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Technological transformation in HRM through knowledge and training: Innovative business decision making

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ABSTRACT

Human resource management (HRM) is a crucial aspect of the global economy, and there is a wealth of literature available on various aspects of managing human resources. There is a need to take these concepts and turn them into practical applications, and organizations and academic institutions have a vital role to play. By providing training and digital tools to enhance innovation and decision making, these entities can prepare the next generation of human resources and business leaders for the challenges they may face. This is especially relevant in light of the economic impact of pandemics and other unpredictable global events, which can have long-lasting effects on the economy. To address these challenges, a study was conducted to explore the potential use of business game simulators (BGS) as a solution. The results of the study are promising, showing that BGS can enhance pandemic preparedness, increase competitiveness, and provide a more comprehensive organizational viewpoint. To explore this hypothesis, the study used specific constructs, which were subjected to empirical processing and analysis. The results indicate that simulating past pandemics through BGS can help HRM and businesses be better prepared for future crises, and the BGS learning approach can offer a more realistic, global perspective for organizations.

1. Introduction

Despite the amount of existing literature regarding aspects of human resource management (HRM), there is a pending challenge regarding their practical applications. To address some of the digital HRM lacks, organizations and academic institutions can support the next generation of leaders through teaching innovation (knowledge and education) and by providing digital and learning tools to improve their digital HRM and business decision-making patterns, reinforcing their gaps to minimize the long-term economic impact of pandemics. Although core research is motivated within a pandemic environment, owing to the overall identified benefits of business game simulators (BGS), the outcomes can be extrapolated to a broad range of business scenarios and dynamic environments.

The concept of BGS has been studied for years by numerous authors, academic institutions, and companies (Faria, 1998, 2001; Faria and Wellington, 2004; Gawel et al., 2022; Labonte-LeMoyne et al., 2017; Samin et al., 2021), and the extensive literature has demonstrated a generally positive response in terms of participants' learning skills, generic and soft skills (Kim et al., 2018; Levant et al., 2016; Mohsen et al., 2019; Ogunrinde, 2022), and better cognitive comprehension (Gatti et al., 2019), among other positive qualities (Arias-Aranda and Bustinza-Snchez, 2009; Strachan, 2016).

These results are consistent among academic institutions combining BGS with a theoretical teaching style (Gawel et al., 2022; Morin et al., 2020) and among in-company training for current and new employees, which is considered to be relatively low-cost and complex.

The coronavirus 2019 (COVID-19) pandemic took the whole of society, business, and industries by surprise, leading to a global economic recession (Carlsson-Szlezak et al., 2020; Wren-Lewis, 2020) within Industry 4.0's digital transformation context and fierce competition among small and medium-sized enterprises (SMEs) requiring innovation, talented employees, and frequent strategic actions to sustain their market share (ONTSI, 2019, 2021c, 2021a, 2021b).

The existing literature indicated that BGS have proven to be a relatively easy digital tool to motivate students and keep them engaged,

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where, due to their gamification factors (Hamari et al., 2016; Jacob et al., 2022; Lin et al., 2018; Samin et al., 2021), it not only fosters competitiveness but also involves team building, as the participants have to cooperate and make decisions within a collaborative environment where all business areas are related and decisions are connected (Capelo et al., 2021; Hernández-Lara et al., 2019a; Hernández-Lara et al., 2019b). As noted by the existing literature, these outcomes depend on the depth and simulated scenario complexity (Moran et al., 2018; North-Samardzic and de Witt, 2019), as they can be of multiple types, with some authors classifying them by the number of business decisions or by the target subject matter (A. J. Faria et al., 2009; Greco et al., 2013; Grijalvo et al., 2022; Machado Leitão et al., 2021; Pascual-Miguel et al., 2016; Ramirez and Rivera, 2022; Thavikulwat, 2004; Zhang, 2022): financial, marketing, investments, and management operations, among others.

However, the idea of using simulation tools is not limited to education, as companies have always tried to forecast the future and assess the impact of their decisions by using specialized enterprise systems software (Subsorn and Singh, 2007), such as decision support systems (DSS) and Executive Support Systems (ESS), which, based on the company's collected information, forecast the expected evolution in conjunction with the established environment parameters, generating reports and charts with the expected results, in order for management staff to make the appropriate decisions (Asemi et al., 2011; Hernández et al., 2012).

Therefore, this study is motivated by a double gap in the existing literature, where there could be a possible link regarding the potential use of BGS against unpredictable environments affected by economic recessions, harsh globalization, pandemics, and complex decision-making processes within unknown constraint factors, due to the known practical uses of BGS in HRM education.

Furthermore, although it is already known that BGS are widely used in academic and in-company environments and that DSS are used by organizations to improve their digital HRM and decision-making processes, a link between the positive impact of the pandemic context and the use of BGS could be established.

Following the recommendations and orientations of existing literature, the premise of the BGS as a pedagogical instrument has been tested following an empirical methodology, on the basis of quantitative research of a 30-item evaluation questionnaire based on a 5-point Likert scale (Dittrich et al., 2007; Taherdoost, 2019; Yockey, 2018), within an *ex-ante* and *ex-post* ("before and after") approach (Adamowicz and Pyra, 2019; Camacho et al., 2019), targeting an estimated group of 400 participants from the Economics undergraduate, master, and PhD faculties at the University of Alcalá. The sample is considered to be highly representative and valuable since the faculty environment comprises all the relevant aspects regarding business innovation and education (Coleman and Blankenship, 2019; Faria, 1998; Faria and Wellington, 2004; Strachan, 2016), obtaining a total of 95 valid samples.

These dependent variables were added to specific constructs for further empirical processing and analysis. In a first stage, the research sets the currently perceived business and academic situation as a baseline, as described by the existing literature within the theoretical framework, to be contrasted with the perceived use of BGS. By contrast, in a second stage, the study examines the actual relationship of the BGS applications within pandemic scenarios, decision making, and education to determine if the hypotheses are supported.

The research includes an introduction section explaining the original prepandemic situation, where society, businesses, and the academic community had to act. These aspects are further portrayed under the theoretical framework and literature section, which contains a detailed and comprehensive analysis of the current gaps, the novelty of the study, and baseline literature that supports the formulated hypothesis. The methodology section explains how the analysis is going to be conducted, together with the actual analysis and results section, which details the outcomes of the applied statistical analysis. Finally, the conclusion section highlights the obtained findings, their theoretical and practical implications, their limitations, and possible future lines to follow.

2. Theoretical framework and literature review

2.1. Theoretical framework

This study is based on data collected from a wide range of official sources in conjunction with extensive literature research work, examining current and previous known pandemics regarding their impact on businesses, how companies approach their decision-making process, and the BGS implications as a pedagogic tool in HRM.

As a consequence of this process, it was noticed that these subject matters have been systematically addressed following empirical research methodology (Bitrián et al., 2020; Buil et al., 2018; Isabel Buil et al., 2020; Camacho et al., 2019; Domínguez et al., 2013; Faria, 1998; Y. Y. Wang et al., 2020), using qualitative, quantitative, or a combination of both methods, promoting and involving the direct participation of students, academic personnel, or private sector employees, to obtain accurate feedback and datasets for the subsequent analysis.

The research pursues existing literature recommendations and orientations and establishes a theoretical framework (Fig. 1) following a similar empirical methodology based on a quantitative approach by means of a form-based questionnaire. Inherently, the quantitative approach provides some key advantages, such as clear and measurable results; however, it also provides some limitations as compared with a qualitative approach that could cover a wider area of research and provide more insights due to the unstructured patterns. However, a qualitative method has its own disadvantages, as it requires more data cleaning and processing and leaves space for a broader interpretation of results.

To obtain the necessary samples that determine the support of the formulated hypotheses, multiple authors indicate the relevance of business schools as a suitable area of study (Coleman and Blankenship, 2019; Faria, 1998; Faria and Wellington, 2004; Strachan, 2016) where all business aspects are discussed and innovation and entrepreneurship are encouraged throughout the entire academic curriculum.

2.2. What is already known

This pandemic crisis impacted society as a whole (Albulescu, 2020; Michie, 2020; Wren-Lewis, 2020), affecting cross-country migration boundaries (Chakraborty and Maity, 2020) and movement restrictions (Chinazzi et al., 2020), from individuals' episodes of depression (Belzunegui-Eraso and Erro-Garcés, 2020) and forced social distancing (Ahorsu et al., 2022; Shader, 2020) to businesses pulled into an economic crisis (Fernandes, 2020; Goodell, 2020) whose employees are forced into teleworking (Song and Gao, 2020) or business shutdown (Lacomba Pérez, 2020); and governments were forced to deploy Universal Basic Income to face the impact on households (Díaz, 2020; Gorjón, 2019), pushing the entire community into unknown scenarios. Hence, decisions must be made to ensure long-term economic sustainability, from economical decisions to education as a way to prepare society and managers for a future business context that will be more unpredictable and global than ever (Baker et al., 2020; Troilo, 2023).

