset from the global pizza chain, customer segmentation was analysed utilising the RFM model and demographic information by applying K-Means clustering and association rule mining. The study has designed 42 scenario types with various inputs for clustering processes, including the value of each RFM variable, scores for each RFM variable, and the average RFM score to segment customers more precisely. Three RFM variables can be assigned weights or combined with demographic data. Categorical data such as Age, Region, and Gender were also converted into numeric data for the K-Means clustering process by being assigned ordinal numbers. The study has carefully evaluated and compared the efficiency of scenarios by applying Neutral Networks. The proposed research method was considered to have achieved the best results. Moreover, with the limited amount of demographic data, the study shows that demographic characteristics play an undeniably important role when combined with RFM data. However, in the processing process, because of applying many clustering methods and rule extraction techniques, the study also needs to use more machine learning methods to improve the speed, time, and ability to extract rules more comprehensively of the data mining tools.

To help businesses gain a deeper understanding of both customer behaviour and demographic characteristics by customer segments, the article proposed the RFMD model with a combination of RFM and demographic factors. The new point, as well as the way to fill in the research gap in this study, is to include all the variables of the RFMD model for the input data of the clustering process with the application of the K-Means algorithm combined with One hot encoding method and K-Prototypes algorithm. Therefore, the relationship or impact of four variables, R, F, M, and D, on customer segmentation is demonstrated. Besides, two clustering algorithms also help the clustering process on a mixed dataset of numeric and categorical data to become more easily and efficiently. In addition, from the works of Covoes et al. (2013) and Romano et al. (2014), this study implemented the ARI and AMI to evaluate the similarity between the two clustering results. AMI and ARI, in general, are quite stable and often used to evaluate clustering results. Cohort analysis is also applied in the study to help

marketers provide valuable insights into how different segments of customers behave over time.

Background

After finding the research gap, the theoretical definitions relevant to building background knowledge and concepts for the research are presented.

Customer segmentation

Customer segmentation was first introduced by Smith (1956), which is an act of dividing into groups. Customers in a group have similar behaviour, characteristics, and needs (McDonald, 2012). Customer segmentation builds customer profiles, the foundation for a customer-centric information system (Bose & Chen, 2015).

The general customers of the market and the business have many different characteristics. In customer segmentation, general factors and characteristics related to each product make up the two main categories of customer values (Wedel & Kamakura, 2000). Customer demographics such as age, gender, and geography are included in general variables. Contrarily, product-specific variables are related to transactional information and consumer behavior, including shopping habits, customer lifetime value (LTV), and spending. On the other hand, product-specific variables pertain to transactional details and customer behavior, such as purchase patterns, customer LTV, and expenditure. Product-specific variables are very effective as the purchase behaviour can be summarised using a very small number of variables, like the RFM model.

Consumer behaviour and experience

Brands must understand how consumers behave and think when making decisions, particularly now, when customers are more aware and able to access information more rapidly online (Jacoby, 1975; Kicova et al., 2018). Many factors influence behaviour, such as demographics, religion, and geographical location (Gajjar, 2013). Research on consumer behaviour is important because it helps marketers understand the impact on customers' purchasing decisions.

Customer experience is the consumer's cognitive and emotional evaluation of their direct and indirect interactions with the business about their purchase behavior.

Clustering

Clustering is a crucial and popular tool for client segmentation (Chiu & Tavella, 2008). Grouping objects into sets of related objects is known as clustering (Al-Augby et al., 2015). Clustering is divided into two popular categories: Hierarchical and Partitional clustering. Hierarchical clustering generates a cluster tree (or dendrogram) using heuristic splitting or merging techniques, which does not need to specify a specific number of clusters. Agglomerative algorithms are well-known ones that create the cluster tree through merging. Each pattern is initially given to a single cluster using a dividing hierarchical technique. Then, until all data points are in the same cluster, splitting is done to a cluster in each stage. Partitional clustering is a method of dividing data into a specific number of clusters. This method is more efficient than hierarchical algorithms (Omran et al., 2007).

K-Means

The K-Means algorithm is one of the machine learning methods of Partitional clustering. K-Means has been popular and in the top 10 most used in data mining and knowledge discovery since 2000 (Wu et al., 2008). Several academics from other fields have

discovered this algorithm, most notably Lloyd (1982), Forgey (1965) and Friedman and Rubin (1967). Indeed, the K-Means algorithm minimises the distance from the values in the cluster to the centroids based on the theory of vector distances in Euclidean space.

$$d(x, C_i) = \sqrt{\sum_{j=1}^{m} (x_j - C_{ij})} \quad (1)$$

K-Means and One hot encoding

For the K-Means algorithm to work with categorical data, we have to encode that data into a numerical format. The method we use is One hot encoding.

"One hot encoding is the most common approach to converting categorical features to a suitable format for input to a machine-learning model" (Seger, 2018). It is an encoding method that expands an initial vector into a multidimensional matrix. Each dimension of the matrix is the number of states in this feature, and each dimension represents a specific state. All other state dimensions are zero due to this processing, and just one feature matrix dimension is typically asserted for each state (Yu et al., 2022). Table 1 presents part of the encoding data.

Table 1

Encoding data

Regular representation	One-hot encoding
0	1
1	10
2	100
3	1000
4	10000
5	100000

Source: Authors' work

K-Prototypes

The K-Prototype algorithm combines K-means and K-Modes (Lakshmi et al., 2018). K-Prototypes is a powerful approach for clustering datasets of different types. The results of Cheng and Chen (2009) also show that the K-Prototypes algorithm is effective when clustering on large and complex datasets in the number of data lines and clusters.

$$d(x_{il}(t), c_j) = \sum_{r=1}^{m_r} \sqrt{(x_{ir}(t) - c_{jr})^2} + \gamma_j \sum_{t=1}^{m_t} \delta(x_{is}(t), c_{js}) \quad (2)$$

Extended RFM model (RFMD)

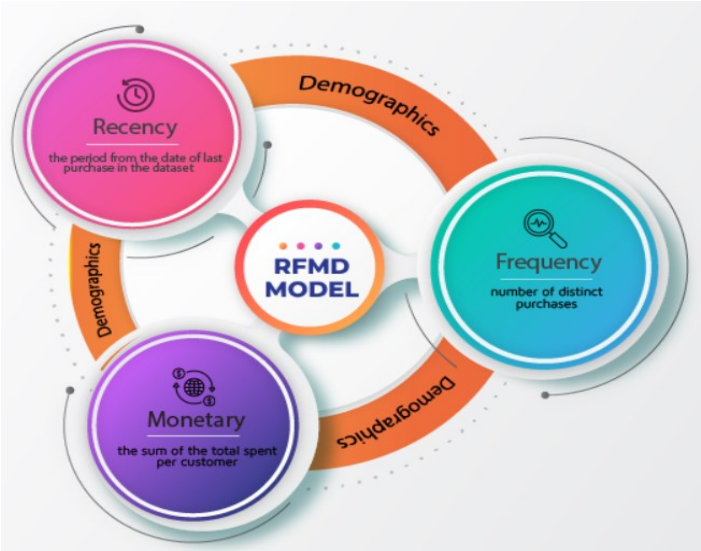
A new model based on the research gap and conceptual background is proposed. The mathematical formula is also demonstrated below.

The RFM model has limitations in accommodating only a limited number of selection factors (Wei et al., 2010). This model does not exploit the influence of customer demographic features. However, customers' demographic values impact the formulation of business and marketing strategies. "Demographics play a specific role in marketing; clearer concept/measure relationships, better techniques, and expanded applications can improve the quality of work seen" (Pol, 1991).

With the affirmation of the importance of Demographic in the customer segment from previous reputable studies, as stated above, this study was conducted to incorporate demographic variables into the RFM model, thereby effectively optimising customer segmentation. Our RFMD model is built from transaction data of business, with variables R(Recency), F(Frequency), M(Monetary), and D(demographic). Figure 3 depicts our RFMD model. Variable D includes categorical variables corresponding to

the customer's demographic attributes. The selected attributes differ depending on the customer's business purpose and strategy. In this model, we assume that the numeric variables in the model R, F, and M have the same impact on the model, and the results are the same.

Figure 3
RFMD model



Source: Authors' work

To evaluate which segment a customer is placed in, we built formula (3) with the same rating assigned to a segment.

RFMDscore = Rscore + Fscore + Mscore + Dscore (3)

The scores of each variable R, F, M, and D are from 1 to 5 depending on the criteria of each different enterprise. In this study, we used 2 machine learning methods, K-Means and K-Prototypes, to cluster the RFMD data model to find customer groups with the most similarity. K-Means and K-Prototype use Euclidean or squared Euclidean distance on the numeric attributes to measure the distortion between data objects and centroid K. (Prabha & Visalakshi, 2014). Assuming the data set is U = {x_1,x_2,x_3,...x_N}, let C be the centre vector of 1 cluster, and N is the number of rows of data. Formulas (4) and (5) demonstrate the Euclidean distance calculation between data points. Example in case of RFM model: there is 1 data centre point c(1,2,3) and one data point x(2,3,4) the distance between two points is equal to $d_{(c,x)} = \sqrt{(1-2)^2 + (2-3)^2 + (3-4)^2} \approx 1.73$. The same calculation method is applied for the RFMD model as formula (4). These 2 formulas show the difference between using RFM and RFMD data models. Adding a customer Demographic attribute variable directly affects the clustering results of machine learning, thereby changing the results in which customers are classified. The distance from a point to cluster entered in the case of the RFM model:

$$d(c;x) = \sqrt{(C_R - Xi_R)^2 + (C_F - Xi_F)^2 + (C_M - Xi_M)^2} \quad (4)$$

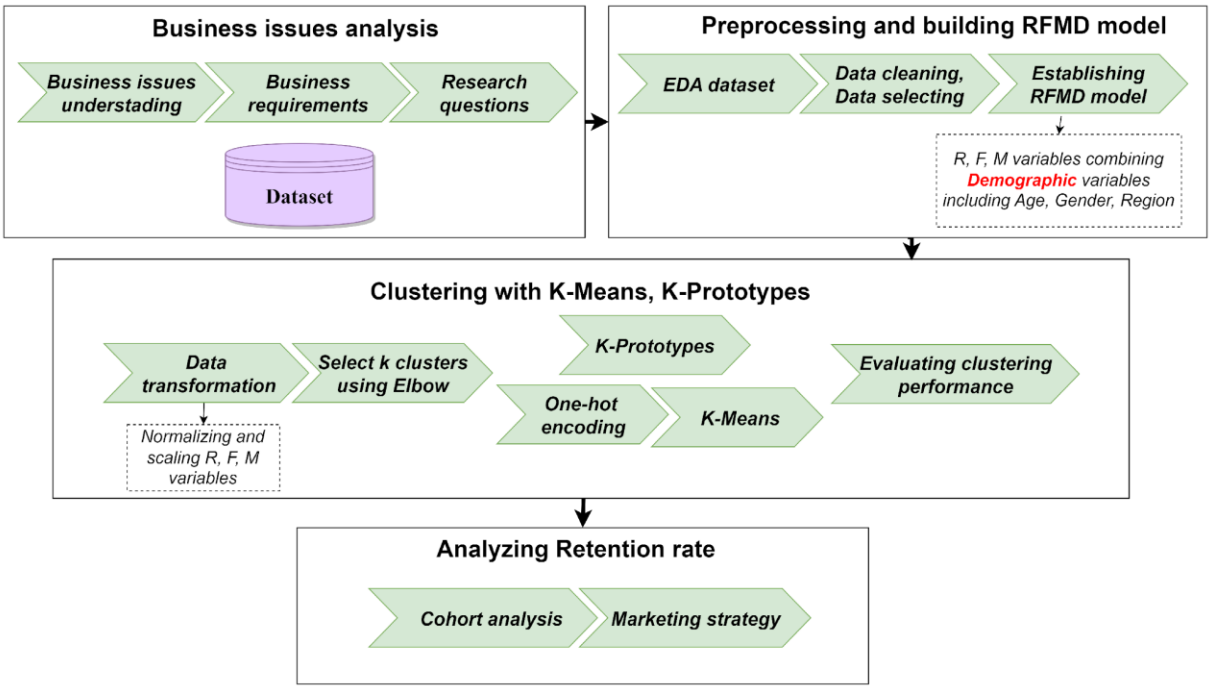
The distance from a vector x to the centre of the cluster of the RFMD model:

$$d(c;x) = \sqrt{(C_R - Xi_R)^2 + (C_F - Xi_F)^2 + (C_M - Xi_M)^2 + (C_D - Xi_D)^2} \quad (5)$$

Methodology

This section elaborates on the experimental framework and explains all the steps. As shown in Figure 4, the research process involves four main stages.

Figure 4
Proposed Methodology



Source: Authors' work

Proposed stages:

(1) At this stage, it is necessary to understand the business problems of the limitations when using the traditional RFM model, thereby setting out the business requirements related to customer segmentation that need to be solved. Next are proposing the questions that need to be answered.

(2) Pre-processing and building RFMD. At this step, the researcher performs data mining and selects suitable features to build the proposed data model. Data pre-processing is then conducted to make the input data compatible with the proposed machine learning methods. This is a very important stage for machine learning to be highly effective. Finally, the proposed RFMD data model is finalised.

(3) Clustering with K-Means, K-Prototypes. At this stage, K-means and K-prototype clustering techniques are used to identify customer groups whose demographic characteristics affect different purchasing behaviour. Firstly, a method is tested and chosen for normalising and scaling the transactional variables to ensure the model is efficient and stable. The Elbow method selects the appropriate number of clusters for the data model. After clustering using two machine learning methods, the indexes ARI and AMI compare the similarity and agreement of the two clustering results.

(4) Analysing Retention Rate. At this final stage, Cohort analysis is performed to dig deeper into the built data model. Besides, the researcher recommends several marketing campaigns based on the results obtained.

Business issues understanding

After summarising domestic and foreign research on customer segmentation and specifically the application of the RFM model to the customer segment, some limitations

of the RFM model have been mentioned. Customer data is increasing, not only focusing on common transactional data such as purchase date, purchase quantity, and total amount but also expanding in terms of customer demographic data such as age, and gender. Therefore, businesses must use this data source to make appropriate decisions.

In addition, the traditional RFM model cannot segment customers and evaluate them comprehensively because it only focuses on customers' shopping behaviour while ignoring other customer characteristics such as demographics. There is a requirement for a new data model that helps businesses acknowledge both the behavioural and demographic characteristics of customers. There are also indispensable clustering machine learning methods for this new data model. From there, businesses can use demographic data well, have a more comprehensive view of customers, and promote accurate marketing and customer service strategies. The current requirements are not only to answer the question of which customer group they belong to but also the question of who they are and their demographic characteristics.

Data preparation and customer segmentation

A dataset of Online Sales in the USA is about the sales of different products, merchandise, and electronics in different states. It contains 286,392 transactions of 64,248 customers during the period between October 2020 and September 2021 with four basic statuses, including Cancelled orders (112,166 transactions), Returned orders (25,713 transactions), Received orders (51,775 transactions), Completed orders (88,968 transactions). There are no missing or duplicate values. Part of the data is presented in Table 2.

Table 2
A piece of original input data

Code	Order_date	Status	Qty_ordered	Price	Cust_id	Gender	Age	Region	Zip	...	Item_id
100354678	10/1/2020	Received	21	89.9	60124	F	43	South	73571	...	574772
100354678	10/1/2020	received	11	19.0	60124	F	43	South	73571	...	574774
100354680	10/1/2020	complete	9	149.9	60124	F	43	South	73571	...	574777
100354680	10/1/2020	complete	9	79.9	60124	F	43	South	73571	...	574779
100367357	11/13/2020	received	2	99.9	60124	F	43	South	73571	...	595185
100367357	11/13/2020	received	2	39.9	60124	F	43	South	73571	...	595186

Source: Authors' work

Firstly, the transactions are removed with Cancelled and Returned status as they do not create value for the company. Following that, the order_id is grouped to create a new dataset where each row represents a distinct order_id. Therefore, the final dataset records 93,873 orders from 42,589 customers. Attributes are selected based on RFMD model features such as order_id (a transaction has only one order_id), order_date (time to execute that transaction), qty_ordered (the number of products in that order), price (price per product), cust_id (Each customer is provided with a unique cust_id), Gender, Age (customer age), Region (The Region where the customer lives with 4 unique values is South, Northeast, West, Midwest). The new dataset is created by grouping each cust_id:

- **Recency:** calculated by the number of days since the newest order_date to the reference day;
- **Frequency:** counts total order_id of each customer;
- **Monetary:** is calculated by adding a column name 'payment' using formula (qty_ordered times to price) as a cell of that column and sum all payments of each customer;

- **Age:** Integer;
- **Region:** Coded;
- **Gender:** Male or Female.

After obtaining the RFMD data model, the customers with a Monetary transaction value of 0 are removed from the data set because these customers do not bring value to the company. The final data set includes 42,492 transactions for each specific customer. Table 3 presents a part of the data of the RFMD model.

Table 3
A part of the data of the RFMD model

Customer ID	Recency	Frequency	Monetary	Gender	Region	Age
115322	1	1	209.6	F	Northeast	56
115323	1	1	8,839.8	M	Northeast	51
115324	1	1	79.8	M	South	52
115325	1	2	179.8	F	South	38
115326	1	1	7,119.8	M	South	28

Source: Authors' work

Clustering with K-Means and K-Prototypes

After completion of the RFMD model, clustering using two machine learning methods, K-Means and K-Prototypes, is initiated. However, before that, normalisation and scaling of the transactional data are selected and performed.

Data transformation

The data normalisation procedure is commonly applied in the data transformation phase during the clustering process of machine learning algorithms. The value of transactional data, specifically Recency, Frequency, and Monetary, is studied and analysed first.

As demonstrated in Table 4, the quartiles of the three indices R, F, and M are considered, revealing Recency's minimum and maximum values as 1 and 365.

Table 4
Descriptive statistics of the Recency, Frequency and Monetary variables

Statistics	Recency	Frequency	Monetary
Count	42,492.00	42,492.00	42492.00
Mean	196.90	2.21	4332.18
Standard Deviation	89.32	5.29	12743.78
Min	1.00	1.00	0.20
25%	136.00	1.00	239.60
50%	192.00	1.00	643.95
75%	279.00	2.00	3200.00
Max	365.00	770.00	582665.40

Source: Authors' work

Some customers have purchased recently, and some have not in 1 year. The mean is larger than the median. The Frequency value ranges from 1 to 770. The Frequency is much distributed at the value of 1 purchase. Especially the mean is higher than the 3rd percentile (75%) due to the large outlier's influence. The data distribution tends to be much left skewed. The Monetary value is distributed from 0.2 to 582,665. Like Frequency, outliers heavily influence monetary value, and the data distribution tends to be much left-skewed. As can be seen, the value domain of R, F, and M has a clear difference,

especially the domain of Monetary is much larger than the two values of Recency and Frequency.

Before scaling the data, the data must be asymptotic to a normal distribution. At this step, the distribution of three transactional data variables is tested: Recency, Frequency, and Monetary. Then, Box-Cox transformation is used as Box-Cox can constitute a best practice in data transformation (Osborne, 2010). The Box-cox transformation method is commonly used to stabilise variance (remove changed variances) and transform non-normal dependent variables into normal shapes.

$$y_i^{(\lambda)} = \{\frac{y_i^{\lambda}-1}{\lambda}, if\lambda \neq 0 \; ln(y_i), if\lambda \neq 0 \quad (6)$$

Table 5
Result of Skewness before and after using Box-Cox transformation

Indicator	Recency	Frequency	Monetary
Original distribution	-0.35	76.10	11.9
Box-Cox transformation	-0.33	0.71	0.04

Source: Authors' work

Based on the result in Table 5, normalising by the box-cox method for all 3 variables gives a good result close to normal distribution. The Frequency and Monetary variables with the original data are very right-skewed. Besides, the R, F, and M scales differ, as they are measured in days, occurrences, and monetary units, respectively. Therefore, the study uses the standard method (StandardScaler) after the data is normally distributed. The Recency, Frequency, and Monetary variables are scaled to a domain of values suitable for clustering algorithms (Table 6).

Standardisation:

$$z = \frac{x-\mu}{\sigma} \quad (7)$$

with mean:

$$\mu = \frac{1}{N}\sum_{i=1}^{N} \quad (x_i) \quad (8)$$

and standard deviation:

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N} \quad (x_i - \mu)^2} \quad (9)$$

Table 6
Part of RFMD data with normalised and scaled transaction variables

CustomerID	Gender	Region	Age	Recency	Frequency	Monetary
115322	F	Northeast	56	-2.16	-0.73	-0.86
115323	M	Northeast	51	-2.16	-0.73	1.29
115324	M	South	52	-2.16	-0.73	-1.59
115325	F	South	38	-2.16	0.99	-0.97
115326	M	South	28	-2.16	-0.73	1.19

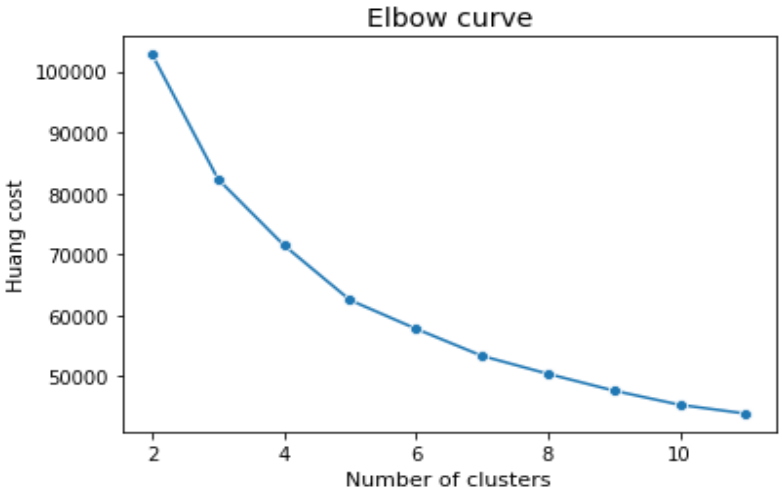
Source: Authors' work

Selecting the number of clusters using the Elbow method

The Elbow method is one of the popular methods to select k clusters for both. The Elbow method is illustrated as a curve graph with the horizontal axis being the number of K clusters (the count of customer segments using the values extracted from the RFMD data model) and the vertical axis being the Huang Cost Function. An index that measures the difference between points in the cluster. "Assume sr is the dissimilarity measure on numeric attributes defined by the squared Euclidean distance and sc is the

dissimilarity measure on categorical attributes defined as the number of mismatches of categories between two objects. The Huang Cost Function defines the dissimilarity measure between sr + γsc, where γ is a weight to balance the two parts to avoid favouring either type of attribute. Because these algorithms use the same clustering process as k-means, they preserve the efficiency of the k-means algorithm, which is highly desirable for data mining" (Cheng & Chen, 2009).

Figure 5
Result of Elbow curve



Source: Authors' work

As shown in Figure 5, the elbow with K = 5 is chosen as the appropriate number of clusters. It is observed that, from cluster number 6 onwards, the value of the cost function is almost uniformly decreasing, or in other words, the Huang Cost is almost linear, indicating the homogeneity between the points in the cluster.

Clustering with K-Means and K-Prototypes algorithms

The clustering results are obtained for K-Prototypes machine learning using the scaled RFMD dataset and the number of previously selected clusters as input (Table 7).

Table 7
Clustering result of K-Prototypes machine learning

Cluster	Number of customers	Mean R	Mean F	Mean M	F	M	Mid-west	North-east	South	West	Age 18-24	Age 25-64
0	7,902	109.0	5.4	12,289.1	3,555	4,352	2,169	1,364	2,888	1,481	1,093	5,474
1	10,463	118.7	1.0	464.9	5,691	4,772	2,890	1,801	3,888	1,884	1,461	7,176
2	7,163	231.7	1.0	3,589.7	3,814	3,349	1,894	1,278	2,686	1,305	996	4,937
3	10,053	277.7	1.0	258.5	4,294	5,759	2,703	1,844	3,707	1,799	1,345	7,037
4	6,911	262.3	3.4	7,784.4	3,853	3,058	1,885	1,232	2,586	1,208	956	4,773

Source: Authors' work

For the special K-Means machine learning that only works with numerical data, One hot encoding method is chosen for all three variables: Age, Gender, and Region. As the K-Means algorithm cannot interpret categorical variables, demographic variables must be encoded with numbers for the algorithm to understand and interpret. One hot encoding technique is chosen because all three variables, Age, Gender, and Region, are nominal categorical variables, and this method creates new (n-1) variables for n values of a categorical value. It uses only 0 or 1 while encoding a variable. The label

coding approach, inappropriate for these three variables, cannot be used for ordinal categorical variables.

Table 8
Descriptive statistics of the Age variable

Statistics	Age
Count	42,492.00
Mean	46.40
Standard Deviation	16.73
Min	18.00
25%	32.00
50%	46.00
75%	61.00
Max	75.00

Source: Authors' work

Table 8 displays the descriptive statistics for the Age variable, encompassing an age range from 18 to 75 within the datasets. Customer ages are categorised into three groups: Youth (18-24), Adults (25-64), and Elderly (over 65) (Ritchie & Roser, 2019), corresponding to the three columns that have been designated: 'Age 18-24', 'Age 25-64', 'Age 65+'. Table 9 displays a dataset segment following the utilisation of One-hot encoding.

Table 9
A part of the dataset after using One-hot encoding

Customer ID	Recency	Frequency	Monetary	Gender F	Gender M	Age 18-24	Age 25-64	Age 65+	Region Midwest	Region Northeast	Region South	Region West
4	-2.155221	1.935947	2.066071	0	1	0	1	0	1	0	0	0
15	0.389741	1.344794	-0.391672	1	0	0	0	1	1	0	0	0
20	-2.155221	1.436696	2.026171	0	1	0	1	0	0	0	1	0
21	0.479979	-0.977193	-1.234476	0	1	0	1	0	0	0	1	0

Source: Authors' work

After using One hot encoding, the Gender variable is divided into two columns, including 'Gender F' as a Female column and 'Gender M' as a Male; the variable Region is divided into 4 columns corresponding to 4 geographic regions of the United States: 'Region Midwest', 'Region Northeast, 'Region South, 'Region West; especially with the Age variable. The clustering results of the K-Means algorithm are presented in Table 10.

Table 10
Clustering result of the K-Means algorithm

Cluster	Number of customers	Mean R	Mean F	Mean M	F	M	Midwest	Northeast	South	West	Age 18-24	Age 25-64
0	9,629	282.58	1.0	262.5	4,722	4,907	2,593	1,779	3,527	1,730	1,098	6,811
1	6,591	266.86	3.3	7,242.8	3,308	3,283	1,812	1,161	2,479	1,139	795	4,532
2	8,248	112.19	5.3	12,481.3	4,112	4,136	2,250	1,438	3,006	1,554	999	5,740
3	10,928	122.03	1.0	445.2	5,604	5,324	3,024	1,863	4,066	1,975	1,320	7,492
4	7,096	229.43	1.0	3,665.1	3,456	3,640	1,862	1,278	2,677	1,279	893	4,862

Source: Authors' work

Evaluation of clustering results

After obtaining two clustering results with the same number of clusters, we use the Adjusted Rand Index (ARI) and Adjusted Mutual Information Index (MI) to compare the similarity and agreement of the two results. Given the knowledge of the method's clustering algorithm assignments between the two-clustering methods K-Means and K-

Prototypes of the same sample, the ARI is a function that measures the similarity. The AMI is a function that quantifies the concordance between two assignments, while disregarding permutations and incorporating chance normalisation (Vinh et al., 2009).

Adjusted Mutual Information:

$$AMI(U,V) = \frac{MI(U,V) - E\{MI(U,V)\}}{\{H(U),H(V)\} - E\{MI(U,V)\}} \quad (10)$$

Adjusted Rand Index:

$$ARI = \frac{\Sigma_{ij} \left(\frac{n_{ij}}{2}\right) - \frac{[\Sigma_i \left(\frac{a_i}{2}\right) \Sigma_j \left(\frac{b_j}{2}\right)]}{\left(\frac{n_{ij}}{2}\right)}}{\frac{1}{2}\left[\Sigma_i \left(\frac{a_i}{2}\right) + \Sigma_j \left(\frac{b_j}{2}\right)\right] - \frac{[\Sigma_i \left(\frac{a_i}{2}\right) \Sigma_j \left(\frac{b_j}{2}\right)]}{\left(\frac{n_{ij}}{2}\right)}} \quad (11)$$

where n_{ij}, a_i, b_i are values from the contingency table.

Table 11
Result of ARI and AMI Index

Adjusted Rand Index (ARI)	Adjusted Mutual Information (AMI)
0.880	0.864

Source: Authors' work

The results presented in Table 11 show that both AMI and ARI > 86%, i.e., the results of the two clusters have high similarity. In other words, our RFMD data model can be tested on both K-Means and K-Prototypes clustering methods.

Results

Cluster description and evaluation

Customers with the same characteristics were categorised into 5 clusters.

Cluster 0: Loyal Customers. This cluster includes 7,902 customers with the most recent purchase (109), the highest Frequency (5), and the first group of customers who spend the most money in the 5 clusters to shop (12,289). According to the Pareto principle, this cluster plays the most important role in contributing revenue to the business. Therefore, it is labelled as a *Loyal Customer* based on purchasing behaviour that shows the great engagement of customers in a business. Customers in this cluster are evenly distributed among age groups. However, the most valuable customer group belongs to women aged 18-24 in the Northeast, age 25-65 in the Southern Region, age 18-24 in the West region, and males aged 25-65 in the Midwest, age 65+ in the Northeast, age 25-65 in the Southern Region, and age 65+ in the West. To increase customer loyalty, businesses must regularly receive feedback and provide better customer experiences. Moreover, businesses can choose up-selling campaigns with higher-value products and services or cross-selling with other accompanying products to increase Monetary value. Table 12 presents the descriptive statistics relevant to cluster 0.

Table 12
Descriptive statistics of variables Recency, Frequency and Monetary and Demographics variables of cluster 0

Variable	Count	Mean	Standard Deviation	Min	25%	50%	75%	Max
Recency	7,902	109.05	55.22	1	68	112	155	203
Frequency	7,902	5.38	11.37	1	2	3	5	770
Monetary	7,902	12,289.12	25,005.52	135.8	1,089.58	4,101.75	12,119.4	582,665.4
Age 18-24	1,093	.	.	.	.	.	.	.
Age 25-65	5,474	.	.	.	.	.	.	.
Age 65+	1,335	.	.	.	.	.	.	.
F	3,550	.	.	.	.	.	.	.
M	4,352	.	.	.	.	.	.	.
Midwest	2,169	.	.	.	.	.	.	.
Northeast	1,364	.	.	.	.	.	.	.
South	2,888	.	.	.	.	.	.	.
West	1,481	.	.	.	.	.	.	.

Source: Authors' work

Cluster 1: New Customers. This cluster includes 10,463 customers who recently purchased with Recency (119) but did not make regular purchases with Frequency (1) and spent only a small amount of money, Monetary equal to (465). This group of customers revealed the features of buying products recently and showed business interest. However, they only purchased with small amounts of money because they were unfamiliar with the business. This cluster is labeled as *New Customers*. The potential customers in this cluster belong to the female customer group, especially those aged 25-65 in the Northeast region. In addition, male customers of all ages in the South region contribute significantly to revenue, and male customers aged 65+ in the Northeast are also prominent customers. Businesses must stimulate new customers to shop with preferential policies and try to convert them into loyal customers with personalised care services. Besides, businesses should help customers experience and understand the value of products and services to use them without problems later and build friendly relationships with customers. Table 13 presents the descriptive statistics relevant to cluster 1.

Table 13
Descriptive statistics of variables Recency, Frequency and Monetary and Demographics variables of cluster 1

Variable	Count (number of customers)	Mean	Standard Deviation	Min	25%	50%	75%	Max
Recency	10,463	118.67	55.1	1	77	136	156	213
Frequency	10,463	1.01	0.11	1	1	1	1	2
Monetary	10,463	464.9	716.95	0.2	158.8	260	479.1	11,263
Age 18-24	1,461	.	.	.	.	.	.	.
Age 25-65	7,176	.	.	.	.	.	.	.
Age 65+	1,826	.	.	.	.	.	.	.
F	5,691	.	.	.	.	.	.	.
M	4,772	.	.	.	.	.	.	.
Midwest	2,890	.	.	.	.	.	.	.
Northeast	1,801	.	.	.	.	.	.	.
South	3,888	.	.	.	.	.	.	.
West	1,884	.	.	.	.	.	.	.

Source: Authors' work

Cluster 2: Needing Attention Customers. This cluster includes 7,163 customers who have not returned to the shopping business for a long time, with Recency (232), spending with small Frequency (1) but with a relatively high amount of (3,590). These customers used to contribute a lot to business but somehow have not come back to business. Therefore, they are labelled as *Needing Attention Customers* because businesses must focus on them to win them back. Male customers aged 18-24 and 25-65 in the Northeast with high Monetary value tend to leave the business in this cluster.

Additionally, male and female customers in the Northeast have not shopped for a long time. Businesses should review their marketing campaigns in the Northeast region and try to re-engage their interest with coupons and personalised emails. Table 14 presents the descriptive statistics relevant to the cluster.

Table 14
Descriptive statistics of variables Recency, Frequency and Monetary and Demographics variables of cluster 2

Variable	Count	Mean	Standard Deviation	Min	25%	50%	75%	Max
Recency	7,163	231.65	64,34	33	174	260	281	365
Frequency	7,163	1	0	1	1	1	1	1
Monetary	7,163	3,589.7	3,686.72	399.8	1,258.65	2,400.0	4,385.5	49,996.5
Age 18-24	996	.	.	.	.	.	.	.
Age 25-65	4,937	.	.	.	.	.	.	.
Age 65+	1,230	.	.	.	.	.	.	.
F	3,814	.	.	.	.	.	.	.
M	3,349	.	.	.	.	.	.	.
Midwest	1,894	.	.	.	.	.	.	.
Northeast	1,278	.	.	.	.	.	.	.
South	2,686	.	.	.	.	.	.	.
West	1,318	.	.	.	.	.	.	.

Source: Authors' work

Cluster 3: At-risk Customers. These 10,053 customers made their last purchase a long time ago, with Recency (277), low Frequency (1), and minimal transaction amount of (259). This is a customer cluster that shows signs of leaving the business. However, the number of customers in this cluster is very large, so if the business does not retain them, it will lose significant revenue and receive negative feedback. With the importance of this cluster and its churn behaviour, this cluster is labelled as *At Risk Customers* because if the business does not respond to this cluster immediately, they can all be churned out soon. These customers are concentrated in the Midwest and Southern regions, aged 65+.

Additionally, male customers aged 18-24 in the Southern Region also need attention. Businesses need to focus more on marketing campaigns for customers aged 65+. Besides, businesses must provide many useful information sources for this customer cluster to retain them. Table 15 presents the descriptive statistics relevant to cluster 3.

Table 15
Descriptive statistics of variables Recency, Frequency and Monetary and Demographics variables of cluster 3

Variable	Count	Mean	Standard Deviation	Min	25%	50%	75%	Max
Recency	10,053	277,66	38,23	174	266	280	288	365
Frequency	10,053	1,01	0,12	1	1	1	1	4
Monetary	10,053	258,54	182,27	0,4	139,6	211,8	330	1.658,3
Age 18-24	1,345	.	.	.	.	.	.	.

Age 25-65	7,037	.	.	.	.	.	.	.
Age 65+	1,671	.	.	.	.	.	.	.
F	4,294	.	.	.	.	.	.	.
M	5,759	.	.	.	.	.	.	.
Midwest	2,703	.	.	.	.	.	.	.
Northeast	1,844	.	.	.	.	.	.	.
South	3,707	.	.	.	.	.	.	.
West	1,799	.	.	.	.	.	.	.

Source: Authors' work

Cluster 4: **Cannot lose them.** This cluster includes 6,911 valuable customers with the second-highest total purchase value (7,784) and an impressive frequency of (3). They contribute a sizable revenue stream to the business if they return to make more purchases. However, they have not purchased in a long time, with an alarmingly high Recency value of (262). These customers are labelled as *Cannot lose them* since they had a relatively important impact on the business's revenue, so the business should not let them go. However, these customers still showed they were leaving the business with that Recency value. In this cluster, women are more likely to leave the business, even though they contribute much higher revenue than men.

Additionally, women over 65 spend a lot of money shopping, but their R-value is the highest. Furthermore, men in the Western Region of the United States aged 18-24 and 25-65 also need attention. Businesses should focus on retaining female customers in all regions and try to entice them with new products to prevent them from switching to a rival company. Businesses must implement the most personalised customer service and strategies to retain this valuable cluster if necessary. Table 16 presents the descriptive statistics relevant to cluster 4.

Table 16
Descriptive statistics of variables Recency, Frequency and Monetary and Demographics variables of cluster 4

Variable	Count	Mean	Standard Deviation	Min	25%	50%	75%	Max
Recency	6,911	262,28	38,23	165	246	277	282	365
Frequency	6,911	3,38	2,4	2	2	3	4	56
Monetary	6,911	7.784,39	11.709,35	99,6	843,3	3.347,2	10.750,5	166.460,9
Age 18-24	956	.	.	.	.	.	.	.
Age 25-65	4,773	.	.	.	.	.	.	.
Age 65+	1,182	.	.	.	.	.	.	.
F	3,853	.	.	.	.	.	.	.
M	3,058	.	.	.	.	.	.	.
Midwest	1,885	.	.	.	.	.	.	.
Northeast	1,232	.	.	.	.	.	.	.
South	2,586	.	.	.	.	.	.	.
West	1,208	.	.	.	.	.	.	.