Extensive literature research covering national- and international-specific studies has been done regarding the effects of pandemics on the economy and society, decision-making processes within businesses, and the evaluation of BGS in education to identify the positive and negative aspects (Table 1) that could be further linked together as the pillars on which the hypotheses of the BGS framework will be verified.

2.3. What is not yet done

The novelty of this study is to check if the combination of (1) pandemics' effects on the economy and society, (2) decision-making processes within HRM and businesses, and (3) BGS in education could be

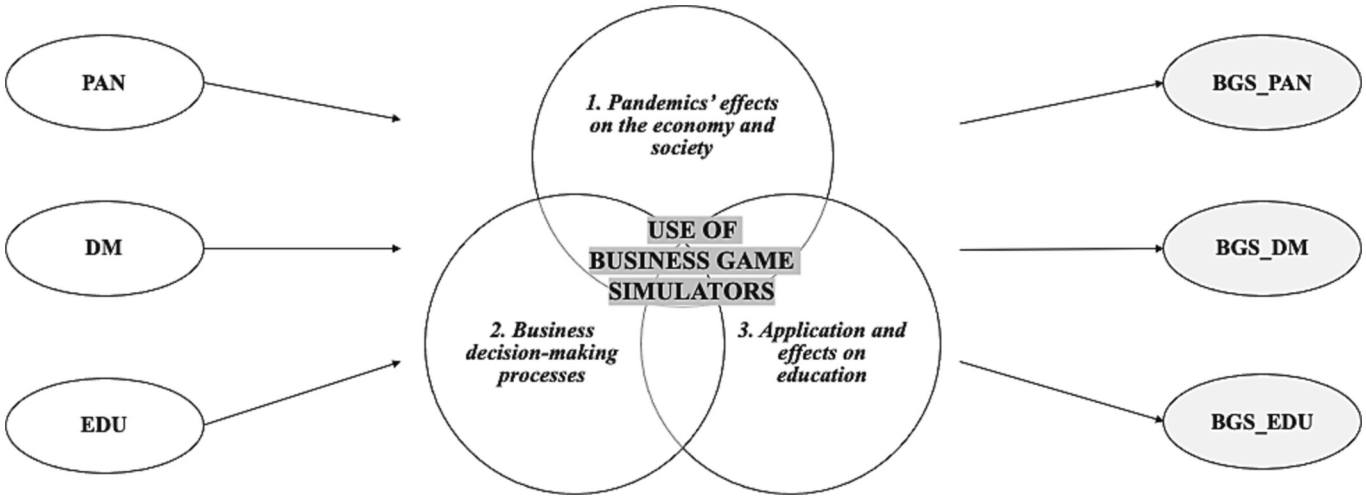

Fig. 1. Evaluation methodology. Own elaboration.
Note: PAN, pandemic; DM, decision making; EDU, education; BGS_, business game simulator.

Table 1
Literature review model. Own elaboration.

Literature review		
1. Pandemics effects on the economy and society	2. Decision-making processes within businesses	3. Business Games Simulators (BGS) in education
How are countries and businesses vulnerable to economic recessions? What management and economic decisions need to be taken? Have pandemic risks always been there? What was done? Are any technology investments required? How do pandemics affect people and the economy? Does teleworking have any impact on employees or the business? Is globalization a weakness? How does business react in unpredictable environments?	How did businesses reduce risks? What are enterprise systems? What uses and architectures can be applied to a business? What are DSS? What are ESS? Why are they considered relevant for business? Do enterprise systems begin a commoditization process? Are there any technological links to Industry 4.0 or Logistics 4.0?	Why are BGS interesting for education and companies? What are the implications of a good BGS design? What benefits does BGS provide to education? Are there any relevant skills? How does BGS gamification maintain motivation? How does BGS manage to engage participants? Can BGS enhance personal aspects such as self-esteem or leadership? How can BGS help with decision-making aspects? Do the practical aspects of BGS provide any employability skills?

linked to verify if they could deliver any significant improvement regarding the identified gaps in addition to the established theoretical foundation, by formulating the following hypothesis:

HBGS. The use of the BGS business decision framework as a pedagogic instrument in HRM has the potential of (a) providing new insights within pandemic scenarios, (b) facilitating decision-making processes, and (c) improving students' overall knowledge, motivation, and skills.

2.4. Pandemics' impact on the economy and businesses

2.4.1. Countries and businesses vulnerable to economic recessions

Businesses, by their nature, regardless of their legal form, have always been exposed to environmental uncertainty factors (Gupta, 2013), such as fierce competitors, customers increasing demand and expectations, suppliers and providers, legal aspects, cybersecurity attacks, and even natural or human disasters. This forces them to make decisions and adapt every day to continue operating.

These factors are not easy to predict and may have a deep impact on business activity, as witnessed by the 2008 Global Economic Recession as "the worst recession in the last 80 years" (Economist, 2013) due to the subprime crisis of banks in the US financial markets (Eichengreen et al., 2012), which led to the loss of global consumer buying power (Dees and Soares Brinca, 2013), which caused lower incomes for companies and left them unable to meet their financial obligations, leading to the termination of their activity and causing unemployment, reducing the overall buying power (Voinea and Filip, 2011). Major European countries, such as Spain, Italy, Portugal, and Greece, considered pillars of the EU economy, had to go through tough economic adjustments to revert the negative balance of the recession on the population and business activities, but the consequences are still visible, and some sectors, such as services or bricks and mortar, have not yet been able to recover to precrisis levels (Kobrin, 2017).

2.4.2. Latent risks of pandemics

Some factors, such as those that are health-related, have normally been underestimated as they tend to come and go, affecting some specific industries or regions without having any initial major impact on the global economy. Some of the most recent and recognizable examples (World Health Organization, 2018) are the following: AIDS/HIV (1980s until the present), mad cow disease (1990s until the present) (Campbell, 2006), SARS (2002) and MERS (2012) (De Wit et al., 2016), avian flu (2003) (Lycett et al., 2019), swine flu (2009–2010) (Wheaton et al., 2012) and Ebola (2014–2016) (Judson et al., 2015). Some of these have caused a significant number of human fatalities, and others have produced major economic losses from dumping (normally incinerating) millions of affected animals and their derivative products. Some countries still maintain a ban on meat from particular regions (Food and Agriculture Organization, 2020). Owing to globalization, an issue in the origin of the third country causes a crisis in local businesses. Most companies have recovered, and some have had to change their business model or face closure. In any case, they had to make hard decisions.

Despite these negative aspects, to adapt to the new environmental threats, opportunities, weaknesses, and strengths factors, as well as to ensure their long-term survival, many businesses have successfully managed to take the appropriate decisions (Giesen et al., 2010; Saebi et al., 2017), such as making their business model leaner, diversifying providers, addressing different customer segments, making strategic investments, and reducing part of the workforce or activity, as some

examples; but this would not have been possible without adopting technology as the pillar of future environmental and economic sustainability.

2.4.3. Technological investments

The investment in digital enablers, part of the so-called Industry 4.0 (De Lucas Ancillo et al., 2022; Gaiardelli et al., 2021; Martinez et al., 2022; Zhou et al., 2016) and Logistics 4.0 (Barreto et al., 2017; Cao et al., 2021), such as the Internet of Things, cloud computing (CC), private and public 5G networks, 3D printing, and artificial intelligence (AI) software tools, can accelerate the digital transformation of the business model with highly disruptive potential, such as the circular economy, where consumer habits and how demand is met change radically (Ata et al., 2022; de Lucas Ancillo and Gavrila Gavrila, 2023; Ghisellini et al., 2016; Lee and Lee, 2020; Murray et al., 2017) for any type of industry or sector, providing new economic opportunities (Gavrila Gavrila and De Lucas Ancillo, 2022; Moreira et al., 2018; To and Chau, 2022). Fortunately, nowadays, there is an enormous abundance of literature in the form of books and research, as many authors have collected these proven and successful solutions and have made them available so that anyone or any organization can easily access and apply them themselves (Tagscherer and Carbon, 2023).

2.4.4. Pandemic economic and social crisis

Unfortunately, an underestimated virus spread and paralyzed the world by forcing population confinement measures on a scale never seen during peacetime. These measures had a direct impact on social, commercial, and productive aspects with unquantifiable losses in the global economy (Nicola et al., 2020), causing multiple unpredictable side effects (Belso-Martínez et al., 2020; Carlsson-Szlezak et al., 2020; Elia et al., 2022; Gavrila Gavrila and de Lucas Ancillo, 2021; Wren-Lewis, 2020), such as panic buying, stockpiling of food, crashes in demand for nonfood products, supply shortages, unemployment in the service sector and staff shortages in the agricultural and medical sectors, direct business activity cutovers, and a large number of fatalities, which still continue to rise worldwide.