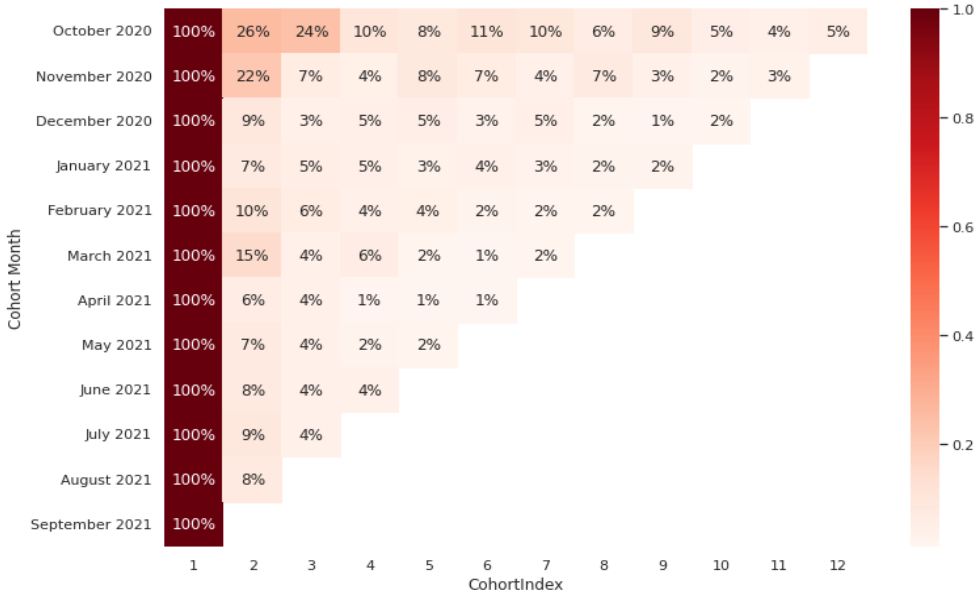
Source: Authors' work

By applying the RFMD model, businesses can have more information about the age, gender, and Region of each cluster. Therefore, businesses can customise marketing strategies based on these demographic features.

Cohort analysis

After analysing all business segments, more than 50% of customers have extremely high R-value>230 days (~ approximately 7 months). The higher the R-value, the higher the churn rate the customer can have. This status needs to be considered, and other aspects of business status, we look at the Cohort analysis below (Figure 6).

Figure 6
Result of Cohort analysis



Source: Authors' work

Cohort analysis is used to measure customer engagement over time:

- Looking at the chart horizontally, the customer retention rate was measured since November 2020 (26%), then it only decreased by 2% in the following month (24%). However, there is a sharp decrease in the retention rate to only 10%, which was reduced by approximately half compared to the previous month. Although it slightly increases by 2-3% in the next months, it continues to decrease to 5% in the last month.
- Looking at the chart vertically, the business obtains the average retention rate after each cycle (one month) with the average value. After a month, the business maintained a ratio of 22%, only declining 4% compared to the previous month. By December 2020, the customer retention rate had declined by 11%. Then, it only increased slightly in February 2021 and March 2021.

In general, this retention rate is very low. Between October 2020 and November 2020, the retention rate remained stable, but in December 2020, there was a severe decline of more than 50%. Enterprise needs to find out the causes and solutions for the dramatic decrease in retention rate in the following months (starting from December 2020). Therefore, a business can improve the churn of customers and reduce R-value.

Discussion

To have a comprehensive overview of the differences, this part divides the previous studies and models into four main types: studies using the RFM model combined with demographics, studies segmenting customers using the RFM model, studies using the RFM model combined with new technologies, and studies segmenting customers using the improved RFM model. This shows the scientific and practical significance of the RFMD model, which is summarised in Figure 2 and the literature review section.

Applying K-Means combined One-hot encoding and K-Prototypes on the RFMD model, five customer segments are determined with different and detailed behaviour and demographic characteristics. However, customer clusters have not been distinctly differentiated; there are similarities in many factors.

Namvar et al. (2010) conducted the first clustering of customers based on the RFM model and then on demographic variables, including Education level, Occupation level and Age, using K-Means algorithms. After two consecutive clustering phases, customers were divided into nine groups compared to three, resulting from the first clustering process. Profiles of nine customer segments were created with the rank of each attribute: RFM, demographic attributes such as Education level, Occupation level, Age, and other characteristics like LTV and Largeness. Sarvari et al. (2016) compared the performance evaluation of 42 scenario types, which had three phases: RFM analysis phase with Weighted RFM analysis, Segmentation Phase with different RFM outputs and Demographic factors, and Association Rules Mining Phase with Demographics if they were not included in Segmentation Phase. Scenario 25 was discovered to be the best with proper numbers of cluster and elapsed time and clusters customers with both R, F, and M scores and demographic data in the segmentation phase. The result produced from this scenario was 5 clusters of customers characterised by R, F, and M scores and demographic factors labelled with ordinal numbers as categorisation.

These studies both include demographic factors in customer segmentation and discover that demographics considerably impact the cluster's effectiveness when integrating with the RFM model to group customers.

However, there are differences between the three studies. First, Namvar et al. (2010) analysis was conducted based on the result with the rank of each attribute. So, it was difficult for marketers to understand more about customer groups. For example, cluster 1 presents the quick general view with the rank of RFM, education level, occupation level and age level, respectively 6, 2, 1, instead of giving detailed information about customers, whether their Education level, Occupation and Age range was. Furthermore, the number of clusters as well as the number of ranks was quite large, which could lead to the fact that each customer segment was not specific or well-defined and the difficulty in targeting customers (Larivière & Van den Poel, 2005; Verhoef et al., 2009). As previously discussed, it was challenging to effectively target its marketing efforts and tailor its products and services to meet the specific needs of each group. Besides (Sarvari et al., 2016), the new finding was a 42-scenario design using K-Means and extracting rules. Using Neutral Network, the clustering with the 25th scenario has been chosen and evaluated to be better than other approaches in comparison with similar works. Despite this, the methodology of this study, with a combination of various clustering and rule extraction approaches, needs to improve the performance of extracting rules with others. Compared to the two studies above, RFMD model research applies K-Means combined One-hot encoding and K-Prototypes to deal with the mixed dataset, including numeric data (R, F, M values) and categorical data (demographic variable), which are popular and proven to be effective clustering algorithms (Hamerly & Elkan, 2002; Huang, 1998). In contrast to previous studies, demographic data are converted into numeric data with One hot encoding when combined with K-Means algorithms in the clustering process instead of being assigned with ordinal numbers. Four variables of the RFMD model can, therefore, be the main inputs for the clustering process and demonstrate the impact of each other in customer segmentation. As a result, customers in each segment are identified with a comprehensive understanding of behaviour and demographic characteristics.

Currently, many improved RFM models have been studied. How does the proposed RFMD model in this study differ in approach or clustering results? To provide a comprehensive overview of the differences, we categorised previous studies into three main types: customer segmentation using the RFM model, customer segmentation using the RFM model combined with new technologies, and customer segmentation using

improved models developed from the RFM model. All are summarised in Figure 2 and the review section.

Many studies have applied new machine learning clustering methods to segment customers using the RFM model. Notable examples include the K-Means++ machine learning method proposed, which was used to segment customers based on the RFM model (Wu et al., 2021). In addition, the DBSCAN and K-Medoids methods have also been applied in clustering. Brahmana et al. (2020) experimented with customer segmentation using the RFM model with three machine learning methods on the same dataset and evaluated them using the Davies Bouldin and Silhouette indices. The results showed that K-Means had the best performance.

The methods are completely different from the techniques used in this study. While newer methods may have better clustering effectiveness, the main objective of this study is to develop an improved model. Therefore, it would be best to use the two most popular clustering methods, K-Means and K-Prototypes, which have been proven effective and serve as a basis for future development methods.

Below is a chronological order comparison of the RFMD model and the existing improved RFM models.

Moghaddam et al. (2017) proposed the RFMV model by adding various products (V), calculated as the number of products a customer has purchased in a given period. Furthermore, the CRISP-DM and K-Means algorithm was used for clustering. Furthermore, Allegue et al. (2020) proposed the RFMC model, using data mining tools to perform customer segmentation based on it. When using the RFMC model, each customer is identified for each Category (C) of the purchased products, and then clustering is performed with the transaction data of each Category. The above studies are completely different from the RFMD model's approach. Rather than proposing a new model for a deeper analysis of purchasing behaviour, we fully utilise customer attribute data, which provides many different perspectives on customers beyond transaction history.

Another study also proposed an improved model to exploit buying behaviour. Wu et al. (2021) proposed an improved model, which includes two additional attributes, S (customer contribution time, referring to the time interval between a user's first and last transactions) and P (repeat purchase attributes), referring to the Frequency of purchases of a specific category of goods made by a particular user within a specified period. Then, they experimented with clustering using the improved machine learning method K-Means++. The results of this study show that some customers are classified as "General" instead of "Loyal", as analysed by the RFM model. That finding is based on a very low S value, indicating that they have never used the app, and a high P indicates that customers only focus on certain products. In the future, the model combined with Demographics values as an input variable for customer segmentation is an interesting topic (Wu et al., 2021).

Conclusion

Summary of research

This study proposes the RFMD model by integrating demographic variables into clustering. With the results of 5 customer segments, detailed information related to behavioural and demographic variables of each segment was extracted to provide useful suggestions for businesses. By successfully testing two popular clustering algorithms, K-Means and K-prototypes, the model demonstrated both the dataset's feasibility and the algorithm selection's suitability. Furthermore, the study also used indicators to evaluate the results and obtained results >0.86 on both clustering

techniques. Cohort analysis is also applied to support in-depth data analysis and propose business marketing strategies.

In business, customer segmentation always plays a crucial role for companies. Finding customer segments allows businesses to identify target customer groups, understand the detailed characteristics of each segment, and develop appropriate business and marketing strategies. Sarvari et al. (2016) developed a study closely related to this research; it was found that analysing demographic factors in customer segmentation is necessary. However, this study proposes a new method by directly integrating demographic variables as input variables into the clustering process along with R, F, and M instead of performing customer segmentation with RFM first and then analysing demographic factors within each cluster. This would support the speed and details of the segmentation process.

This article proposed an extended model RFMD which causes the demographic variables to have a direct impact on the variable's Recency, Frequency and Monetary, making the new model totally different from the old one and completely distinguished from the clustering method using the traditional RFM model and then performing the demographic analysis. Next, two clustering methods are proposed to perform clustering on a mixed dataset with both variables (quantitative variables) and categorical variables (qualitative variables) that are suitable for the RFMD model. Finally, Cohort analysis was conducted based on the clustering results to understand customers better. ARM and AMI are used to compare the clustering results of two proposed clustering methods, which show that the results of both methods are relatively similar. As a result, the RFMD model is a stable data model that can be utilised in customer segmentation to get insight into purchase behaviour and demographic features and evaluate customers more comprehensively.

Implications

The traditional RFM model helps businesses recognise their customer segmentations and purchasing behaviour but cannot reveal the demographic characteristics to launch better-customised marketing campaigns or customer services. The RFMD proposed model can solve this problem, helping businesses reduce marketing and service costs while building effective strategies. For example, instead of sending serial marketing messages or promotions to all customers, which is costly and inefficient, we can customise our marketing strategy based on purchasing behaviour and demographics to target customers. Besides, businesses analyse the relationship between customers' shopping behaviour and demographic characteristics to make the right decisions.

Limitations

Although the research has successfully addressed the research question and yielded good clustering results, the dataset used for testing in this study was from a US retail business that only recorded data for one year. While the mixed data used is suitable for the research objective, the study has only tested on a limited dataset with few demographic attributes, which may limit the generalizability of the method to other attributes or fields. The techniques used in the research are also not diverse; clustering is performed on two common clustering algorithms, and the evaluation index for clustering results is also relatively simple. The research has also not determined the trend of changes in customer shopping behaviour over time; therefore, there is a need for further proposals to improve the method and model.

Future research recommendations

From the above limitations, some recommendations are proposed for future studies. Further studies are suggested to address issues related to the dataset. It is necessary to search and experiment with longer and more diverse demographic variables (such as income and occupation) to make the research results more diverse; each cluster obtained is detailed, and easy to find differences between clusters. One, experiments should also be conducted on multiple datasets in different fields and with many demographic factors to compare accuracy and results and draw conclusions about the impact of each factor. For example, in this study, the variable Region was used to refer to customer addresses, and future studies may further break down this variable into cities, districts or experiment with one demographic variable at a time to obtain more detailed comparison results. In addition, other clustering algorithms should be researched and applied to increase the method's applicability, such as classifying data encoding or another clustering algorithm performed on the entire mixed data. In addition to the above recommendations, the study proposes to apply Time series analysis to analyse the detailed behaviour of each customer cluster in different periods and continuously analyse to help businesses deploy quickly and effectively. Predicting user behaviour is also a suggestion for future studies to support businesses in predicting after analysing detailed results. Although purchasing behaviour and machine learning models can be easily tested and applied, demographic factors, which are diverse, difficult to calculate, and complex, still play a crucial role in customer segmentation.

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Analysis of Entrepreneurial Behaviour in Incubated Technology-Based Companies

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Abstract

Background: The analysis of entrepreneurial behaviour in incubated technology-based companies can help managers to understand their characteristics and how these aspects can be maximized to increase the performance of the companies. **Objectives:** This study proposes to measure the entrepreneurial behaviour of managers of technology-based companies in incubators in southern Brazil facing different stages of the business life cycle. **Methods/Approach:** The Analytic Hierarchy Process is used to measure the entrepreneurial behaviour index of technology-based companies' managers throughout the stage of the business life cycle. **Results:** In the early stages, entrepreneurs have ample self-confidence and are willing to make quick decisions. In the intermediate stages, the entrepreneur shows greater persistence and effort in the tasks. In the later stages, the entrepreneur acquires a greater sense of group activity and punctuality in completing tasks. **Conclusions:** This study analyses how managers demonstrate their entrepreneurial behaviour as the stages the company experiences. The results can help managers better understand their performance and actions reflected through their behaviours.

Keywords: entrepreneurial behaviour; technology-based companies; business life cycle

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Introduction

The entrepreneurial characteristics present in managers of companies are essential for the development of innovation and business performance (Ahmed et al., 2018). Peng et al. (2018) state that entrepreneurial behaviour impacts the economic growth of society and connects with innovation and technology. In this context, technology-based companies stand out for their use of innovation and technology, depending on these factors for internal decision-making and external business development (Kaplan & Vakili, 2015).

The capital-intensive investments in incubators' infrastructure seek to facilitate the emergence of technology-based companies by aiding access to markets and developing ideas (Bliemel et al., 2019). Besides, the potential to develop human and social capital can influence the incubated environments of technology-based companies (Wynn & Jones, 2019). Thus, the entrepreneurs' intellectual capital and behavioural characteristics are crucial during their business's several moments. Pujol-Cols and Dabos (2020) state that emotionally stable individuals focus on their success and the most favourable aspects of their jobs rather than their failures.

Studying entrepreneurial behaviour has been an essential topic in entrepreneurship (Zhang et al., 2015). Kim and Chung (2017) highlight that the research about entrepreneurial behaviour focuses on individuals' more active roles during innovation implementation. This concept considers that individuals' requisite knowledge, skills, and experience effectively engage in entrepreneurship.

In technology-based companies, analyzing characteristics of entrepreneurial behaviour is relevant to increasing business performance and competitiveness throughout its life cycle. Gupta et al. (2019) provide evidence supporting the notion that companies led by managers adept at capturing entrepreneurial aspects of decision-making practices and managerial trends demonstrate superior performance. McClelland (1987) notes that entrepreneurs are differentiated individuals with characteristics distributed in three actions: realization, planning, or power.

According to Rodrigo et al. (2018), the primary motivations driving entrepreneurial activities include pursuing independence, career advancement, economic necessity, expertise in the field, market opportunities, increased leisure time, and self-realization. Claver-Cortés et al. (2015) identify the most critical human capital for companies and which indicators can assist in their measurement. These articles point to the growth of academic interest in entrepreneurial behaviour and concerns about how it should face the different stages of the business cycle. However, few studies associate entrepreneurial behaviour with performance measurement in technology-based companies.

Eijdenberg et al. (2019) highlight that existing research has predominantly examined institutions through social, political, economic, geographical, and ethnic lenses, thereby underscoring a dearth of studies focusing on entrepreneurial behavior and resilience in demanding institutional contexts. There is a gap in identifying how managers of technology-based companies behave as the business develops. So, this study aims to measure the entrepreneurial behaviour of managers of incubated technology-based companies facing the different stages of the business life cycle.

This study contributes to theory through a method to measure the entrepreneurial behaviour level of 31 managers of 7 incubated technology-based companies in southern Brazil. Moreover, this study understands human behaviour while managers participate in complex systems such as incubated technology-based companies and analyses performance characteristics to guarantee the success of the businesses. This study also shows that entrepreneurs' behaviour and emotions directly influence

business success and points out that organizational performance must be measured from several perspectives, including in the behavioural field.

Theoretical background

One of the main factors that measure the level of competitiveness and performance is human capital, specifically the levels of entrepreneurs' leadership, innovative spirit, and team cohesion (Xiao & Zhao, 2017). These aspects represent some of the essential characteristics for the development of an entrepreneur. As stated by Isichei et al. (2020), it is essential to understand and strengthen entrepreneurs' internal characteristics and capabilities to ensure significant gains for companies.

Kirkley (2016) states that entrepreneurial behavior encompasses values and needs that foster intrinsic motivation and self-determination. Studies examining entrepreneurs and their impact on national economic development reveal that individuals exhibiting entrepreneurial behavior tend to display increased confidence and courage in taking risks, leading them to make decisions that yield valuable experiences (Bockorny & Youssef-Morgan, 2019).

Theoretically, personal entrepreneurial characteristics are defined by the United Nations Conference on Trade and Development (UNCTAD) as a set of ten attributes identified by McClelland (1987). UNCTAD is an institution belonging to the UN (United Nations), representing one of the leading organizations developing projects for inclusive and sustainable development. Thus, entrepreneurial behaviour has well-defined characteristics supported by a global institution. Despite this, the opportunities and obstacles encountered throughout a company's development can define how managers develop their entrepreneurial behaviour (Adizes et al., 2017).

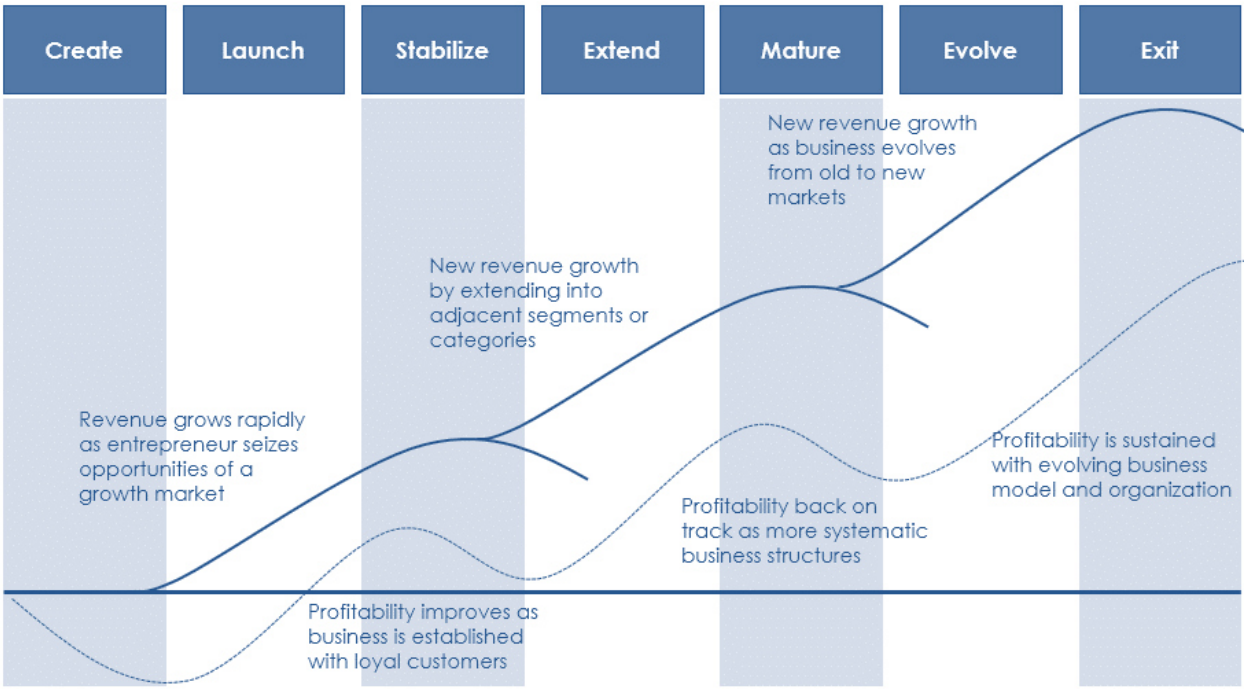
According to Michelin et al. (2021), managers' behaviour can be influenced by the phase the company goes through, interfering with the company's results and performance. The different situations present during the stages experienced by companies justify the importance of business life cycle analysis.

Since the business life cycle interferes with the manager's behaviour, it was considered an essential variable for data compilation. de Oliveira Reis et al. (2018) highlight that most research evaluates the business life cycle according to the time companies remain active in the market. Given the different approaches expressed in the literature, Fisk's (2008) method was chosen because it comprises a dynamic market view and is used in companies' practical contexts.

Figure 1 shows a possible scenario for a company involving all stages. Though each stage results from its age, size, and performance, its structure and sophistication can also be characterized. Each company's evolution level is different, depending on the type of business. There are other priorities and challenges, propositions, and the managers' level of investment at each stage.

Recognizing the influence of the business life cycle on the behaviour of company managers (Adizes et al., 2017; Michelin et al., 2021), the particularities of certain companies can also determine the behaviour of managers. Incubated technology-based companies cultivate a culture of decision-making based on innovative and technological processes (Kaplan & Vakili, 2015). These companies need managers with entrepreneurial behaviour to work with the different challenges found in their niche. Creativity, opportunity identification, initiative, perseverance, and teamwork are characteristics needed for technology-based companies to thrive (Lopes & Sassi, 2019).

Figure 1
Business life cycle proposed by Fisk (2008)



Source: Fisk (2008)

The challenges technology-based companies encounter at different stages of the business life cycle influence the behaviour of managers. Characteristics in McClelland's (1987) proposal of entrepreneurial behaviour may define how managers maintain the habits that determine the companies' performance.

Methods

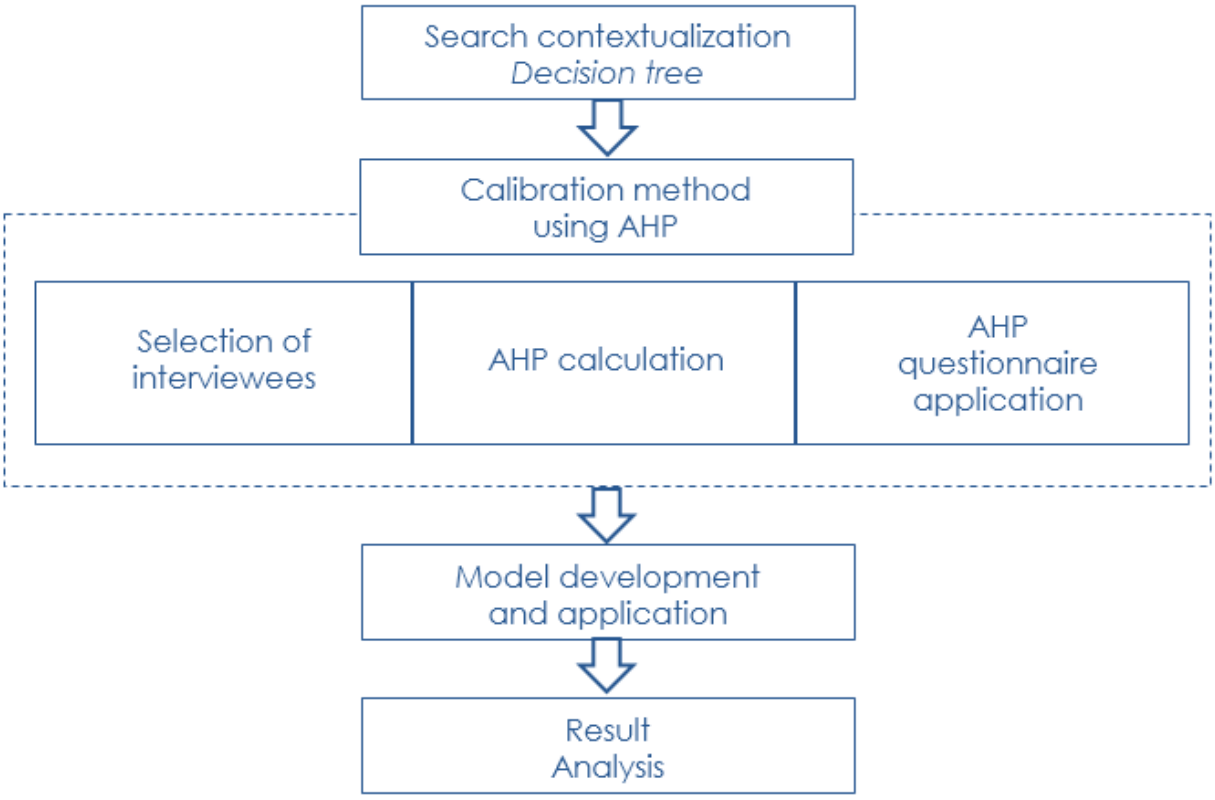
Studies using different quantitative methods have been observed in the academic literature on entrepreneurial behaviour in managers of companies. Badri and Hachicha (2019) conducted a study investigating the influence of entrepreneurship education on students' inclination to start their businesses. Ataei et al. (2020) evaluated the impact of young people's entrepreneurial skills in creating new businesses through the Fuzzy Analytic Hierarchy Process method.

Multiple-criteria decision analysis (MCDA) contributes precisely to help make this process less complicated by having tools that elucidate the cause-and-effect relationships on the decision-maker's preferences, increasing knowledge about the problem (Love et al., 2015). Zhü (2014) says that the Analytic Hierarchy Process (AHP) method is an adequate tool for measuring intangibles side by side with the tangibles and a widely used multicriteria tool in the decision-making of defining priorities.

Through this analysis, none of the methods already published in the literature aims to measure managers' entrepreneurial behaviour of technology-based companies. Also, it is noted that the MCDA methods can assist in measuring entrepreneurial behaviour to better understand the manager's perception at each stage of the business life cycle. Thus, the proposed method uses the Analytic Hierarchy Process and Key Performance Indicators (KPI) concepts to measure the entrepreneurial behaviour of managers of technology-based companies.

The development of the method consists of four main steps. They include the decision tree construction, the modelling calibration, the building and application of the model, and the result analysis. Figure 2 shows the research flowchart.

Figure 2
Research flowchart



Source: Authors' work

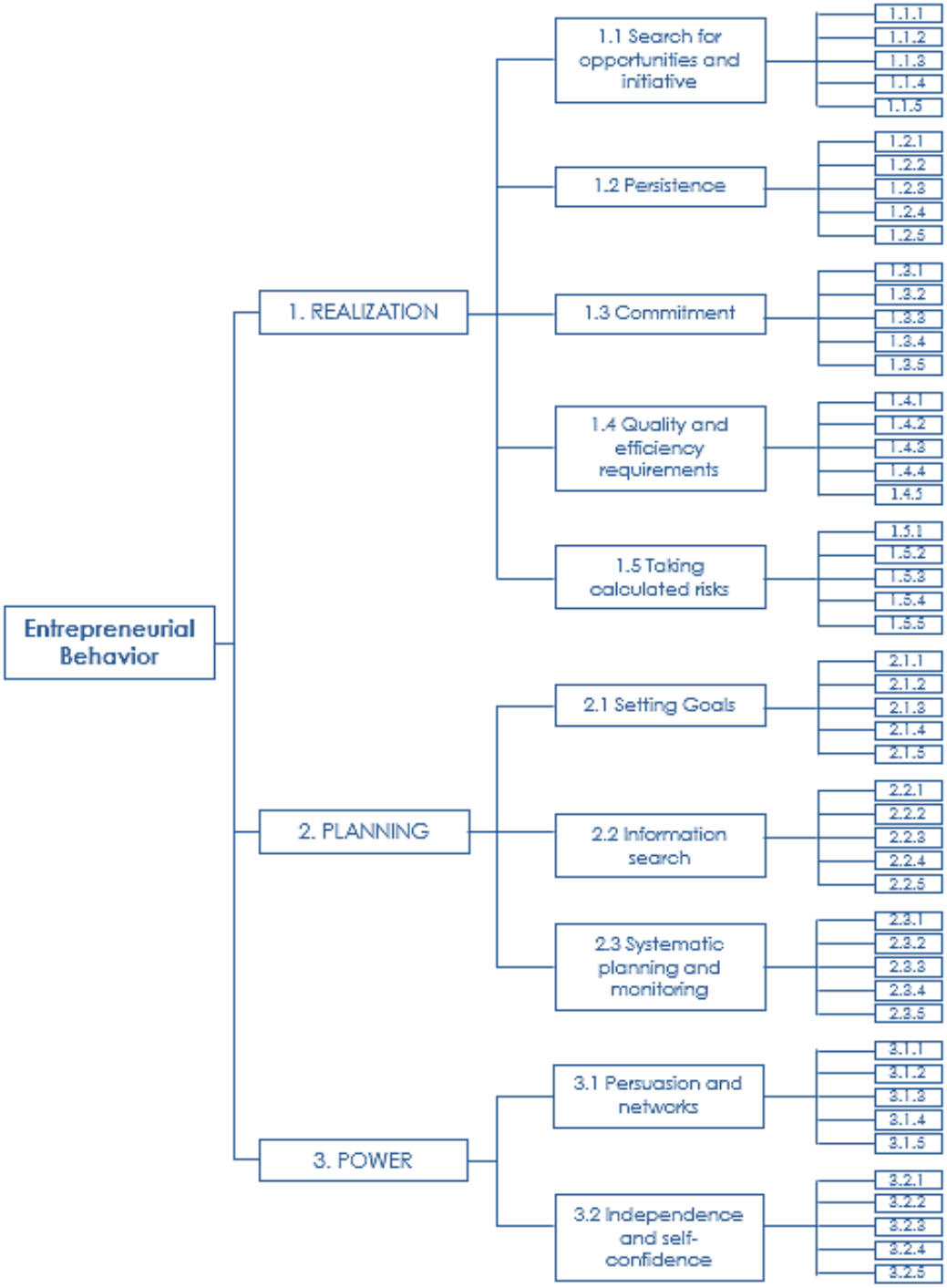
Decision tree

The proposed decision tree was elaborated from the Characteristics of Entrepreneurial Behaviour (CEB) by McClelland (1987) and adapted from the United Nations Conference on Trade and Development Division on Investment and Enterprise (2021).

Three dimensions are related to McClelland's and are defined as Fundamental Points of View (FPV): Realization, Planning and Power. They are deployed in 10 characteristics that reflect the Critical Success Factors (CSF), which are extended to 50 KPIs related to entrepreneurial behaviour.

Figure 3 shows the decision tree representing the hierarchical structure for evaluating the manager's entrepreneurial behaviour in a technology-based company, culminating in the decision tree study.

Figure 3
Decision tree



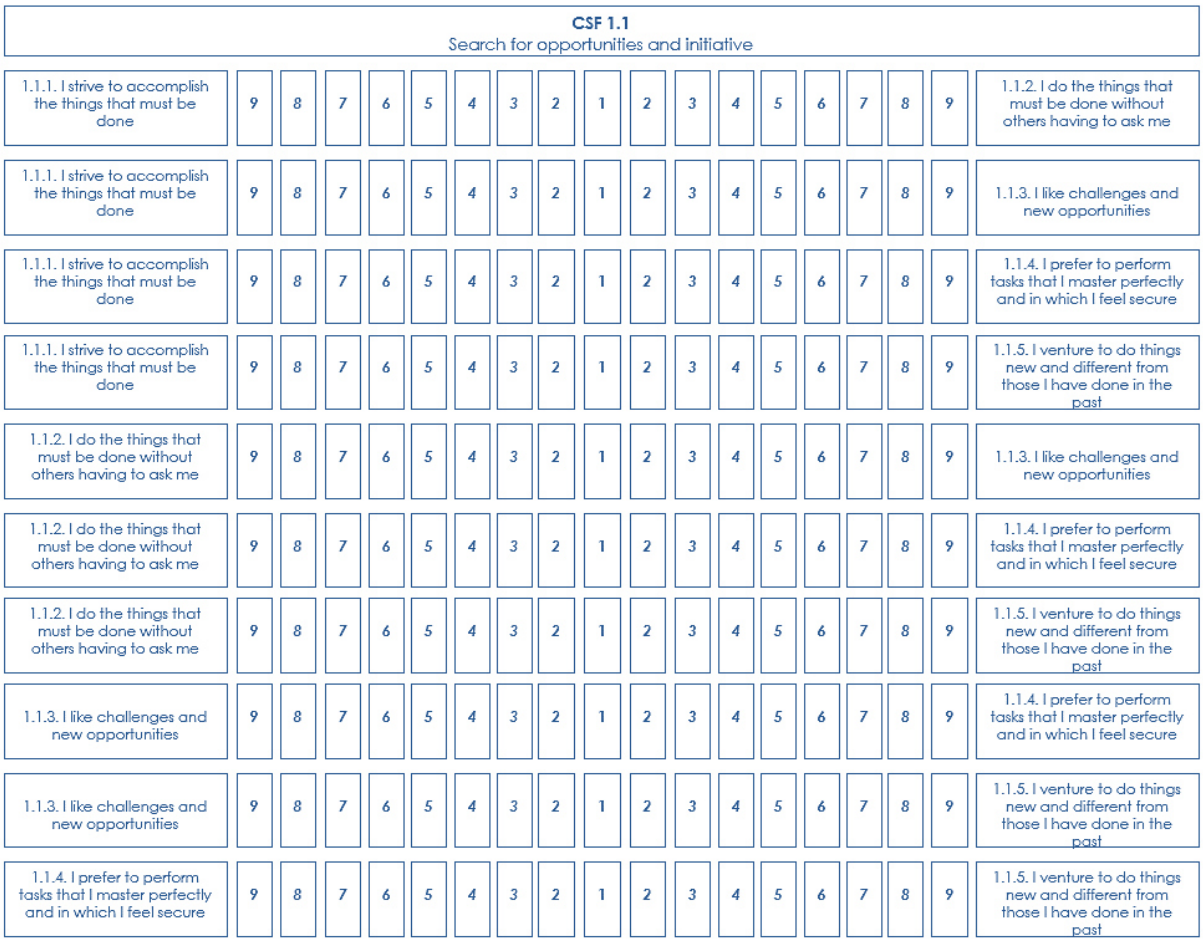
Source: Authors' work

Calibration of KPIs

The stage of the company's business life cycle influences the result of its manager's entrepreneurial behaviour. Thus, KPIs' must be calibrated, so weights were defined for each of them using the AHP methodology to reflect the company's stage (Saaty, 1980). In the next step, each KPI will have a multiplier factor to make the manager's entrepreneurial behaviour appropriate to their reality.

The questionnaire was applied to managers of 31 technology-based companies. The questions encouraged respondents to compare each CSF's KPIs in a paired way to meet the criteria for starting the calculation using the AHP methodology. Respondents needed to score KPIs on a scale of importance so that 1 represents equal importance, 3 represents marginally strong importance, 5 represents strong importance, 7 represents very strong importance, and 9 represents extremely strong importance. Besides, managers could select intermediate importance values (2, 4, 6, and 8) (Saaty, 1980). Figure 4 shows how the questions were presented to managers.

Figure 4
Questions of CSF 1.1



Source: Authors' work

The questionnaires' results were entered into a spreadsheet in the ExcelTM software, modelled to perform AHP calculations. The AHP method decomposes problems into a hierarchy of qualitative and quantitative criteria, facilitates the analysis, and compares alternative solutions to selected criteria. In this case, the first level comprises the problem to be solved or the decision's goal. The second level corresponds to the criteria that influence the decision (de Oliveira & Martins, 2015).

The steps used to calculate the KPI indexes followed Zanardo et al. (2018)'s methodology. The consistency ratio index (CR) was used to verify the decision-maker's data when deciding the criteria' priority. If CR is equal to or lower than 10%, then the data is consistent (Saaty, 1980), and the questionnaire must be applied again with the manager. In this study, all the consistency ratio indexes were lower than 10%, indicating that the data is consistent.

After data collection was conducted in the 31 companies, and the calculations performed were consistent, the KPIs' weights were calculated. Each manager selected at which stage of Fisk's (2008) business life cycle the company was at that moment. In each stage of the cycle, the importance of each KPI can be different, so this analysis is essential to understand the company's characteristics. So, the average of each KPI for each stage of the business life cycle was calculated. These values were used as a multiplier factor in the next step to calculate the managers' entrepreneurial behaviour.

Calculation of the indicators of entrepreneurial behaviour

The second survey questionnaire was applied based on McClelland's (1987) entrepreneurial characteristics in this stage. This data collection instrument refers to a structured questionnaire that approaches the indicators from Annex A and consists of a series of questions answered by the respondent without interference from the researcher (Triviños, 2008). This questionnaire is used in the projects developed by the United Nations Conference on Trade and Development Division on Investment and Enterprise in more than 27 countries. This study used McClelland's (1987) questionnaire to measure entrepreneurial behaviour since this is the most comprehensive and applicable model.