To palliate the negative effects on the economy, some governments, such as that in Spain, in addition to the tax relief policy, have created special economic help for households, such as the Basic Universal Income (Díaz, 2020; Gorjón, 2019), and subsidized temporary unemployment wages for companies whose business activity was cut, to preserve their employees at the prospect of resuming operations as soon as possible (known as "ERTE") (Lacomba Pérez, 2020).

2.4.5. Teleworking impact

Employees who kept their jobs and businesses that maintained their activity, especially those in the service sector, were forced not only to adapt to the pandemic safety measures, but also, due to the limited deployment of information and communication technologies (ICTs) in Spain (ONTSI, 2019, 2021c, 2021a, 2021b), they had to embrace and rapidly cost all sorts of new communication technologies that enabled them to perform their work remotely (Belzunegui-Eraso and Erro-Garcés, 2020; de Lucas Ancillo et al., 2021; Pazzanese and Writer, 2021; Rimbau, 2020; Santana and Cobo, 2020; Vecchi et al., 2021).

2.4.6. Globalization as a weakness

Globalization and the development of international trade connect markets and create a global network of business and opportunities. Over time, as part of normal business practices to reduce costs, increase production, or gain access to more competitive goods and services, companies have expanded trade and outsourced their business to third-party countries such as China or India. However, in recent years, this process has accelerated. To balance the negative effect of economic recessions on their local markets and with more mature technological conditions (Kaplan, 2009), such as access to high-speed internet, computers, and ICT education (Baldwin, 2017), businesses saw the opportunity for internationalization and globalization of their activities (Wiersema and Bowen, 2008), allowing companies to continue producing or importing from remote suppliers or directly from manufacturers at lower costs.

Again, owing to the scarce information regarding the initial pandemic outbreaks, all countries underestimated its impact and considered it a simple Chinese domestic health issue. As mentioned by the OECD (OECD, 2020), not only is the Chinese economy at risk but also the global economy, as since the last economic recession, globalization and outsourcing have created strong commercial links. However, they resulted in a highly vulnerable system in which the pandemic has been disrupting all established supply chains (Luca and Martin, 2020), where the weakest link potentially can break the whole system, where shortages of raw materials, insufficient manpower, or production disruptions can create significant challenges for all parties involved.

2.4.7. Business model changes in unpredictable environments

Soon after the World Health Organization declared it a global pandemic issue, China initiated the confinement of millions of citizens to reduce exposure to the virus. This drastic measure inevitably led to a temporary production shutdown, affecting virtually all industries, from services and goods exchange to medical, aeronautics, and automotive. What was considered an initial domestic healthcare crisis generated an unpredictable environment for businesses in importing countries (Goodell, 2020; McKibbin and Fernando, 2020). A good example is the production and supply of medical face masks and personal protective equipment (M.W. Wang et al., 2020; World Health Organization (WHO), 2020). Since most of the production was outsourced to China, the pandemic caused a worldwide shortage of supplies, increasing prices almost exponentially due to high demand and low availability. Many businesses tried to cover the lack of supplies by starting local production, but unfortunately could not keep up with demand. A similar situation occurred with medical devices for assisted breathing, where multiple automotive manufacturers across Europe (Mahase, 2020) had to temporarily switch their production lines to develop those devices to cope with the needs of hospitals.

Therefore, inevitably, businesses were forced to live under ever-unpredictable environmental factors and adapt their business models to survive these stressful situations, formulating the following hypotheses:

H1a. Businesses can learn from previous pandemic scenarios.

H1b. Businesses can learn from previous economic crisis scenarios.

H1c. Businesses always need to adapt to unpredictable environmental factors.

H1d. Businesses are forced to make multiple management and economic decisions.

2.5. Decision-making (DM) processes

2.5.1. Businesses have always sought to reduce risks

Companies, as part of their daily business operations, are confronted with the challenge of DM regarding internal and external aspects (Desyatirikova et al., 2017; Fang and Marle, 2012), such as investments, financial decisions, human resources decisions, marketing decisions, competitors' market share, or even internationalization aspects. Therefore, a top priority for any organization is to minimize any impact, risk, or uncertainty arising as a result of those decisions that have relative significance to the survival of the business itself.

Since businesses are managed by human beings, some authors indicate that they are inherently susceptible to the same mistakes (Culkin and Smith, 2000; Musso et al., 2020) and psychological factors (Sadler-Smith, 2016; Santos and Dacorso, 2016): the higher the number of options, the more difficult it is to make a choice; the higher the degree of uncertainty, the more likely it is to underestimate the risks involving the

decision; and often they are biased by feelings, sometimes called "intuition," among others.

Therefore, the software industry has developed specialized solutions to support companies in their DM processes (Subsorn and Singh, 2007), adapting them to the particular characteristics and requirements within each department and business model. While some solutions consist of simple spreadsheet software used to perform rapid calculations, such as accounting purposes, other solutions have a higher degree of complexity, known as enterprise systems (ES), composed of multiple on-premise installed hardware elements such as servers and workstations, which integrate financial information, human resources information, sales, marketing, and even warehouse and product inventory aspects.

2.5.2. Use of ES

According to the relevant literature regarding ES, they can be classified into four major categories, each with the required level of information for each employee (Asemi et al., 2011; Hernández et al., 2012). Transaction Processing Systems (TPS) is the entry level and is in charge of simply registering the business activity generated by events such as economic transactions or product stock. Management Information Systems (MIS) are in charge of providing useful insights to middle management regarding the current and historical activities within the TPS so that they can have a full picture of the business activity, such as quick reports regarding incomes, product defects, customer-opened issues, HR issues, sales, or marketing aspects. DSS provide support to middle and senior management who are required to act, such as buying, selling, or establishing a score rating, within preestablished decision model factors, such as going ahead with an operation if the customer score is above an established threshold. Finally, at the top level, the ESS provide senior management with the necessary tools to freely create customized queries on the organization's databases to elaborate on forecasts and simulations.

From a business DM process point of view, the success of the DSS and ESS consists in the actual modeling of the business based on the information extracted from the data generated by the daily activity within TPS and MIS, such as transactions with customers, providers, or manufacturers, sales data, marketing campaign data, internal human resources data, internal knowledge generation, and communication exchanges between employees.

2.5.3. DM cases within businesses

ES, specifically DSS and ESS solutions, were first introduced in the 1970s (Shim et al., 2002) and were used by businesses for better DM on the basis of some preconfigured parameters that mimicked specific business aspects. Over the years, the algorithms and technology have improved, but the overall concept remains unchanged. An example of DSS implementation would be the bank rating system (O'Donoghue et al., 2014; Rigopoulos et al., 2008; Yung-Hsin and Ta-Hua, 2010), which would mix information provided by the customer, such as utility bills or mortgages, internal bank information, such as configured risk parameters, and environmental information, such as expected interest rates, to calculate a credit score that would either provide or deny the financial product to that particular customer. This helped bankers identify opportunities and focus on their activity by removing part of the human error. On the other side, the ESS implementation would support what-if DM, empowering managers to perform several nonstructured queries and compare outcomes, such as based on the average salary information, what would be the optimal location for another branch? However, such systems often tend to be extremely expensive and require a high degree of business expertise, dedicated management staff, dedicated IT teams, well-qualified managers, etc. Therefore, small businesses simply cannot afford them, and operations often require several hours or even days to be simulated, given the high amount of processing power required to model all the business aspects.

2.5.4. Commoditization of ES

Some incipient research envisioned the future ES architectures integrating some sort of intelligence service that could quickly extract the information from the data generated by business activity (Nemati et al., 2002), as well as their transitions from proprietary and closed technologies toward a web-based approach (Bhargava et al., 2007), allowing an open integration with clients and suppliers while leading to leaner and more agile software development cycles. Moreover, in recent years, DSS and ESS systems have started to attract businesses' attention since CC technology has achieved a sufficiently mature level to become a mainstream tool capable of delivering AI and machine learning (ML) services (Crespo-Perez and Ojeda-Castro, 2017), providing them with innovative solutions that shift the paradigm of the DM process to a data-driven DM process (Awasthi and Pandita, 2019).

Thanks to the use of web technologies and CC, software providers have launched multiple affordable subscription-based, user-friendly interfaces and feature-focused solutions that could mean the democratization of DSS and ESS in the long term within SMEs, as now they could instantly integrate with cloud solutions without any need to invest in any on-premises hardware installation (Benatia et al., 2016), thereby allowing businesses to focus on their objectives rather than spending time on acquisition processes. These rapid cloud solutions can be virtually implemented for any kind of business type, from agricultural purposes, where they combine data from sensors with Geographical Information Systems (Manna et al., 2020; Matthews et al., 2005), to medical purposes (Rubino et al., 2020).