The survey had multiple-choice questions for each indicator. It enabled the creation of a ranking of importance among the indicators. Consequently, evaluating and comparing the participating managers' performance was possible since the instrument allowed standardized data collection. The performance was assessed from each indicator and also globally. The entrepreneurial characteristics and behaviours were identified in each stage of the business life cycle. Equation 1 shows how entrepreneurial behaviour was calculated for each technology-based company.

$$c = \sum_{i=1}^{3}\left[\sum_{m=1}^{M}\left(\sum_{j=1}^{5} v_j . p_{1j}\right) . p_{2i}\right] . p_{3i} \qquad (1)$$

where:

c = the company's entrepreneurial behaviour;
v = value obtained for KPI j in the second data collection;
j = KPI number for a given CSF;
m = CSF number of a given FPV;
i = FPV number;
p1 = weight of each KPI [obtained through the AHP calculation (first questionnaire)];
p2 = weight of each CSF (standard for each FPV – Table 1);
p3 = weight of each FPV (standard – Table 1)

The value attributed to each KPI by managers in the second questionnaire was multiplied by the KPI weight previously calculated in the calibration step. It represented the stage of the business life cycle in which the company is. The sum of each CSF's KPI product was multiplied by the weight assigned to the corresponding CSF, equivalent to the number of CSFs each FPV has. Finally, the sum of the products of CSFs was multiplied by the weight of each FPV, which was defined proportionally to the number of CSFs that comprise them. This calculation generated the manager's

entrepreneurial behaviour. Table 1 shows the weights assigned to the CSFs and FPVs used during the calculation.

Table 1
Weight of CSF and FPV

FPV	Weight attributed to FPV	Weight attributed to each CSF
Realization	50%	20%
Planning	30%	33%
Power	20%	50%

Source: Authors' work

Results

Stage of the business cycle of companies

This section presents the analysis of the results obtained by applying the methodology of evaluating the manager's entrepreneurial behaviour, facing the different business life cycle stages. Managers of technology-based companies were considered the unit of analysis, and the respondents' selection was made intentionally.

All of the incubators are located in higher education institutions since companies linked to educational institutions provide interaction among research groups, expand the network of contacts, and enable the exchange of knowledge. Thus, the sample consists of managers of 31 companies in seven incubators from five cities in Southern Brazil.

The first question to the managers was: What stage of the business life cycle is your company currently experiencing? In this way, the concepts of each stage of the business life cycle of the Fisk (2008) model were presented. The managers indicated which stage the company was experiencing. Table 2 shows the result of the application of the question.

Table 2
Number of technology-based companies in each stage of the business life cycle

Stage of the business life cycle	Number of technology-based companies
Create	8
Launch	5
Stabilise	9
Extend	3
Mature	1
Evolve	5
Exit	0

Source: Authors' work

Model construction and application

The KPIs analysis allowed the evaluation of each factor's impact on the managers' entrepreneurial behaviour. Table 3 shows the three KPIs with the highest predominance for each stage of the business life cycle and their average percentage impact.

Table 3
KPIs with the highest predominance by the stage of the business life cycle

Stage of the business life cycle	KPI	Average predominance
Create	3.2.1. I am confident that I can succeed in any activity that proposes me to perform.	32.90%
	1.2.2. I insist several times on getting other people to do what I want.	31.83%
	1.1.1. I strive to accomplish the things that must be done.	30.00%
Launch	2.2.3. I make decisions without wasting time looking for information.	31.95%
	1.2.2. I insist several times on getting other people to do what I want.	31.17%
	1.3.1. I finish my work/activity on time.	28.59%
Stabilise	1.1.1. I strive to accomplish the things that must be done.	28.40%
	1.2.2. I insist several times on getting other people to do what I want.	28.08%
	2.1.4. I count on a clear plan of life.	28.03%
Extend	1.4.5. I find the fastest way to finish work at home and at work/college.	37.56%
	2.3.1. I plan a large project by dividing it into simpler tasks.	33.41%
	1.4.4. I'm never really satisfied with how things are done; I always think there is a better way to do them.	33.30%
Mature	2.3.1. I plan a large project by dividing it into simpler tasks.	47.20%
	1.4.5. I find the fastest way to finish work at home and at work/college.	46.41%
	1.3.3. If necessary, I do not mind doing the work of others to meet a deadline.	46.41%
Evolve	1.3.1. I finish my work/activity on time.	37.35%
	1.2.2. I insist several times on getting other people to do what I want.	34.80%
	2.1.3. The more specific my expectations are concerning what I want to achieve, the greater my chances of success.	31.19%

Source: Authors' work

Through this analysis, it was possible to perceive that the indicator that most impact the managers' entrepreneurial behaviour in the Creation stage is confidence in obtaining success in any activity. Managers need a strong belief in the value of what they are trying to accomplish to overcome the initial rejection of their innovations. Thus, when people have confidence in their ability to perform specific tasks, they are more likely to take the initiative, face challenging situations, and have more significant risks, leading to higher returns (Neto et al., 2018; Piperopoulos & Dimov, 2015).

The most striking indicator of managers' entrepreneurial behaviour for companies in the Launch stage is making decisions without wasting time searching for information. Nandram et al. (2018) relate the managers' rapid decision-making to the "context of intuition". This result is supported by Robert Mitchell et al. (2005), who attest that entrepreneurs often use intuition to explain their actions. The use of intuition is directly

related to identifying opportunities. On the other hand, the result found in this study, which reflects the behaviours of incubated entrepreneurs and, therefore, connected to more significant opportunities, contrasts in parts with Ardichvili et al. (2003) afirmam que os empresários individuais consideravam a identificação de oportunidades significativamente mais crucial do que os empresários ligados em rede. Além disso, os empresários individuais consideravam-se mais criativos e estavam mais dispostos a dedicar tempo específico a actividades criativas.

In the Stabilize stage, the indicator that most impacts managers' entrepreneurial behaviour is the effort applied in carrying out the activities. This factor relates to entrepreneurial intent and indicates to what extent an individual is motivated to engage in entrepreneurial behaviour and invest in business management activities (Neneh, 2019). Shirokova et al. (2016) argue that the more time and effort devoted to accomplishing a task, the more likely it will be to achieve and succeed. Fried and Tauer (2015) say that business success can be measured through the owner hours' variable, which measures the entrepreneur's commitment and effort to run the company.

Finding the fastest way to finish work at home and work/college is the predominant indicator of entrepreneurial behaviour and significantly impacts the companies' Expand stage. In general, most small business managers tend to address competing work and life demands ad hoc manner, lacking a structured or planned approach to managing these responsibilities. Home-based technology has subliminally extended the day's work for these entrepreneurs as they engage in more work-at-home. This situation reflects that entrepreneurs in fast-growing companies seek increasingly more immediate results, taking work to do at home.

Planning a project through its unfolding in more straightforward tasks is the primary indicator of entrepreneurial behaviour in the Mature stage. Martens et al. (2018) support this assertion by emphasizing that managers of companies face mounting complexities, necessitating the adoption of highly competitive strategies and project execution through escalated activities to effectively respond to rapidly changing market dynamics. Implementing project-based activities within the organizational environment is commonly accompanied by strategies that foster evolution and comprehend their impact on business performance and success. Thus, as project activities are successful, organizational results can be favoured, contributing to technology-based companies' performance, efficiency, innovation, and development (Yang et al., 2014).

In the Evolve stage, the indicator of entrepreneurial behaviour with the most significant impact was finishing work/activity on time. Punctuality is one of the primary non-cognitive skills that positively impact the success of technology-based companies (Alva, 2019). Also, Bluedorn and Martin (2008) concluded that the fewer activities are carried out, the more likely it is to be punctual in delivering the activities to be fulfilled by the entrepreneurs. On the other hand, the higher number of jobs developed simultaneously tends to cause the managers to perform the activities demanded in a shorter time than if the activities were done in isolation.

Entrepreneurial behaviour by the stage of the business life cycle

Analyzing leading indicators of performance and critical success factors allowed us to find the overall index of each manager's entrepreneurial behaviour, which corresponds to the critical success factor's proportionality from the fundamental point of view. Table 4 shows the entrepreneurial behaviour of each company's managers studied and the average rate per stage of the business life cycle.

Table 4
Managers' entrepreneurial behaviour by the stage of the business life cycle

Stage of the business life cycle	The average index of managers' entrepreneurial behaviour	Index of managers' entrepreneurial behaviour	Technology-based companies
Create	80.70%	84.12%	Auster
		83.93%	Conífera
		81.30%	Diferencial
		79.72%	Fisalis
		70.90%	Fox
		74.52%	MachPal
		89.52%	Tecknogelatto
		81.57%	TecSynthesis
Launch	79.45%	82.99%	Chemweg
		83.33%	Expin
		80.42%	Mais Gestão
		74.81%	Mercateria
		75.70%	Qiron Robotics
Stabilise	79.33%	76.51%	Café
		88.97%	Conplan
		79.75%	Cowmed
		79.01%	Dillon
		80.84%	GCB Drone
		82.36%	Pizetta
		82.48%	Soha On Taxi
		68.27%	Taskka
		75.76%	XL7
Extend	80.52%	85.29%	Polvo Louco
		76.85%	Sonnen
		79.41%	WeeVee
Mature	91.29%	91.29%	Seven
Evolve	82.44%	88.53%	Agener
		78.08%	Enovative
		81.91%	FP2
		77.81%	Perseus
		85.87%	SRA

Source: Authors' work

This analysis showed that the average entrepreneurial behaviour rates are higher in the business life cycle's final stages. It should be noted that only one company was identified as belonging to the mature stage, explaining the highest index. Conversely, Riviezzo et al. (2019) contend that managers of companies with a longer operating history are more inclined to exhibit deeply ingrained entrepreneurial behaviour. Furthermore, as the company evolves into a well-organized and disciplined business, the founding team must establish the groundwork for a rapidly expanding enterprise, building credibility and acquiring vital resources for growth (Picken, 2017b). It requires managers to adjust their leadership style and management behaviour and have experience and competence to deal with strategic direction and market positioning (Picken, 2017a).

The Create stage also exhibited a notable level of entrepreneurial behavior, as it involves significant engagement in business creation, product launch, and pursuit of expansion opportunities during the initial stages. In the early stages of the cycle, managers must build networks with actors to develop and communicate with

academia and businesses to accelerate research and technology transfer (Pettersen & Tobiassen, 2012). Entrepreneurs must proactively manage their company's social capital in business creation to foster knowledge acquisition and establish a competitive advantage. They should also encourage the exchange of knowledge between the company and its customers to form a basis for alliances that can lead to even more excellent opportunities for wealth generation (Pettersen & Tobiassen, 2012). Also, the entrepreneurs' research and business planning activities, through generating new ideas for products or services, continue to be essential for the company's performance throughout the business life cycle (Baron et al., 2016).

The intermediate stages of the cycle presented the lowest entrepreneurial behaviour rates among the business life cycle stages. These steps are marked when a company gains strength in the market and represent a bridge between the vaguely structured informality of a technology-based company and the formal and disciplined form required for rapid scaling. So, there is a substantial increase in managers' challenges since new resources must be developed, and partnerships must be established to make the business sustainable (Picken, 2017b). That is why managers need to create effective planning in the early stages of their business life cycle. They must identify potential milestones and obstacles and align their functional objectives with their companies' organizational goals so that the materialization of results and their entrepreneurial behaviour indices are more significant in the business life cycle's intermediate stages (Păunescu & Badea, 2014).

Conclusion

Summary of research

Entrepreneurial behavioural characteristics are fundamental for developing technology-based companies, influencing the business's success. In the initial stage of incubated companies' operation, measuring these characteristics helps managers verify how they can evolve and their impact. Thus, the study proposed and tested a model to measure and evaluate managers' entrepreneurial behaviour in technology-based companies. This model was successfully tested in 31 companies, obtaining data from all its managers. Study findings demonstrate that all entrepreneurs present McClelland's (1987) features. The behavioural perspective can guide managers' decision-making and help them achieve higher performance indices, making their companies more competitive.

The questionnaires applied to the managers of technology-based companies verified their entrepreneurial behaviours in their actions, the constant search for competitiveness, permanence in the market, intention to leave a legacy, and improved development and economic growth. Thus, technology-based companies that enjoy the structure, networking, and mentoring from business incubators and avail themselves of universities' specific knowledge may have a competitive advantage during the business's initial stages.

The managers highlight the search for opportunity and initiative, persistence, commitment, goal setting, information search and persuasion, contact networks, independence, and autonomy. Besides, managers cited other entrepreneurial behaviour features not named by the researchers, such as discernment, pragmatism, resilience, empathy, communication skills, and observation.

Implications for theory and practice

The results of this study improve the understanding of the entrepreneur in the organizational context. It happens because its characteristics can be affected by

environmental changes and the different stages experienced in its business. The study makes a new contribution by proposing an original method to measure the entrepreneurial behaviour of managers of technology-based companies throughout the business life cycle. Hence, this study generates opportunities for entrepreneurs and their companies and advances for the scientific community, reinforcing that the union between universities, companies, and society can contribute efficiently to economic development.

This study provides some recommendations that give the managers of technology-based companies better understand their performance and their actions reflected through their behaviour. This comprehension can develop skills, address gaps, seek improvements, reduce uncertainties, favour the business's success, and contribute to technology-based companies' growth and economic development. Thus, the model developed in this paper offers a rich set of data and different types of results that can be explored, analyzed, and adapted to measure other intangible assets' performance.

Besides, a study involving performance measurement and intangible assets helps technology-based companies to position themselves competitively. Tripathi et al. (2019) emphasise that human capital is essential in the technology-based company ecosystem analysis. Studies have shown that entrepreneurs' emotions and behaviours significantly influence business development and success (Wang et al., 2019). So, performance can be measured from many perspectives, including in the behavioural sphere.

Limitations and suggestions for future research

Although this study provides significant contributions, the results must be analyzed within some factors that limited its development. One of the limitations concerns the non-existence of companies classified in the Exit stage within the business life cycle of the analyzed sample. Also, the study did not represent many business incubators in southern Brazil. Moreover, it is noteworthy that although the study was developed in Southern Brazil, the conclusions can be extended to other emerging economies with similar characteristics.

The knowledge and results obtained during this research's development can generate a new study, which involves applying the proposed model to analyze entrepreneurial behaviour in other sectors. It is possible to adjust the model to measure other intangible assets and deepen the diffusion of other undefined characteristics since their definitions address the abilities and ways of acting that contribute to the entrepreneurial individual's development.

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Enhancing Digital Promotion of Cultural Attractions: Assessing Websites, Online Marketing Tools and Smart Technologies

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Abstract

Background: Built heritage in developed tourism destinations presents a resource of attractiveness, and its presentation through digital technology impacts the perception of culture. **Objectives:** The paper aims to determine opportunities for further development of digital promotion of cultural attractions by identifying the potential of websites, online marketing tools and smart technologies implemented by tourism attraction decision-makers. **Methods/Approach:** Qualitative and qualitative research methods were used as longitudinal research and structured interviews with decision-makers of the tourist destination. **Results:** Positive developments in implementing the digital promotion of cultural heritage during and after the pandemic are evident, but not fast enough considering the accelerated development of new smart technologies. At the same time, decision-makers recognise the importance of the digital promotion of cultural heritage. However, they are still unfamiliar with the possibilities of smart technology to affirm the digital promotion of cultural heritage. **Conclusions:** The paper points to the conclusion of how the advantages and potentials of developing a smart culture in destinations, recognised as a strategic policy of development, are implemented in the digital marketing of heritage sites.

Keywords: Heritage buildings, Technologies, Online promotion, Smart destination
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Introduction

In times of accelerated development of ICT technology, where traditional marketing tools are substituted by modern e-marketing, implementing smart technology in promoting cultural heritage is becoming a catalyst of experiences of affirm tourists' curiosity and interest. Tourism attractions are the main natural and anthropogenic resource bases representing the key factor of tourism development. However, as society and tourism are developing in times of fast experiential transience, where searching for new experiences is of the utmost importance, an accelerated trend is evident of digital affirmation of the promotion of tourist attractions (Floričić et al., 2022). This is developed in the domain and context of smart destinations, where culture, sustainability, accessibility, and technologies synergistically blend. In the paper, using the comparative longitudinal study of the evaluation of digital promotion of selected attractions of the Town of Poreč in 2018, 2020 and 2022, the implementation is analysed of modern tourism trends, which include technology, heritage evaluation and sustainable development. Based on the obtained data, the paper aims to consider shifts and possibilities of even better tourism evaluation of the entire destination employing digital promotion. Therefore, five cultural tourism attractions of tourist destinations have been selected and explored. The study included the analysis of improvement progress during the three biennial periods, i.e., the observed six-year period and the perspectives for the future.

Promoting tourist attractions is expected to have room for a more substantial application of smart technologies. Considering the collected attitudes of decision-makers, they are expected to continuously indicate the existence of implementation plans and trend monitoring in that direction.

This will also help to identify the problem area which affects heritage sites formed as tourist attractions. Therefore, the study includes research on the perception and the attitudes of the tourism destination promotion, namely destination decision makers from the supply side, including destination governance, the county tourism board, destination management organisations and cultural attraction managers. The results indicate new knowledge and contribute to the topic's scientific and practical context. The questions are articulated as follows:

Q1. What are the possibilities of promoting cultural attractions through website elements?

Q2. What are the developments in website elements for the digital promotion of cultural attractions over six years?

Q3. Are decision makers utilising the opportunities and recognising the importance of digital promotion, online marketing tools, and smart technologies in promoting cultural attractions?"

The qualitative and quantitative methodology used in this research includes the study of professional and scientific literature, Internet website search and comparison of the obtained data with statistical processing.

The paper is structured in four main parts. The first introductory chapter presents the theoretical framework and literature review of the research topics of the paper, while the second chapter describes the methodology and research design. The third chapter presents the research results and discussion, followed by conclusive remarks in the fourth chapter. Besides them, it includes the study's limitations and perspective for future research and the contribution of this longitudinal research that innovatively approaches the topic.

Theory and literature review

Cultural attractions and impact on smart destination development

Kušen (2002) defines tourist attractions as elements that can or are already luring tourists to visit the destination where they are staying. In continuance, he differentiates anthropogenic attractions, which are developed from the basic cultural resources and enters the domain of cultural tourism:

- Cultural and historical heritage (cultural monuments, archaeological sites, urban protected areas, old towns, castles and churches)
- Cultural and religious buildings (museums, theatres, pilgrimage centres)
- Events (festivals and theatre plays)
- Work-life balance culture (gastronomy, local population's lifestyle, ethnicity, folklore, tradition, and handicraft).

Goeldner and Ritchie (2009) diversify attractions as natural, recreational, cultural, event and entertainment attractions. Valorisation is related to accessibility where marked physical and public access via various transportation means is considered. On public surfaces and roads, attractions are marked by so-called "brown signposting," according to international standards, and pedestrian and similar roads have special signposts. The use of tourist attractions is achieved primarily through sightseeing with the aim of education and leisure through recreation and well-being. Looking from the financial aspect, access to a tourist attraction can be free or with a charge for an entrance ticket. That can be organised at information points where attractions' information can be found, sanitary points, interpretation boards, souvenir shops, printed brochures, flyers and multimedia materials, virtual animations and technological innovations (Floričić & Floričić, 2019).

Attractions can be fitted with specific equipment (Kušen, 2002). Depending on the tourism attraction, including ambient light, sound, tactile elements and other sensory experiences (Floričić, 2016).

This is why stakeholders, the local government destination management organisations (DMOs) and other stakeholders should consider the affirmation potential of the resources and classify and evidence it in the map of tourism attractions. It should be evaluated as the basis for the performance of synergic action and the development of marketing placement and promotion strategies in the tourism market. Tourist boards, whose role in the tourism system is primarily promotional, informative, and educational, have that key role. Križman Pavlović and Živolić (2008) emphasised the importance of cooperation between destination stakeholders and the formation of strategic, coordinated marketing in the placement of tourism products.

The promotion goals in tourism are often stated as the AIDA model and relate to the drawing of attention (*attract*), creation of interest (*interest*), activating of desire (*desire*) and encouraging action (*action*) (Jakovljević, 2011).

The experience economy, as an experience melting pot, assumes a dominant position in creating demand. Offer stakeholders should increase the value for consumers and create unforgettable experiences through the 4E elements: entertaining, educational, escapist, and aesthetic, form special services and programmes through the implementation of co-creation and stress Pine and Gilmore (2000). Furthermore, numerous authors deal with the topic of special experience in tourism. Williams (2006), Loureiro (2014), and Kim et al. (2012) explore the experience economy, presenting it as a recognition factor in the achievement of competitiveness in tourism (Kunst, 2009; Jurin, 2016). When considering promotional aspects, the predominant significance of digital promotion is elaborated.

Digital promotion of cultural attractions involves using online channels and technologies to promote cultural attractions, such as museums, galleries, historical sites, and cultural events. It is a growing trend in the tourism industry as more people use digital platforms to research and plan their travel experiences.

Several authors have written about the importance of digital promotion for cultural attractions. Miguéns et al. (2008) argue that digital marketing is essential for attracting visitors to cultural destinations, enabling a wider reach and more targeted promotion. They highlight the importance of creating engaging online content, such as virtual tours and multimedia exhibits, to provide a taste of the cultural attraction and encourage visitors to come in person.

Pine and Gilmore (2000) discuss creating memorable customer experiences. He suggests that cultural attractions can use digital technologies to enhance the visitor experience, for example, by providing interactive exhibits, augmented reality features, and personalised recommendations based on visitor interests. Neuhofer et al. (2015; 2019) have written extensively about the potential of digital technologies to transform the tourist experience. They argue that cultural attractions can use digital channels to offer seamless and personalised experiences for visitors by providing relevant information and recommendations through mobile apps, social media, and other digital platforms.

Moreover, Hudson et al.(2016) investigate the role of social media in shaping consumer-brand relationships. They suggest that cultural attractions can leverage social media platforms to engage with potential visitors, showcase their offerings, and foster a sense of community among visitors. Gretzel et al. (2000) examine the revolutionary transformations brought about by technology in the tourism industry. They argue that cultural attractions, such as virtual reality and gamification features, can use digital technologies to provide immersive and interactive experiences for visitors.

These authors highlight the importance of digital promotion for cultural attractions, as it enables wider reach, targeted promotion, and enhanced visitor experiences. Cultural attractions can attract more visitors using digital channels and technologies effectively, providing more engaging experiences and increasing their impact on local economies and communities.

Websites play a crucial role in the digital promotion of cultural attractions. A well-designed and optimised website can effectively attract potential visitors, provide detailed information about the attraction, and enhance the overall visitor experience. Boniface and Cooper (2001) argue that websites are essential for cultural attractions to promote themselves effectively to potential visitors. They highlight the importance of providing accurate and detailed information about exhibits, events, and opening hours and creating engaging content, such as virtual tours and multimedia exhibits. Buhalis and Law (2008) discuss the role of websites in destination marketing and how they can be used to provide a more personalised and interactive experience for visitors. They suggest that cultural attractions can use websites to offer online ticketing, provide visitor feedback mechanisms, and create social networking communities around their attractions.

Kock and Josiassen (2009) argue that websites are an important component of destination branding for cultural attractions. They suggest that a well-designed website can help to create a distinct and memorable brand identity and can be used to showcase the unique features of the attraction. Fesenmaier and Xiang (2010) discuss the importance of search engine optimisation (SEO) for destination marketing. They argue that a well-optimised website can help improve cultural attractions'

visibility in search engine results, making it easier for potential visitors to find them online.

Kolb (2012) emphasises the importance of websites for cultural attractions to engage with potential visitors and create a positive brand image. They suggest that websites should be designed with the visitor in mind and provide relevant and engaging content to encourage visitors to explore the attraction further. In continuance, Wang (2022) emphasises the importance of website design, its components, its influence on UX, and website user experience. He introduces the relevant web design situation and then analyses the key elements in web design, such as visual elements and their innovative applications. Also, Neuhofer et al. (2019) discuss the role of websites in providing seamless and personalised visitor experiences. They suggest that cultural attractions can use websites to provide relevant information and recommendations to visitors based on their interests and preferences and to facilitate online ticketing and other services that improve the visitor experience. Furthermore, Cyr (2014) elaborates on how website design can engender visitors' loyalty and impact return visits.

Smart technologies and cultural attractions

As a result of the accelerated development of technologies, in the past several decades, changes have penetrated all the business and communication spheres in tourism (Atembe, 2016; Smart Tourism, 2020). They are reflected in digital transformation, the use of mobile appliances, applications and social networks, by which opportunities are also opening for innovations in the tourism business, ensuring possibilities of adaptation for specific market requirements (UNWTO, 2020, 2021). For example, QR codes are used in promotion, scanning of which facilitates the opening of websites or interactive content with specific information about attractions, events or other useful pieces of advice. The importance of virtual technologies is stressed: AR - augmented reality and VR – virtual reality technologies. Google Glass is highlighted as a hands-free appliance similar to glasses, which can be connected to the Internet and thus connect with other appliances. It is voice-activated and, among other functions, can send messages, take photographs, make recordings and others, and has found a useful way of use during certain promotional processes (Google, 2020). Technologies open numerous possibilities, not only because of the efficiency of specific simplified methods of use and finding of information but also due to the originality. In other words, novelty is presented to visitors, stimulating their interest and attractiveness for certain products and services, especially if introduced to competitors (Boes et al., 2015). An increased number of applications facilitate, improve, or, in some other way, affect the visits to smart destinations (European Commission, 2020). Spain has thus initiated "Interactive National Parks of Spain", an application which enables access to information about national parks (history, flora, fauna, and other curiosities). However, 2D and 3D models show high-resolution virtual scenes recorded by drones (The Smart City Journal). Furthermore, the attractiveness of cultural routes is encompassed by virtual walks and attractions, conceived as virtual museums (PGZ County, n.d.).

An example is AR technology in museums, which enables visitors to be informed interactively (Ding, 2017). So, nowadays, many museums offer virtual exhibitions on their official websites. Theatre plays, concerts, and festivals also take place online, as well as virtual tours of certain sites. Many other adaptations to different situations in which specific restrictions and measures are imposed, limiting visits and physical contact due to the pandemic conditions. Robots and digital assistants and self-service

kiosks were soon used, which, although extremely useful, cannot replace interpersonal communication with guests who wish to have it.

Smart tourism is frequently misunderstood and linked expressly to technology, and all the aspects of such action are not considered. This is why it is necessary to provide a better definition of the smart concept and the greater involvement of government institutions in creating and implementing smart tourism projects (Gretzel et al., 2015). This smart destination concept primarily refers to cultural affirmation, sustainable development, inclusion and physical accessibility.

Through tourist boards and developed DMOs, tourism organisation directly impacts the placement of tourist information through promotional materials and the tourist information system.

Despite the absence of a unique definition, Donaldson and Preston (1995) state that the stakeholders are all those who have any interest in the organisation or its activities. March and Wilkinson (2009) stress the importance of stakeholder cooperation within tourism destinations; however, according to Adebayo and Butcher (2022). Community participation in these processes, including cultural and political structures, occurs in a wider context. On the other hand, Sautter and Leisen (1999) regard cooperation as essential as an expression of sustainability through two stakeholders' basic roles: development and planning (Bramwell & Lane, 2000), as well as cooperation and marketing activities (Fyall & Garrod, 2005). Kujala et al. (2022) suggest that stakeholder inclusion refers to the goals, activities and effects of stakeholders' relationship on moral, strategic and/or pragmatic processes. Some authors stress the importance of DMOs as key stakeholders in the coordination, management and facilitation of the implementation of smart initiatives in tourism (Gretzel, 2022) and in the development and affiliation of different stakeholders in the destination (Sorokina et al., 2022).

Methodology

Selection of tourist attractions

The research design included the identification of a significant destination and the heritage site, including identifying and evaluating its decision-makers. That enabled the reliability of the data and the study. The Town of Poreč was chosen because of its attractive geographical position. It is situated in the predominant tourist region in Croatia – Istria, which produced 32.9% of the total number of overnights and 28.7% of the total number of arrivals in the Republic of Croatia in 2021 (Croatian Bureau of Statistics, 2022). Constant investment in tourism development results in numerous awards and acknowledgements, elevating the destination as one of the leaders of Croatian tourism for many years. Due to the considerable tourist traffic and protected UNESCO cultural heritage, the Town of Poreč was selected as a research site.

The criteria for selecting cultural heritage in this research are directed towards the availability of cultural heritage digital promotion, given that as many as 55.5% of tourists visiting Croatia use the Internet as the main source of information about the destination (Institut za turizam, 2019), the scope of material and non-material cultural heritage and the cultural attraction specificities.

Website analysis

For the research of digital promotion of the listed Poreč attractions, official Internet websites of the attractions themselves were chosen, i.e., attraction management websites and the County of Istria Tourist Board websites. These sites are usually the point

of the initial interaction between tourists and tourist attractions and contain conjoined information about the tourist offer, including information about cultural attractions.

It is important to create Internet websites that contain or express their purpose, history, products, and vision and which, at first sight, are attractive and sufficiently interesting to encourage repeat visits (Kotler et al., 2014); website elements were selected for evaluation of digital promotion of Poreč cultural attractions, taking into account the design elements of an efficient Internet website, according to Kotler et al. (2014) – context, content, community, customisation, communication, connection and commerce. According to the elements' coverage, the following website elements were selected: foreign languages, reviews/grades, photo gallery, virtual walk, Facebook, Instagram, Twitter, Pinterest, Newsletter, online booking and email contact form.

Data analysis includes the descriptive and comparative longitudinal statistical analysis of the three observed years, which implies the development of the smart tourism destination and its online promotion through differentiated website elements. The desk research was conducted in March 2018, 2020, and 2022, and the results represent a platform for new knowledge and provide answers to research questions.

Qualitative research

Furthermore, research on the perception of key decision-makers in tourism destinations was conducted who are, directly or indirectly, involved in cultural heritage management and promotion. They represent cultural institutions, regional and local tourist boards – DMOs and local government. For research anonymity, the personal communications are coded with a scale from A – E, as follows:

- Cultural attraction decision maker A and B (Personal communication A and B)
- Tourist destination decision maker C and D (Personal communication C and D)
- The policy decision maker (Personal communication E)

The research used semi-structured interviews between 15th November and 15th December 2022. The interview aimed to determine whether tourism destination decision-makers recognise the potential of smart technologies to affirm cultural heritage promotion. The method of discourse analysis was used for processing the qualitative research data, and statistical indicators encompass the results.

Results

Website analysis

Digital promotion involves using digital channels to promote products or services, attract potential customers, and build brand awareness. A business's website is often the primary channel for digital promotion because customers can learn about the business, view products or services, and make purchases or bookings. A crucial aspect of digital promotion is website elements, which are essential for building and maintaining a website.

Further, the digital promotions data evaluation is presented from the Internet website of the County of Istria Tourist Board, selected tourism attractions from 2018, 2020 and 2022, and are longitudinally evaluated. Parallel, the data on digital promotion from the official Internet website of the selected tourist attractions is also evaluated for the same years. The evaluation elements are divided into 10 website tool categories: foreign languages, reviews/grades, photo gallery, virtual tour, Facebook, Instagram, Twitter, Pinterest, Newsletter, online booking and email contact form.

The existence of a specific element is numerically coded with 1 and non-existence with 0. Letters and numbers with changes concerning the previous years are marked in red. To avoid coding bias, authors use multiple persons to code the data and triangulation, i.e., verifying interpretations with other sources (on social media channels).

Table 1 presents website elements as part of digital promotion used by the official tourist body, in this case, the Istria Tourist Board.

Table 1

Evaluation of website elements as part of the digital promotion of the Town of Poreč tourist attractions from the Internet website of the Istria Tourist Board in 2018, 2020 and 2022

Website elements	Year	The Euphrasian Basilica	The Poreč Heritage Museum	The Zuccato Palace	Giostra	The Istrian Parliament
Foreign languages	2018	IT, DE, ENG, FR, RUS, NL	0	IT, DE, ENG, FR, RUS, NL	0	IT, DE, ENG, FR, RUS, NL
	2020	IT, ENG, DE	0	IT, ENG, DE	IT, ENG, DE	IT, ENG, DE
	2022	IT, ENG, DE	0	IT, ENG, DE	IT, ENG, DE	IT, ENG, DE
Reviews/ grades	2018	0	0	0	0	0
	2020	0	0	0	0	0
	2022	0	0	0	0	0
Photo Gallery	2018	0	0	0	0	0
	2020	0	0	0	0	0
	2022	0	0	0	0	0
Virtual tour	2018	0	0	0	0	0
	2020	0	0	0	0	0
	2022	0	0	0	0	0
Facebook	2018	1	0	1	0	1
	2020	1	0	1	1	1
	2022	1	0	1	1	1
Instagram	2018	1	0	1	0	1
	2020	1	0	1	1	1
	2022	1	0	1	1	1
Twitter	2018	1	0	1	0	1
	2020	1	0	1	1	1
	2022	1	0	1	1	1
Pinterest	2018	0	0	0	0	0
	2020	0	0	0	0	0
	2022	0	0	0	0	0
Newsletter	2018	1	0	1	0	1
	2020	1	0	1	1	1
	2022	1	0	1	1	1
Online booking	2018	0	0	0	0	0
	2020	0	0	0	0	0
	2022	0	0	0	0	0
Email contact form	2018	0	0	0	0	0
	2020	0	0	0	0	0
	2022	0	0	0	0	0

Source: Authors' work

From Table 1, it is evident that the tourist attraction of the Poreč Heritage Museum has not been evaluated, i.e., on the County of Istria Tourist Board Internet website, information is not available about the said attraction because the facility is closed due to the restoration of the Sinčić Palace where the Museum is housed. The designing of a new collection, exhibitions and social events take place only periodically. Therefore,

it will be exempt from further data analysis. Also, the information on the tourism attraction Giostra, in 2018, was not available on the stated Internet website.

Considering the availability of information on selected cultural attractions in foreign languages, it can be perceived from Table 1. that, on the Internet website of the County of Istria Tourist Board, the number of foreign languages has been reduced in the last four years. In 2018, information on selected cultural attractions was available in six foreign languages, while in 2020 and 2022, three foreign languages were eliminated (French, Russian and Dutch), and only three languages (Italian, English and German) remained. The reason for this is a decrease in costs due to the unforeseen COVID-19 pandemic, and the criteria for selection of available foreign languages in 2020 and 2022 were partly directed towards the largest number of arrivals and overnights according to the countries of origin (the choice of the German language). The choice of the Italian language was determined in line with the bilingualism of the Town of Poreč area. In contrast, the choice of the English language is essential, as it is a world language that dominates all communication forms.

Certain website elements – reviews, photo galleries, virtual walks, Pinterest, and online booking for the mentioned tourism attractions are not available on the Internet website of the County of Istria Tourist Board. Implementing digital tools to increase the interest of more visitors to the tourism destination presents the additional possibility of promoting stated attractions.

On the Internet website of the County of Istria Tourist Board, a possibility is available for sharing information on social networks, such as Facebook, Instagram and Twitter, for all the listed attractions (except for the Poreč Heritage Museum, for the above-cited reason and Giostra, which was listed as a tourist attraction on the stated Internet website after the year 2018). Also, the possibility of a newsletter is available for the listed attractions as a tool for providing information and direct communication with potential visitors.

Additionally, an analysis of website elements, as part of the digital promotion of the selected tourist attractions on the official Internet website of attractions, is provided, shown in Table 2.

When analysing the availability of foreign languages on the Internet websites of tourist attractions, it is evident that, throughout the observed years, the attraction Euphrasian Basilica has the highest number of foreign languages. It justifies that it is one of the most beautiful, preserved monuments of Early Byzantine art in the Mediterranean, included on the UNESCO World Cultural Heritage List. Other tourist attractions have two to three foreign languages, apart from Zuccato Palace, which has no available foreign languages.

Website elements – reviews, Twitter, Pinterest, and online booking are not represented as possibilities on the Internet websites of the selected tourist attractions. A photo gallery is available on the Internet website of the listed attractions, apart from the Poreč Heritage Museum. In contrast, a virtual tour, as a modern marketing tool which enables the realistic experience of the space, regardless of the space and time, is not available for any tourist attraction.

While the social network Facebook is available on the Internet websites of all stated attractions in the last four years, the social network Instagram is available on the websites of two attractions – Poreč Heritage Museum and Zuccato Palace. The only tourist attraction in 2022 which has the possibility of a newsletter on the Internet websites is the Zuccato Palace. It is commendable that all Internet websites of the listed tourist attractions have email contact forms.

Comparing website elements as part of the digital promotion of selected tourist attractions - the website of the Istria Tourist Board and the official website of tourist

attractions, it is evident that the Internet website of the tourist attraction Euphrasian Basilica contains three foreign languages (Russian, French and Spanish) more than the County of Istria Tourist Board Internet website in the years 2020 and 2022. On its Internet website, the Zuccato Palace has no availability of foreign languages, and the Istrian Parliament has one foreign language on the County of Istria Tourist Board Internet website.