2.5.5. Technological links to Industry 4.0 and Logistics 4.0

Some researchers point out (Abd Rahman et al., 2020; Doltsinis et al., 2020) that the use of ES within the Industry 4.0 environment has tremendous potential in businesses due to their "Data Lakes," which contain any kind of structured or unstructured data generated by digitalized business activity, and the Industry 4.0 digital enablers (Guo et al., 2020), such as Internet of Things sensors, robots, AI, ML, or incipient 5G connected devices, which still have not been fully exploited. Businesses can process that data by means of commercial ES implementing AI and ML algorithms (Demirkan and Delen, 2013) and collect new insights and identify variables, constraints, and opportunities usually overlooked by the company, resulting in better DM simulations or forecasting of solutions.

Therefore, after analyzing and understanding the vast literature regarding how businesses have tried to improve their DM process, the following hypothesis has been formulated to address their applicability in a pandemic situation:

H2a. Businesses have always looked to reduce risks.

H2b. Reducing the uncertainty level could help businesses in their DM processes.

H2c. Investments in ICTs could help businesses in their DM processes and competitiveness.

H2d. Businesses are forced to make fast management and economic decisions.

2.6. Education aspects

2.6.1. Definition of BGS

Following the published literature, the principle of using BGS for education purposes, regardless whether within higher education or in-company training, is not completely novel, given the fact that the available studies have established military war games throughout history as the incipient origin of the BGS (Eilon, 1963), while setting the decade of the 1950s as the beginning of the "modern business game," and by the 1980s, approximately 228 known BGS were documented within "The Guide to Simulation" (Zuckerman, 1970).

These dynamic role-play games normally consist of a set of rules

mimicking real-life environment constraints, such as "maximum budget for an investment" or "existing financial issues," and a set of objectives equivalent to business management decisions, such as "deploy a marketing campaign using the available budget" or "launch a new product on the market," that the player or group of players, normally acting as "the business or department managers," need to achieve in the most efficient manner.

The player or group of players would then go through a DM process regarding their available options within that set of constraints and would expose, either verbally, in writing, or electronically on a computer, their optimal solution following their calculated risks. These solutions are normally open; however, the purpose of the BGS is to maximize the beneficial outcomes while reducing the operation risks, and ideally, the game would be orchestrated in a multiplayer session to generate a competitive environment between players who are challenged to achieve the highest score to win.

2.6.2. BGS use cases

Multiple studies have observed that BGS are widely available and used across a variety of higher education level subjects, covering virtually every aspect of a business, such as marketing, finance, accounting, management, and business policy (Faria, 1998, 2001; Faria and Wellington, 2004). Other authors, owing to the observed high potential regarding DM analysis, validation, and holistic thinking, have foreseen the massive use of BGS in real businesses as part of companies' human resource training and preparation (Forssén and Haho, 2001; Piskurich, 1993), citing major corporations such as IBM and General Electric, among others, which indicate an overall positive acceptance and enhanced experience among their employees.

Given the fact that BGS have always generated a considerable amount of interest within the academic community, a broad spectrum of literature has been produced addressing many interesting aspects regarding the fitness of BGS for educational purposes. To avoid repetition of the vast and extensive BGS literature, the relevant studies for this article have been summarized in Table 2: (1) why BGS are attractive for academics and businesses in terms of skills, achievements, and performance; (2) the design of a BGS in terms of its structural architecture and the technologies that support its deployment; (3) BGS uses in education-related aspects regarding learning achievements, generic skills, and soft skills; (4) gaming aspects on how motivation affects learning acquisition and how gamification can act as a strong motivator; (5) engagement aspects on improving the learning experience and learning adherence; (6) leadership and self-esteem aspects as a side-effect of the practical activities' trust and confidence; (7) DM aspects from practicing using real-life scenarios and situations; and finally, (8) employability skills due to the acquired practical competences on the matter.

Therefore, after the extensive literature analysis regarding the use of BGS, the following hypotheses have been formulated to address its fitness within the educational context of a pandemic situation:

H3a. Students value experiencing hands-on aspects.

H3b. Students need motivators to succeed in the subject.

H3c. Students' learning process involves the development of self-esteem and leadership skills.

H3d. Students expect real-life, connected situations rather than theoretical examples.

3. Research methodology

3.1. Methodology and structure

The premises of BGS have been tested following an empirical methodology on the basis of quantitative research, as supported under the theoretical framework section (Bitrián et al., 2020; Buil et al., 2018; Buil et al., 2020; Camacho et al., 2019; Domínguez et al., 2013; Faria,

Table 2
Business game simulators reviewed literature. Own elaboration.

References	Methodology	Main outcomes
Why are BGS interesting for education and companies?		
(Y.Y. Wang et al., 2020)	Empirical research	The use of BGS indicates positive effects on student concentration levels and overall learning achievements.
(Arroteia et al., 2021)	Empirical research	The use of BGS in higher education and business training indicates a positive effect on students' academic performance.
(Gatti et al., 2019)	Empirical research	The use of BGS indicates positive effects regarding the development of critical thinking skills.
(Hernández-Lara et al., 2019a; Hernández-Lara et al., 2019b)	Empirical research	Students who used BGS appreciated the positive benefits regarding information processing, DM, teamwork, uncertainty management, and negotiation skills.
(Buil et al., 2018)	Empirical research	The use of BGS indicates positive effects on students' generic skills, learning achievements, and satisfaction.
Design of BGS aspects		
(North-Samardzic and de Witt, 2019)	Empirical research	Incremental BGS-level design is directly related to student engagement. Some BGS solutions can be deployed as part of the existing Learning Management System.
(Bocciarelli et al., 2017; Wallace et al., 2010)	Empirical research	Cloud technologies appear to facilitate the deployment of BGS solutions. BGS solutions could integrate ML capacities to create dynamic variable scenarios.
(Faria et al., 2009; Greco et al., 2013; Pascual-Miguel et al., 2016; Thavikulwat, 2004)	Literature research	BGS designs are extremely flexible and can accommodate any type of academic curriculum.
BGS uses on education aspects		
(Morin et al., 2020)	Empirical research	The use of BGS, in addition to engagement and motivation, combined with a flipped-classroom teaching style, indicates positive effects on students' learning achievements.
(Mohsen et al., 2019)	Empirical research	Students who used BGS appreciated the positive benefits regarding cognitive comprehension, generic skill development, and motivation.
(Levant et al., 2016)	Empirical research	Students who used BGS appreciated the positive benefits regarding the development of soft skills, such as communication, leadership, or teamwork.
(Mayer et al., 2011)	Empirical research	Students who used BGS perceived a higher transfer of learning as compared with traditional theoretical learning styles.
(Xu and Yang, 2010)	Empirical research	Students who used BGS perceived positive benefits regarding problem-solving and DM skills.
Gamification aspects		

(continued on next page)

Table 2 (*continued*)

References	Methodology	Main outcomes
(Gatti et al., 2019)	Empirical research	The BGS gamified experience appears to improve students' motivation and cognitive skills outcomes.
(Kim et al., 2018)	Book	BGS gamification applied to education appears to provide positive student performance in curriculum achievement and both generic skills and soft skills development.
(Hamari et al., 2016)	Empirical research	The use of BGS and gamified experiences appears to positively enhance the comprehension of complex concepts and strategies.
Engagement aspects		
(Isabel Buil et al., 2020)	Empirical research	BGS is a useful tool to dynamically engage students in the learning process.
(Moran et al., 2018; North-Samardzic and de Witt, 2019)	Empirical research	Incremental BGS-level design is student engagement.
(Lin et al., 2018)	Empirical research	The use of BGS under collaborative group dynamics appears to positively enhance students' learning performance.
(Hamari et al., 2016)	Empirical research	The use of BGS and gamified experiences appears to positively enhance students' learning engagement.
Leadership aspects		
(Henriksen and Børgesen, 2016)	Empirical research	The use of BGS indicates positive effects on students' leadership skills and is beneficial for the students in conjunction with their theoretical learning style.
(Salas et al., 2009)	Empirical research	The use of BGS dynamics indicates positive effects on students' leadership skills as compared with knowledge-based training methods.
(Arias-Aranda and Bustinza-Snchez, 2009)	Empirical research	Students who used BGS perceived positive benefits regarding self-control, self-esteem, and conflict management.
DM aspects		
(McNamara and McNamara, 2019)	Empirical research	The use of immersive BGS scenarios, such as start-ups like business decisions, indicates positive benefits regarding DM skills.
(Sugahara and Lau, 2019)	Empirical research	The use of immersive BGS scenarios, such as general management decisions and accounting training, indicates positive benefits regarding DM skills.
(Moran et al., 2018)	Empirical research	The use of immersive BGS scenarios, such as accounting training, indicates positive benefits regarding DM skills.
(Fuchsberger, 2016)	Empirical research	The use of BGS under collaborative group dynamics indicates positive benefits regarding DM skills.
Employability skills		
(Avramenko, 2012)	Empirical research	The use of BGS indicates positive benefits regarding students' confidence and employability skills.
(Strachan, 2016)	Empirical research	The use of BGS indicates positive benefits regarding students' awareness of business operations, resulting in potentially higher employability skills.