Table 2
Evaluation of website elements as part of the digital promotion of the Town of Poreč Tourism Attractions from the Official Internet Website of Tourism Attractions in 2018, 2020 and 2022

Website elements	Year	The Euphrasian Basilica	The Poreč Heritage Museum	The Zuccato Palace	Giostra	The Istrian Parliament
Foreign languages	2018	ENG, IT, DE, RUS, FR, ESP	ENG, IT	0	ENG, IT, DE	ENG, IT
	2020	ENG, IT, DE, RUS, FR, ESP	ENG, IT	0	ENG, IT, DE	ENG, IT
	2022	ENG, IT, DE, RUS, FR, ESP	ENG, IT	0	ENG, IT, DE	ENG, IT
Reviews/grades	2018	0	0	0	0	0
	2020	0	0	0	0	0
	2022	0	0	0	0	0
Photo Gallery	2018	1	0	1	1	1
	2020	1	0	1	1	1
	2022	1	0	1	1	1
Virtual tour	2018	0	0	0	0	0
	2020	0	0	0	0	0
	2022	0	0	0	0	0
Facebook	2018	0	1	1	1	1
	2020	1	1	1	1	1
	2022	1	1	1	1	1
Instagram	2018	0	0	0	0	0
	2020	0	1	1	0	0
	2022	0	1	1	0	0
Twitter	2018	0	0	0	0	0
	2020	0	0	0	0	0
	2022	0	0	0	0	0
Pinterest	2018	0	0	0	0	0
	2020	0	0	0	0	0
	2022	0	0	0	0	0
Newsletter	2018	0	0	0	0	0
	2020	0	0	0	0	0
	2022	0	0	1	0	0
Online booking	2018	0	0	0	0	0
	2020	0	0	0	0	0
	2022	0	0	0	0	0
Email contact form	2018	1	1	1	1	1
	2020	1	1	1	1	1
	2022	1	1	1	1	1

Source: Authors

The advantage of the tourist attractions Internet websites over the Internet website of the County of Istria Tourist Board is evident in the tool photo gallery, as all the selected tourist attractions (apart from the Poreč Heritage Museum) have a photo gallery on their Internet websites as an essential element of drawing attention and awakening interest in a potential visitor.

Apart from the advantages of the tourist attractions Internet websites, an advantage can also be perceived in the email contact form tool. It facilitates direct contact and two-way communication with potential visitors for all the listed attractions concerning the Internet website of the County of Istria Tourist Board.

The deficiencies of the Internet websites of the listed attractions concerning the Internet websites of the official tourism portal of the County are evident from the availability of the social networks (especially Instagram and Twitter) and the newsletter. It is present only on the Internet websites of the attraction Zuccato Palace in 2022. With the development of new technological trends and accelerated expansion of mass use of applications, changes occur in consumers' behaviour and the use of more recent social networks. It is, therefore, necessary to follow the world's trends in technology and tourism and to adapt one's offer to the tourists' requirements to achieve a more efficient promotion and attract more tourists.

Reviews, virtual tours, Pinterest and online booking represent website elements that are not present on either of the two observed Internet websites and represent a potential for further development and improvement.

Digital promotion of cultural attractions can be a powerful tool for increasing awareness and attracting visitors through developing a strong online presence. This needs to include creating a website for cultural attractions that provides visitors with a virtual tour of the space, detailed information about exhibits, online booking and practical details like opening hours and ticket prices. Moreover, creating social media accounts to share engaging content and interact with potential visitors represents the potential that must be listed on the website and vice versa.

Qualitative research

Qualitative research was conducted based on the quantitative research data and determination of the potential for further development of cultural heritage digital promotion through website elements. The purpose is to determine the opinions and attitudes of tourist destinations and cultural attraction decision-makers about the possibilities of digital promotion through communication channels, online marketing tools and smart technologies. The research was carried out during November 2022, i.e., outside of the main tourism season, for greater dedication to surveying decision-makers and obtaining higher-quality responses. The decision-makers were contacted by email, and almost all the approached decision-makers agreed to participate in the research. The decision maker who did not respond to the invitation represents the Euphrasian Basilica, a cultural attraction included in the UNESCO World Cultural Heritage List. He never participates in research as he is a church clergy member.

Semi-structured interviews were distributed to cultural attraction decision-makers, tourist destination decision-makers and policy decision-makers. The data stated in this research, which concerns one cultural attraction, is incomplete due to the current reconstruction investment.

Initially, the interview contained questions about the current cultural heritage promotion situation. After that, the questions were directed towards digital promotion, the concept of smart technologies, their use and, at the very end, plans for implementing cultural heritage digital promotion (in the sense of qualitative research) and their importance (in the sense of quantitative research). The average duration of the interview was 30 minutes.

When analysing the question: "Does your organisation have a promotional strategy?" three decision-makers, A, C and D, replied positively, while two replied negatively, noting that one of the decision-makers, B, plans to introduce it. Given that promotional strategy aims to increase the interest in a specific product, i.e. cultural

attraction and attraction of a larger number of visitors, its importance is unquestionable, especially in today's digital trends.

All decision-makers, apart from policy decision maker E, promote cultural attractions by directing themselves towards the current promotion of cultural attractions. They are cooperating between themselves but also with other partners such as the diocese, event organisers and surrounding tourist boards. Mutual decision-maker performance certainly contributes to a more efficient cultural heritage model.

The following question was open-ended, and the decision-makers were asked to state their channels of communicating information. The results are presented in Table 3., a ranking scale of the frequency of key cultural attraction decision-makers use of communication channels.

The results indicated that they communicate information most frequently through social networks, then by website portal postings and newsletters. As a communication channel, at the same time, the decision-makers generally stated the term media, considering the wide context of information distribution. Certain decision-makers also use printed materials, i.e., newsletters, to communicate with potential visitors.

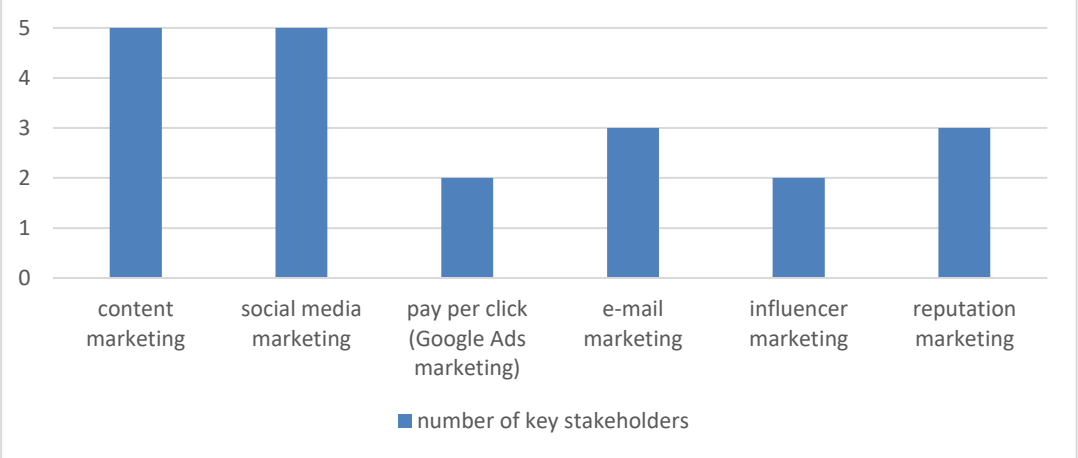
Table 3
Key Cultural Attraction Decision Makers' Communication Channels

Rank of usage	Communication channels
1	Web portals
2	Newsletters
3	Social networks
4	Press release
5	Media
6	Public newsletter

Note: 1-the most frequent, 6-the least frequent
Source: Authors' work

The decision-makers were asked what online marketing tools they use from the possible options: content marketing, social media marketing, and pay-per-click (Google Ads marketing). Email marketing, influencer marketing and reputation marketing.

Figure 1
The Use of Online Marketing Tools by Decision Makers in Tourism Destination



Source: Authors' research

According to the data shown in Figure 1, it can be noted that all the surveyed decision-makers use content and social media marketing as essential strategies in today's online marketing. Tourist destination decision-makers C and D take the lead in the use of online marketing tools in comparison with other heritage offer decision-makers. They are the only ones who use all the offered online marketing tools, including influencer marketing, which is increasingly gaining importance in recent years. They are finding influential people who match the values of tourism destinations. They echo well with target customers; the stated marketing strategy has proved extremely efficient in attracting visitors to tourist destinations.

At the same time, cultural attraction decision maker A uses email marketing and reputation marketing and is adapting to the digital requirements of today's trends.

Concerning the considerable pressure of today's tourism, accompanied by an increase in visitors and a potential threat to the sustainability of cultural attractions and tourism destinations, the digital visitor management system was discussed with the decision-makers. Although statistical data is monitored by tourist destination decision-makers using the digital tourist registration system, they are used to determine the set plans' realisation. They are increasing yearly and are not adjusted with efficient visitor management, i.e., tourism destination sustainability. Cultural attraction decision maker A has implemented a digital visitor management system, i.e., an online booking system, which is used for paying for events and for those free of charge for planning an optimal number of visitors and cultural attraction sustainability.

As today's smart technologies are perceived as an inevitable trend in the competitive market, while implementing innovative and dynamic changes in the tourism destination cultural offer, the decision makers were asked what smart technologies they were using to promote cultural attractions, i.e., destination cultural heritage. Given that it was an open-ended question without listing any options, all the surveyed decision-makers stated they were not using any smart technologies. However, cultural attraction decision maker A stated that they intended to introduce QR codes which would promote cultural heritage. In contrast, after setting up the permanent display, cultural attraction decision maker B plans to implement a marketing campaign based on smart technologies, which it had not defined.

Its implementation plans were initiated after establishing its position in cultural heritage digital promotion. They stated possibilities, and the decision-makers, apart from modestly presented plans in the previous question, listed numerous other smart technology possibilities. This shows that the decision-makers are not sufficiently acquainted with smart technologies within the context of cultural heritage digital promotion. After listing possible smart technologies, cultural attraction decision maker B presented the most comprehensive plans to introduce virtual and augmented reality (VR, AR). 3D mapping, digital ticketing, digital souvenirs and postcards, QR codes, audio guide and mobile application. Cultural attraction decision maker A states the plans for introducing digital assistants, digital ticketing and QR codes. The decision-makers who do not directly manage cultural attractions, i.e. those who are focused on tourism destination management as a whole, do not plan to implement digital tools, apart from the tourist destination decision maker D, which stated that even though it does not directly manage cultural attractions, they plan to introduce digital souvenirs and postcards, QR codes, audio guide and mobile applications, aiming to stimulate visitors' interest in the destination's culture.

Regarding the plans for implementing smart technologies in the cultural attraction promotion, the decision makers were asked about the challenges to which smart technologies have not already been implemented in the business. Their biggest challenge is the lack of financial means and workforce.

For the determination of decision makers' attitudes and opinions about cultural heritage promotion and the impact of digital promotion on the realisation of a considerable number of visits, sustainable management and destination competitive advantage, the decision makers were given statements and possibilities to answer the following Likert scale of 1, which included "I do not agree at all.", up to 5 "I completely agree." The results of decision makers' attitudes and opinions are shown in Table 4 and the descriptive statistical analysis results.

Table 4
Destination Decision Makers' Attitudes and Opinions About Cultural Heritage Promotion

Statements	Mean	Std. Dev.
The current promotion of the destination cultural heritage/destination attractions you manage is not sufficiently developed.	2.20	0.837
By additional investment in the destination's digital promotion of cultural heritage/cultural attractions, many visits would be realised.	3.60	1.673
Cultural heritage digital promotion could substantially impact the sustainable management of the destination cultural heritage/cultural attractions I manage.	4.40	0.894
The destination's competitive advantage can be achieved by digital cultural heritage promotion.	4.60	0.894

Source: Authors' research

It is evident from Table 4. that the largest average grade (4.60) was awarded to the statement, "The destination competitive advantage can be achieved by cultural heritage digital promotion", which points to the fact that the decision-makers are aware of the importance of cultural heritage digital promotion. However, regardless of the importance of cultural heritage digital promotion, the decision makers believe that the current promotion of destination cultural heritage, i.e. cultural attraction they manage, is not sufficiently developed, and this statement was given the average grade of 2.20.

The decision-makers gave a high average grade of 4.40 to the statement, "Cultural heritage digital promotion could substantially impact sustainable management of the destination cultural heritage/cultural attractions I manage", which points to the fact that they are aware of the impact digital promotion has on cultural heritage sustainable management.

Discussion

In consideration of positive shifts in the period from 2018 to 2022, a discussion is developed about the dynamics of the implementation of technological tools. The longitudinal research points to digital promotion with a special reference to the COVID-19 pandemic period, where the destination decision-makers and attraction managers had the time for consideration and a reset. Namely, due to a lull in tourist traffic, the attraction management recognised the advantages of digitalisation, that is, the necessary need for communication with potential visitors, which remains present in the minds of consumers through social networks and affirms competitiveness for the post-pandemic period.

Given the importance of continuous communication with potential visitors, Internet websites must serve as a tool for promoting tourist attractions and as the main information and communication channel. The pandemic period served to reflect on

improving them, and, in recent years, certain website elements were included on the stated Internet websites, such as social networks and newsletters, which enable interactive communication with potential visitors.

It is presumed that, in the choice of tourist destination and tourist attractions, visitors primarily inform themselves on the main tourism Internet website, by which they expect to receive useful information. It is, therefore, very important that the Internet website is simple and well-structured and contains multimedia content, i.e., it encompasses website elements that will intrigue potential visitors and encourage them to move into action. By analysing the selected Internet websites, it is evident that they have improved concerning the pre-pandemic period; however, there is still substantial potential for the development of certain website elements, such as virtual tours, reviews, and online booking which, by being implemented, would contribute to the quality of the website itself. Further to this, considering the year 2022, a tendency is recognised towards the realisation of new competitiveness through the monitoring of modern trends, the realisation of tourist visits and comprehensive excellence, which is aimed at increasing the integrated quality of the destinations as smart destinations of the future.

Website elements represent an important potential for promoting cultural attractions. Certain website elements can help attract attention and arouse interest among potential visitors. The research determined that the observed websites as key promoters of cultural attractions in destinations do not use all the observed website elements to promote cultural attractions. Although most websites use a photo gallery, some use email contact forms, different foreign languages, social networks (limited), and newsletters, and the possibilities are visible in the introduction of other website elements such as reviews, virtual tours, online booking and expansion to other social networks, which answers Q1.

Although there are visible advances in the implementation of digital promotion of cultural attractions during and after the pandemic period in six years period, there is certainly significant potential for further development and introduction of new tools for websites to increase the interest of potential visitors, following new trends, technology development and promotional opportunities. For example, the potential for development is certainly manifested in the introduction of virtual tours, which today represent an essential web tool that enables potential visitors to have a virtual perception of cultural attractions, i.e., a view from another perspective, representing the answer to Q2. The absence of certain website elements that are outputs of new trends in digital technology can represent a missed opportunity for further promotion and improvement of the website. Digital promotion of cultural attractions does not fully follow the development of technology, promotional tools and possibilities. Namely, in today's dynamic world, the development of technology, promotional tools and other digital possibilities occurs very fast. Thus, the lagging behind digital promotion of tourist attractions is not surprising. It arises from the research that the reaction to the challenges in developing the digital promotion of tourist attractions should be more energetic, as it does not keep pace with the promotional tools and the possibilities of technological benefits. Technology development and promotional tools provide cultural attractions with newer, simpler and more efficient possibilities for reaching the target groups concerning previous promotion types. Therefore, destination decision makers need to have mutual strategic marketing performance and constantly follow the trends of technology development, i.e., promotional tools, to get to know the ways of its promotion in a newer, technologically advanced manner and, in this way, assume the leading role in the competitive market.

Most decision-makers recognise the importance of digital promotion, online marketing tools and smart technology in promoting cultural attractions. Although they promote cultural attractions through social networks, web portals and newsletters, only certain decision-makers have a promotional strategy. This basic document directs the promotion and attracts specific target groups. When considering online marketing tools, decision-makers recognise their importance, and some use them in their businesses, with tourist destination decision-makers leading the way in using them. The concept of smart technologies is not a well-known concept among decision-makers. However, there are plans for their implementation. Based on these considerations, the answer to Q3 can be given as decision-makers recognise the importance of digital promotion, online marketing tools and smart technology in promoting cultural attractions. However, they do not sufficiently exploit their potential.

Although the awareness of the importance of digital promotion of cultural attractions seems to be present among decision-makers and institutions, there still seems to be a lack of knowledge and skills necessary to apply these strategies successfully. Investment in education and the development of digital skills is needed to increase the quality of digital promotion of cultural attractions and their visibility on a global level. In addition, it is necessary to provide adequate financial resources to enable the use of the latest technologies in promoting cultural attractions, which could attract a larger number of visitors and increase the economic value of cultural attractions.

Conclusion

A powerful development of technological achievements, especially during the pandemic, has created new possibilities for promoting heritage tourism, enabling future "buyers" to view it from another perspective. The progress of technology and new possibilities of presentation and virtual reality have brought new, revolutionary, and interactive presentation methods.

Modern society is defined by information technologies used daily by modern tourists. Mobile technologies, applications, social networks and different Internet platforms facilitate interactivity, continuity, fast information transfer, information dissemination, trading and flexibility in tourism. To adapt to modern tourists influenced by new technologies, adopting new ways of thinking and perceptions of tourism and culture, website elements, as possibilities for digital promotion of cultural attractions, have been evaluated in the paper.

The study results generate practical and scientific implications in the smart destination context.

The paper provides practical insights for tourism destination decision-makers, cultural institutions, and regional and local tourist boards by identifying effective website elements for promoting cultural attractions and providing guidance on creating an efficient Internet website according to the design elements proposed by Cyr (2014) and Wang (2022).

The paper's longitudinal data analysis helps tourism destination decision-makers track the effectiveness of their online promotion efforts and adjust their strategies accordingly. The paper provides practical insights into leveraging smart technologies to promote cultural heritage. It may be useful for tourism destination decision-makers and cultural institutions looking to enhance their online presence and promotion efforts. In this sense, the importance of education in e-marketing for improving customer experience is emphasised, and it complements the research of Kim et al. (2012). On the other hand, benchmarking for implementing good practices and competitiveness measurement is detected as another strong marketing tool.

In periods of extraordinary situations, in particular, in which human factors cannot affect or may affect in a small measure, the importance of unhindered interactive communication with virtual "buyers" is evident, which, with the development of digital promotion, can help the destination in individual approach and satisfaction of potential visitors. The recommendation for destination stakeholders' collaboration produced by this research and leaned on the study of Gretzel (2022) and Kujala et al. (2022) are related to the improvement of digital promotion of tourist attractions and cultural heritage and are directed towards all stakeholders in a destination. With a joint approach, the decision-makers, managers of cultural attractions and cultural heritage, DMOs, and all destination stakeholders consider implementing digital e-tools to present their offer "to the world" in a contemporary, digital manner. The content must be interesting and simple, provoking a "genuine" perception of tourism and cultural heritage. By considering potential website elements, they will be acquainted with modern models of digital promotion possibilities of their implementation and thus access a larger number of potential visitors.

The paper contributes to the academic literature on the digital promotion of cultural attractions by evaluating the effectiveness of various website elements elaborated by Neuhofer et al. (2019) and Ding (2017)

The paper provides a longitudinal analysis of data from three observed years, which helps track the development of the destination's online promotion through differentiated website elements.

The paper contributes to the academic literature by exploring the potential of smart technologies for promoting cultural heritage and determining whether tourism destination decision-makers recognise the potential of smart technologies to affirm cultural heritage promotion.

The paper utilises a discourse analysis method for processing qualitative research data, which may interest researchers in tourism studies.

This paper's research results represent a scientific contribution to the field of social sciences, marketing, and tourism field, which is manifested in the interactive approach of smart technologies and cultural attractions as a potential for the development of "smart" destinations that complement theoretical aspects of European Commission (2020) and Boes et al. (2015). Considering the topics that will contribute to new knowledge, the need is presented to research promotion on social networks, given that an evident shift is stressed in the affirmation of that online promotion tool. Therefore, the theoretical platform was developed by Buhalis and Law (2008) and Hudson et al. (2016). Future research should also include tourists as stakeholders of the tourist demand. The research limitations are reflected in the sample choice and its specific features as one of the most visited destinations in Croatia.

The topics challenging the factors of influence on visits, perception of attractiveness and implementation of innovations where they, by themselves, carry certain levels of attractiveness, represent a platform for the development of smart destinations which, besides technology and social and cultural sustainability, also affirm inclusion and accessibility for sensitive groups.

The research contributes to the affirmation of the possibility of developing digital promotion of tourism destination cultural heritage, considering its specificities. It presents a unique study that equally points to the importance of implementing smart technologies by the tourism destination key managing stakeholders and their mutual strategic marketing performance.

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Does the Type of Nominal Personal Income Tax Rate Affect Its Progressivity? A Case Study from the Czech Republic

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Abstract

Background: The article evaluates the influence of the type of nominal personal income tax rate on its progressivity. This is examined in the Czech Republic in the period 1993–2020. Between 1993 and 2007, the nominal tax rate was progressive, while from 2008 until the end of 2020, the nominal rate was linear. **Objectives:** The paper aims to analyse if the type of nominal tax rate affects personal income tax progressivity. **Methods/Approach:** The article uses analysis, synthesis, comparison and regression analysis methods. The progressiveness of the tax obligation indicator is used to evaluate the degree of tax progressivity. **Results:** In the context of the analysis of the degree of tax progressivity, personal income tax is more progressive in the period of validity of the nominal linear rate for taxpayers with incomes below the average wage level. **Conclusions:** Since the linear rate has been in force, the government in the Czech Republic has often mistakenly presented that tax rate innovations will ensure that everyone pays the same tax.

Keywords: personal income tax; progression; tax reliefs; tax reform; Czech Republic.

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Introduction

The Czech Republic was established on January 1, 1993. On the same date, significant tax reform took place. Since this tax reform, personal income tax has been imposed on the income of natural persons. This tax replaced the payroll tax and inhabitant income tax.

In the historical context of the Czechoslovak state, however, the income tax originally had an important role. The Income Tax Act regulated taxation during the First Republic (1918 – 1938). The income tax was newly created, as the tax system adopted after Austria-Hungary was unsuitable for a country exhausted by the war conflict. The income tax law, like the tax laws in the surrounding European countries, was set up so that taxation was progressive. The tax burden increased faster with income growth; the tax rate was 1% to 29%. During the period of the Protectorate (1938 – 1945), the state's war expenses increased, and thus, the tax burden also increased, with the highest rate being up to 61%.

A significant change occurred with the implementation of the currency reform in 1952. A total of nine new taxes were created. The tax system consisted of taxes from the economic sector and the population's income. The change in the economic and political situation forced a change in personal income taxation. The original income tax law was repealed because it did not meet the political conditions of the time. A typical symbol was the high tax burden, especially in private business. The wage tax was decisive for taxing citizens who did not do business. This tax rate was also progressive, compared to the income tax during the period of the First Republic, but the degree of progression of this tax was much higher. When determining the tax rate, it was not only the amount of income that was decisive, but especially the number of dependents - children of the taxpayer. Persons with only one or no dependents could have the tax rate increased by up to 40%; however, with five or more dependents, the tax rate was reduced by up to 45% of the original value.

The construction of this law thus fulfilled the state ideology's requirement of equality and other political conditions that applied in the states of the Soviet Union. Also, the high Taxation of the entrepreneurial activity of natural persons very significantly dampened unwanted private entrepreneurial activity, which was a typical feature of Eastern European countries. For example, entrepreneurs could be taxed at a tax rate of up to 85%. This also fulfilled the ideology of shared ownership, equality, the existence of state enterprises, zero private entrepreneurship and the role of fiscal policy in a centrally planned economy. This trend was also typical in the neighbouring countries of the former Soviet Union.

After the political coup in 1989, the intention was to switch from a centrally planned economy to a market economy. It was necessary to reform the existing tax system to make this step possible. Until then, it had been set up in such a way as to favour state enterprises in the tax burden at the expense of private business. However, this was not the case only in Czechoslovakia at the time but also in the surrounding states that used to form the Soviet Union.

The idea to modify the provisions of the payroll tax law was ultimately not accepted. It turned out that the original tax system was utterly inappropriate. This led to the creation of a new system of the Czech Republic containing direct and indirect taxes. The structure of these regulations was set by the modern market environment so that the Czech Republic would be competitive in the European market environment. The transition from a centrally planned economy to a market economy and its orientation towards Western markets were other reasons for this tax reform. The ideology prohibiting private business or equality between citizens has also changed. It might appear at first glance that the new law has switched from a progressive tax rate to a

linear one. However, this did not happen, and even in the Income Tax Act, which regulated the Taxation of the income of natural persons, the tax rate was progressive in the version valid on January 1, 1993.

In addition to income tax, direct taxes included property taxes, such as real estate or road tax. Their share in the tax mix and tax revenue is only one per cent in the long term. The second significant tax is a value-added tax. This tax is one of the indirect taxes and ensures relatively stable tax revenue in the long term due to its functioning mechanism. It should be noted that compared to income tax, the currently valid value-added tax law is highly harmonised with the direction of the European Union. In addition to value-added tax, the system of indirect taxes also includes excise duties and energy taxes.

The income distribution in society is unequal (Rattan et al., 2021). A progressive income tax rate is a tool to reduce inequality in the distribution of incomes in the economy. Its principle is based on the fact that as income increases, income tax increases faster than the taxpayer's income. This fact then causes the distribution of incomes in society to be more balanced. The question of tax progressivity must be analysed in connection to fiscal solidarity since taxpayers with higher incomes pay higher amounts to the state budget than taxpayers with lower incomes. The tax revenues cover the costs of running the state of public goods and services, and the result is that taxpayers with higher incomes have a higher share of the payment of these costs. The research of Vasilopoulou and Talving (2020) or Seelkopf and Yang (2018) in the European Union states shows that citizens who live in poorer countries are less willing to fiscal solidarity than citizens from more prosperous countries. Solidarity aspects are applied to the construction of the tax by the state, guaranteeing a certain non-taxable minimum, whether in the form of a zero tax rate, a non-taxable part or a tax relief. Another aspect of solidarity is based on the fact that social security contributions are also deducted from the taxpayer's income. Social support benefits are paid from this insurance to those registered as unemployed. For example, there has been a change in the historical context in this area since 1989, as unemployment was not possible under the former communist regime.

Income polarisation must also be considered when deciding whether and to what extent to set the progressivity of the personal income tax. Suppose the goal is to reduce inequality in income distribution in society. In that case, the tax rate will be structured differently in states where a higher proportion of households are low-income than, for example, in states with a large number of the middle class and a minimal number of low-income or high-income households. The study's conclusions by Panek and Zwierzchowski (2020) show that, for example, in Poland, individuals in the lower and upper classes are gradually approaching the middle-income group with their incomes. The results of Wang et al. (2017) also testify that income polarisation is higher in Central and Eastern Europe than in Western Europe.

From a macroeconomic point of view, fiscal policy mainly has a stabilising function. Based on changes in government revenues and expenditures, the goal is to eliminate deviations of the real product from the potential product. Fiscal policy instruments include built-in stabilisers and deliberate measures. An example of a built-in stabiliser is the income tax. The question is whether the income tax should be linear or progressive.

According to Beramendi and Rehm (2016), one of the positives of the progressive tax rate is that the tax burden of persons with lower incomes is reduced. The tax liability increases faster than the taxpayer's income, which also applies in the opposite direction; when the income decreases, the tax burden, in percentage terms, falls more than the taxpayer's income. If a progressive tax is applied, it will also reduce income inequality, as taxpayers with higher incomes bear a higher tax burden. In contrast,

taxpayers with below-average incomes can have zero tax burdens. As mentioned by Lapov and Mayburov (2021), the advantages of progressive Taxation are also from the state's point of view, specifically in the form of higher tax revenue. Higher economic growth is also a benefit of progressive Taxation. This is because lower-income taxpayers have a higher net income with which they purchase goods and services. On the contrary, taxpayers with higher incomes would not spend their entire income, and a part would be saved, which, on the contrary, will reduce economic growth according to the conclusions of analysis by Ganchev and Todorov (2021) or Oh (2017).

On the other hand, if the tax burden increases faster with the increase in income, according to studies by Čok et al. (2013) or Buffon and Stefano (2022), this fact has demotivating character. Employees may not be willing to work more as their net income decreases. This fact can harm economic growth. Another disadvantage is the possible migration of residents with higher incomes if the degree of tax progression is significantly lower in the surrounding states. This fact thus negatively affects tax revenues. A very high progression can also lead to citizens not officially recognising part of their income, which leads to tax evasion. According to a study by Coelho and de Oliveira (2019), an increase in tax by 1% leads to an increase in tax evasion by up to 3%.

The Income Tax Act, which regulates the area of personal income taxation, has undergone extensive changes throughout its validity period. Changes in tax rates were relatively frequent, especially in the first years of the act´s validity. In 1993, income tax rates were set in six bands ranging from 15% to 45%. In the last year, when the nominal tax rate was in force, i.e. in 2007, four bands ranged from 12% to 32%. What remained the same until the year 2008 was the nominal type of rate, which was progressive. Thus, due to the nominal progressive tax rate, personal income tax was expected to be a progressive tax in this period. However, one of the research questions is whether this was the case in all situations, regardless of how high the employee's wage was. The existence of tax reliefs, which were often implemented in the form of non-taxable parts of the tax base, could affect tax progressivity.

Significant tax reform took place in 2008, which, among other things, changed the type of nominal tax rate. The nominal linear tax rate replaced the nominal progressive tax rate. This legislation was valid in the Czech Republic until the end of 2020. Was it also valid that with the growth of the taxpayer's income, the tax liability increased faster than the taxpayer's income, or was the income tax in this period a so-called flat tax? Non-taxable-part for the taxpayer has been abolished, so at first glance, it might seem that for this reason, not only the nominal but also the real tax rate will be linear. However, this may not be the case, as the newly implemented relief for taxpayers was used to reduce tax liability. This relief affects tax progressivity.

Another research question is to examine whether the progressivity was higher in 1993–2007, i.e. when the nominal tax rate was progressive, or in 2008–2020, when the nominal tax rate was linear. Could there be a paradoxical situation? The nominal flat tax rate, often presented to the public as a real flat rate, could be a more progressive tax than a nominal progressive rate. Or, on the contrary, did the nominal linear rate cause a more evenly distributed tax burden?

The article aims to evaluate whether the personal income tax in the Czech Republic was a progressive tax when the nominal tax rate was linear. Another aim is to determine whether income tax was more progressive when the nominal progressive tax rate was valid or whether the degree of progressivity was higher when the nominal tax rate was linear. Another goal is to evaluate personal income tax progressivity from 1993 to 2020.

The structure of the article is as follows. The introduction of the article defines the research problem. The next part deals with an overview of studies examining the area of personal income tax – in the Czech Republic and abroad with a focus on tax progressivity. The introduction of the methodological part briefly defines the methods and indicators used for analysis and the input data. The main section deals with the study of tax progressivity. These results are discussed and summarised in the final part of the article.

Literature

A tax is progressive if the taxpayer's tax burden grows faster than his income. General aspects of tax progression are the subject of study, for example, Mattesini and Rossi (2012) or Chen and Guo (2019). The progressive tax rate is an automatic stabiliser and reduces inequalities in income distribution. If the tax rate were only linear, cyclical fluctuations would deepen, as confirmed by the results models of Alessandrini (2021). Therefore, a progressive income tax is typical for most of the world's tax systems. These are confirmed by Berens and Gelepithis (2019) and Nadirov et al. (2021). Globally, the trend is to reduce the degree of tax progression (Wu, 2021). This increases income inequality (Chen, 2020). Greater equality in income distribution can only be achieved if the tax is more progressive, as evidenced by the results of Oishi et al. (2018), who examined personal income tax progressivity in the USA.

Wagstaff et al. (1999) and Husman and Brezeanu (2021) analysed the degree of income tax progression in Europe. According to the results of the studies, the tax was highly progressive in Sweden and Finland. When determining the degree of progression, it is essential to respect the aversion of taxpayers with high above-average incomes to progressive Taxation and the high preference of low-income groups for progressive Taxation (Puy, 2019). An Australian study by Joseph and Mallon (2019) states that when there are more tax bands, the tax becomes less regressively progressive at the higher end of each tax bracket. Wiśniewska-Kuźma (2020) examined the degree of progression of the personal income tax in the former post-communist countries of Europe, which are now members of the Organisation for Economic Co-operation and Development (from now on, OECD). In most OECD countries, progression occurs.

A study in the Czech Republic examining tax progression has already been conducted. Tax progressivity using interval indicators of progressivity in the context of the effective tax rate during 1993–2008 was examined by Friedrich et al. (2012). The study evaluated progressivity, where the basic deduction is applied to the taxpayer. According to the study results, the income tax was progressive in all examined intervals until 2007. This study thus expanded the original results of Široký and Maková (2009), analysing tax progressivity and effective tax rates in the Czech Republic from 1993 to 2007. Interval indicators were also used in this case to evaluate progressivity. Krajňák (2019) also used indicators of interval tax progressivity to examine whether income tax is progressive in the Czech Republic, among other things. However, this study did not primarily analyse tax progressivity but the influence of tax advantages on the tax revenue of personal income tax.

The connection between tax progressivity and non-religion was the subject of a study by Čábelková et al. (2022). Progressivity was not analysed here using tax progressivity indicators but by regression analysis. An important factor influencing the attitude towards tax progressivity is classification in a specific social class according to income; in the context of the connection with religion, which was the second analysed factor, the justification for tax progressivity follows, as the rich should support the poor. The study by Čábelková and Smutka (2021) also shows similar conclusions.

In addition to tax progressivity, the mentioned effective tax rate marginal and average tax rates were examined (Dušek et al., 2014). Also, these results obtained through effective tax rates confirm the tax progression. Vítek (2012) and Vítek and Pavel (2013) state that the Czech tax reform 2008 has reduced tax progression.

The tax reform in the Czech Republic in 2008 also implemented ecological taxes. This was one of the impulses for the study of Brůha and Šťasný (2008). The study analysed the impact of implementing ecological taxes in the Czech Republic, specifically on the related distributional effects. Progressivity was analysed in the context of individual taxes and the tax system as a whole. It was found that the tax system of the Czech Republic is slightly progressive. Environmental taxes, according to Suit index values, reduced this progressivity.

In other countries, tax progressivity was analysed concerning the Gini coefficient by Stanovník and Verbič (2013). The study was conducted in Slovenia, and the period examined was from 1991 to 2009. Tax reforms have led to an increase in tax progressivity. Onrubia and Picos (2013) analysed progressivity in Spain, where income tax was progressive from 1999–2007. In particular, the 2007 reform led to a decline in tax revenues. The study of tax progressivity is the subject of research not only in the European environment, e.g. in China, but the Peng study (2009) also analysed this issue. The study examined the progressivity of this tax from 1995 to 2007. Although the tax was progressive, according to the study results, it was recommended to carry out a more significant reform in income taxation to ensure the redistributive function of taxes in the economy. In addition to progressiveness, tax reliefs, for example, were also examined (Kubátová & Jareš, 2011).

Research studies deal not only with the issue of tax progressivity in personal income tax but also with other taxes, such as energy taxes (Hájek et al., 2019), excise duties (Kukalová et al., 2021), value-added tax (Krzikallová & Tošenovský, 2020; Andrejovská et al., 2020).

An overview of research studies shows that the evaluation of tax progressivity in the Czech Republic for 1993–2020 has not been comprehensively performed. Only partial studies investigating aspects of tax progressivity have been conducted over a shorter period. The distribution of household incomes in the Czech Republic was not taken into account in the studies of Široký and Maková (2009), Friedrich et al. (2012) or Krajňák (2019) when calculating interval progressivity indicators. This study will consider this when analysing progressivity. Likewise, other studies mentioned above did not consider inequality in the distribution of household incomes when calculating progressivity indicators.

An innovative approach to addressing this issue also lies in including social security contributions for tax payment or applying other tax reliefs, which previously conducted studies abstracted. All facts emphasise the uniqueness of this study, the originality of this research and its added value.

Data and Methodology

The input database of data for the analysis consists of amounts of gross wages of employees and tax obligations from this gross wage, including social security contributions. Average wage data is sourced from the Czech Statistical Office (2021). Social security contributions and tax liability from the employee's gross wage were calculated according to the valid legislation in 1993–2020.

To achieve the paper´s objective, the author used standard positivist economic methodology, including the scientific methods of description, deduction, comparison, and study of legal sources and synthesising methods; regression analyses were used for a dependency analysis between the examined factors.

Indicators of tax progressivity are used to assess whether income tax is progressive. These indicators can be divided into two large groups - global and interval. Interval indicators determine the degree of progression within a specific range. The group of global indicators is based on the analysis of income distribution.

According to Seidl (2009), global indicators have the disadvantage that they can compensate income subintervals with opposite properties of tax schedules. Jakobsson (1976), Kakwani (1979) and Liu (1985) also consider interval indicators for measuring tax progressivity to be credible. A study by Duclos and Tabi (1996) states that interval indicators of progressivity are suitable for measuring the progressivity of income taxes. Also, studies have already been conducted in the Czech Republic or abroad. E.g. Široký and Maková (2009) and Friedrich (2012), Tran and Zakariyya (2021) or 57.

Wiśniewska-Kuźma (2020) used interval indicators of tax progressivity to measure progressivity.