1998; Y.Y. Wang et al., 2020), consisting of a 30-item evaluation questionnaire where the respondents were asked to indicate within a 5-point Likert scale whether they agreed or disagreed with the presented statements (Dittrich et al., 2007; Taherdoost, 2019; Yockey, 2018).

The evaluation questionnaire was conceived in an *ex-ante* and *ex-post* ("before and after") approach (Adamowicz and Pyra, 2019; Camacho et al., 2019), where the participants were given an initial 15 questions relating to a specific theme (each block containing a set of 5 questions): impact of pandemics on businesses (H_{1a}–H_{1d}*); business DM process (H_{2a}–H_{2d}*); and education aspects (H_{3a}–H_{3d}*). Upon completion of these blocks of questions, the participants were presented with the BGS concept by means of a brief explanation and a detailed diagram explaining the possible use scenarios, followed by an additional block of 15 questions connected to the initial blocks of questions, but this time focusing on the applicability of BGS principles. As a result of the evaluation questionnaire, an initial baseline could be constructed on which the potential contribution of the BGS application could be assessed in further analysis.

3.2. Data collection and sample characteristics

The evaluation questionnaire was designed on the basis of an electronic web form, which was further distributed by e-mail between Economics undergraduates, master and PhD students, and academic staff members from the Faculty of Economics, Business, & Tourism at the University of Alcalá prior to the 2021 academic year. The approached target group was estimated at a total of 400 candidates who, from the perspective of the research objectives, have been considered to be highly representative and valuable since the faculty environment comprises all the relevant aspects regarding business, innovation, and education (Coleman and Blankenship, 2019; Faria, 1998; Faria and Wellington, 2004; Strachan, 2016).

Upon completion of the evaluation questionnaire deadline, a total of 112 samples were collected; however, a clean-up process was conducted to eliminate incomplete, nonvalid samples and unnecessary fields inserted by the online survey platform, thus obtaining a total of 95 valid samples that were used as input for this study. The collected data were then imported and processed through specialized statistical software (SPSS), frequently employed in data research analyses (Coleman and Blankenship, 2019; Strachan, 2016; Yockey, 2018).

3.3. Research model

Following the proposed theoretical framework and literature review, the research model (Fig. 2) was developed to reflect the relationship regarding BGS adoption and practicality regarding pandemic uses (H_{1a}–H_{1d}*), business DM processes (H_{2a}–H_{2d}*), and education aspects (H_{3a}–H_{3d}*), suggesting the analysis and identification of common business-plan-related decision patterns by means of a predefined BGS black box model within an established number of business years under uncertain, dynamic market scenarios or a combination of previous pandemic scenarios, in order for the BGS participants to make their decisions based on their intuition from the shown indicators. These decisions are stored in a decision database for further data analysis or extrapolation to the real environment, if considered relevant by the BGS

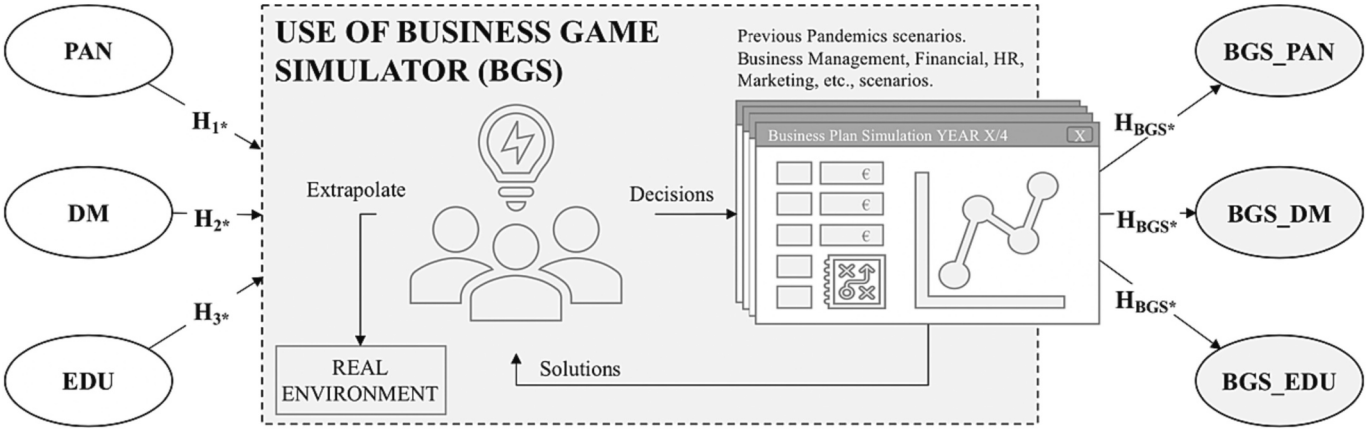

Fig. 2. Use of the business game simulator model framework. Own elaboration.

participants.

4. Analysis and results

4.1. Data analysis and constructs

The model is built in line with the evaluation questionnaire structure (Table 3), upon 30 dependent variables, each one focused on particular aspects of the research, such as pandemics (PAN), decision making (DM), or education (EDU), that have been grouped together under six new constructs following the "before aspects" (PAN), (DM), and (EDU) and "after BGS aspects" classification (BGS_PAN), (BGS_DM), and (BGS_EDU) for comparison purposes. From the point of view of independent variables, the only one applicable within this context is the actual participant. Finally, the PAN5 variable has been designed for quality control purposes to assess the participants' awareness level, since a positive answer was expected as opposed to the overall negative score.

As a first step, an SPSS internal reliability analysis based on Cronbach's alpha coefficient has been performed to determine the quality and robustness of the collected data (Table 4), where a value at or above 0.90 is considered excellent and between 0.80 and 0.89 is considered good (Yockey, 2018). The outcomes indicate that the 38 analyzed items provide a coefficient of 0.826, validating and considering as good the consistency and reliability of the data.

4.2. Paired samples t-test

Since the evaluation questionnaire was designed on the basis of "before and after" effects perceived by the participants regarding the use of BGS involving 30 dependent variables, a paired samples *t*-test was conducted to assess whether the scores between non-BGS and use of BGS are statistically significant or, on the contrary, similar.

Following Yockey's (2016) guidance for paired samples *t*-test, two hypotheses were established during the samples analysis: H_{null}: $\mu_{non\text{-}BGS} - \mu_{use\text{-}BGS} = 0$, as the null hypothesis where the means between samples are considered to be equal and therefore would cancel each other; and $H_{alternative}$: $\mu_{non\text{-}BGS} - \mu_{use\text{-}BGS} \neq 0$, as the alternative hypothesis, where the means between samples are considered to be different and therefore would be some variation.

Upon processing the data using SPSS software, the following decision criteria were considered for adequate hypothesis selection regarding a 2-tailed analysis: if $p < 0.05$, then reject H_{null} and select $H_{alternative}$; otherwise, if $p > 0.05$, then select H_{null} and discard $H_{alternative}$, as the sample means values are not statistically different.

A quick analysis of the output variable pair comparison under Table 5 indicated that the overall score obtained regarding the scenario in which BGS is not in the picture is significantly lower, as well as more involved dispersion TOTAL ($M = 39.54$, $SD = 9.83$), as compared with the use of BGS framework score BGS_TOTAL ($M = 58.64$, $SD = 7.89$).

The following step was taken to determine how meaningfully different the pairs may be considered; consequently, a Cohen's *d* effect size analysis (Cohen, 2013) was done and estimated according to the following scale: 0.20 as a small effect size, 0.50 as a medium effect size, and 0.80 or beyond as a large effect size.

Applying the decision criteria, it was established that the collected samples are significantly different, including the constructs PAN ($M = 12.73$, $SD = 3.38$) and BGS_PAN ($M = 19.73$, $SD = 3.12$), $t(94) = -13.13$, $p < 0.05$, $d = -1.35$ (large effect size); DM ($M = 15.21$, $SD = 4.24$) and BGS_DM ($M = 19.57$, $SD = 3.21$), $t(94) = -7.36$, $p < 0.05$, $d = -0.76$ (large effect size); EDU ($M = 11.60$, $SD = 4.38$) and BGS_EDU ($M = 19.32$, $SD = 2.57$), $t(94) = -16.77$, $p < 0.05$, $d = -1.72$ (large effect size). However, there are some exceptions, such as pair 5: PAN5 and BGS_PAN5, which, according to the test, are not significantly different but are considered correct as PAN5 was left on purpose as a positive control variable.