If these interval indicators are used, a particular limitation of the results may occur, according to the mentioned studies, if the intervals are poorly chosen, e.g., because the entire population's coverage is not ensured using the selected intervals. Also, a not properly chosen width of the interval, e.g. if even the nominal tax rate is progressive, can lead to finding results that are not relevant. However, these limitations do not occur in this study, as the analysis is performed up to 8.0 times the average wage, which ensures coverage of more than 99% of the population. Intervals with a higher frequency of up to 2.0 times the average wage for analysis are graded by a multiple of a tenth of the average wage for an interval with a lower frequency above 2.0 times by 0.5 times the average wage. Approximately 90% of the population receives an income up to 2.0 times the average wage, and a further 9.9% of the population in the Czech Republic gets an income between 2.0 and 8.0 times (Czech Statistical Office, 2022). This ensures the coverage of the entire population and, in the case of progressive tax rates, also the filling of the marginal values in each band of the applicable tax rate.

It is possible to evaluate whether the tax is progressive based on an interval indicator of progressivity. Because the calculations are made on average wages or their multiples, using an interval indicator to analyse progressivity is a logical step.

Tax progression is analysed using the interval indicator progressiveness of tax obligations (PTO_T), which is based on a comparison of the elasticity of tax liability concerning pre-tax income (1),

$$PTO_T = \frac{\frac{T_1 - T_0}{T_0}}{\frac{Y_1 - Y_0}{Y_0}}, \tag{1}$$

where Y_0 is the taxpayer's gross wage in the lower-income interval, Y_1 is the taxpayer's gross wage in the upper-income interval, T_0 is the tax liability after applying for reliefs, non-taxable parts in the lower-income interval, T_1 is the tax liability after applying for reliefs, resp. non-taxable parts in the upper-income interval (De Sarralde et al., 2013).

OECD classifies social security contribution as a payment of tax character (OECD, 2022). Therefore, a social security contribution deducted from the employee's wage will be included as a tax payment. The form of the PTO_{T+I} indicator is then modified into (2),

$$PTO_{T+I} = \frac{\frac{T_1 - T_0}{T_0}}{\frac{Y_1 - Y_0}{Y_0}}, \tag{2}$$

Y_0 is the taxpayer's gross wage in the lower-income interval, Y_1 is the taxpayer's gross wage in the upper-income interval, T_0 is the social security contribution, which is deducted from the employee's wage and the tax liability after applying for reliefs, resp. non-taxable parts in the lower-income interval, T_1 is social security contribution from the employee's wage paid by the employee and the tax liability after applying for reliefs, non-taxable parts in the upper-income interval.

According to the OECD methodology (OECD, 2022), a taxpayer who applies only the basic deduction (deduction per taxpayer) is used to assess the tax burden. Tax reliefs reduce the tax burden, as follows from the study by Farfan-Portet et al. (2008). The deduction per taxpayer shows the tax-free minimum to which each taxpayer is entitled. This shows S_0 situations. According to Husman and Brezeanu (2021), the second most used deduction includes the deduction for children. Therefore, two more cases will also be analysed when evaluating tax progressivity. These situations - S_1 and S_2 are based on the assumption that, in addition to applying the basic deduction to the taxpayer, a deduction is also applied to one or two children. The range of used deductions then affects the total tax burden. The above shows that the tax liability will be lower with more deductions. However, it is a question of how tax progressivity will develop. While the OECD methodology abstracts from applying this deduction to children, this study does not abstract from this second most commonly applied deduction to increase added value and use the study results more widely in practice. The already mentioned deductions do not represent variables for regression analysis. These deductions express the deduction's total value in CZK and the taxpayer's tax liability difference.

In summary, tax progressivity is evaluated from the taxpayers' point of view in three model situations. These situations differ according to the type of deductions.

- S_0 - deduction per taxpayer is applied,
- S_1 - deduction per taxpayer and one child is applied,
- S_2 - deduction for the taxpayer and two children is applied.

These are the most common situations in income Taxation from the dependent activity. An interval indicator progressiveness of tax obligation (from now on, PTO) is used to evaluate progressivity (Tran & Zakariyya, 2021). Multiples of average wages limit the intervals; therefore, average wages and their multiples in the Czech Republic for 1993–2020 are used as primary input data (Czech Statistical Office, 2021). Progressivity is examined at intervals of up to 8.0 times the average wage to ensure sufficient explanatory power. Concerning the distribution of wages in the population, approximately 99.5% of the population is covered (Cengiz et al., 2019; Bílková, 2012).

Concerning the distribution of wages, the intervals with a higher frequency of wages (up to 2.0 times the average wage) are graduated by 0.1 times the average wage. At the same time, to cover as much of the population as possible, the minimum wage limits the first income interval. The minimum wage is approximately 30 to 35% of the average wage (Meixnerová & Krajňák, 2020). For this reason, this income interval is determined by threshold values such as the minimum wage and 0.4 times the average wage. Intervals with a lower wage frequency (from 2.0 times the average wage to 8.0 times the average) are graduated by 0.5 times the average wage.

The calculation of social security contribution, which is deducted from the employee's wage, is generally formalised by (3),

$$SSC = AB \cdot S, \tag{3}$$

SSC is the social security contribution deducted from employees' wages, AB is the assessment base, and S is the social security contribution rate.

The calculation of the tax liability is performed differently in each analysed period. In the first period from 1993 to 2007, the relation (4),

$$T = (GW - SSC - NTP) \cdot TR, \quad (4)$$

where *T* is tax, *GW* is gross wage, *SSC* is the employee's social security contribution, *NT* is the non-taxable part for taxpayers or children, and *TR* is the tax rate. Since 2005, there has been a change in the tax liability calculation. The deduction was not in the form of a non-taxable part but in the form of a tax relief, a tax credit, which can be formally indicated using (5),

$$T = [(GW - SSC) \cdot TR] - TC, \quad (5)$$

where *T* is tax, *GW* is gross wage, *SSC* is social security contribution paid by the employee, *TC* is a taxpayer´s relief or tax credit for children and *TR* is the tax rate.
Following the reform from 2008 to the end of 2020, the calculation of *T* using formula (6),

$$T = (SGW \cdot TR) - TC, \quad (6)$$

where *T* is tax, *SGW* is super-gross wage, *TC* is a taxpayer´s relief or tax credit for children, and *TR* is the tax rate.
Combined regression lines (Choi & Seo, 2022) will be used to evaluate the dependence of the type of tax rate and tax progressivity. The angle expresses the dependence between regression lines. Formally defines the above equations (7),

$$cotg\ \varphi = \frac{|r_{xy}|}{1-r_{xy}^2}\left(\frac{s_y}{s_x} + \frac{s_x}{s_y}\right), \quad (7)$$

where r_{xy} is the correlation coefficient, r^2_{xy} is the coefficient of determination, s_x is the variance of the values of the character x, s_y is the variance of the character y. Therefore, the model assumes two regression lines. The first line expresses the progressiveness of the tax liability in 1993–2007 when the nominal tax rate was progressive. The second regression line was in 2008–2020 when the nominal tax rate was linear.

Results and discussions

The evaluation of the tax progressivity of personal income tax is performed on two levels. First, the indicator of the progressiveness of the tax obligation is used to determine in which income intervals and in which years the personal income tax was progressive. The second part of the analysis deals with the impact of the public finance reform, which took place in 2008, on tax progressivity.

Evaluation of tax progressivity

Tax progressivity is evaluated using the PTO indicator in the three mentioned situations. Each of them is not the same because there are differences in the type of applied deductions. First, the progressivity of the personal income tax will be analysed in the case where the taxpayer uses only the basic deduction (per taxpayer). The results are presented in Figure 1.

Figure 1
Evaluation of tax progressivity in the period 1993–2020

Multiple of AW	1993-2007	2008-2009	2010-2011	2012	2013	2014-2020
> 6		REGRESSIVE				
> 4						
> 2		PROGRESSIVE				
> 1						
> 0.4						
> MW		LINEAR				

Note: AW - average wage, MW - minimum wage
Source: Author´s illustration

The personal income tax was always progressive in 1993–2007 and 2014–2020. The reason for this between 1993 and 2007 is that the nominal tax rate was progressive.

The results for the period 2008–2013 are somewhat different. The tax is linear in the intervals between the minimum wage and 0.4 times the average wage. The reason for this linearity is not the nominal linear tax rate. The taxpayer receiving income at the minimum wage and 0.4 times the average wage has the tax before the tax relief lower than the taxpayer's relief amount. In practice, this means zero tax liability (more equation 6). This has not been the case since 2014 because a taxpayer with an income of 0.4 times the average wage did not have a zero tax liability. The relief per taxpayer did not increase from 2008 until the end of 2020, so its real value decreased due to the increase in the price level. The results obtained here partially deviate from the already performed study by Friedrich et al. (2012), which stated that in 2008, the income tax was either progressive or regressive. In contrast to the above study, the examined interval was refined in this case, which led to a partially different conclusion.

In most analysed income intervals, the personal income tax had a progressive character even when the nominal rate was not progressive. Income tax was progressive due to a non-taxable minimum in the form of tax relief. This non-taxable minimum caused tax progressivity.

As shown in Figure 1, taxpayers receive income more than four or six times the average wage; however, tax obligation developed regressively in 2008–2012. This is due to the construction of the tax base for dependent activity and the maximum assessment bases for social security contribution. In that period, the tax base was a super-gross wage, which can be formally written according to equation (8),

$$TB = GW + 0.09 \cdot GW + 0.25 \cdot GW, \quad (8)$$

where *TB* is the tax base, *GW* is the gross wage, the coefficient 0.09 expresses the health insurance rate paid by the employer, and the coefficient 0.25 is the rate of social security premium and the contribution to the state employment policy, which the employer pays. The method of determining the tax base in this way is valid only until the moment when the maximum assessment bases for social security contribution is exceeded; from this moment, the tax base is determined according to (9),

$$TB = GW + 0.09 \cdot MBHI + 0.25 \cdot MBSP, \quad (9)$$

where *TB* is the tax base, *GW* gross wage, *MBHI* is the maximum assessment base for health insurance premiums, and *MBSP* is the maximum assessment base for social security premiums and the contribution to the state employment policy (from now

on referred to as MBSP). If the maximum assessment bases are exceeded, the tax base is not a super-gross wage but a gross wage of the amount exceeding this maximum assessment base. The tax rate remains the same, but the tax base decreases, and the tax liability develops regressively despite a nominal linear tax rate.

Why has this situation not occurred since 2013? The maximum assessment base for public health insurance has been abolished. Another reason is the application of another 7 % tax rate. This is a solidarity tax surcharge. This causes income tax to be progressive from this year onwards, even after exceeding the MBSP.

The next part of this analysis study again evaluates progressivity. However, the difference in comparison with the first situation is in the concept of social security contributions. Both contribution and personal income tax are tax payments. The results are in Figure 2.

Figure 2
Evaluation of tax progressivity in the period 1993–2020

Multiple of AW	1993-2007	2008-2009	2010-2011	2012	2013	2014-2020
> 6		REGRESSIVE				
> 4						
> 2		PROGRESSIVE				
> 1						
> 0.4						
> MW		LINEAR				

Note: AW - average wage, MW - minimum wage
Source: Author´s illustration

In contrast, where social security contribution is not considered a tax payment, there are no differences in income intervals and periods when the tax burden is linear. On the contrary, differences arose in 2013–2020 in intervals above 4.0 times the average wage. The MBSP causes the regressivity here. Although the solidarity surcharge is applied, the tax liability develops regressively.

Furthermore, progressivity will be analysed if tax deduction for children is applied. Formalized is in (1). In the case of applying a deduction for one child, see results in Figure 3a and two children in Figure 3b. Differences arise mainly in the periods when the tax is linear. A tax payment in this section of the analysis is personal income tax.

Figure 3a
Evaluation of tax progressivity in the period 1993–2020

Multiple of AW	1993-1995	1996-1997	1998-2001	2002-2007	2008-2009	2010-2011	2012	2013	2014-2020
> 6					REGRESSIVE				
> 4									
> 0.4					PROGRESSIVE				
> MW	LIN		LIN		LINEAR				

Note: AW - average wage, MW - minimum wage, LIN - linear
Source: Author´s illustration

Figure 3b
Evaluation of tax progressivity in the period 1993–2020

Multiple of AW	1993	1994-2002	2003-2004	2005-2007	2008-2009	2010-2011	2012	2013	2014-2020
> 6					REGRESSIVE				
> 4									
> 0.6									
> 0.5					PROGRESSIVE				
> 0.4									
> MW	LINEAR				LINEAR				

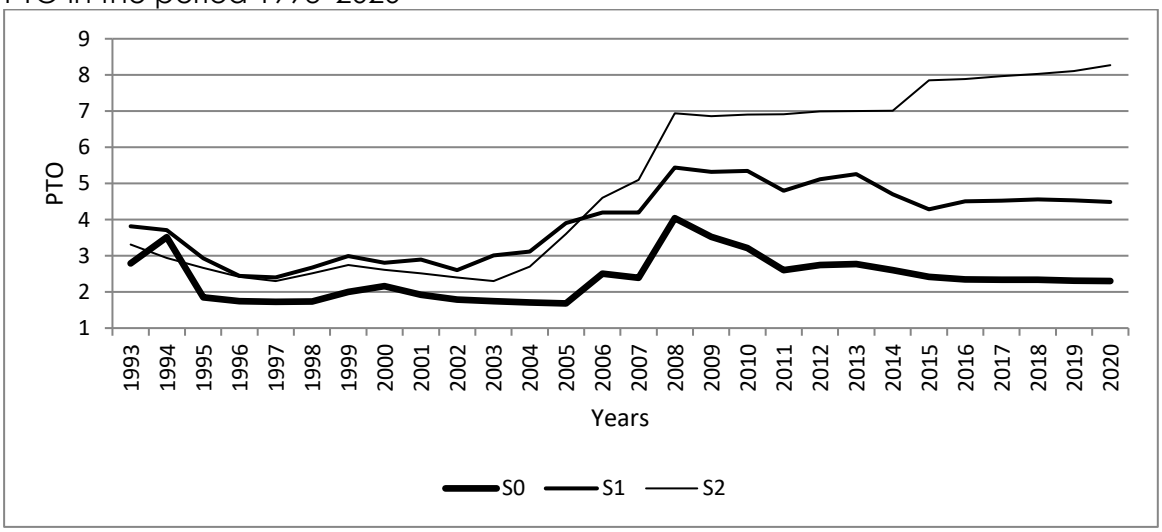
Note: AW - average wage, MW - minimum wage
Source: Author´s illustration

If the deduction for children is applied, the tax liability is also linear in 1993–1995 and 1998–2001, i.e., when the nominal tax rate was progressive. The reason for linearity is not tax relief or tax credit but the existence of non-taxable parts of the tax base for the taxpayer or the children. These cause the same tax base for a taxpayer with an income at the minimum wage level and 0.4 times the average wage (this applies in 1993–1995 and 1998–2001 if the deduction for one child is used). The same fact would be the reason for linearity if the deduction for two children in 1993–2004 were applied.

At the same time, according to the results of PTO values, income tax is linear in the years 2008–2013 in the income interval between the minimum wage and 0.4 times the average wage. This is the same as only the basic taxpayer deduction is applied. Also, the intervals when the income tax is regressive are the same as in the S_0 situation. These identical results are based on why only the deduction per taxpayer is applied.

The research question also remains about how tax progressivity has evolved regarding the degree of progressivity. The answer to this question is given in Figure 4, capturing the average PTO values for all three analysed situations (S_0 - deduction per taxpayer, S_1 - per taxpayer and one child, S_2 - per taxpayer and two children). There are weighted averages of PTO values for all analysed income intervals while respecting the distribution of wages in the intervals in the Czech Republic. Concerning this fact, the last year presented is 2020 (due to the current unavailability of information on inequalities in the distribution of wages for 2021).

Figure 4
PTO in the period 1993–2020



Source: Author´s illustration

PTO values changed over time. Compared to the initial analysed year 1993 and the last year 2020, progress has slightly changed for taxpayers applying for tax relief only to the taxpayer. In all situations, the highest increase in progressivity is between 2007 and 2008, even though a linear tax rate has replaced the nominal progressive tax rate. The increase in this progressivity is the increase in tax relief and tax credits for children.

In the case of situation S_0, tax progression increased in the years 1993 and 1994 - however, the reason was not a change in the rate or change in the values of non-taxable parts of the tax base, but an increase in wages, which caused shifting to bands with higher nominal tax rates. Another slight increase between 1998 and 1999 caused an increase in the non-taxable parts of the tax base and a change in the range of bands at the nominal progressive tax rate. Since 2006, the non-taxable part of the taxpayer's tax base has been replaced by a tax relief, which increases tax progressivity. Since 2008, there has been a gradually declining trend. A slight increase can be seen in 2013 when a solidarity tax surcharge was implemented into tax legislation. As wages increase, the degree of tax progression gradually decreases, as neither the nominal tax rate nor the tax relief value per taxpayer changes.

Tax progressivity is different in some years if the taxpayer applies a deduction for one child. The replacement of the non-taxable part of the tax base by a tax credit in 2005 caused an increase in progressivity, most notably when the deduction for two children was applied. As the amount per second child has significantly increased since 2015 than the amount per first child, this fact also increases tax progression.

The lower value of PTO until 2005 in the case of the deduction for two children is mainly. In the intervals between the minimum wage, 0.4 and 0.5 times the average wage, there was often a zero tax base, which means that the tax was the same as for a taxpayer with an income at the minimum wage level, for example, a taxpayer with 0.5 times the average wage. However, this has not been the case since 2005.

The above analysis results decrease the PTO for taxpayers who apply only a deduction for the taxpayer. This is the same conclusion as the results of the analysis of Vítek (2012) and Vítek and Pavel (2013). On the contrary, when applying the other deductions from which the studies were abstracted, the conclusions of this analysis are different. The increase in tax progressivity occurs if the taxpayer also applies other deductions.

Analysis of the influence of the tax rate type on tax progressivity

The effect of the nominal tax rate on tax progressivity is compared using the empirical regression equation and the angle that these regression lines form. In situation S_0 (Fig. 5a), the tax is more progressive at intervals up to the average wage in 2008–2020, even though the nominal tax rate was of a linear type (see line PTO2). On the contrary, in intervals above the average wage due to the progressive nominal rate, progressivity is higher in 1993–2007 (see line PTO1). This analysis concludes that tax progression has increased for taxpayers with below-average wages since the public finance reform in 2008. The main reason is the value change of the taxpayer´s relief between 2007 and 2008 (CZK 7,200 in 2007, CZK 24,840 in 2008).

Similar conclusions are from the analysis of the tax progressivity of taxpayers, which also applies deductions to children (Fig. 5b, Fig. 5c). Higher progressivity in 1993–2007 is for taxpayers with incomes over 1.25 times the average wage. On the contrary, from 2008–2020, the higher degree of progressivity of the personal income tax in income intervals was up to 1.25 times the average wage. It is confirmed that tax progressivity increases with increasing amounts of deductions, as evidenced by the results for situation S_2. In particular, the deduction for children, which has been in the form of a

tax credit since 2005, increases the tax progressivity of taxpayers with below-average wages, as this deduction takes the form of a tax bonus.

Using relation (7), the degree of similarity in developing tax progressivity in 1993-2007 and 2008-2020 will be verified.

This similarity in the development of progressivity will be verified again for all three mentioned situations S_0, S_1 and S_2, which differ in the scope of applied deductions. For these stated situations, Fig. 5a-5c shows 2 regression lines. The first regression line, linear PTO1, shows the dependence between the income interval and the progressivity values in 1993–2007. The second regression line, linear PTO2, shows the dependency between the income interval and the progressivity values in 2008–2020.

The angle the regression lines enclose is 21°38' for S_0 (see Figure 5a). This fact indicates a moderate dependence between the developments of tax progressivity in both analysed periods. What is common to both periods is higher progressivity in income intervals up to the amount of the average wage.

For the S_1 situation (Figure 5b), when the deduction for one child is also applied, a lower degree of tax progressivity in 1993–2007 also results in an interval of up to 1.25 times the average wage. On the contrary, the indicator PTO takes on higher values in intervals above 1.25 times the average wage in 1993–2007. Compared to situation S_0, the angle between the regression lines PTO1 and PTO2 is 1°76', indicating a very close dependence between the two regression lines. Thus, in situation S_1, the differences in tax progressivity are the lowest in both analysed periods. It is confirmed that the tax progressivity also increases due to the higher number of applied deductions.

The lowest degree of dependence between the regression lines shows the development of tax progressivity depending on the income level in situation S_2. In this situation, the deduction is also applied to two children (Figure 5c). The angle takes on a value of 22°67'. It is confirmed that tax deductions significantly increased tax progressivity, especially in years when the tax rate was linear. Higher tax progressivity is in intervals up to 1.75 times the average wage in 2008–2020.

Figure 5a. Empirical lines of regression

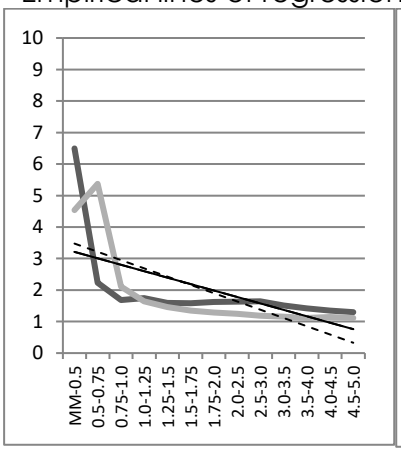


Figure 5b.

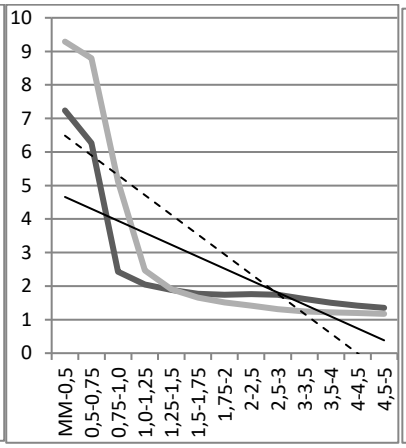
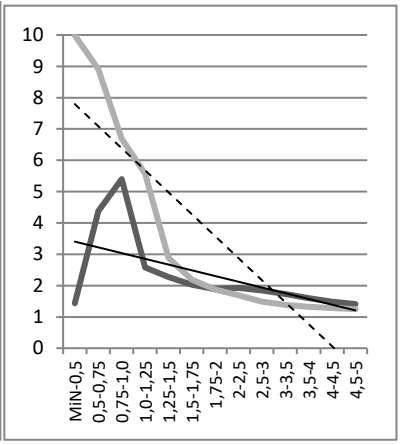


Figure 5c.



PTO1 PTO2 Linear PTO1 Linear PTO2

Note: MM…minimal wage, PTO1 = period 1993–2007, PTO2 = period 2008–2020
Source: Author´s illustration

Conclusion

The article aimed to evaluate the progressivity of personal income tax in the Czech Republic from 1993 to 2020. Another objective was to determine whether income tax

was more progressive when the nominal tax rate was progressive or whether the degree of progressivity was higher when the nominal tax rate was linear.

The personal income tax was progressive throughout the period analysed, with a few exceptions. This was invalid from 2008 to 2012 if the MBSP was exceeded. Taxpayers with an income over this maximum assessment base pay a lower tax on each additional unit of their income, which means that personal income tax is regressive in these income intervals.

Taxpayers with an income close to the minimum wage had the linear character of the tax obligation from 2008 to 2013. In applying the deduction to children, it was found that the income tax was also linear in some intervals below the average wage, even in years when the nominal tax rate was progressive. The weighted values of the indicator PTO, which were calculated based on the distribution of wages in the Czech Republic, confirmed that the degree of tax progressivity increases if taxpayers use more deductions for tax liability reduction. Concerning the weighted values of the indicator PTO, income tax is paradoxically more progressive in years when the nominal tax rate was only linear.

The personal income tax is essential to the state's fiscal policy. The research results confirm that the type of tax rate is not the only factor that depends on whether income tax is progressive. It is important to analyse other personal income tax parameters, such as determining the tax base or the number of deductions in the form of non-taxable parts of the tax base or tax reliefs. All of these factors affect whether income tax is progressive and to what extent it is progressive.

The research was carried out in the conditions of the Czech Republic. Other countries were not included in the study, mainly due to the peculiarity of constructing the tax base until the end of 2020 as a super-gross wage. The construction method of the tax base determined this way was not in other states neighbouring the Czech Republic or other states of the European Union.

About the ongoing tax reform on 1 January 2021, which abolished the super-gross wage, it is possible to carry out another similar study in the future (depending on the availability of data), which may lead to an extension of the period under study. In addition to the change in the structure of the tax base, the tax relief for taxpayers and the tax credit for children also increased in the Czech Republic. Exploring differences in tax progressivity parameters can further expand scientific knowledge in this field.

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Using Fuzzy TOPSIS and Balanced Scorecard for Kaizen Evaluation

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Abstract

Background: Kaizen is a very important continuous improvement technique; however, measuring kaizen results/benefits have not been clearly and comprehensively addressed by the literature. **Objectives:** This paper aims to propose a kaizen measuring system by integrating a Balanced Scorecard (BSC) and a Fuzzy Technique for Order Performance by Similarity to Ideal Solution (Fuzzy TOPSIS). **Methods/Approach:** Three research instruments were distributed to kaizen experts to allocate kaizen benefits into the four BSC perspectives. The best measures of kaizen benefits were determined by employing the Fuzzy TOPSIS technique. **Results:** The results present a kaizen performance evaluation system where the benefits were allocated into the four BSC perspectives, and the best measure for each kaizen benefit was chosen using fuzzy TOPSIS. **Conclusions:** The research contributes to the literature by proposing a kaizen measurement system that will pair each benefit of using kaizen with BSC perspectives and measures, thus expanding the advantages of adopting kaizen to any sector or industry.

Keywords: Balanced Scorecard, Continuous improvement, Evaluation, Fuzzy TOPSIS, Kaizen, Performance measurement.
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Introduction

Organizations have been competing to achieve superior performance. They are pressured to improve their performance and reduce their costs. Thus, the need for continuous improvement in every aspect of the operation is becoming more relevant.

The continuous improvement cycle includes both large improvements—known as innovation— and small improvements, commonly known as kaizen, or as some refer to, "little innovations" (Moore, 2007). Kaizen is a Japanese philosophy of encouraging all organizational levels to implement small improvements continuously to increase the efficiency, effectiveness, and adaptability of the operational process (Imai, 1986; Kumar & Pandey, 2013).

Several studies have attempted to measure innovation and create a benchmark for industries to follow (Hájek et al., 2018). However, when it comes to kaizen, only a few studies have attempted to measure it (Doolen et al., 2008; Gonzalez-Aleu et al., 2018; Liu & Farris, 2008). Unfortunately, no comprehensive measure has been developed because of the multidimensionality of the kaizen process and the intangibility of kaizen results.

As kaizen is implemented in every stage and process in any organization, it makes it very difficult to see its direct effect on the financial performance, as it could be easier to measure the waste and cost reduction. However, when it comes to improving employees' attitudes or increasing their motivation towards improvement, it could not be easy to measure that in financial terms, leading to having different evaluation tools for the same process and results. This makes measuring processes difficult for managerial accountants. Therefore, developing a comprehensive kaizen measuring system is essential for maintaining measurable, successful, competitive, and continuous improvement goals.

Multicriteria Decision Making (MCDM) techniques were employed to represent the direct involvement of decision-makers. The MCDM techniques are commonly used in evaluating management and economic decisions with high uncertainty and vagueness due to human judgments (Chandrahas et al., 2014; Tzeng & Huang, 2011; Wu et al., 2009).

Fuzzy theory is employed to interpret imprecise input by capturing the preference structure of decision-makers. In particular, the Fuzzy Technique for Order Performance by Similarity to Ideal Solution (Fuzzy TOPSIS) is employed with linguistic variables to deal with the concepts' ambiguity associated with subjective human judgments (Chandrahas et al., 2014; Saghafian & Hejazi, 2005; Tzeng & Huang, 2011).

This research proposes a novel approach to kaizen measurement literature by employing the fuzzy TOPSIS technique from the perspective of BSC to find the proper measures for kaizen evaluation.

The rest of this paper is organized as follows. In section 2, the Theoretical background discusses kaizen measurement, BSC for performance measurement, and fuzzy TOPSIS. Section 3 explains the data and research methodology, including benefits allocation in BSC and fuzzy TOPSIS for the selection of measures. Section 4 demonstrates the results. The last section summarises the findings, research limitations, and suggestions for potential future work.

Literature Review

Having presented the kaizen definition and importance in the previous section, this section concerns the literature review, where three subsections will be developed: kaizen measurement, BSC for performance measurement, and fuzzy TOPSIS.

Kaizen Measurement

To implement kaizen, small groups work together to achieve the goals of continuous improvement projects (CIPs). CIPs are defined as "systematic team-based processes, typically with a different background or from different departments, working to improve a process performance metric during a short period, such as days, weeks, or months" (Gonzalez-Aleu et al., 2018, p. 336). Kaizen's main goal is to increase efficiency by reducing costs, timely delivery, and increasing quality to enhance the company's market performance and customer satisfaction (Imai, 1997; Moore, 2007).

Ker and Wang (2015) explored the benefits of kaizen implementation in the healthcare sector that enhanced workflow by reducing the delay time and overall costs while increasing the quality and efficiency of managing healthcare services. Adams et al. (1999) implemented kaizen to eliminate unnecessary tools, machines, workforce, and any source of waste, resulting in reduced capital investment, factory space, and increased profitability.

Other studies (e.g., Bartel, 2011; Farris et al., 2009; Ghicajanu, 2009; Glover et al., 2008; Kumar & Pandey, 2013; Kumar et al., 2018; Nagaretinam, 2005; Thessaloniki, 2006) concluded that organizations can achieve several benefits if they implement the kaizen system effectively. Each study used kaizen for either cost reduction, improving production process efficiency, or both. However, the study of El Dardery et al. (2021) provided a comparison of the literature review related to kaizen benefits and found that the study of Vento et al. (2016) compiled Kaizen benefits mentioned in all previous studies and classified them into economic and human resources benefits, providing the largest, most comprehensive number of kaizen benefits.

Liu and Farris (2008) measured kaizen performance using data envelopment analysis and recommended using fuzzy logic for kaizen measurement in future studies. This study answers Liu and Farris' call by employing fuzzy TOPSIS for measuring and evaluating kaizen benefits, as no previous studies have designed a comprehensive evaluation system of kaizen benefits. Kaplan and Norton (2001) explained that traditional accounting measures are inappropriate for decision-making as they do not explicitly associate financial and non-financial results. Thus, the study employed a balanced scorecard framework to integrate financial and non-financial measures of kaizen.

BSC for Performance Measurement

Performance measurement is the process of periodic quantification of the effectiveness and efficiency of an action. It also reports the results to decision-makers to implement strategies and support decision-making (Raval et al., 2019). Having a continuous improvement process requires that cost management systems be more flexible and comprehensive. BSC balances the usage of quantitative and qualitative measures (Hájek et al., 2018) and integrates internal and external measures for performance evaluation (Raval et al., 2019) for strategic decision-making (Jassem et al., 2021).

Kaplan and Norton introduced BSC in the 1990s as a comprehensive measure to replace the financial measure, which focuses only on past performance without considering intangible values (Jassem et al., 2021; Kaplan & Norton, 1992; Taticchi & Balachandran, 2008). BSC improves competitiveness and enhances long-term profitability (Kaplan & Norton, 1993; Liu et al., 2014), as it depends on a set of cause-and-effect relationships (Bremser & Barsky, 2004).

BSC categorizes organizational strategies into four perspectives. The financial perspective concerns cost evaluation, return on investment (ROI), and revenue growth. The Customer/Stakeholder perspective measures customer profitability,

satisfaction, and retention rate. The Internal Business Process perspective is related to measuring organizational internal changes to achieve its objectives. The fourth perspective is Learning and Growth, which measures employee performance enhancements, routine processes, skills, and training (Kalender & Vayvay, 2016).

BSC can be used for different measuring purposes. Raval et al. (2019) developed a BSC-based framework to identify the adoption of lean Six Sigma performance measures, while Wu et al. (2009) employed BSC with fuzzy MCDM to evaluate banking performance. Moreover, Hájek et al. (2018) used BSC and fuzzy TOPSIS to evaluate innovation performance, while Parsa et al. (2016) used BSC and fuzzy TOPSIS to evaluate the performance of national Iranian gas companies.

In response to the limitations of previous studies of not having a comprehensive kaizen measurement, this study aims to develop a comprehensive measurement system necessary to help managers quantify the outcomes of kaizen practices. Thus, the first research question can be stated as follows:

- *RQ1: How can kaizen benefits be allocated into BSC perspectives to frame a comprehensive kaizen evaluation system?*

Fuzzy TOPSIS

Decision-making is determining the best option out of the different alternatives where the judging criteria for those alternatives are available. For most issues, decision-makers want to make multiple-criteria decisions (Roudini, 2015; Saghafian & Hejazi, 2005). TOPSIS is an MCDM technique proposed by Hwang and Yoon (1981) to help objectively evaluate alternatives (Tzeng & Huang, 2011; Kore et al., 2017).

Unlike the analytic hierarchy process (AHP), TOPSIS allows the use of an unlimited number of alternatives and criteria in the decision-making process, and its simplicity made it one of the most frequently used MCDM techniques (Chandrahas et al., 2014; Hájek et al., 2018; Wu et al., 2009). Additionally, fuzzy TOPSIS has been extensively used in judgmental decision-making cases and has proven effective when dealing with vague, imprecise information (Yaakob, 2017).

TOPSIS is based on compensatory aggregation by applying weights to each criterion in a set of alternatives to compare those alternatives. The chosen alternative is the one that has the shortest geometric distance to the positive ideal solution (PIS) and the longest geometric distance to the negative ideal solution (NIS) (Arif-Uz-Zaman, 2012; Kore et al., 2017; Saghafian & Hejazi, 2005; Wu et al., 2009). In TOPSIS, the weights for criteria are known, but in real-life scenarios, they are not. Therefore, using linguistic rather than numerical values is more appropriate. Linguistic values may include low, medium, and high values.

Fuzzy set theory measures concepts' vagueness associated with the subjectivity of human judgments (Saghafian & Hejazi, 2005; Tzeng & Huang, 2011). As a result, using fuzzy numbers to analyze the criteria simplifies the evaluation process, as criteria are mostly incompatible. For fuzzy numbers, a conversion scale is used to transform linguistic terms into fuzzy numbers. A scale of 1 to 5 is commonly used for rating alternatives and weighing criteria. The intervals within the scale are chosen to have a unified representation from 1 to 5 for fuzzy numbers. For example, the five-point linguistic terms can be translated to fuzzy numbers, as in Table 1 (Arif-Uz-zaman, 2012; Awasthi et al., 2010; Govindan et al., 2013; Kore et al., 2017).

Table 1
Fuzzy Numbers for Linguistic Variables

Linguistic Alternatives	Linguistic Weights	Fuzzy Number
Strongly Disagree	Not Important	(1,1,3)
Disagree	Less Important	(1,3,5)
Neutral	Medium Important	(3,5,7)
Agree	Important	(5,7,9)
Strongly Agree	Very Important	(7,9,9)

Source: Arif-Uz-zaman (2012); Awasthi et al. (2010); Govindan et al. (2013); Kore et al. (2017)

The complex and vague nature of assessing performance indicators is why fuzzy techniques are integrated with BSC (Hájek et al., 2018). The four perspectives of BSC are considered equal weights as they are equally important and interdependent, as the performance in one perspective will affect the performance in other perspectives (Kaplan & Norton, 1992). As a result, the second research question can be stated as follows:

- *RQ2: How to determine the measures of each kaizen benefit and define the best measure for each benefit using Fuzzy TOPSIS to reach a comprehensive system to evaluate kaizen performance in organizations?*

Methodology

Research instruments

To achieve the objective of this paper, three research instruments were designed and distributed over the two stages of the study, targeting a sample of kaizen experts. An expert/judgmental sample is based on choosing experienced individuals in a certain area of interest (Singh, 2007), practising kaizen, and knowing its measurement process.

In the first stage, the first and second research instruments were designed. The first research instrument was used to answer the first research question and allocate the kaizen benefits selected from the literature review (Vento et al., 2016) to the four perspectives of BSC. A pilot study was conducted over one month in June 2021, and the feedback was used to make a few minor adjustments, such as adjusting the education level to include high school, as some Japanese workers have not obtained higher degrees. Also, definitions were added to the four BSC perspectives, and the kaizen performance question was adjusted to include the option of practising kaizen as a daily activity, as this is common in Japan.

The research instrument was then distributed among experts in kaizen to guarantee accurate results for allocating benefits and to collect proper kaizen benefits measures based on actual work experience. The research instrument, including LinkedIn, kaizen websites, and emails, was distributed online. The responses were collected over four months, targeting kaizen experts. There were 11 responses removed from the final sample for not passing the manipulation check question related to familiarity with kaizen practices. Thus, the final number of experts included in the sample of research instrument one was 69 respondents.

The second research instrument was designed to answer the part of the second research question related to determining the measures of each kaizen benefit. It includes all the measures previously collected through the first research instrument based on experts' actual usage to refine the measures before using them in the third research instrument. The research instrument was distributed via different online

means over two months, and the final number of experts included in the sample of research instrument two was 17 respondents.

In the second stage, the third research instrument was designed to obtain data for weighing the importance of each kaizen benefit and ranking the measures of each benefit. These weights and ranks were used in fuzzy TOPSIS analysis. There were a limited number of respondents for this research instrument as not only kaizen experts were needed, but also a concise selection of data sources was required.

Sample

Previous studies related to TOPSIS used expert samples ranging from 3 to 30 experts. In contrast, the study of Wu et al. (2009) depended on the opinion of 12 experts, and Yaakob (2017) depended on 3 experts' opinions only, while Roudini (2015) and Dang et al. (2019) depended on the opinion of 10 experts. Finally, the study by Abbassinia et al. (2020) relied on the opinion of 30 experts. This study will depend on the opinion of 15 experts for the fuzzy TOPSIS analysis from the research instrument data collected over one month.

Fuzzy TOPSIS process

The steps of the fuzzy TOPSIS process are as follows (Parsa et al., 2016; Salih et al., 2019; Tavana et al., 2020):

First, the linguistic answers are converted into numbers, as in Table 1, to construct the decision matrix of alternatives (the measures for each benefit in this case). To clarify that, assume an expert group has K decision makers and ith benefit on jth measures. There are three to five measures (Collected via research instrument one, refined by research instrument two) for each of the 23 benefits mentioned in the study of Vento et al. (2016), and 15 experts/decision-makers, namely DM1 till DM15.

For a decision-making matrix, if $\tilde{x}$ denotes the linguistic terms for each measure, and a vector of three numbers represents each linguistic term for fuzzification, namely (a_{ij}, b_{ij}, c_{ij}), as seen in Table 1, then:

$$\tilde{x} = (a_{ij}, b_{ij}, c_{ij})$$

$$DM = \begin{bmatrix} a_{11}^1 & b_{11}^1 & c_{11}^1 \\ \vdots & \vdots & \vdots \\ a_{ij}^k & b_{ij}^k & c_{ij}^k \end{bmatrix} \qquad Decision - Making\ Matrix\ (1)$$

Second, the criteria weights from the rankings of benefits' importance as in Table 1. Afterwards, the combined decision matrix and the combined weighted matrix are constructed by getting the minimum value of first place among all members, then the average of values of the middle place, and finally, the maximum value of last place.

$$a_{ij} = \min_k\{a_{ij}^k\}, \qquad b_{ij} = \frac{1}{K}\sum_{k=1}^{K} b_{ij}^k, \qquad c_{ij} = \max_k\{c_{ij}^k\} \qquad for\ the\ decision\ matrix\ (2)$$

$$w_{j1} = \min_k\{w_{j1}^k\}, \quad w_{j2} = \tfrac{1}{K}\textstyle\sum_{k=1}^{K} w_{j2}^k, \qquad w_{j3} = \max_k\{w_{j3}^k\} \qquad for\ the\ weights\ matrix\ (3)$$

Third, the normalized decision matrix is computed for the 23 benefits depending on the nature of each benefit, as some benefits need to be maximized, such as 'increasing profits', while others need to be minimized, such as 'cost reduction'.

$$\widetilde{r_{ij}} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right) \quad and c_j^* = \max_i\{c_{ij}\} \qquad for\ the\ benefit\ criteria \quad (4)$$

$$\widetilde{r_{ij}} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right) \quad and\ a_j^- = \min_i\{a_{ij}\} \qquad for\ the\ cost\ criteria \quad (5)$$

Fourth, the weighted normalized fuzzy decision matrix is computed by multiplying the normalized decision matrix by the combined weighted matrix.

$$\widetilde{v_{ij}} = \widetilde{r_{ij}} \times w_j \quad (6)$$

Fifth, the Fuzzy Positive Ideal solution (FPIS) and Fuzzy Negative Ideal (FNIS) were determined.

$$FPIS \quad A^* = \left(\widetilde{v_1^*}, \widetilde{v_2^*}, \cdots, \widetilde{v_n^*}\right) \quad where\ \widetilde{v_j^*} = \max_i\{v_{ij3}\} \quad (7)$$

$$FNIS \quad A^- = \left(\widetilde{v_1^-}, \widetilde{v_2^-}, \cdots, \widetilde{v_n^-}\right) \quad where\ \widetilde{v_j^-} = \min_i\{v_{ij1}\} \quad (8)$$

Sixth, the distance of each alternative from the FPIS and FNIS was determined.

$$d(\tilde{x}, \tilde{y}) = \sqrt{\frac{1}{3}\left[(a_1 - a_2)^2 + (b_1 - b_2)^2 + (c_1 - c_2)^2\right]} \qquad (9)$$

Seventh, computing the closeness coefficient for each alternative measure.

$$CC_i = \frac{d_i^-}{d_i^- + d_i^*} \qquad (10)$$

Ranking the measures based on their closeness coefficient from the highest to the lowest, where the highest measure is optimal for the benefit criteria, while the lowest measure is optimal for the cost criteria.

Results

The following section displays the main results and findings and is divided into preliminary and main analyses for each stage.

Stage One: BSC Framework for Kaizen Benefits Allocation

Preliminary Analysis

Cronbach's Alpha for the first research instrument items was 0.962, considered highly reliable (Omoush et al., 2020; Tsao et al., 2015). The Kaiser-Meyer-Olkin measure was used for sample adequacy to determine the variation percentage, and the resulting value was 0.791; Bartlett's sphericity significance test was 0.000 (Bartlett, 1954; Kaiser, 1974).

The sample descriptive statistics show that 55% of the respondents were from Egypt, while 45% were from Japan and other countries. The sectors covered included Manufacturing, Oil & Gas, Healthcare & Medicine, Real estate & Construction, Communications and information technology, Transportation and shipping services, educational services, Food, drinks, and tobacco. The final sample size was 69

participants, as mentioned before. Egypt was selected due to the recent attention from the industry and government towards implementing continuous improvement activities to achieve the SDGs. Moreover, it has been making progress in adopting kaizen with the help of JICA (GRIPS Development Forum, 2009). Also, kaizen has been recently introduced in the hospital sector (Ishijima et al., 2019). As for Japan, it was selected as the benchmark for kaizen best practices.

Main Analysis

The allocation was conducted by calculating the frequency of each benefit in each perspective; additionally, as a confirmation, the mode of each perspective was calculated. The perspectives were ranked 1 for Financial, 2 for Customer/ Stakeholder, 3 for Internal Business Process, 4 for Learning and Growth, and 5 for none of them (for cases where a respondent did not want to allocate any of the benefits into any of the 4 perspectives) Although the research instrument was disseminated in different countries, there were no significant differences in benefits allocation among countries. Kaizen's economic benefits are shown in Table 2, while human resource benefits are shown in Table 3.

Table 2

Kaizen Economic Benefits Allocation into BSC

Kaizen Economic Benefits (EB)	Final BSC perspective	The perspective with the Highest mode	BSC perspectives Frequencies				
			Financial	Customer/ Stakeholder	Internal business Process	Learning and Growth	Others
Reducing the delivery time	Customer/ Stakeholders	2	21	26	18	2	2
Achieving better economic balance	Financial	1	38	7	11	1	12
Increasing profits	Financial	1	43	10	6	2	8
Reducing production process stages	Internal Business Process	3	20	7	34	5	3
Decreasing failures in equipment and machinery	Financial	1	23	5	21	4	16
Cost reduction	Financial	1	47	6	7	4	5
Reducing operation cycles and design time	Internal Business Process	3	20	5	30	8	6
Productivity increase	Financial	1	26	8	20	5	10
Improving Cash inflows	Financial	1	54	3	6	2	4
Reducing defective products	Customer/ Stakeholders	2	16	18	17	11	7
Reducing movement distances	Internal Business Process	3	16	3	32	7	11
Reducing inventory waste	Financial	1	31	3	18	6	11
Reducing waiting time and materials transport waste	Internal Business Process	3	22	5	26	5	11

Source: Developed by the authors

Table 3
Kaizen Human Resource Benefits Allocation into BSC

Kaizen Human Resource Benefits (HB)	Final BSC perspective	The perspective with the Highest mode	BSC perspectives Frequencies				
			Financial	Customer/ Stakeholder	Internal business Process	Learning and Growth	Others
Increasing customer satisfaction	Customer/ Stakeholders	2	6	50	6	3	4
Employees' responsibility and commitment became more visible	Learning and Growth	4	8	8	17	25	11
Reducing accidents from inappropriate work conditions	Internal Business Process	3	10	3	27	11	18
Managers are more motivated to make continuous improvement changes	Learning and Growth	4	6	9	18	28	8
Improving communication between administrative staff	Internal Business Process	3	5	6	32	19	7
Increase employee collaboration.	Internal Business Process	3	6	8	28	14	13
Improvement changes have positively affected individuals	Learning and Growth	4	8	12	8	24	17
The company's employees participate in kaizen activities and/ or construct a new system.	Internal Business Process	3	7	8	20	17	17
Employee turnover has decreased.	Learning and Growth	4	16	7	11	22	13
Employees' self-esteem has increased.	Learning and Growth	4	7	8	11	27	16

Source: Developed by the authors

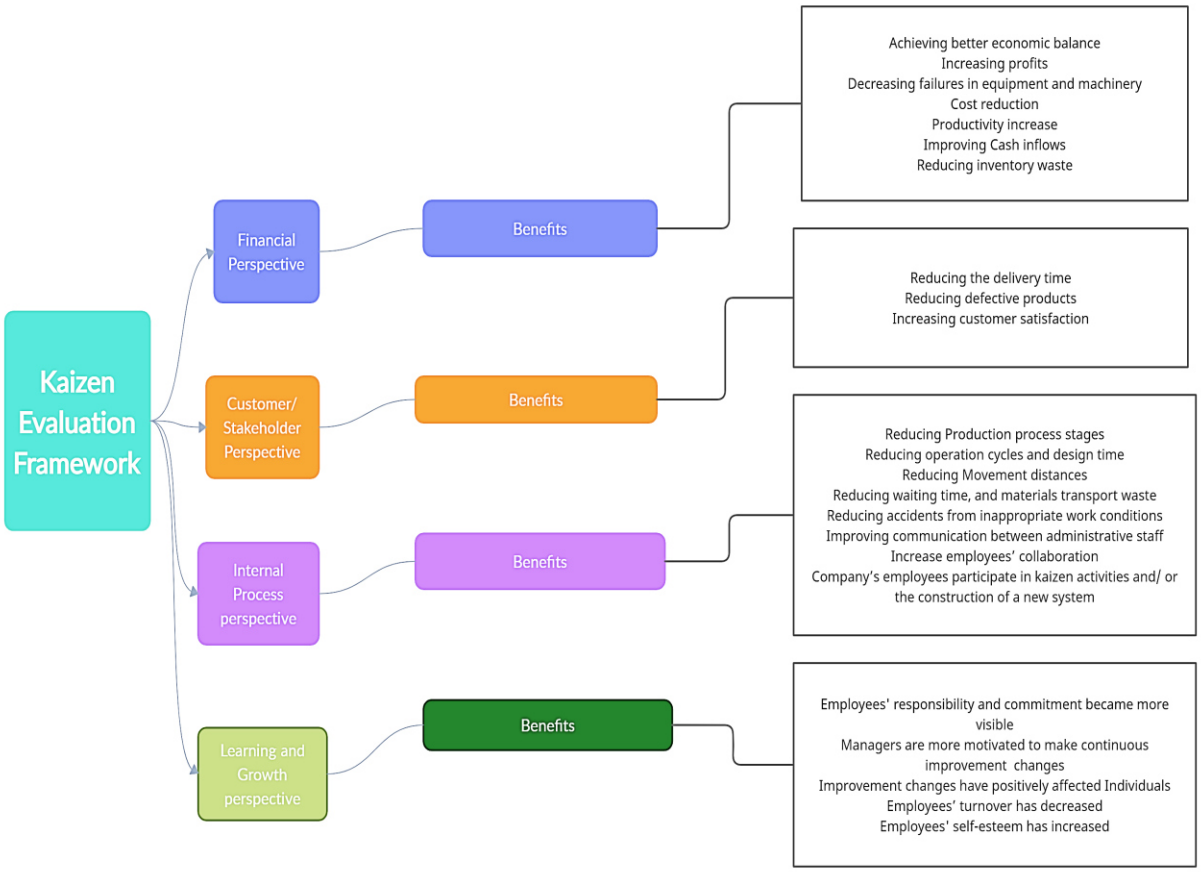
Figure 1 summarises the final allocation of benefits into BSC, where the financial perspective included only economic benefits and the learning and growth perspective included only human resource benefits. This can reflect the nature of the benefits as more related to financial or human aspects. As for the other two perspectives, they included both economic and human resource benefits.

As a result of this research instrument, for the open-ended questions related to adding the measures, it is noticed that for the economic benefits, several measures were provided by the respondents, unlike the human resource benefits, where only a few were mentioned. One possible explanation is that economic benefits can mostly be measured financially. In contrast, human resource benefits are measured by qualitative means, which makes it harder to express them in financial terms (the collected measures are mentioned in Table 4).

Cronbach's Alpha for the second research instrument item was 0.813, considered highly reliable (Omoush et al., 2020; Tsao et al., 2015). This research instrument was distributed via different online means, and the final sample consisted of only 17 who provided full, usable responses. The purpose of this research instrument was to refine the measures of kaizen benefits by asking the respondents to choose or add new measures via open-ended questions. The resulting measures were used to define the final measures for the third research instrument. The respondents were given a set of measures to choose the ones they use and add other used measures if they were not in the options list.

The research instrument results reduced some of the measures of economic benefits while increasing the number of human resource benefits measures. Finally, the 23 benefits had between three to five measures each, totalling 103, as shown in the third column in Table 4.

Figure 1
BSC for Kaizen Benefits Evaluation



Source: Author's Illustration

Table 4
Kaizen Benefits' Measures Collected Via Stage One

BSC Perspectives	Kaizen Benefits (Economic and Human Resources)	Measures Collected via the First Research instrument (Input in 2nd research instrument)	Measures Refined by the Second Research Instrument (Input in 3rd research instrument)
Financial perspective	Achieving better economic balance	1. Decrease process cost 2. ROI 3. IRR 4. financial return 5. Net profit (Profitability increases) 6. Balance of unit price vs. number of inquiries 7. Value stream and business impact	1. Decrease process cost 2. Return on Investment (ROI) 3. Internal rate of return (IRR) 4. Net profit (Profitability increases) 5. Value stream and business impact
	Increasing profits	1. Profit margin, Net profit 2. Monthly expenses 3. Cash revenue collection 4. budget controlling	1. Profit margin, Net profit 2. Monthly expenses 3. Cash revenue collection 4. budget controlling
	Cost reduction	1. Waste reduction 2. Manufacturing cost 3. Cost before vs. after 4. Net profit, Profitability increases, 5. Breakdowns, time off, and stops 6. deviation rates 7. Defect percentage	1. Waste reduction 2. Manufacturing cost 3. Cost before vs. after 4. Net profit, Profitability increases, 5. Breakdowns, time off, and stops
	Productivity increase	1. Material yield, process yield 2. waste reduction 3. Calculation of production quantities/working hours 4. Overall Operations Effectiveness (OOE) 5. Process performance 6. Value Stream 7. The number of products per employee	1. Material yield, process yield 2. waste reduction 3. Calculation of production quantities/working hours 4. Overall Operations Effectiveness (OOE) 5. The number of products per employee
	Improving Cash inflows	1. Inventory cycle cost 2. Automated system 3. Sales volume 4. Profitability increases 5. Monitoring customer behaviour 6. Business Impact	1. Inventory cycle cost 2. Automated system 3. Sales volume 4. Profitability increases 5. Business Impact
	Reducing inventory waste	1. Inventory cost, inventory life cycle 2. For the final product, Calculate the difference between what is produced and what was released to the customer after storing it; for raw materials, Calculate the Quantities of raw materials that were disposed of due to their expiration. 3. Process performance and effectiveness	1. Inventory cost, inventory life cycle 2. For the final product, Calculate the difference between what is produced and what was released to the customer after storing it; for raw materials, Calculate the Quantities of raw materials that were disposed of due to their expiration. 3. Process performance and effectiveness
Customer/ Stakeholders	Reducing the delivery time	1. tracing time 2. Lead time- calculate the timeline 3. delivery time after- delivery time before/delivery time before 4. Number of days before Versus after 5. increase customer satisfaction 6. increase customer orders 7. Reduce customer complaints about the delivery delay	1. tracing time 2. Lead time- calculate the timeline 3. delivery time after- delivery time before/delivery time before 4. increase customer satisfaction 5. Reduce customer complaints about the delivery delay

Customer/ Stakeholders	Reducing defective products	1. Defect percentage (Number of defective parts) = % of defects before VS after 2. Deviation ratios 3. quantities of waste 4. customer satisfaction, 5. Decrease non-conforming 6. Maintenance breakdowns affect the master box production 7. The amount of production per hour with the percentage of waste	1. Defect percentage (Number of defective parts) = % of defects before VS after 2. quantities of waste 3. customer satisfaction, 4. Decrease non-conforming 5. Maintenance breakdowns affect the master box production
	Increasing customer satisfaction	1. Sales transactions 2. sales KPIs 3. Complaint rate (Customer feedback with increased demand) 4. Net Promoter Score (NPS) is a customer loyalty and satisfaction measurement	1. sales transactions 2. sales KPIs 3. Complaint rate (Customer feedback with increased demand market surveys and feedback from customers) 4. Net Promoter Score (NPS) is a customer loyalty and satisfaction measurement. **5. On-Time in Full Delivery (OTIF)**
Internal Business Process	Reducing Production process stages	1. Cycle/s time before Versus after 2. rework reduction 3. Measuring the actual time of each process with the production quantity per hour 4. Takt time (the amount of time an item or service needs to be completed) 5. Process performance 6. Number of processes in production	1. Cycle/s time before Versus after 2. rework reduction 3. Measuring the actual time of each process with the production quantity per hour 4. Takt time (the amount of time an item or service needs to be completed) 5. Process performance
	Decreasing failures in equipment and machinery	1. Mean Time to Failure (MTTF) 2. malfunction record (equipment malfunctions and amount of production Reports every hour or two) 3. Mean Time to Repair (MTTR) 4. Overall Operations Effectiveness (OOE) 5. Failure rate FR 6. Breakdown's time 7. meantime between failure MTBF 8. Overall equipment effectiveness OEE	1. Malfunction record (equipment malfunctions and amount of production Report every hour or two) 2. Mean Time to Repair (MTTR) 3. Overall Operations Effectiveness (OOE) 4. Breakdown's time 5. Overall equipment effectiveness OEE
	Reducing operation cycles and design time	1. Setup time 2. Calculate timeline and lead time 3. Overall equipment effectiveness OEE 4. Project progress & % of adherence to target planned dates 5. Process performance	1. Setup time 2. Calculate timeline and lead time 3. Overall equipment effectiveness OEE 4. Project progress & % of adherence to target planned dates 5. Process performance
	Reducing Movement distances	1. product movement 2. Timesaving % 3. Increase production 4. Process performance 5. Motion Waste reduction	1. product movement 2. Timesaving % 3. Increase production 4. Process performance 5. Motion Waste reduction
	Reducing waiting time and materials transport waste	1. Process yield 2. process cycle 3. calculate wait time 4. Delay Cost reduction 5. Overall equipment effectiveness OEE 6. Process performance	1. Process yield 2. process cycle 3. calculate wait time 4. Delay Cost reduction 5. Process performance

Internal Business Process	Reducing accidents from inappropriate work conditions	1. Records of work stops. 2. No Of injury, the record of work accidents in quality, safety, and occupational health reports 3. industrial security report	1. Records of work stops 2. No Of injury, the record of work accidents in quality, safety, and occupational health reports 3. industrial security report 4. Frequency and severity of accidents 5. Risk Priority Number (RPN)
	Improving communication between administrative staff	1. Reduce wastage in production time 2. Efficiency report	1. Reduce wastage in production time 2. Efficiency report **3. Scrap rate** **4. Interaction in daily meetings reduced the number of problems due to miscommunication.**
	Increase employee collaboration	1. Increase production 2. Processes interactions	1. Increase production/ Productivity 2. Processes interactions **3. Increase Efficiency**
	The company's employees participate in kaizen activities and/ or the construction of a new system	1. The extent of implementation of improvement projects 2. company's reputation 3. Processes review and upgrades 4. Projected sustainability	1. The extent of implementation of improvement projects 2. company's reputation 3. Processes review and upgrades 4. Projected sustainability **5. Audit plan**
Learning and Growth	Employees' responsibility and commitment became more visible	1. Employees efficiency 2. Increase production	1. Employees efficiency 2. Increase production **3. Achieving KPIs** **4. Performance appraisal**
	Managers are more motivated to make continuous improvement changes	1. Efficiency Report 2. Objectives achievement	1. Efficiency Report 2. Objectives achievement **3. Planning VS actually** **4. Cost reduced in terms of wastes (time, movements, scrap, rework)** 5. **Quality enhancement**
	Improvement changes have positively affected Individuals	1. Increased profit 2. Continuous improvement, especially in product quality 3. Employment turnover rate	1. Increased profit 2. Continuous improvement, especially in product quality 3. Employment turnover rate
	Employee turnover has decreased	1. Increase operations efficiency. 2. The empathy of Understanding Issues, Solutions, and Disagreements 3. Resignations 4. Employment rate	1. Increase operations efficiency 2. The empathy of Understanding Issues, Solutions, and Disagreements 3. Resignations 4. Employment rate
	Employees' self-esteem has increased	1. Employees are Thinking in Harmony about Improvements & Safety 2. Learning Curve increase 3. Resignation's rate	1. Employees are Thinking in Harmony about Improvements & Safety 2. Learning Curve increase 3. Resignation's rate

Note: The newly added measures resulting from 2nd research instrument are in bold
Source: Developed by the authors

Stage Two: Fuzzy TOPSIS Analysis for A Comprehensive Kaizen Evaluation System

Preliminary Analysis

Cronbach's Alpha for the third research instrument item was 0.953, which is considered highly reliable (Omoush et al., 2020; Tsao et al., 2015). This research instrument targeted a small group of experts, and the final sample included 15 kaizen experts.

Main Analysis

The experts were asked to rank the importance of kaizen benefits from not important to very important using a five-point Likert scale and choose the measures that they agreed on through a five-point Likert scale from strongly disagree to strongly. The responses were analyzed using the seven fuzzy TOPSIS equations on Microsoft Excel, previously mentioned. The results of this analysis are mentioned in the final measures in Table 5.

Table 5
Final Measures

BSC Perspectives	Kaizen Benefits (Economic and Human Resources)	Final Selected Measures Using Survey 3 Results, Analyzed by Fuzzy TOPSIS
Financial perspective	Achieving better economic balance	Net profit (Profitability increases)
	Increasing profits	Profit margin, Net profit
	Cost reduction	Cost before vs. after
	Productivity increase	Waste reduction
	Improving Cash inflows	Profitability increases
	Reducing inventory waste	Inventory cost, inventory life cycle
Customer/ Stakeholders	Reducing the delivery time	Lead time- calculate the timeline
	Reducing defective products	Quantities of waste
	Increasing customer satisfaction	On-Time in Full Delivery (OTIF)
Internal Business Process	Reducing Production process stages	Takt time (the amount of time an item or service needs to be completed)
	Decreasing failures in equipment and machinery	Malfunction record (equipment malfunctions and amount of production Report)
	Reducing operation cycles and design time	Calculate timeline and lead time
	Reducing Movement distances	Timesaving %
	Reducing waiting time and materials transport waste	Calculate wait time
	Reducing accidents from inappropriate work conditions	Frequency and severity of accidents
	Improving communication between administrative staff	Efficiency report
	Increase employee collaboration	Increase production/ Productivity
	The company's employees participate in kaizen activities and/ or the construction of a new system	The extent of implementation of improvement projects
Learning and Growth	Employees' responsibility and commitment became more visible	Achieving KPIs
	Managers are more motivated to make continuous improvement changes	Quality enhancement
	Improvement changes have positively affected Individuals	Increased profit
	Employee turnover has decreased	Increase operations efficiency
	Employees' self-esteem has increased	Learning Curve increase

Source: Developed by the authors

Discussions on the relevant kaizen benefits and measures for each BSC perspective are presented below. The research findings showed that the relevant kaizen benefits from ***the financial perspective*** included achieving better economic balance, increasing profits, and improving cash inflows. The increase in profitability can measure these benefits. Decreasing failures in equipment and machinery can be measured by tracing the malfunction record. Cost reduction is measured by comparing costs before and after each kaizen event. The reduction in waste measures productivity

increase. Reducing inventory waste is measured by monitoring inventory cost and inventory life cycle.

The customer/stakeholders' perspective included the following benefits: reducing the delivery time, measured by calculating timeliness and lead time; reducing defective products, measured by quantities of waste before and after kaizen; and finally, increasing customer satisfaction, measured by On Time in Full Delivery (OTIF).

The benefits from ***the internal business process perspective*** include reducing production process stages, which was measured by calculating the takt time. Another benefit is reducing operation cycles and design time by calculating timeliness and lead time for operations. Moreover, one of the benefits is reducing movement distances measured by the percentage of timesaving. Additionally, reducing waiting time and materials transport waste is one of the benefits, which was measured by calculating the wait time. Another benefit was reducing accidents from inappropriate work conditions, measured by the frequency and severity of accidents. Also, some of the other benefits include improving communication between administrative staff measured by monitoring the changes in the efficiency report, increasing employees' collaboration measured by the increase in productivity, the company's employees' participation in kaizen activities, and/or the construction of a new system measured by the extent of implementing improvement projects.

The learning and growth perspective included the following benefits: improvement changes, which have positively affected Individuals, were measured by the increase in profit. Another benefit is that employees' responsibility and commitment became more visible, measured by achieving KPIs. Also, managers are more motivated to make continuous improvements measured by quality enhancement. Benefits also include decreased employee turnover, measured by increasing operations efficiency. The final benefit is that employees' self-esteem has increased, which was measured through the increase in the learning curve.

Conclusion

This research proposes a kaizen measurement system by integrating BSC and fuzzy TOPSIS. Kaizen benefits and measures allocation into BSC perspectives (financial, customer/stakeholder, internal business process, and learning and growth) will help managers make better strategic and operational decisions.

The research problem was to close the gap of not having a defined kaizen measure, hence introducing a kaizen measurement system. Using one of the MCDM techniques, namely fuzzy TOPSIS with BSC, three survey research instruments were implemented firstly to allocate kaizen benefits into BSC perspectives; secondly, to define kaizen measures from the practitioners' perspective; and finally, the last research instrument was to determine the importance of each benefit and rank their measures to be used as an input in fuzzy TOPSIS to reach the optimal measure of each benefit.

In summary, the managerial decision-making process depends on the quality of performance evaluation to gain sufficient knowledge about the strengths and weaknesses of different processes. Performance evaluation of kaizen activities was, till recently, directed with little attention as studies focused on measuring kaizen without integrating all possible kaizen measures into a measurement system. Gathering the benefits and measures under a BSC framework will help systematically evaluate kaizen performance. It will facilitate the selection of better kaizen activities from different alternatives. Finally, it will guarantee the sustainability of successful kaizen activities and enhance the kaizen evaluation process from the managerial accounting perspective.

Although the previously mentioned measures are comprehensive and should cover all kaizen activities implemented for different purposes, one limitation of this research is not being able to generalize the results due to the nature of the study. One important contribution of this research is using fuzzy TOPSIS and BSC to frame the set of kaizen benefits measures. However, there is still more to do, and future studies may extend this research firstly by testing the designed system in a specific industry or sector to validate its holistic and secondly by comparing the results of this BSC-fuzzy TOPSIS measurement with other MCDM techniques. Finally, testing the collected measures through other empirical studies.

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Assessing the Appraisal of Research Quality in Social Sciences and Humanities: A Case Study of the University of Montenegro

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Abstract

Background: A noteworthy attempt has recently been made to extend the same or analogous evaluation criteria traditionally employed in natural and technical sciences to social sciences and humanities domains. However, this endeavor has sparked considerable reactions among researchers, leading to robust discussions and debates. **Objectives:** This research aims to describe the scholars' perception of the research quality evaluation in Montenegro's social sciences and humanities. **Methods/Approach:** Focus-group interviews in which 25 interlocutors from various fields of social sciences and humanities were used. The participants discussed the given topic in five focus group interviews and were prompted by questions that specified the topic. **Results:** Different perceptions occur within the social sciences and humanities and are visible within individual areas. Respondents think that the current way of evaluating the results of research work in social sciences and humanities ignores the specificities of research methodologies and practices. **Conclusions:** The respondents show a common element of perception, i.e., that the research quality evaluation in the social sciences and humanities must be multidimensional, meaning that it must include the necessary indicators adjusted to concrete research field as much as possible but also contain agreeably qualitative criteria.

Keywords: social sciences and humanities; research quality; research quality perception; qualitative vs. quantitative evaluation

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Introduction - Statement of the problem

Evaluation of the quality of scientific research in the social sciences and humanities (SS&Hs) has become one of the issues that cause significant interest in the international community of researchers (Moed, 2005). Some research institutions are particularly committed to defining quality indicators and are trying to implement a bottom-up approach by adjusting the opinions of social and humanities researchers (Ochsner et al., 2014). There are often situations in which the method of evaluating the quality of research in the natural and technical sciences is mirrored in SS&Hs, which induces radical changes in research methodologies and in the practice of publication. In this regard, *The Leiden Manifesto* for research metrics (Hicks et al., 2015) suggests that quantitative indicators must be applied cautiously, under the nature and character of the research, as well as the most frequent usage of research work and its publication in each field.

Part of the problem is that modern ways of scientific communication and related new practices of the so-called visibility and competitiveness of universities and researchers mainly recognize mechanisms in which natural and technical science achievements are compared. Impact factors, h-indexes, and other scientometric parameters were formulated and derived from the practice of sciences in these fields. In contrast, SS&Hs do not have or do not recognize sufficient compatibility with the previously mentioned scientometric parameters. They strongly depend on qualitative evaluation (peer review) and are reserved for quantification in the research assessment.

The situation in European developing countries is even more critical for SS&H researchers. Notably, the subject of research evaluation is not significantly examined in this region (Grančay et al., 2017). For instance, in Serbia, as found by Urošević and Pavlović (2013), the research evaluation system produces a clear demotivating effect on researchers working in the social sciences. Moreover, Grančay et al. (2017) found that some researchers (in economics) from ex-communist countries publish mainly in local or "predatory" journals intending to achieve the conditions for academic advancement. In the same vein, Pajić (2015) concluded that the policies of European developing countries are too formal and more oriented towards the quantity than the quality of publications.

In 2016, the academic and scientific promotion criteria were adopted in Montenegro. Therefore, the empirical research presented in this paper was conducted in 2019, and the discussion in this study refers to the criteria adopted before that year. These criteria foresee significant changes compared to the previous one from 2004 in evaluating the quality and quantity of research work, which many scientists from the SS&H have not positively assessed. New rules for doctoral studies are defined along with the criteria based on the same principles that form the criteria. Debates and discussions on both critical documents were widespread.

To define an acceptable evaluation framework for SS&H, it is necessary first to empirically analyze the opinions and attitudes of members of relevant communities. The primary focus of this article is to examine previous literature and the opinions of relevant communities to identify suitable policy implications. Additional background to the evaluation in SS&H is presented in Section 2. In Section 3, we introduce the qualitative methodology. Section 4 presents the analysis findings, while Section 5 presents a discussion and concludes this paper.

Literature Review

Numerous scholars have discussed the various aspects of this complex topic regarding the evaluation of SS&H (Nederhof, 2006; Giménez-Toledo & Román-Román, 2009; Engels et al., 2012; Ochsner et al., 2012; Giménez -Toledo et al., 2013; Ochsner et al., 2013; Gogolin et al., 2014; Ochsner et al., 2014; Hicks et al., 2015; Grosu et al., 2022; Janinovic et al., 2020). As determined by Ochsner et al. (2016), existing procedures for evaluation "do not include an explicit understanding of quality" (p. 44) in the field of humanistic studies, to a significant extent in social sciences (Hicks et al., 2015; Zuccala, 2012), and especially in inter- and trans-disciplinary areas of research for which evaluation procedures need to be created (Belcher et al., 2016; Nagy, 2016; Hunady et al., 2017; Pejić Bach et al., 2023; Šuštaršić et al., 2022; Dubreta, 2014). A quantitative way of evaluating research becomes dominant, although extensive studies indicate that the indicators have "a weak theoretical link to quality" (Brooks, 2005, p. 1).

This topic is present worldwide (Hazelkorn, 2011). Still, a relatively small number of studies aim to construct a network of indicators, i.e., a particular matrix for assessment in social and humanistic sciences. Exceptions, such as the Swiss project (Ochsner et al., 2012; Ochsner et al., 2013; Ochsner et al., 2014; Perić et al., 2013) that focused on establishing a complex and thorough assessment matrix for humanistic sciences are very rare.

The assessment of the quality of research work in natural and technical sciences has long reached consensus in the international community and is accepted by researchers, with many parameters and indicators being followed, tested, and reviewed (Hicks et al., 2015; Moed, 2005). This is entirely expected regarding the nature of research in these sciences, the multi-decade practice, and the so-called linearity in producing scientific knowledge. However, such a framework is lacking in SS&Hs.

The SS&Hs are attributed to the same or similar natural and technical sciences measurements without different quality assessment measures. This is promoted and supported by internet services, such as databases and other tools with which numerous research data sources are stored in electronic form and easily accessible for numerous calculations and analyses. Hazelkorn (2011) points to the development of such a vision of using indicators and, in particular, on the scientometric boom.

Many universities interested in global visibility and position on international rankings apply similar metric qualifications through benchmarking in researcher ranking to all groups of science: natural, social, and humanistic (Hazelkorn, 2011; Hicks et al., 2015). This often provokes strong disapproval on the part of researchers from the SS&Hs, and they raise many reasons that are opposed to such a unification of different sciences (Stack, 2016), which in some cases may lead to the disappearance of research fields (McGettigan, 2013). The following assumption is of particular significance:

> Psychology, psychiatry, and other social sciences related to medicine, health, and economics are more similar to science fields and show good yet not excellent ISI coverage. Other social sciences, including sociology, political science, education, and anthropology, tend to show more resemblance to the humanities, where ISI coverage is moderate (Moed, 2005, p. 148).

Such conclusions of the scientometrists should be one of the bases for defining the matrix that will evaluate the quality of research in SS&Hs. Under the term 'the matrix', in this paper, we mean the network of assessment elements (What is assessed?) and the corresponding quality indicators (What achievements are expected? and/or What is the expected level of achievement?).

In addition, the nature of the research process – concretized through appropriate methodology – must also influence the quality of the research. *The Leiden Manifesto for Research Metrics* (Hicks et al., 2015) emerged. Its authors cite ten principles that

must be respected in each assessment research to avoid using scientometric parameters incorrectly or contrary to their real meaning and significance.

The application of quantitative indicators causes different reactions among researchers. Some are completely adapted to the new assessment method (mostly those whose research is "more related" to the sciences that most often use quantitative methodology based on statistics). At the same time, many do not agree with strictly quantitative ways of evaluating their research work and perceive a serious threat in quantification (Hazelkorn, 2011; McGettigan, 2013). Between these two extremes, there is a whole range of researchers who are not exclusive and open to changing the way of evaluation but doing so in a manner that would respect the specifics of the sciences in which they are involved. The experiences of colleagues in sciences may and must be used, but this does not mean literally taking over (or even imposing!) parameters that are not essentially compatible with the nature of the research process in SS&Hs. In this regard, "It must be noted that even within a single subfield, different approaches or paradigms may reveal different publication and referencing characteristics" (Moed, 2005, p. 149). In other words, a one-size-fits-all approach does not fit at all for research evaluation.

Differences in research methodology and constructing knowledge between natural and technical sciences, on the one side, and SS&Hs, on the other, must also be reflected in evaluating research work and its results. Some of the most discussed differences are:

Nature of knowledge process - nonlinear vs linear knowledge. Researchers in the sciences necessarily rely directly on the state of the art in their field of study (Archambault et al., 2006) because building the knowledge system is linear. In the SS&Hs, the situation is not necessarily like that because these sciences develop many parallel paradigms, which are simultaneously valid. Research suggests a great deal of difference in the age of references in natural or SS&Hs (Glänzel & Schoepflin, 1999), which is directly related to the way of the production of knowledge.

Individual vs. team research. While the natural sciences are strongly associated with large-scale laboratories and teamwork, the SS&Hs are more individual and for smaller groups of researchers (Hellqvist, 2010). With that in mind, monodisciplinary or interdisciplinary research concepts are also directly related. Teamwork becomes more efficient when interdisciplinary, while individual research is almost necessarily monodisciplinary. Finkenstaedt (1990) highlights the individual nature of research in the humanities as an essential factor influencing the slowdown in the quantitative assessment of research quality. The number of authors involved in the research is directly reflected in the impact of this research (Glänzel & Schubert, 2004). It is not realistic, for example, to expect that the same or nearly equal number of citations be accomplished from research conducted by an individual in comparison to the research conducted by a few hundred scientists (such studies are often in Physics, for example). Individuality in research necessarily leads to lower productivity. With social sciences, the situation is somewhat different, and research in smaller teams is more common.

Publication in English or national languages. Humanities researchers often call this group of sciences an identity one, and social researchers are oriented toward specific societies and their problems. These scientists are particularly committed to publishing in national languages because they want to preserve, develop, and study them. In addition, these scholars consider it their duty to make a difference in a specific society and to publish for that society in the community language (Hicks et al., 2015). Nederhof et al. (1989) associate these differences with the local orientation of SS&Hs. Bibliometric indicators are critical for assessing international influence but are not a

sufficient indicator of the quality of research (Nederhof et al., 1989). This is also the third principle of *The Leiden Manifesto*: "Protect excellence in locally relevant research" (Hicks et al., 2015). For example, *The Leiden Manifesto* states an absurd situation in which Spanish sociologists used American data to publish in highly quoted journals in WoS, which are dominantly published in the U.S. in English. Research shows that more and more researchers accept this practice (Engels et al., 2012).