According to the outcomes of the paired samples *t*-test and Cohen's *d* effect size factor (Table 6), the constructs pairs PAN–BGS_PAN, DM–BGS_DM, and EDU–BGS_EDU, as well as the rest of the dependent variable pairs, except for pair 5 PAN5–BGS_PAN5, can be considered statistically different ($H_{alternative}$: $\mu_{non\text{-}BGS} - \mu_{use\text{-}BGS} \neq 0$) together with a relevant effect size, and therefore the formulated hypotheses regarding the pandemic aspects (H_{1a}–H_{1d}*), DM (H_{2a}–H_{2d}*), and education aspects (H_{3a}–H_{3d}*) are supported.

4.3. Correlation analysis

As the paired samples *t*-test indicates, the proposed (H_{1a}–H_{1d}*), (H_{2a}–H_{2d}*), and (H_{3a}–H_{3d}*) hypotheses are supported. A further analysis regarding the constructs' correlation was performed to determine the existence of any relationship regarding the BGS framework's output applicability to pandemics, DM, and education aspects.

An internal reliability analysis was done for each pair of constructs to assess the Cronbach's alpha coefficient value as an indicator of the internal construct consistency, obtaining PAN (0.742, up to 0.814 if PAN5 was removed), DM (0.796, up to 0.807 if DM3 was removed), EDU (0,853), BGS_PAN (0.844), BGS_DM (0.829), and BGS_EDU (0.841). According to Yockey's (2016) guidance, the level of consistency can be assessed as excellent if above 0.90, good if between 0.90 and 0.80, and fair if between 0.80 and 0.70; therefore, the internal constructs consistency can be considered good, except as indicated for PAN and DM, which are slightly affected by PAN5 (PAN 0.814 if removed) and DM3 (DM 0.807 if removed). However, finally, it was decided to keep them in the construct as the consistency above 0.70 was considered sufficient

Table 3
Evaluation questionnaire. Own elaboration.

Construct	Item (English translation; an evaluation questionnaire developed and distributed in Spanish)	
Pandemic aspects (PAN)		*BGS pandemic aspects (BGS_PAN)*
PAN1	Businesses know how they should face a pandemic economic crisis.	Simulating previous pandemics could show a business how to deal with a pandemic economic crisis.
PAN2	Businesses know about solutions to leverage a pandemic economic crisis.	Simulating previous pandemics could extrapolate solutions to leverage a pandemic economic crisis.
PAN3	Businesses can easily make budget cutovers.	Simulating previous pandemics could facilitate businesses' better economic decisions.
PAN4	Businesses can easily make decisions.	Simulating previous pandemics could facilitate businesses' DM.
PAN5	Business survival is threatened. * (+) Expected	Simulating previous pandemics could result in a positive effect on business survival.
Decision-making (DM)		*BGS decision making (BGS_DM)*
DM1	Businesses can still be competitive.	BGS could help businesses become more competitive during a pandemic.
DM2	Businesses can make quick decisions (agile).	BGS could encourage businesses to make quick decisions (act fast).
DM3	Businesses can continue with the same business model.	BGS could encourage businesses to transform their business models.
DM4	Businesses can make decisions under uncertain conditions.	BGS could encourage businesses to make decisions under uncertain conditions.
DM5	Businesses still consider ICT investments.	BGS could encourage businesses to consider ICT investments.
Education (EDU)		*BGS education (BGS_EDU)*
EDU1	The theoretical learning approach provides sufficient knowledge.	The BGS learning approach could provide more knowledge as compared with a theoretical learning approach.
EDU2	The theoretical learning approach keeps students motivated.	The BGS learning approach could keep students more motivated as compared with a theoretical learning approach.
EDU3	The theoretical learning approach improves self-esteem and leadership skills.	The BGS learning approach could improve self-esteem and leadership skills as compared with a theoretical learning approach.
EDU4	The nonlinked business department learning approach provides sufficient knowledge.	BGS using connected business departments could provide a more global perspective as compared with a theoretical learning approach.
EDU5	A nonlinked business stage learning approach provides sufficient knowledge.	BGS using several years of business stages could provide a more realistic perspective as compared with a theoretical learning approach.

(Fornell and Larcker, 1981; Hair et al., 2019) for the scope of the research, taking into account the overall internal consistency.

Since the research objectives focus on BGS applications, the correlation analysis will be limited only to BGS constructs: BGS_PAN, BGS_DM, and BGS_EDU.

Again, following Yockey's (2016) guidance for the Pearson *r* correlation test, two hypotheses were established during the constructs analysis: H_{null}: $\rho = 0$, as the null hypothesis, where the *r* correlation coefficient is considered irrelevant, and therefore no kind of correlation exists between pairs; and $H_{alternative}$: $\rho \neq 0$, as the alternative hypothesis, where the *r* correlation coefficient is considered significant and therefore correlation exists between pairs.

Upon processing the data using SPSS software, the following decision criteria were considered for the adequate hypotheses selection regarding correlation effect: if $p < 0.05$, then reject the H_{null} and select $H_{alternative}$; otherwise, if $p > 0.05$, then select H_{null} and discard $H_{alternative}$, as the constructs bear no relationship.

Table 4
Reliability analysis. Own elaboration.

Reliability statistics			
Cronbach's alpha	0.826	No. of items	38

Item statistics			
Item	Mean	Std. deviation	N
PAN1	2.4211	0.98477	95
PAN2	2.4632	1.04993	95
PAN3	1.9158	0.98568	95
PAN4	2.0737	0.93675	95
PAN5	3.8632	1.42628	95
DM1	3.2842	1.05853	95
DM2	3.0211	1.19377	95
DM3	2.2737	0.93901	95
DM4	2.9368	1.22744	95
DM5	3.6947	1.26385	95
EDU1	2.4947	1.06065	95
EDU2	2.4632	1.15603	95
EDU3	2.0526	1.13333	95
EDU4	2.4526	1.13708	95
EDU5	2.1368	1.03770	95
BGS_PAN1	3.9368	0.82269	95
BGS_PAN2	3.8526	0.78508	95
BGS_PAN3	3.9789	0.79866	95
BGS_PAN4	3.9789	0.72902	95
BGS_PAN5	3.9895	0.84419	95
BGS_DM1	3.8211	0.83766	95
BGS_DM2	3.9579	0.88625	95
BGS_DM3	3.8211	0.87493	95
BGS_DM4	3.9263	0.77517	95
BGS_DM5	4.0526	0.79048	95
BGS_EDU1	4.1263	0.77517	95
BGS_EDU2	4.2842	0.66305	95
BGS_EDU3	4.1368	0.67808	95
BGS_EDU4	4.1789	0.66810	95
BGS_EDU5	4.2316	0.70639	95
PAN	12.7368	3.82659	95
DM	15.2105	4.24238	95
EDU	11.6000	4.38663	95
BGS_PAN	19.7368	3.12577	95
BGS_DM	19.5789	3.21426	95
BGS_EDU	19.3263	2.57831	95
TOTAL	39.5474	9.83672	95
BGS_TOTAL	58.6421	7.89144	95

The following step was taken to determine how meaningfully the correlation may be considered. Consequently, Cohen's *r* effect size analysis (Cohen, 2013) was done and estimated according to the following scale: ±0.100 as a small effect size, ±0.300 as a medium effect size, and ± 0.500 or greater as a large effect size.

Applying the decision criteria, it was established that constructs have a significant positive correlation with each other regarding BGS applications to pandemics, decision making, and education aspects: BGS_PAN and BGS_DM, $r(93) = 0.808$ (large effect size), $p < 0.05$; BGS_PAN and BGS_EDU, $r(93) = 0.580$ (large effect size), $p < 0.05$; and BGS_DM and BGS_EDU, $r(93) = 0.600$ (large effect size), $p < 0.05$. Therefore, the HBGS hypothesis is supported. The authors point out that having only three constructs facilitates the correlation relationship. However, as depicted in Table 7, this relationship extrapolates to the individual dependent variables used as input for the constructs creation and framework model.

4.4. Results

The result of this study provides another perspective regarding companies' and academic institutions' use and applicability of BGS within a pandemic context, as it validates the hypothesis by means of a total of 95 samples following an *ex-ante* and *ex-post* evaluation questionnaire of a relevant target of students and academic staff from the

Table 5
Paired samples statistics. Own elaboration.