Type of publication. Researchers in the natural sciences are more oriented toward publishing in scientific journals, while others are more focused on writing books. Glänzel and Schoepflin (1999) point out that quality indicators must consider the different characters of publications, serial and monographic. Hemlin (1996) found some similarities in publishing research papers in the SS&Hs and differences in publishing frequency. Giménez-Toledo and Román-Román (2009) estimate the possibilities of evaluating monographs; the publisher's estimation does this, but in the continuation of the research of the book evaluation, it is emphasized that the best way to evaluate is reading the publication itself (Giménez-Toledo et al., 2013). However, some research confirms the change in the publication of research in the SS&Hs in international databases (Engels et al., 2012), whereby social sciences adapt faster to journalistic requirements than the humanities do.

Quantitative vs. qualitative research methodology. The evaluation of research quality must align with the nature of the research methodology, which is based on the essence of the phenomena that specific sciences deal with and which is reflected in the way of publication. The natural and technical sciences are predominantly investigated in laboratories, so the experiment is an appropriate method. Some social sciences are prone to a quantitative research approach, which directly corresponds to the levels of measurement available to them. For example, sports science has the possibility of direct measurements, which reflects the overall methodology of scientific research work, primarily quantitative and used with the most reliable methods of parametric statistics (Fraenkel et al., 2012). Economic sciences also use direct measurements and calculations; econometrics has been developed, and the same thing can be said for psychology – psychometry has wide usage. Very different in this respect are sciences such as sociology, educational sciences, etc., in which rare direct measurements and qualitative methodology have been developed equally with the quantitative (Moed, 2005; Swygart-Hobaugh, 2004). In recent decades, through a general belief in quantification, qualitative research has been actively marginalized (Gogolin et al., 2014; Swygart-Hobaugh, 2004). This leads to an unwanted reduction of poly-methodism to mono-methodism (Chatterji, 2008; Elliott, 2001; Howe, 2004). The qualitative methodology with interpretative and critical abilities is equivalent to the humanities (Hemlin, 1996), where many papers are written without a specific explanation of research methods (Lamont, 2009).

It is evident that the SS&Hs themselves are not homogeneous, and their distinction from natural or technical areas is considerably higher, and that it is practically absurd to compare one science to others. However, some common elements should be found within the social and/or humanistic sciences. In each research study, however, it is evident that common quality indicators are difficult to attain even in relatively related scientific areas, such as the educational sciences (Gogolin et al., 2014).

All these factors essentially shape the research itself, directly reflected in the individual work's quality evaluation (and impact). Numerous studies have shown that the use of ISI Citation Indexes in the SS&Hs must be made in a fundamentally different way concerning their application in natural and technical sciences (Bridges, 2009; Glänzel, 1996; Hazelkorn, 2011; Hicks, 2004; Hicks et al., 2015; Lewison, 2001; Nederhof & Zwaan, 1991; Nederhof & van Raan, 1993; Nederhof, 2006).

The main question is which type of evaluation to use: quantitative assessment, qualitative (informed peer review), or, possibly, some combination of both. Besides, it is important to develop appropriate quantitative measurements for specific fields. Donovan (2007) points out that using only quantitative parameters to evaluate research quality in the SS&Hs is impossible. This is important because the concepts of research orientation, topic, methodology, and related factors are very different from science to science and consider the broader socio-economic-political image in which research is conducted. Bazeley (2010) points to the exceptional attention given to research performance, which is increasingly evident and is the factor that necessarily implies the need for the SS&Hs to develop appropriate methodologies for assessing the quality of research. In defining the conceptual framework for research performance, the basic elements are engagement, task orientation, research practice and intellectual processes, and dissemination (Bazeley, 2010), for which the visibility of research results is necessary in the modern world.

In direct relation to visibility is the so-called impact and other quantitative measurements. Brewer (2011) concentrates on impact, its significance for researchers and the community of scientists, and so many important dilemmas for this notable term. Brewer's research (2011) raises many questions, points to dilemmas, and, perhaps most importantly, emphasizes the need for a phenomenon of impact to open constructive dialogue in the academic community. Citation analysis, on which the impact directly relies, has serious constraints concerning the SS&Hs (Butler & Visser, 2006). Specifically, work with serious methodological or other disadvantages can be cited as a negative example. In addition, many citations may not have the intention of successful research if they are not based on the most interesting topics in the world. Nederhof (2006) did citation analysis in SS&Hs and pointed to numerous limitations in applying the same scientometric methods. Evaluation of the quality of research in SS&Hs must be expanded with elements better suited to the nature of these sciences than citation indexes and impact factors. Zuccala (2012) considers peer review the best way to evaluate quality in SS&Hs, while impact factor(s) can be a secondary supplement in impact monitoring.

This study seeks to take the initiative in empirically examining the perceptions of the academic community toward the evaluation of SS&H while simultaneously proposing a suitable framework.

Methodology

Research Context

Criteria for academic and scientific rankings at the University of Montenegro from 2004 were common to all areas and implied a qualitative and quantitative assessment. The qualitative assessment section indicates that the applicants must have references for the relevant area and work recognized within the domestic and international public as appropriate. Some articles from *Criteria* are subject to interpretation. For instance, Article 12, which defines the references for promotion to the position of associate professor, indicates that the person to be promoted should also satisfy the following:

- *At least two articles, from which at least one should be realized after the previous promotion, must be recognized by the international and domestic public as a significant contribution to science or must have great significance for national or state sovereignty or culture (Criteria for academic and scientific promotion2004, Article 12).*

In Article 13 (referring to the promotion to the full professor position), such requests are duplicated. Article 12 is not unambiguous, so social and humanities researchers

mostly interpreted it one way and natural and technical science researchers another. The opinion of the others was overwhelming, so these articles were directly recognized as a request for articles in journals from SSCI or A&HCI lists for SS&Hs SCI for natural and technical sciences. Candidates who have not published articles from this category did not meet the criteria for a higher promotion, regardless of the other elements of the bibliography.

The *Criteria* adopted in 2016 were more explicit in this respect, so the relevant articles point out the research published in the mentioned databases as a necessary condition for the promotion process (Criteria for academic and scientific promotion, 2016). The regulations related to doctoral studies followed in parallel with the *Criteria*. To become a Ph.D. supervisor in the social sciences and/or humanities, one needed to have three original research papers published in journals indexed in SSCI or A&HCI in the previous five years.

Such an interpretation of the Criteria for academic and scientific promotion (2016), the procedures for the promotion process, and approval for Ph.D. supervisor have provoked disapproval among many social and humanities researchers. The transition to the described interpretation of Criteria for academic and scientific promotion (2004) occurred in 2014. To comply with the requirements, the Scientific Committee has been established at the University of Montenegro, whose task is to review the electoral procedure and give the Senate an opinion on fulfilling the conditions for the promotion process. The Committee is not "above" the other bodies involved in monitoring the electoral procedure; on the contrary, the basic councils, the Social Sciences Council, and the Committee bring independent opinions and send them to the Senate. However, while the councils are led by the reviewers' opinions (qualitative-quantitative estimates), the Scientific Committee focuses on the quantitative features of the bibliography, i.e., to determine whether the candidate has worked in Clarivate Analytics databases. If so, how many of these works exist? What is the candidate's copyright status on published papers (first, leading, second, etc. author)?

Research design

Our research aims to establish the perception of the quality assessment of research work in the SS&Hs at the University of Montenegro. We have chosen a qualitative methodology, the focus-group technique (Anfara & Mertz, 2006; Fern, 2001), which will provide the phenomenological concept of research (Wilig & Stainton Rogers, 2008) that will enable us to observe "the world as it occurs in the experience of human beings within certain contexts and in certain times" (Vilig, 2016, p. 187). The results should serve as a part of the material in future activities to improve procedures for evaluating the quality of scientific research work in SS&H in Montenegro.

We have conducted focus groups with this topic set as a problem issue: How do scientists from the field of work estimate the quality of research evaluation in the field?

Perception is an important psychological phenomenon that significantly influences researchers' overall behavior in scientific work. It is based on the beliefs, attitudes, and values that the researchers have and on which they function (Fish, 2010).

This topic has been discussed through a series of questions:

- Is there any agreement on evaluating the quality of scientific research work among researchers from the same scientific field employed at your faculty?
- Is that assessment applied in similar institutions in the country or abroad?
- Does the academic community you belong to (university) agree with that assessment?
- Is it better to assess the quality of research in your scientific area by employing indicator-based evaluation or in some other way?

- Do you acquire better results via qualitative or quantitative research in your scientific area?
- Assess the possibility of cooperation in research in your science field- is it more suited to teamwork or individual research?
- Assess the possibility of interdisciplinary/multidisciplinary research in your scientific field.
- What are the possibilities of internationalizing the results of your research?

Data Collection

Focus-group interviews lasted for one hour each and were organized face-to-face. We conducted a total of five half-structured interviews. The groups had four to six members and were sufficiently homogeneous, i.e., in one group, there were researchers from the same field, except in the fifth focus group, which was mixed. All the interviews were recorded on a tape recorder and later transcribed. Based on the final material, we have outlined those comments that, in the opinion of the research authors, most clearly expressed the opinions of the whole group.

Data Analysis

The transcribed material went through the stages of coding, categorization, and thematization, with six steps proposed by Braun and Clarke (2006, p. 87): 1. familiarizing with the data, 2. transcribing data, 3. reading the data, initial coding, searching for categories and themes, 4. reviewing themes, 5. defining themes, and 6. writing the report.

The procedure for analyzing the transcribed data (phases 3, 4 and 5) was as follows: a. one researcher (the first author of the paper) coded the data after several repeated readings, b. the transcribed material was read by the other authors and the codes were recognized according to the resulting code grid. c. Discussions were organized during which the initial codes were slightly corrected to the agreement of the researchers, and themes were determined as well as categories.

The results are presented according to themes. We have outlined three themes: (non) adjustment to the research quality assessment, quantitative and/or qualitative assessment, and specificities in research and publication in SS&Hs.

Research Sample

The study was realized based on the participation of 25 respondents employed in four units of the University of Montenegro: The Faculty of Economics, Philosophy, Philology, and the Faculty of Sport. Respondents were three full professors, seven associate professors, nine assistant professors, three PhD teaching assistants, and three PhD candidates. In the text afterward, respondents are labeled with the letter R and an ordinal number. In this way, the participants were anonymized.

The reasoning behind selecting these faculty units rely on the theoretical part of the study – we choose those SS&Hs that are more similar to science fields in their research methodologies (economics and sport science) and those that do not have so good ISI coverage (philosophy, and philology). Besides, we opted for different experiences and selected different roles (from PhD candidates to full professors). It is realistic to assume that the academic career stage strongly influences the researchers' perception.

Ethics

Before the focus group interviews, the participants were thoroughly acquainted with the topic, and their research participation was voluntary. The research authors

contacted the participants directly and explained the topic to them. All the invited participants responded to the survey, emphasizing their interest.

The anonymity of the respondents was guaranteed when they were invited to participate. Then, the same information was repeated at the beginning of each interview, when the researchers asked for verbal permission to record the interview with a voice recorder. To avoid possible recognition of respondents' answers (the four faculty units that are covered are unequal in terms of the number of employees in all categories), in this paper, in certain isolated comments, only the number of respondents (1–25) is written with the mark R (respondent), without the characteristics of the academic title or faculty from which the respondent comes.

Reliability and Validity

The validity of the research was achieved by the independent opinions of the authors of the work and the respondents' opinions of the final research report. The reliability was achieved through five independent group interviews with participants from four faculties.

The chosen methodology has biases and limitations, among other things, because the focus group interviews included fewer respondents. Their diversity mitigates the limitation of the small number of respondents - different academic titles and different faculties. In addition, the interviews were semi-structured, which gave respondents much more freedom in answering the questions. This problem was solved by having the researchers read the transcribed material several times to identify themes.

Results

The respondents (25 of them) were grouped into five focus groups. It has already been mentioned that we leave out the more complete designations of the respondents (faculty and academic title) for anonymization. Where relevant - for example, for a range of responses - we provide such data at the focus group level. All mentioned comments are listed as direct quotes from respondents. We marked the respondents with the letter R (respondent), and next to the letter is the ordinal number of the respondents. Respondents 1-5 are from the Faculty of Philosophy and Philology (first focus group), same as 6-9 (second focus group), 10-15 from the Faculty of Economics (third focus group), 16-19 from the Faculty of Sports (fourth focus group) and 20-25 from the Faculty of Economics, Philosophy and Philology (fifth focus group). Such a combination was almost necessary because providing a time and place that suited all the invited participants is quite complex.

(Non) adjustment in the assessment of the research quality

The initial questions in the focus group interviews aimed at assessing colleagues' (lack of) agreement on evaluating research work. All respondents commented on this, as well as every subsequent question. Their perceptions are quite different. After repeated readings of their comments, we determined four categories of answers. Therefore, the categories were not given in advance, but we arrived at them from the respondents' answers and comments.

The opinions of the (non) agreement can be grouped into four categories:

1. Consent does not exist: "There is no such thing, and in my estimation, the reform tendencies are more in the direction of some marketing and formal presentation of science" (R4); "Some colleagues believe in highly rated journals evaluation, while some of them are more for qualitative evaluation." (R20); "The

work can be bad, but if it is published in a journal that the university values, it will be assessed as a good one" (R24).

2. According to some respondents ' opinions, it is not familiar that there is agreement; it is not known what quality is. They said: "We are caught by the criteria from 'above', which come to us as a mold for a dough – *Criteria* are like a mold, and we are a dough" (R7); "We do not have serious debates" (R22); "We are surprised because they do not estimate us qualitatively, but quantitatively" (R7); "We do not have a national list of scientific journals anymore. We only have marked 'space' where we are running to in an attempt to publish, and we are fighting to publish something that we think is scientific work." (R5).
3. The third focus group has a degree of agreement (R10–R15). Still, it is difficult to compare the work from different fields: "We can compare, and we have a high level of approval within a subcategory" (R11); "If you talk to a colleague from another department, there are differences that are sometimes extraordinarily large" (R10); "Now, we have a really good feeling for that, thanks to the fact that we are forced to write papers for the SSCI list. When someone writes for SSCI one time, (s)he cannot move to a lower level" (R13); "In the part of elementary methodological postulates, I think we have no differences" (R12).
4. There is agreement at the level of the category: "We can agree in our research field. The best quality works are published in the most prestigious journals" (R16); "The rules are very clear" (R17).

The third and fourth groups of answers were obtained from economics and sports science employees: areas considered to use methodologies used in the natural and technical sciences. Other categories of responses have been highlighted in the comments of researchers in the humanities and social sciences, such as sociology and the science of education. Most respondents still have dilemmas about the quality of research work and how it is assessed. Without special instructions from the examiners, all respondents linked the quality evaluation issue with publication in the databases and Clarivate Analytics journal list.

Since the respondents in the third focus group initially introduced the SSCI during the interview, they were asked: "Do you unconditionally believe in the SSCI?" The first reaction was common to the whole group. The respondents denied unconditional trust: "There are very high-quality papers in SCOPUS and other databases. It does not matter if the journal is on SSCI or not. Quality work is of high quality by itself" (R11); "The fact is that the SCI list is not a guarantor for the quality. However, some methodological requests in the indexed journals, in terms of a form – which is very similar from journal to journal – I believe that that template is obligatory for researchers and that its function is a better quality of work" (R12); "It makes us read 200 research papers to write a research question or hypothesis. Those papers we wrote earlier were not exactly like that" (R13); "You have complete theoretical papers at the SSCI - like interviews - which surprised me. But still, that work has quality" (R14) (As part of tacit knowledge, the connection of "good" work with the quantitative methodology is noticed.); "I do not have preferences for SCOPUS or the SSCI list, but I have found more concrete results in some SCOPUS journals – they better responded to the defined goal and asked question. On the other hand, I saw some papers on the SSCI list - everything is good and packaged in the form, but if you would ask me: *What did these guys do?* I could not say" (R15).

The second issue aimed at determining the respondents' awareness of how the research work is evaluated in related institutions. Familiarity with the topic plays an important role in the objectivity and completeness of perception. A few respondents

(three) said they were unfamiliar with it. In the third focus group, which had the representative comment: "We are harmonized, and that can be seen from a large number of our joint works" (R13), other respondents had different comments: "In Slovenia, they have a consensus among themselves and rules that do not imply this SSCI 'madness'" (R3); "Everyone has objections to the Criteria. I had the opportunity to hear about it in Croatia, Slovenia, and Serbia. The university system has become business - and science, and criteria, and I think it is not easy for anyone" (R1); "There are differences, for sure. In conversation with colleagues, we have concluded that they have kept a lot of the old system, in the sense that there are chambers, conferences, and reviewers, which are a key link in determining the quality of work, and, of course, there are councils of social sciences that have a greater role concerning senates" (R8); "We are in a worse situation than all of them. Why? For example, there is a national journal list in Croatia in Serbia. In Montenegro, no list of journals is recognized as relevant, so..." (R9).

The question of academic promotion procedures was raised among the respondents. Their information is directly related to such procedures in the surrounding countries. With a general assessment that the demands are increasing everywhere, respondents point out that the University of Montenegro is more demanding concerning related institutions in the surrounding countries, which may be a subjective perception. Nevertheless, a national journals list is often mentioned (it exists in other countries) as something that is missing in Montenegro.

Some respondents had concrete examples in which they highlighted the unscientific social environment and, partly, the political flows that have a crucial impact on work assessment, which is in favor of unclear quality assessments. It is a suggestion for a series of potentially relevant factors that can influence the publication of the research. Specifically, the work that received positive reviews was not published for unknown reasons: "I sent a paper to a regional journal. What happened? The work was praised, and two excellent reviews were written, but the editor declined to publish the work for 'his' reasons. What does that testify to? It testifies that the quality of work is not considered. In the linguistic and political situation in which we are now, some other factors are much more important" (R6).

Other participants also responded to this example, referring to similar situations in which the works were rejected because they did not coincide with the language, political, or other directions represented by the journal editors. Such comments and examples are credible for SS&Hs, whose important characteristic should be criticism. If the criticism is directed towards an (in)appropriate direction that strongly influences the fate of the work: "The work that does not suit the official political picture will not be published. This problem is not just in the region" (R7). Respondents agreed: "I do not think such agreement exists in the region or beyond. It is not always a rule that the quality of work directly impacts its publication. Let us compare some of the works published in well-ranked environmental journals and compare them with some rejected papers. One can see disagreement - it seems that some of the rejected papers are better than some of the published ones" (R16) or "We have reviewed many works in the SSCI list and encountered an uneven quality" (R24).

The question of how valuable the quality of research in the region is and beyond is further related to purely economic factors: "The whole list, which we have to respect in the style of Publish or Perish, is like a company, a corporation, it is a private business that determines purely quantitatively what is good and what is bad. There are no stories about quality; there are no places for SS&Hs because there is no place for them if there is no profit" (R7). Other participants support this comment.

Regarding agreement at the university level, all respondents point out that there is no harmonization: "We often have disproportionate needs - someone needs equipment, some instruments, lawyers, historians... all have their own needs. There are many disagreements" (R16). Formal compliance was established at the University of Montenegro through the *Criteria* and their interpretation by the competent authorities – primarily the Scientific Committee and the Senate of the University, but there is no real agreement: "Formal synchronization exists. We are moving more and more towards having fewer and fewer possibilities for (mis)interpretation of the rules" (R1). However, what is the common attitude of the respondents? "I think the sanction part is prevalent. This second, motivational, incentive is less expressed – although there are some new steps" (R21); "We do not have, and we should have our vision" (R9). Comments from natural and technical sciences colleagues who apply estimates derived from their research fields were numerous. Respondents especially point out that it is unclear to them how experts in one area give themselves the right to comment on works and achievements in other areas: Agreement was not expressed for several years, two or three, in some transitional period, of the criteria for ranking. We had a situation - it is not good if it is not on the SSCI list. That was the attitude of colleagues from other organizational units, both natural and technical. Although maybe they were not competent to evaluate the work themselves, they had an immediate defense - if the work is in SCOPUS or ... and not in the SCI, they immediately think that the work is not good" (R15). A comment caused special acclaim: "There are differences that were not considered. This should be considered when evaluating our work" (R16).

Quantitative and/or qualitative assessment?

All respondents agreed that both types of assessment are possible, necessary, and vital, and "I think it is a mistake not to consider the reviewers' opinions. Many are high-quality workers in some segments –teaching, professional work, etc., but they may not have their papers in top-level journals" (R16). In addition, they point out that SS&HS needs to include various activities and their results in the evaluation: conferences, monographs, textbooks, professional activities, etc. Such an opinion is pointed out: "From all aspects, one should analyze one's work. It is a real problem taking only one parameter. It is necessary to have a spread out indicator system" (R3). Let us say, "We have a colleague who has ten books. If he had applied for promotion now, he would not be promoted because he does not have articles in SSCI" (R13). Respondents believe it is necessary to recognize the specifications for SS&Hs and that a qualitative assessment, "reading the work by the reviewer" (R9), has a special significance. The respondent points out that "the indicators should be redefined, and then the criteria will be respected" (R12). In all groups, the opinion is that quantitative assessment is insufficient, as suggested by other studies (Ochsner et al., 2014). It is necessary to have a qualitative assessment, whereby it is crucial to develop a set of indicators, which would also improve peer review (Lamont, 2009).

With this issue, the respondents directly related the question of reviewing, with their experiences being completely different, ranging from trust to distrust in qualitative assessment: "Reviews can be subjective. It is difficult for a man to isolate subjectivity. It is recognized throughout the community that for some leading authors, it is easier to publish than for anonymous ones. That is subjectivity" (R21). We point out the metaphorical comment aimed at creating a quality assessment matrix: "It is necessary to do something like in gymnastics – to assess both the acrobatic part and the aesthetics" (R17).

Specificity in research and publishing in SS&Hs

Qualitative vs. quantitative research. The relationship between the two paradigms is often associated with the possibility of publishing papers in a good journal, so the main belief is that quantitative research is assessed as better. Qualitative research is interpretative-analytical, explicitly mentioned: "We are dealing with phenomena, and there has to be an interpretive paradigm" (R1). Quantitative research is related to empirical data collection and its statistical processing. Both studies have important relevance to SS&Hs, but their evaluation is not always synchronized, so sometimes "faith in the number" prevails over the abovementioned interpretative part: "There is a tendency to force for quantification more than we want" (R1); "In psychology, we measure everything now, although it is not necessary" (R4).

Respondents in all groups are convinced that both studies are important and that the research paradigm should be chosen according to the topic and goals. However, they consider that "In these journals that are in the databases only the quantitative ones have an advantage" (R8), but "The authenticity of humanities is based on valuable evaluation, and this cannot be quantified" (R5); "We have in linguistics some journals that offer quantitative analysis, but without a critical review, without any comments, without any essential insight" (R6). Economists have the impression that exclusively quantitative research has the chance to be published in top journals. They point out that their attention has been drawn to it (R11) and that "Economics is familiar with the quantitative approach. More or less we are all able to get something through some statistics" (R12). Our collocutors think it is a pity if (almost) all the sciences keep or achieve this methodological quantification course.

Team/individual work. Starting from the thesis that in advance, it is difficult to say whether the best results are given in individual or team research, this question was asked, bearing in mind that we will partially illuminate the respondents' experiences through answers. The focus groups were not homogeneous: respondents from the Faculty of Philosophy highly value teamwork, but they believe that how it is currently being realized is ethically questionable. Economists are focused on teamwork and evaluate it as a necessity by offering examples and arguments for it: "What an independent author – it is meaningless" (R14) or "In the last years, I used to download one or two works almost every day, and I did not read one that had been written by one author" (R15). Researchers in sports are focused on teamwork: "We are networking for every research study. It is much easier and much more effective" (R18). The work functions so that "we always work in teams, three to four members, sometimes also six to seven, depending on what we do. We all have tasks. We split up, for example, by defined variables. When we write, everyone writes a part" (R19), and, in addition, "We often do comparative analyses with colleagues from other countries" (R17).

Representatives of the humanities, however, have different opinions, as well as significantly poorer experience with teamwork. One respondent has no experience working in the team: "It seems that there are topics – or I have dealt with such topics – where I am not sure that it would work out in the team" (R6). Philologists think big teams (more than two or three people) cannot function in their research field, except with large corpora (R8). Small teams are considered possible and useful, primarily concerning different insights into the topic, especially if interdisciplinarity (R5) is achieved, which is highly valued by all respondents. Respondents who have experienced teamwork point out the benefits: "It is the greatest benefit for the development of my scientific research because one person can learn something from a colleague. I have no experience with how this would look if three people were

involved, but in a team of two, it is great" (R5). All respondents believe that interdisciplinarity is the future of science (R16).

One element of the hidden form of cooperation appeared during the discussion on this issue. Namely, the respondent pointed out: "I am absolutely for teamwork, but it does not prevail. I do not like the teamwork we are dealing with, 'add a colleague to be part of the work.' Such teamwork does not make sense" (R2). In this group, a consensus has been reached that there is no future without teamwork, but they do not see that this work functions as it should.

The demand for research to be published in international journals, usually in English, encourages dialogue on the possibility of internationalizing research results. Naturally, journals at the other end of the planet are not interested in research concerning mainly Montenegro. They are interested in different subjects, those that are globally important or those that correspond to their social reality. "I have to change the focus to be interesting for international journals. I am dealing with the relations between Montenegro and Italy. If I mention Italy in my work more than Montenegro, then there is a chance that I will attract some international publishers" (R9). To some researchers, this works counterproductively, and they are not motivated to work (R8). In addition, social scientists consider how the *Criteria* treat conferences as extremely adverse due to the possibility of international exchange of experiences.

During the interviews, it was pointed out that researchers from the smaller communities are now almost forced to use data from another system and that the problem is, for example, the size of the sample for quantitative analysis that can be obtained in Montenegro (R11) or even in the Balkans (R14). That is why "There was an absurd situation that scholars from Montenegro analyzed public debt in Germany" (R15). There are big differences in the perception of the internationalization of research results. There are extreme opinions, from "I wrote about the Durmitor dialect. Who cares? Nobody! It is very interesting for linguists, but not for others" (R2) to "We can do it - man is man, here and in America" (R17).

Another important component that is highlighted regards the choice of the topic for research; if one wants to publish work in indexed journals, one must start from the interest of these journals and not from the needs of Montenegrin society and science: "There are no journals from Russia on this one journal list, from Poland, after all - from Montenegro. How will anyone dealing with our language be interested... Three or five journals may deal with politics; they are interdisciplinary. They want to be quoted. To be quoted, the topic must be current" (R7). The other collocutors are fully in agreement and have similar experiences.

The third factor must be considered a type of discrimination: "Not to speak of the 'ić' question. If John Smith sends the work, he has a 30% better chance to publish than Petar Petrović, Marko Marković [...] There is a blog made by an African scientist. He describes his experience and the experiences of other people who do not have this Anglo-Saxon name and surname. We can joke about it and be angry, but it is just like that" (R7).

Discussion and Conclusions

Summary of the research

Our research aim was to describe the perception of the quality assessment of research work in the SS&Hs at the University of Montenegro. We opted for a qualitative methodology with a focus-groups technique. A total of 25 respondents from four SS&H research fields were included as the study participants.

Focus groups are led nondirective, meaning interviewees are free to elaborate on the topic in the way they think they need to and how they encourage each other. This was done to keep the focus on perception and to obtain the basic ideas that appear to the researchers concerning this topic. All invited researchers were involved in research, which was not the case in some similar analyses (Giménez-Toledo et al., 2013; Ochsner et al., 2016).

The reported results show the richness and complexity of the topic, which suggests different perceptions of researchers and their diverse experiences. The agreement regarding the assessment of the quality of the research has not been established to the necessary extent. The direct and practical association in assessing the research quality for all our examinees was the publication in the journals from SSCI and A&HCI lists. Humanities researchers have shown that evaluation through these lists is not clear enough for them and is unfamiliar. Some social sciences (economics, sports sciences) quickly adapted to publishing requirements in the Clarivate Analytics databases, while other social sciences and all the humanities are still far from such indicators. Even "customized" social sciences do not reliably evaluate the quality of works published in the abovementioned databases, i.e., WoS's journals are not synonyms for quality for our respondents. Following the nonlinear nature of building up knowledge in these sciences, researchers believe that "good work" can be evaluated almost independently from the journal or the publisher; it can be indexed in Scopus or some other indexing service.

Respondents have different views on how the quality of research is assessed in our region and beyond. Still, some of them express the belief that the demands of the University of Montenegro are very high. Lack of reliable information can be one of the factors that hinder researchers. Regarding compliance at the university level, it is suggested that researchers in natural and technical sciences have prevailed in assessing the quality of research in SS&Hs. Some groups of social scientists have accepted this, believing that quality evaluation could consider the specificity of different sciences.

The question of qualitatively vs. quantitative quality assessment of research work for our respondents is not either/or. In this section, they agree both evaluations are necessary. In doing so, linear progress (through impact factors, for example) does not correspond to the SS&Hs. For these sciences, a more complex matrix or matrices should be developed. The respondents emphasized positive and negative opinions on the review of their work and their assessment indicator. They were positive about reading the paper during the peer review process. Still, many negative factors can accompany this process, whereby subjectivity is a common denominator. As for the indicator assessment, the general state is insufficient.

Factors that are directly related to the current dominant indicator methods of evaluating work, such as the number of papers, rank of the journal list, or impact factor, are directly related to methodological paradigms (qualitative vs. quantitative), research practices (individual or teamwork), but also the possibilities of internationalizing research results. All these factors differ among scientific areas, showing that social sciences are more successful in designing and implementing quantitative team research with more general topics.

Theoretical implications

According to our respondents ' perception, research shows that SS&Hs are in many ways different from the natural sciences and that the same quality assessment indicators do not match them. This data corresponds to our theoretical framework

(Brooks, 2005; Hicks et al., 2015; Ochsner et al., 2012, 2013, 2014; Perić et al., 2013). Namely, differences in research methodologies and practices between scientific fields should be considered in any research assessment. Our respondents discussed mostly publication practices (emphasizing the WoS's journals), and the reason behind their perceptions could be found in the Criteria for academic and scientific promotion(2016).

It is also clear that the qualitative assessment alone is insufficient, as many reasons point to subjectivity, even in an informed peer review. Our results have confirmed this situation: Our respondents in the field of several SS&Hs have spoken about so many dilemmas, challenges, and experiences, which support the common, most important conclusion, namely that the evaluation of the quality of scientific research in SS&Hs must be both qualitative (based on informed peer review) and quantitative (based on indicators derived from the very nature of these investigations). This data follows previous research (Ochsner et al., 2012, 2013, 2014; Perić et al., 2013), notwithstanding our respondents were not skilled with scientometrics terminology.

Managerial Implications

As important factors in defining the quality assessment matrix and specific indicators, but also in improving the peer review, we highlight the following implications from this research.

First, the internal agreement in the perception of quality evaluation is higher in those areas that rely more on statistics. This does not mean, however, that all sciences should be directed toward statistics to increase consensus. To increase the internal consensus in the quality assessment, it is necessary to identify clear, precise, unambiguous indicators that will also show the specificity of SS&Hs. An agreement on what quality of research in SS&Hs can be achieved through the three necessary processes: 1. through research that will involve most of the population of researchers (in this case, on the University of Montenegro), 2. good theoretical link to quality issues, and 3. comparative studies.

The indicator part should not be one-sided, i.e., as a criterion of quality of work, it is not sufficient to use one measure: works in one basis of a journal, works from one category, or the impact factor. The specific characteristics of SS&Hs are not just something our respondents discuss. On the contrary, they are a global feature of these sciences and should be considered.

Along with creating the mentioned matrix, it would be necessary to develop some discussion and exchange of ideas among researchers. Our respondents' experiences are different, and exchanging these experiences could positively affect the overall working atmosphere. Through research, for example, we have observed that the experience for some researchers in teamwork is very frustrating, while other researchers have clear procedures for teamwork. In the modern world, science is rarely an individual question; the phenomenon's complexity stimulates the work of teams, and, in this respect, it develops interdisciplinary.

Limitations of the paper

This paper has limitations. Most constraints are from the methodology used, which did not include all the significant issues and open topics, nor did we include a significantly larger number of respondents, which should be done in future research. Our focus groups were exclusively composed of the researchers of SS&Hs: in future research, it would be useful to provide discussion in groups of completely heterogeneous composition. This would lead to the deepening of the topic and its better understanding by the participants.

Future Studies and Recommendations

According to our data, indicators are needed, but which indicators should be chosen is the issue that has to be addressed in future research, which should include a significant part of the population of social and humanistic researchers at the University of Montenegro. Quality indicators are not easy to harmonize, which is well documented by a focused series of research studies (Ochsner et al., 2016), meaning that some future studies should focus on finding objective qualitative indicators. Besides, future studies in research evaluation in the SS&Hs in the Montenegrin context could address questions such as publication practices (journal vs. monograph), team vs. individual research, and experiences with international journals.

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Lifelong Education in Economics, Business and Management Research: Literature Review

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Abstract

Background: Lifelong education includes formal and nonformal forms of learning during an individual's life cycle for the conscious and continuous development of one's quality and the quality of life in society. **Objectives:** The goal of the research is to identify the most frequent research topics related to lifelong education in economics, business, and management research using a systematic literature review. **Methods/Approach:** The study analysed 272 lifelong education papers in Business, Management, and Economics journals using bibliometric analysis, text mining, and Provalis Wordstat content analysis, identifying frequent journals, authors, nations, and funding entities. **Results:** Research on lifelong education, focusing on older adults, critical thinking, quality of life, poverty reduction, professional training, and human capital, is primarily published in the International Journal of Lifelong Education. Four clusters have been identified. **Conclusions:** The number of lifelong education papers is increasing, primarily published in educational journals. The most common keywords highlight its focus on human capital, supporting economic and social development.

Keywords: lifelong education, bibliometric analysis, topic mining, economic and business, cluster analysis

JEL classification: I21, I25, I26, O31
Paper type: Research article

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Introduction

In an ever-evolving global economy, the dynamics of formal education have steadily expanded beyond traditional classroom boundaries (Moore, 2015). Lifelong education, encompassing both formal and nonformal avenues of learning, has emerged as an essential paradigm in ensuring the continuous and deliberate development of individual capabilities and, by extension, the betterment of society (Nylander et al., 2022). Such a form of education is no longer seen as an enrichment activity but rather as a necessity, especially in fields such as economics, business, and management, characterised by rapid changes and innovations (Waller et al., 2020). Given its significance, a comprehensive understanding of the thematic focuses within lifelong education research in these areas is paramount.

This paper delves into a systematic literature review of lifelong education studies within Business, Management, and Economics, unearthing trends, leading contributors, and central topics. Through rigorous methods of bibliometric analysis, text mining, and topic mining, we aim to provide an encompassing landscape of the field and underline its crucial role in shaping contemporary economic and social structures. This research sets out to discern the predominant research themes associated with lifelong education in economics, business, and management, applying a systematic literature review approach.

Our methodology pivots on a comprehensive exploration of the Web of Knowledge database. With a focus on "lifelong education" as the primary keyword, the search was tailored exclusively to scientific journals under Business, Management, and Economics. This refined search yielded a pool of 272 pertinent papers. A rigorous bibliometric analysis was subsequently executed on this collection, mapping out the recurrence of specific journals, prominent authors, contributing nations, and the institutions that funded the research. Furthermore, examining the most cited papers within this collection offered a deeper insight into the influential works in this niche. Text mining techniques were employed to extrapolate the recurrent research themes, illuminating the most frequent keywords, phrases, and overarching topics. The analytical tool, Provalis Wordstat (Provalis, 2022), facilitated a robust content analysis, identifying clusters representing recurrent phrases and terms, especially within paper titles, abstracts, and keyword sections.

In the paper, the introduction outlines the significance of lifelong education across disciplines, emphasising its growing relevance in economics, business, and management. The methodology section details the approach taken, including the refined search on the Web of Knowledge and the ensuing analytical techniques employed. A bibliometric analysis is conducted to map out the prevalent journals, authors, nations, and funding institutions involved in lifelong education research. The paper investigates frequent keywords, phrases, and overarching topics through text mining, further delving into a granular analysis of the word and phrase frequencies. Conclusively, the paper emphasises the intersection of lifelong education with human capital development and its pivotal role in steering economic and societal advancement.

Methodology

This chapter provides an overview of previous research on lifelong education. First, the search strategy of scientific databases and the analysis procedure of the found articles are explained, and then the bibliometric analysis of the articles is presented.

Finally, the most common research topics related to lifelong education were identified.

Searching the literature of scientific databases on lifelong education for this work began with identifying relevant databases. As a result, the focus is on works indexed and cited in the scientific databases Web of Science and Scopus (AlRyalat et al., 2019). The mentioned two scientific databases were selected as relevant for the literature search process because they are widely used in various literature searches as a reliable source of review articles (Nguyen-Duc et al., 2015). In addition to the above, the two mentioned scientific databases are the most extensive and contain the most relevant publications, and both databases are most often used for literature review (Aghaei Chadegani et al., 2013). Moreover, Aghaei Chadegani et al. (2013) explain that the Web of Science is the only database of citations and publications that covers all scientific domains internationally, while Scopus represents its good alternative since it is the largest database of citations and abstracts and conclude that the mentioned two databases cover the majority of current and relevant works and are therefore highly valued as they shape potential research fields. Moreover, the Croatian legislation recognises the works indexed in the two databases as the highest quality (Rulebook on the conditions for selection into scientific professions, NN 28/2017, document no. 652), another reason for choosing the two scientific bases just mentioned.

Bibliometric analysis of articles

Bibliometric analysis for "lifelong education" includes 272 publications from 1995 to 2022. The analysis is further enhanced by "Document type: Articles" and includes the following Web of Science categories: education, educational research, social sciences interdisciplinary, management, economics, business, and business finance.

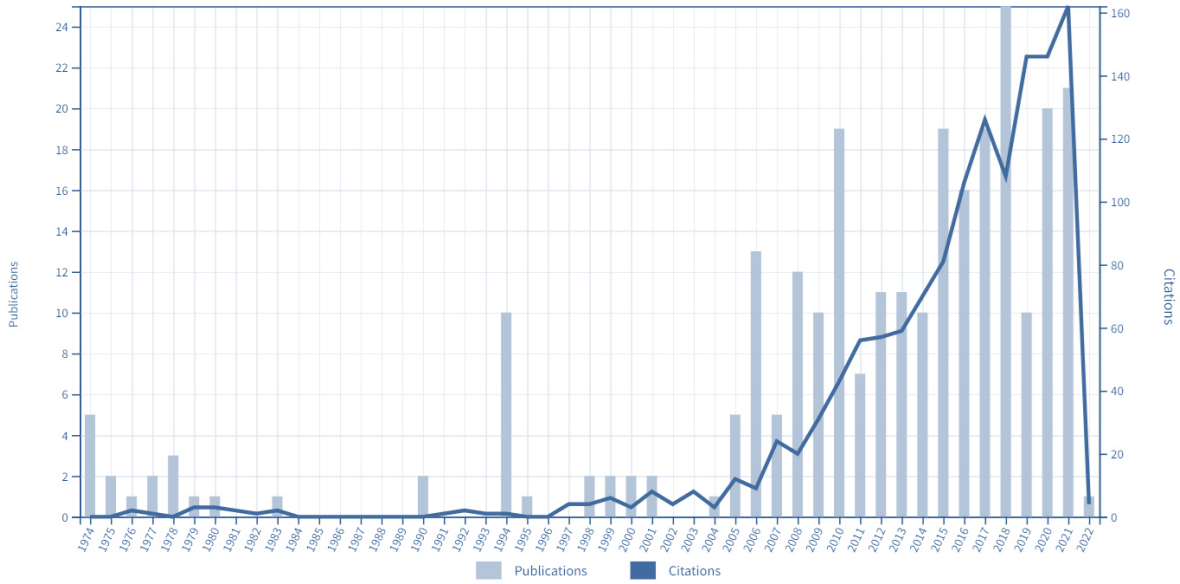
The total number of cited articles is 1,252. These citing articles cite one or more items in the citation report, while the total number of citing articles, but with removed articles that also appear in the citation report, is 1,228. The total number of citations of the analysed articles is 1,319, of which 1,289 are without self-citations, which makes the average per article 4.85. The average number of cited articles for all items in the result set. It is the sum of cited times divided by the number of results in the set. Furthermore, the h-index value is based on a list of publications arranged in descending order by the number of citations. An index of 19 means that there are 19 papers, each of which is cited at least 19 times.

Figure 1 visually shows the included publications and citations from 1974 to 2022. It can be noted that the topic of "lifelong education" was of most interest to researchers in 2018 and somewhat less so in 2010, 2015, 2017, 2020, and 2021. The topic's popularity growth is observed from 2005 to 2022, which means that additional growth can be expected in the next period. Recent research has examined and included various aspects of lifelong education, and raising the importance of the topic is aimed at generating and discovering new knowledge in the field of lifelong education through empirical methods (Lang, 2023).

The bibliometric analysis of the topic of lifelong education is grouped into the areas of educational research, interdisciplinary social sciences, management, economics, and others (Table 1). It can be noted that most of the research conducted in lifelong learning is focused on the field of Education, reaching a record number of 244 out of 272 or 89.71% of the included articles. Furthermore, Interdisciplinary Social Sciences comprise 12 out of 272 records or 4.41%, followed by a slightly smaller percentage of

3.31% or 9 records from the field of Management and 2.21% or 6 records from Economics. The rest of the 22 records included in the bibliometric analysis, or 8.09% belong to other fields.

Figure 1
Number of papers and citations in the Web of Science database



Source: Author's work, Web of Science (WoS) database; Retrieved 30th January, 2022

Table 1
The number of papers according to the field of research defined according to the Web of Science classification

Field	Record number	Structure in %
Education	244	89.71%
Interdisciplinary social sciences	12	4.41%
Management	9	3.31%
economy	6	2.21%
The rest	22	8.09%

Source: Author's work, Web of Science (WoS) database; Retrieved 30th January 2022

The bibliometric analysis was further extended to classify included articles by journals (Table 2). Most of the research, or 43 out of 272 records (15.81%) from the field of lifelong learning, were published in the Internet Journal of Lifelong Education, followed by 24 records, or 8.82%, in the International Review of Education, 6 records (2.21%) were published in the journal Educational Gerontology. Furthermore, the analysis shows that 5 articles, or 1.84%, were published in each of the journals: Adult Education Quarterly, European Journal for Research on the Education and Learning of Adults, Journal of Adult and Continuing Education, Education, and Science, Prospects, followed by 4 records each or 1.47% in the Asia Pacific Education Review and Science and Education Review.

Table 2
Structure of articles according to publication journals

Magazine	Record number	Structure in %
International Journal of Lifelong Education	43	15.81%
International Review of Education	24	8.82%
Educational Gerontology	6	2.21%
Adult Education Quarterly	5	1.84%
European Journal for Research on the Education and Learning of Adults	5	1.84%
Journal of Adult and Continuing Education	5	1.84%
Education and Science	5	1.84%
Prospects	5	1.84%
Asia Pacific Education Review	4	1.47%
Science and Education Review	4	1.47%
Czech Polish Historical and Pedagogical Journal	3	1.10%
E Mentor	3	1.10%
Education and Information Technologies	3	1.10%
Educational Philosophy and Theory	3	1.10%
Problems of Education in The 21st Century	3	1.10%
Studies in the Education of Adults Niace	3	1.10%
Turkish Online Journal of Distance Education	3	1.10%
British Journal of Educational Studies	2	0.74%
Comparative Education	2	0.74%
Croatian Journal of Education	2	0.74%
Didactica Slovenica Pedagogical Horizon	2	0.74%
Educar EM Magazine	2	0.74%
Economic Review	2	0.74%
Eurasia Journal of Mathematics Science and Technology Education	2	0.74%
Globalisation Societies and Education	2	0.74%

Source: Author's work, Web of Science (WoS) database; Retrieved 30th January 2022

Table 3 shows the publication of articles in open-access journals. Any article with a version available in the repository identified by Unpaywall is considered to belong to the green aspect. This process contains 18 or 17% green published articles, 5 or 2% green accepted, and 29 or 11% green submitted.

Table 3
The form of publication of articles according to open-access

Form of publication according to openness of access	Record number	Structure in %
All Open Access	69	25%
Gold	40	15%
Gold-Hybrid	3	1%
Free to Read	10	4%
Green Published	18	7%
Green Accepted	5	2%
Green Submitted	29	11%

Source: Author's work, Web of Science (WoS) database; Retrieved 30th January 2022

To determine the frequency of publication of articles in lifelong education by country, an additional analysis of the Web of Science database was carried out. The results are presented in Table 4. It can be noted that 10 or more articles were published in the USA, Canada, England, the People's Republic of China, Spain, Portugal, Russia, South

Korea, Australia and Brazil. Less than 10 articles were published in countries like Ukraine, Poland, Croatia, Greece, Turkey, Czech Republic, France, Slovakia, Slovenia, Chile, India, Italy, Japan, Malta and New Zealand.

Table 4
Representation of the country of origin of the authors of the articles

Countries/Regions	Record number	Structure in %
USA	25	9.2%
Canada	19	7.0%
England	19	7.0%
China	14	5.1%
Spain	14	5.1%
Portugal	13	4.8%
Russia	13	4.8%
South Korea	12	4.4%
Australia	11	4.0%
Brazil	10	3.7%
Ukraine	9	3.3%
Poland	8	2.9%
Croatia	7	2.6%
Greece	6	2.2%
Czech Republic	5	1.8%
France	5	1.8%
Slovakia	5	1.8%
Slovenia	5	1.8%
Chile	4	1.5%
India	4	1.5%
Italy	4	1.5%
Japan	4	1.5%
Malta	4	1.5%
New Zealand	4	1.5%

Source: Author's work, Web of Science (WoS) database; Retrieved 30th January 2022

To further expand the analysis, Table 5 presents the classification of the citation index of the included articles from the field of lifelong education. It can be noted that 176 out of 272 studies, or 64.71%, were published in journals included in the Emerging Sources Citation Index (ESCI), and the journals included in this index cover all disciplines and range from international and interdisciplinary publications to those that provide a deeper regional or specialised area coverage. The following 86 articles, or 31.62%, were published in journals with the Social Sciences Citation Index (SSCI) as a multidisciplinary index that indexes over 3000 social science journals - from 1985 to the present. Furthermore, 9 records, or 3.31%, were published in journals indexed in the Book Citation Index – Social Sciences & Humanities (BKCI-SSH), followed by 4 articles each or 1.47% contained in the Arts & Humanities Citation Index (A&HCI) and Science Citation Index Expanded (SCI-EXPANDED) and 1 research paper or 0.37% of the analysed records published in a journal with the Conference Proceedings Citation Index – Social Science & Humanities (CPCI-SSH).

Table 5
Representation of the citation indexes in which the articles are indexed

Citation index	Record number	Structure in %
Emerging Sources Citation Index (ESCI)	176	64.71%
Social Sciences Citation Index (SSCI)	86	31.62%
Book Citation Index – Social Sciences & Humanities (BKCI-SSH)	9	3.31%
Arts & Humanities Citation Index (A&HCI)	4	1.47%
Science Citation Index Expanded (SCI-EXPANDED)	4	1.47%
Conference Proceedings Citation Index – Social Science & Humanities (CPCI-SSH)	1	0.37%

Source: Author's work, Web of Science (WoS) database; Retrieved 30th January 2022

Identification of the most common research topics

To identify the most common research topics, in addition to the available tools offered by the scientific databases Web of Science and Scopus, the Wordstat tool was also used. For each 272 identified articles, the analysis used the following data: article title, abstract, and keywords.

Analysis of the frequency of occurrence of individual words

Word frequency analysis in publications has long been used to display the knowledge structure of research areas, which is considered a fundamental part of transferring knowledge concepts in bibliometric research and has been widely used to reveal the knowledge structure of study areas (Su & Lee, 2010). The use of frequent word analysis to derive new useful bibliometric indicators/approaches is essential for the continued growth of this subject area (Ding et al., 2001).

A comprehensive overview of common words used in the analysed articles from the field of lifelong education is presented in Table 6. The analysis includes frequency, percent frequency, number of cases, and percent of cases. For example, the word Education appears in 253 articles, in which it appears 1068 times. As shown in Table 6 and indicated by their frequency, Education, Learning, Lifelong, Development, Educational, Research, Study, Social, Adults, and Training are considered the most frequently used keywords in the analysed articles and are the most frequent words in the entire corpus of articles related to along with lifelong education.

Table 6
The most frequently represented keywords in the analysed articles

	Frequency	% total	No. of papers	% papers
Education	1068	2.20%	253	95.47%
Learning	615	1.27%	150	56.60%
Lifelong	568	1.17%	231	87.17%
Development	228	0.47%	99	37.36%
Educational	223	0.46%	107	40.38%
Research	166	0.34%	91	34.34%
Study	162	0.33%	89	33.58%
Social	152	0.31%	84	31.70%
Adult	146	0.30%	51	19.25%
Training	143	0.29%	67	25.28%
Students	136	0.28%	49	18.49%
Knowledge	123	0.25%	64	24.15%
Paper	122	0.25%	77	29.06%

Article	112	0.23%	83	31.32%
Based	112	0.23%	69	26.04%
Teachers	107	0.22%	41	15.47%
System	105	0.22%	55	20.75%
Professional	101	0.21%	33	12.45%
Analysis	96	0.20%	68	25.66%
Higher	95	0.20%	39	14.72%
Society	88	0.18%	62	23.40%
Life	87	0.18%	54	20.38%
Results	87	0.18%	62	23.40%
Work	83	0.17%	62	23.40%
University	75	0.15%	41	15.47%
School	74	0.15%	39	14.72%
Teaching	69	0.14%	28	10.57%
Concept	67	0.14%	38	14.34%
Formal	66	0.14%	31	11.70%
Process	64	0.13%	49	18.49%
Skills	63	0.13%	36	13.58%
Policy	62	0.13%	42	15.85%
Context	61	0.13%	44	16.60%
Economic	61	0.13%	35	13.21%
Quality	61	0.13%	33	12.45%
Model	57	0.12%	31	11.70%
Cultural	56	0.12%	31	11.70%
People	54	0.11%	39	14.72%
Methods	53	0.11%	34	12.83%
Practices	52	0.11%	39	14.72%
Role	52	0.11%	45	16.98%
World	52	0.11%	41	15.47%
Critical	51	0.10%	36	13.58%
Learners	51	0.10%	25	9.43%
Time	51	0.10%	29	10.94%
Approach	50	0.10%	34	12.83%
Policies	50	0.10%	28	10.57%
Humane	49	0.10%	31	11.70%
Age	48	0.10%	21	7.92%
Management	48	0.10%	20	7.55%
Days	47	0.10%	34	12.83%
National	47	0.10%	32	12.08%
Findings	46	0.09%	33	12.45%
Countries	45	0.09%	24	9.06%
Field	45	0.09%	31	11.70%
Part	45	0.09%	32	12.08%
European	44	0.09%	23	8.68%
Important	44	0.09%	37	13.96%
Adults	43	0.09%	27	10.19%
Children	43	0.09%	14	5.28%
Continuing	43	0.09%	25	9.43%
Experience	43	0.09%	24	9.06%
Informal	43	0.09%	22	8.30%
Main	43	0.09%	38	14.34%
Modern	43	0.09%	26	9.81%
Pedagogical	43	0.09%	22	8.30%
Current	42	0.09%	38	14.34%
Information	42	0.09%	32	12.08%

Practices	42	0.09%	29	10.94%
Competences	41	0.08%	14	5.28%
Courses	41	0.08%	22	8.30%
Institutions	41	0.08%	23	8.68%
Audience	41	0.08%	22	8.30%
Purpose	41	0.08%	35	13.21%
Future	40	0.08%	24	9.06%
Teacher	40	0.08%	19	7.17%
Focus	39	0.08%	31	11.70%
Importance	39	0.08%	30	11.32%
After	38	0.08%	30	11.32%
Basic	38	0.08%	27	10.19%
Participation	37	0.08%	28	10.57%
Framework	36	0.07%	31	11.70%
Level	36	0.07%	25	9.43%
Literature	36	0.07%	18	6.79%
State	36	0.07%	29	10.94%
Activities	35	0.07%	25	9.43%
Individual	35	0.07%	32	12.08%
Personnel	35	0.07%	28	10.57%
Problems	35	0.07%	23	8.68%
Active	34	0.07%	19	7.17%
Present	34	0.07%	29	10.94%
Vocational	34	0.07%	15	5.66%
Academic	33	0.07%	26	9.81%
Challenges	33	0.07%	27	10.19%
Programmes	33	0.07%	22	8.30%
Programs	33	0.07%	24	9.06%
Related	33	0.07%	30	11.32%
Author	32	0.07%	20	7.55%
Economy	32	0.07%	21	7.92%
Educators	32	0.07%	24	9.06%
Methodology	32	0.07%	28	10.57%
Order	32	0.07%	30	11.32%
Strategies	32	0.07%	27	10.19%
Aim	31	0.06%	29	10.94%
Assessment	31	0.06%	11	4.15%
Formation	31	0.06%	17	6.42%
Language	31	0.06%	12	4.53%
Processes	31	0.06%	24	9.06%
Technology	31	0.06%	20	7.55%
Case	30	0.06%	24	9.06%
Innovative	30	0.06%	17	6.42%
Opportunities	30	0.06%	28	10.57%
Political	30	0.06%	26	9.81%

Source: Author's work, Web of Science (WoS) database; Retrieved 30th January 2022; analysed using Wordstat Provalis

A word cloud (Heimerl et al., 2014) was generated and shown in Figure 2 to demonstrate the use of the most frequent keywords in the analysed articles on lifelong education.

Figure 2
Word-cloud graph of the most frequently used words in scientific articles on lifelong learning

Source: Author's work, Web of Science (WoS) database; Retrieved 30th January 2022; analysed using Wordstat Provalis

Analysis of the frequency of occurrence of certain phrases

To determine the most frequently used phrases with the frequency of appearance in more than 5 scientific articles in the field of lifelong education, an analysis was carried out in the Wordstat Provalis software (Table 7).

The phrase importance metric values are in the TF*IDF column (Kim et al., 2019), which can be used to estimate the importance of a phrase in a large number of documents (for example, abstracts of all studied patents in a certain field), rather than just one document (for example, an abstract of only one article). As a result, TF-IDF is a measure that allows authors to estimate the importance of a phrase in many studied articles.

Table 7
The most frequent phrases in the analysed articles (5+ articles)

	No. of occurrences	No. of papers	% papers	TF • IDF
European Union	16	9	3.31%	23.7
Older Adults	16	8	2.94%	24.5
Critical Thinking	15	6	2.21%	24.8
Quality of Life	14	8	2.94%	21.4
Poverty Reduction	13	3	1.10%	25.4
Professional Training	12	8	2.94%	18.4
Socio Economic	12	10	3.68%	17.2
Linguistic Personality	11	1	0.37%	26.8
Adult Educators	10	6	2.21%	16.6
Formal and Informal	10	10	3.68%	14.3
Human Capital	10	5	1.84%	17.4
Active Citizenship	9	4	1.47%	16.5
Formal Adult	9	3	1.10%	17.6
Knowledge and Skills	9	7	2.57%	14.3
Labour Market	9	5	1.84%	15.6

Life Long	9	6	2.21%	14.9
South Korea	9	4	1.47%	16.5
Eastern Africa	8	1	0.37%	19.5
United Nations	8	6	2.21%	13.3
United States	8	5	1.84%	13.9
Entrepreneurial Competences	7	1	0.37%	17.0
Future Teachers	7	3	1.10%	13.7
Information and Communication	7	6	2.21%	11.6
Labour Market	7	6	2.21%	11.6
Nonformal and Informal	7	1	0.37%	17.0
Public Education Centres	7	1	0.37%	17.0
Senior Citizens	7	2	0.74%	14.9
Teacher Training	7	4	1.47%	12.8
University Students	7	3	1.10%	13.7
Concept of Higher	6	1	0.37%	14.6
Continuous Training	6	5	1.84%	10.4
Digital Inclusion	6	2	0.74%	12.8
Elderly Learners	6	2	0.74%	12.8
Formative Assessment	6	2	0.74%	12.8
Higher Technical Educational Institutions	6	1	0.37%	14.6
Hong Kong	6	2	0.74%	12.8
Knowledge-Economy	6	2	0.74%	12.8
Lean Production	6	1	0.37%	14.6
Older Women	6	1	0.37%	14.6
Professional Activity	6	4	1.47%	11.0
Professional Concept	6	1	0.37%	14.6
Professional Preparation	6	3	1.10%	11.7
Social Networks	6	3	1.10%	11.7
Ukrainian Language	6	1	0.37%	14.6
Vocational Training	6	3	1.10%	11.7
Young People	6	5	1.84%	10.4
Adult Continuing	5	2	0.74%	10.7
Adult Education Policies	5	2	0.74%	10.7
Adult Learners	5	5	1.84%	8.7
Beginning of Old Age	5	1	0.37%	12.2
Competence Context Model	5	2	0.74%	10.7
Decision Making	5	4	1.47%	9.2
Design Methodology Approach	5	5	1.84%	8.7
Digital Divide	5	4	1.47%	9.2
Economic Competence	5	1	0.37%	12.2
Electronic Portfolio	5	1	0.37%	12.2
Free Time	5	2	0.74%	10.7
Guidelines for Lifelong Education Management	5	1	0.37%	12.2
Human Beings	5	2	0.74%	10.7
Human Rights	5	2	0.74%	10.7
Impaired Learners	5	1	0.37%	12.2
Individual and Collective	5	4	1.47%	9.2
Innovative Business Structures	5	1	0.37%	12.2

Late Life	5	2	0.74%	10.7
Management to Mobilize	5	1	0.37%	12.2
Online Courses	5	4	1.47%	9.2
Professionalism and Professional	5	1	0.37%	12.2
Public Policies	5	5	1.84%	8.7
Questionnaire Survey	5	5	1.84%	8.7
Recent Years	5	5	1.84%	8.7
Scientific Novelty	5	5	1.84%	8.7
Semi-Structured	5	5	1.84%	8.7
Social Cultural Context	5	1	0.37%	12.2
Social Purpose	5	2	0.74%	10.7
Transversal Competences	5	1	0.37%	12.2
University Professors	5	2	0.74%	10.7
Women of Color	5	1	0.37%	12.2
Year College Students	5	1	0.37%	12.2
Youth Work	5	1	0.37%	12.2

Source: Author's work, Web of Science (WoS) database; Retrieved 30th January 2022; analysed using Wordstat Provalis

The ability to compare the frequency of phrases or groups of content in different sources (e.g., journals, countries) or to look for variations over time could be used to track the development of a scientific discipline, the rise and fall of specific ideas or concepts, the process of differentiation of scientific publications, or the geospatial distribution of scientific activities (Provalis, 2022). A schematic diagram was created, shown in Figure 3. to highlight the use of the most popular phrases in the researched lifelong learning publications.

Figure 3
Word-cloud graph of the most frequently used words in scientific articles on lifelong learning

Source: Author's work, Web of Science (WoS) database; Retrieved 30th January 2022; analysed using Wordstat Provalis

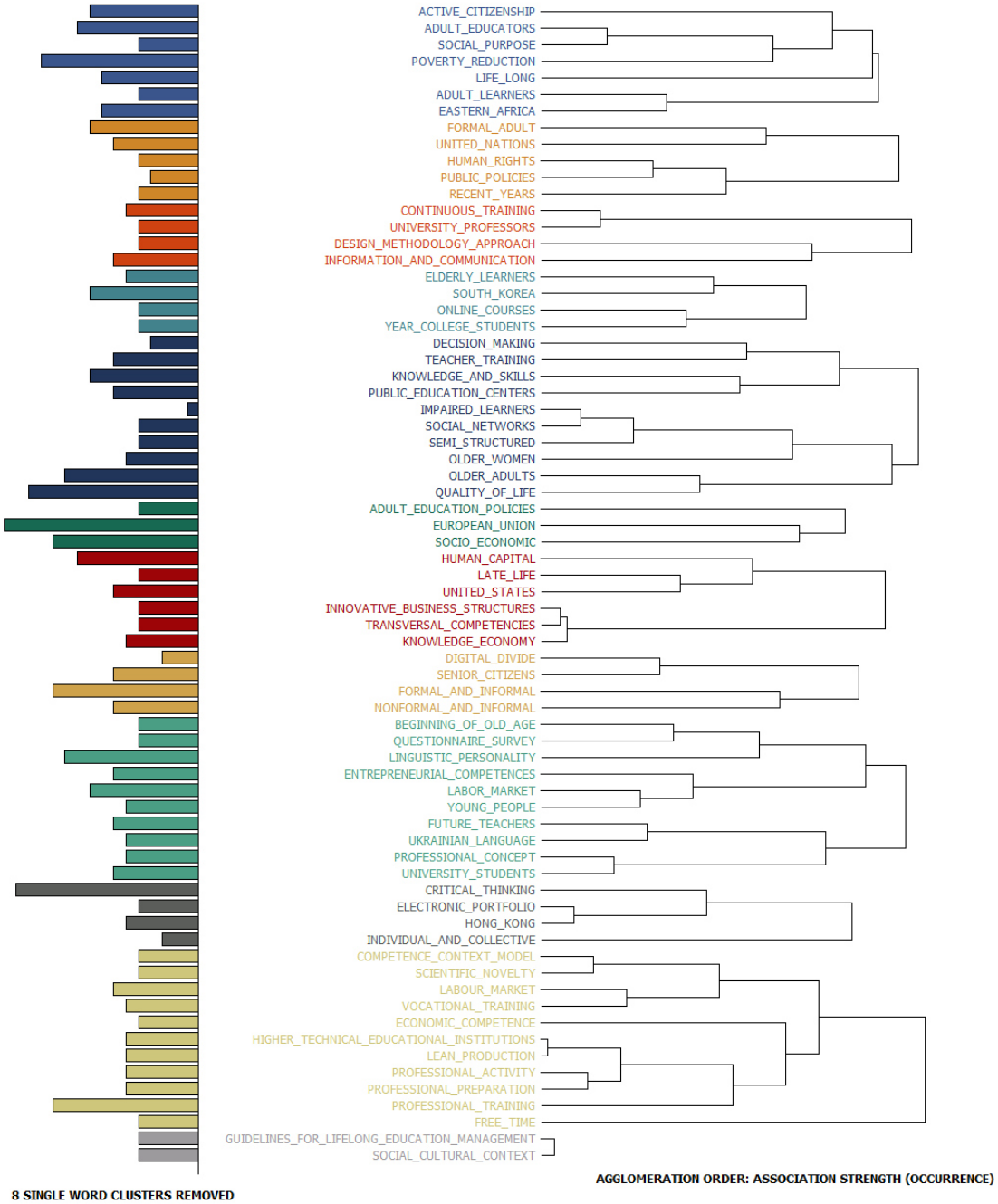
Cluster analysis of selected phrases

Cluster analysis of isolated phrases can be used to identify themes that appear in research on lifelong learning (Chang et al., 2021). Phrases that usually occur together are joined in the first step in the agglomeration process. In contrast, those that are independent of each other or do not appear together are joined later (Provalis, 2022). A cluster analysis was carried out to identify topics related to lifelong education, which identified 12 topics (Figure 4).

Based on the extracted phrases, clusters were generated. The result is displayed as a dendrogram (Eryilmaz et al., 2022). Items are represented on the vertical axis, while clusters created at each stage of the clustering operation are represented on the horizontal axis.

- Cluster 1 includes abstracts of 7 groups of scholarly articles, with the phrases appearing: poverty reduction and active citizenship in East Africa for social purposes; lifelong, adult learners and adult teachers in East Africa.
- Cluster 2 includes abstracts of 5 groups of scholarly articles with co-occurring phrases: public policies and human rights of formal adults in the United Nations in recent years.
- Cluster 3 includes summaries of 4 groups of scientific articles with co-occurring phrases: an approach to design methodology for information and communication and continuous professional development of university professors.
- Cluster 4 includes 4 groups of scholarly articles with co-occurring phrases: online courses for college-aged and senior students in South Korea.
- Cluster 5 includes abstracts of 10 groups of research articles with co-occurring phrases: quality of life and social networking of older adults, older women, and students with learning disabilities using a semi-structured approach; decision-making and teacher training in public education centres using a semi-structured approach.
- Cluster 6 includes summaries of 3 groups of scientific articles with co-occurring phrases: socioeconomic and adult education policies in the European Union.
- Cluster 7 includes abstracts of 6 groups of scientific articles with co-occurring phrases: transversal human capital competencies in late life, innovative business structures, and the knowledge economy in the United States.
- Cluster 8 includes 4 scientific articles with co-occurring phrases: formal and informal, informal and informal, digital divide, and senior citizens.
- Cluster 9 includes 10 groups of scientific articles with associated phrases: determination of language personality of prospective teachers of the Ukrainian language using a questionnaire; research of entrepreneurial competencies and professional concepts of students and young people on the labour market using questionnaires.
- Cluster 10 includes abstracts of 4 groups of scholarly articles with co-occurring phrases: critical thinking and individual and collective electronic portfolio in Hong Kong.
- Cluster 11 includes 11 groups of scientific articles with phrases that appear together: vocational training, vocational training, vocational training in higher technical educational institutions; professional activity and lean production in the labour market; development of competence models and determination of economic competence.
- Cluster 12 includes abstracts of 2 groups of co-occurring scientific articles: guiding lifelong learning management in a socio-cultural context.

Figure 4
Cluster analysis of the most frequent phrases in the analysed articles (5+ articles)

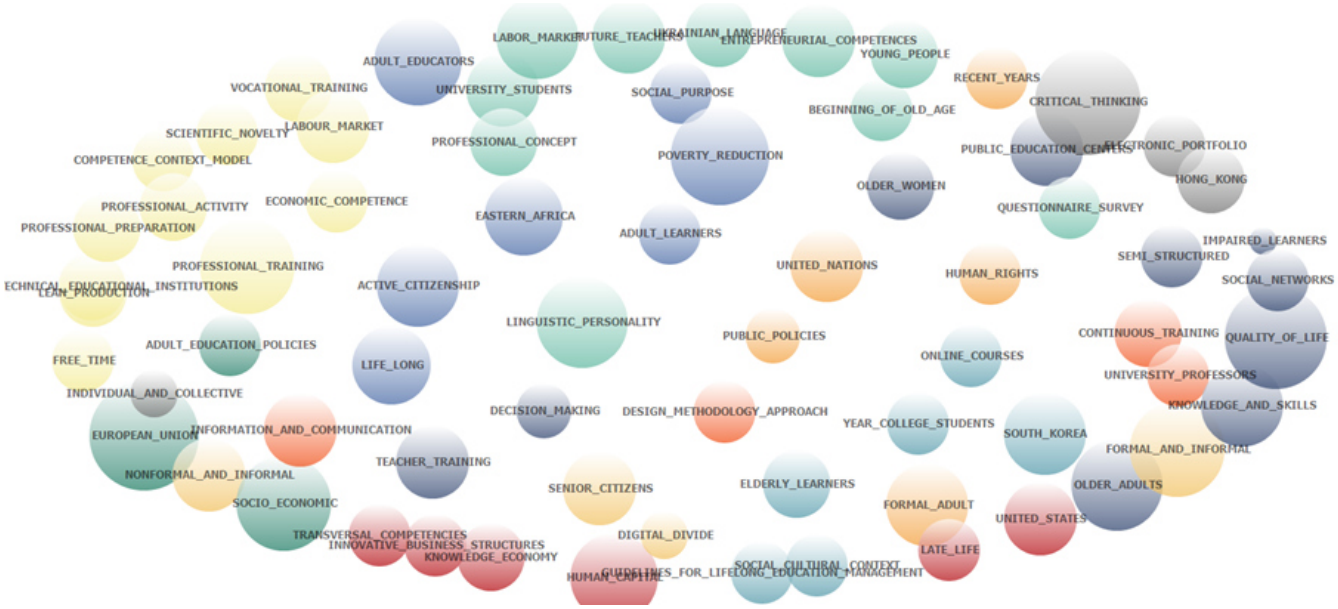


Source: Author's work, Web of Science (WoS) database; Retrieved 30th January 2022; analysed using Wordstat Provalis

Concept maps can represent proximity values calculated for all included keywords using multidimensional scaling (Taricani & Clariana, 2006). A point represents an item (keyword or content category) on the concept maps, and the distances between pairs of items reflect the probability that these items appear together. In other words, things that appear close to each other on the graph are more likely to appear together, while terms or categories that are unrelated or do not appear together are

spread throughout the graph. Colours indicate the belonging of certain items in different hierarchical groups. In this connection, Figure 5 represents 12 previously identified and analysed clusters.

Figure 5
Conceptual map of clusters of the most frequently represented phrases in the analysed articles (5+ articles)



Source: Author's work, Web of Science (WoS) database; Retrieved 30th January 2022; analysed using Wordstat Provalis

Analysis of topics in articles whose subject is a lifelong education

Topic extraction is a key step in bibliometric data analysis, text mining, and knowledge discovery, as it identifies important topics from large groups of scholarly articles (Pejić Bach et al., 2019). Traditional topic extraction systems need human interaction and involve extensive data preparation to represent text collections properly. For this purpose and with a focus on lifelong education, the most common topics were singled out, along with their coherence indicator (Normalized Point Mutual Information - NPMI) and the number or percentage of cases in which they appear (Bouma, 2009).

The results of the analysis are presented in Table 8. Most of the topics are related to the various aspects of learning, such as professional training, technology and time, and higher institutions. Several topics stress various aspects of the subject of lifelong learning, such as sustainability, entrepreneurship, and their balance (Pejić Bach et al., 2023).

Table 8
Topics extracted with Wordstat software

NO	Topic	Keywords	Coherence (NPMI)	Freq.	Cases	% Cases
1	Professional Training	Professional; Teachers; Methodology; Aim; Data; Personal; Pedagogical; Training; Quality; Work; Teacher; School; Practice; Level; Professional Training;	0,306	267	99	37,36%
2	Technology Time	Technology; Time; Main; Assessment; Basic; Information; Innovative; Modern; Economy; Knowledge; Skills; Professional; After; System; Vocational; Information and Communication;	0,165	265	102	38,49%
3	Field Policies	Field; Policies; Strategies; Importance; Practices; Aim; Political; Educators; Economic; Focus; Policy; Adult; Social; Critical; International Journal; Important Role;	0,163	248	108	40,75%
4	Higher Institutions	Higher; Institutions; University; Courses; Innovative; Students; Academic; Future; Present; Knowledge;	0,230	200	75	28,30%
5	Cultural Approach	Cultural; Approach; Personal; Concept; Part; Aim; Methodology; Order; Social; Language;	0,233	136	80	30,19%
6	Pedagogical Framework	Pedagogical; Framework; Context; Author; Part; European; Teaching; Practice; Basic; Challenges; World;	0,232	115	62	23,40%
7	Adults Academic	Adults; Academic; Adult; Teaching; Continuing; Public; Language;	0,126	109	64	24,15%

Table 8 (continued)
Topics extracted with Wordstat software

NO	Topic	Keywords	Coherence (NPMI)	Freq.	Cases	% Cases
8	Quality Of Life Programs	Programs; Age; Life; Activities; Participation; Social; Quality of Life; Older Adults; Young People;	0,195	98	54	20,38%
9	National Countries	National; Countries; Public; Formation; Economy; State; Policies; Main; Level;	0,235	89	51	19,25%
10	Formal And Informal	Formal; Informal; Experience; Adults; Formal and Informal;	0,179	84	38	14,34%
11	European	European; Programmes; Countries; Current; Policy; Strategies; System; Labour Market; Human Capital;	0,161	71	51	19,25%
12	Opportunities Participation	Opportunities; Participation; Learners; Society; Critical;	0,190	60	40	15,09%
13	Competence Model	Competence; Model; Formation; Individual; Approach;	0,202	60	27	10,19%
14	Human Processes	Human; Processes; Management; Current; Order; Related;	0,180	54	32	12,08%
15	Challenges Important	Challenges; Important; Vocational; Assessment; Active; Courses;	0,146	47	33	12,45%

Source: Author's work, Web of Science (WoS) database; Retrieved 30th January 2022; analysed using Wordstat Provalis

Conclusion

Lifelong education is traditionally a research topic investigated within psychology and education. However, lifelong education is important in economics, business, and management.

The Web of Knowledge has been researched with the keywords "lifelong education" narrowed to the papers published in scientific journals in Business, Management, and Economics, resulting in 272 papers. The collected papers have been examined using bibliometric analysis, including analysing the most frequent journals, authors, countries, and funding institutions. The most cited papers have been analysed. The research topics have been investigated using text mining, which revealed the most frequent keywords, phrases, and topics. Provalis Wordstat has been used for content analysis, resulting in clusters of the phrases that occur the most often in the paper titles, abstracts, and keywords.

The most important results are as follows. Most research in lifelong education was published in the International Journal of Lifelong Education, followed by the International Review of Education and Educational Gerontology. A comprehensive overview of common words used in the analysed articles in lifelong education. The analysis includes frequency, percentage of frequency, number of cases, and percentage of cases. The most frequent words occurring in the titles and abstracts of the examined papers are education, learning, lifelong education, development, educational, research, study, social, adult, and training. The most frequent phrases identified are as follows: European Union, older adults, critical thinking, quality of life, poverty reduction, professional training, socioeconomic, adult educators, formal and informal, and human capital.

Cluster analysis of isolated phrases can identify topics that appear in research on lifelong education. Phrases that usually appear together merge in the first step in the agglomeration process, while those that are independent or do not appear together merge later. To identify topics related to the topic of lifelong education, a cluster analysis was conducted, which identified 12 groups of topics. The topics including the largest number of scientific articles are as following: (i) Cluster 1 includes summaries of 7 groups of scientific articles with phrases that appear: poverty reduction and active citizenship in East Africa for social purposes; lifelong, adult learners and adult teachers in East Africa; (ii) Cluster 2 includes summaries of 5 groups of scientific articles with phrases that appear together: public policies and human rights of formal adults at the United Nations; (iii) Cluster 3 includes summaries of 4 groups of scientific articles with phrases that appear together: design methodology, information and communication technologies, continuous improvement, and university professors, and (iv) Cluster 4 includes summaries of 10 groups of scientific articles with phrases that appear together: quality of life and social networking of older adults, older women and students with disabilities using a semi-structured approach; decision-making and in-service teacher training in public education centres using a semi-structured approach.

Bibliometric analysis and topic mining of the articles investigating the topic of lifelong education indicate that the number of papers in this area is increasing, with most papers published in educational journals. The most frequent keywords and phrases indicate that lifelong education is mostly related to the human capital translated into the benefits relevant for adult learners, thus supporting nations' economic and social development.

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