Paired samples statistics		Mean	N	Std. deviation	Std. error mean
Pair 1	PAN1	2.4211	95	0.98477	0.10103
	BGS_PAN1	3.9368	95	0.82269	0.08441
Pair 2	PAN2	2.4632	95	1.04993	0.10772
	BGS_PAN2	3.8526	95	0.78508	0.08055
Pair 3	PAN3	1.9158	95	0.98568	0.10113
	BGS_PAN3	3.9789	95	0.79866	0.08194
Pair 4	PAN4	2.0737	95	0.93675	0.09611
	BGS_PAN4	3.9789	95	0.72902	0.07480
Pair 5	PAN5	3.8632	95	1.42628	0.14633
	BGS_PAN5	3.9895	95	0.84419	0.08661
Pair 6	DM1	3.2842	95	1.05853	0.10860
	BGS_DM1	3.8211	95	0.83766	0.08594
Pair 7	DM2	3.0211	95	1.19377	0.12248
	BGS_DM2	3.9579	95	0.88625	0.09093
Pair 8	DM3	2.2737	95	0.93901	0.09634
	BGS_DM3	3.8211	95	0.87493	0.08977
Pair 9	DM4	2.9368	95	1.22744	0.12593
	BGS_DM4	3.9263	95	0.77517	0.07953
Pair 10	DM5	3.6947	95	1.26385	0.12967
	BGS_DM5	4.0526	95	0.79048	0.08110
Pair 11	EDU1	2.4947	95	1.06065	0.10882
	BGS_EDU1	4.1263	95	0.77517	0.07953
Pair 12	EDU2	2.4632	95	1.15603	0.11861
	BGS_EDU2	4.2842	95	0.66305	0.06803
Pair 13	EDU3	2.0526	95	1.13333	0.11628
	BGS_EDU3	4.1368	95	0.67808	0.06957
Pair 14	EDU4	2.4526	95	1.13708	0.11666
	BGS_EDU4	4.1789	95	0.66810	0.06855
Pair 15	EDU5	2.1368	95	1.03770	0.10647
	BGS_EDU5	4.2316	95	0.70639	0.07247
Pair 16	PAN	12.7368	95	3.82659	0.39260
	BGS_PAN	19.7368	95	3.12577	0.32070
Pair 17	DM	15.2105	95	4.24238	0.43526
	BGS_DM	19.5789	95	3.21426	0.32978
Pair 18	EDU	11.6000	95	4.38663	0.45006
	BGS_EDU	19.3263	95	2.57831	0.26453
Pair 19	TOTAL	39.5474	95	9.83672	1.00923
	BGS_TOTAL	58.6421	95	7.89144	0.80964

Faculty of Economics, Business, and Tourism of the University of Alcalá. The paired samples *t*-test outcomes (Tables 5 and 6) indicate a significant perceived difference between the nonuse of BGS and the actual application of BGS to pandemics, DM, and education aspects (Yockey, 2018), with a large effect size (Cohen, 2013) between PAN ($M = 12.73$, $SD = 3.38$) and BGS_PAN ($M = 19.73$, $SD = 3.12$), $t(94) = -13.13$, $p < 0.05$, $d = -1.35$, EDU ($M = 11.60$, $SD = 4.38$) and BGS_EDU ($M = 19.32$, $SD = 2.57$), $t(94) = -16.77$, $p < 0.05$, $d = -1.72$, and a more moderate effect size between DM ($M = 15.21$, $SD = 4.24$) and BGS_DM ($M = 19.57$, $SD = 3.21$), $t(94) = -7.36$, $p < 0.05$, $d = -0.76$, suggesting a major perception difference for education aspects where the practical BGS hand-on learning style prevails over the traditional theoretical approach. Some exceptions were noticed in the PAN5 and BGS_PAN5 variables (Tables 5 and 6), as they failed the *t*-test, mainly because PAN5 was designed as a control variable; therefore, it was considered an acceptable situation.

The final analysis executed was to explore whether and to what extent the results of the BGS are related to each other. Before that, the Cronbach's alpha was calculated (Table 4), with a spread between 0.75 and 0.84 for *ex-ante* constructs and between 0.82 and 0.84 for *ex-post* constructs, thus suggesting that the internal consistency is relatively fair >0.70 (Fornell and Larcker, 1981; Hair et al., 2019). However, given that the correlation analysis was focused on the BGS use scenario, the alpha ratio was considered acceptable, although a sample analysis could be done as a future research step to check if it is due to how the evaluation questionnaire was formulated, such as multiple interpretations, or perhaps the selected sample is more heterogeneous than it appears, requiring further sorting and grouping analysis. As for the actual correlation scores (Table 7), the BGS constructs appear to have maintained a positive correlation between them: BGS_PAN and BGS_DM, $r(93) = 0.808$ with a large effect size (Cohen, 2013), whereas BGS_PAN and BGS_EDU, $r(93) = 0.580$, and BGS_DM and BGS_EDU, $r(93) = 0.600$, scored a lower *r* correlation rate but are still considered to have a large effect size.

Therefore, the use of BGS is supported, where: (1) simulating previous pandemics could provide the ability to cope with a pandemic crisis, extrapolate solutions to leverage economic impact, facilitate businesses to make better economic decisions, and conduct a better DM process, resulting in a positive effect on business survival. (2) BGS could encourage businesses to become more competitive, act faster, transform their business model, make decisions under uncertain conditions, and take into consideration ICT investments. (3) The BGS learning approach could provide more knowledge, more motivation, improve self-esteem and leadership skills, and provide a global and more realistic organization perspective.

Table 6
Paired samples *t*-test and Cohen's *d*. Own elaboration.

		Paired differences			95 % confidence interval of the difference		t	df	Sig. (2-tailed)	Cohen's d
		Mean	Std. deviation	Std. error mean	(Lower)	(Upper)				d
Pair 1	PAN1–BGS_PAN1	−1.51579	1.25362	0.12862	−1.77116	−1.26041	−11.785	94	0.000	−1.21
Pair 2	PAN2–BGS_PAN2	−1.38947	1.33125	0.13658	−1.66066	−1.11828	−10.173	94	0.000	−1.04
Pair 3	PAN3–BGS_PAN3	−2.06316	1.35906	0.13944	−2.34001	−1.78630	−14.796	94	0.000	−1.52
Pair 4	PAN4–BGS_PAN4	−1.90526	1.26385	0.12967	−2.16272	−1.64780	−14.693	94	0.000	−1.51
Pair 5	PAN5–BGS_PAN5	−0.12632	1.67104	0.17145	−0.46672	0.21409	−0.737	94	0.463	−0.08
Pair 6	DM1–BGS_DM1	−0.53684	1.45727	0.14951	−0.83370	−0.23998	−3.591	94	0.001	−0.37
Pair 7	DM2–BGS_DM2	−0.93684	1.57649	0.16174	−1.25799	−0.61569	−5.792	94	0.000	−0.59
Pair 8	DM3–BGS_DM3	−1.54737	1.39733	0.14336	−1.83202	−1.26272	−10.793	94	0.000	−1.11
Pair 9	DM4–BGS_DM4	−0.98947	1.46951	0.15077	−1.28883	−0.69012	−6.563	94	0.000	−0.67
Pair 10	DM5–BGS_DM5	−0.35789	1.47256	0.15108	−0.65787	−0.05792	−2.369	94	0.020	−0.24
Pair 11	EDU1–BGS_EDU1	−1.63158	1.25522	0.12878	−1.88728	−1.37588	−12.669	94	0.000	−1.30
Pair 12	EDU2–BGS_EDU2	−1.82105	1.42156	0.14585	−2.11064	−1.53147	−12.486	94	0.000	−1.28
Pair 13	EDU3–BGS_EDU3	−2.08421	1.31005	0.13441	−2.35108	−1.81734	−15.507	94	0.000	−1.59
Pair 14	EDU4–BGS_EDU4	−1.72632	1.41754	0.14544	−2.01508	−1.43755	−11.870	94	0.000	−1.22
Pair 15	EDU5–BGS_EDU5	−2.09474	1.22972	0.12617	−2.34524	−1.84423	−16.603	94	0.000	−1.70
Pair 16	PAN–BGS_PAN	−7.00000	5.19410	0.53290	−8.05809	−5.94191	−13.136	94	0.000	−1.35
Pair 17	DM–BGS_DM	−4.36842	5.78158	0.59318	−5.54619	−3.19065	−7.364	94	0.000	−0.76
Pair 18	EDU–BGS_EDU	−7.72632	4.48980	0.46064	−8.64094	−6.81170	−16.773	94	0.000	−1.72
Pair 19	TOTAL–BGS_TOTAL	−19,09474	12,78802	1.31202	−21.69979	−16.48968	−14.554	94	0.000	−1.49

Table 7
BSG correlations. Own elaboration.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	BGS_PAN	BGS_DM
BGS_PAN1	PC.	–																
	Sig.2	–																
BGS_PAN2	PC.	0.529**																
	Sig.2	0.000																
BGS_PAN3	PC.	0.597**	0.555**															
	Sig.2	0.000	0.000															
BGS_PAN4	PC.	0.370**	0.403**	0.566**														
	Sig.2	0.000	0.000	0.000														
BGS_PAN5	PC.	0.520**	0.463**	0.615**	0.570**													
	Sig.2	0.000	0.000	0.000	0.000													
BGS_DM1	PC.	0.416**	0.477**	0.614**	0.516**	0.584**												
	Sig.2	0.000	0.000	0.000	0.000	0.000												
BGS_DM2	PC.	0.478**	0.572**	0.570**	0.443**	0.611**	0.620**											
	Sig.2	0.000	0.000	0.000	0.000	0.000	0.000											
BGS_DM3	PC.	0.457**	0.519**	0.482**	0.444**	0.430**	0.478**	0.470**										
	Sig.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000										
BGS_DM4	PC.	0.326**	0.402**	0.427**	0.487**	0.470**	0.438**	0.491**	0.467**									
	Sig.2	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000									
BGS_DM5	PC.	0.447**	0.510**	0.575**	0.353**	0.591**	0.577**	0.565**	0.429**	0.388**								
	Sig.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000								
BGS_EDU1	PC.	0.396**	0.293**	0.348**	0.212*	0.425**	0.396**	0.410**	0.269**	0.175	0.493**							
	Sig.2	0.000	0.004	0.001	0.039	0.000	0.000	0.000	0.008	0.090	0.000							
BGS_EDU2	PC.	0.267**	0.224*	0.273**	0.233*	0.328**	0.380**	0.419**	0.235*	0.165	0.438**	0.468**						
	Sig.2	0.009	0.029	0.008	0.023	0.001	0.000	0.000	0.022	0.109	0.000	0.000						
BGS_EDU3	PC.	0.321**	0.378**	0.339**	0.415**	0.541**	0.418**	0.435**	0.275**	0.222*	0.582**	0.453**	0.575**					
	Sig.2	0.002	0.000	0.001	0.000	0.000	0.000	0.000	0.007	0.031	0.000	0.000	0.000					
BGS_EDU4	PC.	0.369**	0.335**	0.366**	0.466**	0.475**	0.533**	0.462**	0.292**	0.334**	0.486**	0.552**	0.580**	0.626**				
	Sig.2	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.004	0.001	0.000	0.000	0.000	0.000				
BGS_EDU5	PC.	0.392**	0.331**	0.424**	0.464**	0.397**	0.430**	0.339**	0.257*	0.303**	0.473**	0.373**	0.471**	0.577**	0.520**			
	Sig.2	0.000	0.001	0.000	0.000	0.000	0.000	0.001	0.012	0.003	0.000	0.000	0.000	0.000	0.000			
BGS_PAN	PC.	0.775**	0.751**	0.850**	0.730**	0.813**	0.664**	0.683**	0.593**	0.536**	0.634**	0.431**	0.339**	0.509**	0.512**	0.510**		
	Sig.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000		
BGS_DM	PC.	0.553**	0.645**	0.693**	0.582**	0.696**	0.809**	0.823**	0.745**	0.713**	0.762**	0.453**	0.426**	0.500**	0.546**	0.465**	0.808**	
	Sig.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
BGS_EDU	PC.	0.426**	0.397**	0.432**	0.473**	0.544**	0.545**	0.467**	0.366**	0.347**	0.592**	0.522**	0.686**	0.802**	0.762**	0.735**	0.580**	0.600**
	Sig.2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

PC=Pearson correlation; Sig.2 = Sig. (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

5. Conclusions

5.1. Discussions

Given the global situation regarding the needs of digital HRM, the research covers the identified double gap in the existing literature, highlighting the novelty of the application of BGS to economic scenarios and DM processes within companies and academic institutions. BGS are indicated to be a promising application through the analysis of business decision patterns and continuous simulation-based gap reinforcement.

From a *theoretical* point of view, the study confirms the potential of BGS to support future professionals by means of practical simulation aspects and underscores the ability of BGS to assist businesses in managing economic crises, extrapolating solutions to mitigate economic impacts, and fostering better DM. Moreover, it encourages businesses to adapt under uncertain conditions and to consider investments in ICTs.

From a *practical* point of view, in terms of educational impact, BGS offer an alternative to traditional theoretical approaches by sustaining motivation and improving self-esteem among participants by means of gamification. At the same time, it enables participants to analyze and learn from historical business scenarios and mistakes, fostering an in-depth business understanding.

Future studies could deepen the applications of BGS, in particular to other aspects of digital HRM or their related dynamic environments. In parallel, it may also help to establish the foundation of some future lines to follow, such as a benchmarking mechanism framework, facilitating the collection and analysis of the participants' decisions along with their performance, which could lead to a valuable knowledge database for future lines of research.

5.1.1. Theoretical implications

In terms of simulating previous pandemics, the findings regarding the applicability of BGS to these types of scenarios along with their respective benefits are consistent with the literature. A BGS learning in digital HRM approach could (1) show a business how to deal with a pandemic economic crisis by importing known pandemic scenarios (Campbell, 2006; De Wit et al., 2016; Judson et al., 2015) where the participant can check the evolution of environmental constraints as well as interact with them by simulating decisions and observing their evolution within the context of that timeframe, obtaining valuable information on how to manage within that kind of situation (Faria et al., 2009; Greco et al., 2013; Pascual-Miguel et al., 2016; Thavikulwat, 2004), which later can be extrapolated to real-world business. It could (2) extrapolate solutions to leverage pandemic economic impact by modeling those scenarios' constraints, testing and validating them in a controlled environment (Giesen et al., 2010; Saebi et al., 2017), and mimicking current or previously known pandemic scenarios (McNamara and McNamara, 2019; Sugahara and Lau, 2019). It could (3) facilitate businesses' better economic decisions, as on the one hand it allows to execute the desired number of iterations until a solution is considered successful (Subsorn and Singh, 2007), and on the other hand, repetition facilitates the cognitive (Mohsen et al., 2019) and self-control (Arias-Aranda and Bustinza-Snchez, 2009) aspects. Finally, it could (4) facilitate businesses' DM due to the continuous involvement of the participant within BGS by means of the complex interactions of the scenario (Bocciarelli et al., 2017; Wallace et al., 2010), gamification aspects (Jacob et al., 2022; Kim et al., 2018), and practical hands-on (Xu and Yang, 2010).

In regard to the business DM process within pandemic or general contexts, the findings regarding the applicability of BGS are considered to be in line with the existing literature, while in addition providing valuable benefits as compared with dedicated DSS and ESS solutions or a theoretical learning style, as collected in Table 8. BGS could (1) help businesses become more competitive during a pandemic, as virtually any kind of scenario can be simulated and adjusted to reflect the real business situation and therefore test and validate the appropriate solutions, such as investments or price negotiation, which could ultimately increase overall business competitiveness (Awasthi and Pandita, 2019). BGS could (2) encourage businesses to make quick decisions (act fast), as BGS are relatively quick to set up to run any simulation (Faria et al., 2009; Greco et al., 2013; Pascual-Miguel et al., 2016; Thavikulwat, 2004), and due to the fact of repetitiveness, the business can elaborate their hypotheses, test and validate them, and finally extract a potential solution ready to be applied in real-life business (Subsorn and Singh, 2007). BGS could (3) encourage businesses to transform their business model, whereby, by means of testing and validating new scenarios, the businesses can check if the proposed business model changes are indeed effective or, on the contrary, have a negative economic impact in the long term (Desyatirikova et al., 2017; Fang and Marle, 2012). BGS could (4) encourage businesses to make decisions under uncertain conditions, where practicing simulated scenarios increases trust, control, and cognitive skills facilitating decisions (Sadler-Smith, 2016; Santos and Dacorso, 2016). Finally, BGS could (5) encourage businesses to consider ICT investments (Abd Rahman et al., 2020; Doltsinis et al., 2020) by simulating them and analyzing their forecasted costs and benefits, as well as exploring technological scenarios such as the use of Industry 4.0-related digital enablers (Demirkan and Delen, 2013; Guo et al., 2020).

Table 8
Decision-making tools and education tools comparison. Own elaboration.

	Dedicated DSS and ESS	Business game simulator	Theoretical approach
Costs	Extremely expensive	Medium	Cheap
Accuracy	Highly accurate real business data	Low to medium accuracy	Limited accuracy
Complexity	Extremely difficult to use, requires specialist staff	Medium difficulty, requires basic training on BGS	No major difficulties
Parameters	Extremely difficult to configure	Medium difficulty	Limited parameters and variables
Training	Not suitable	Extremely suitable. Supports blended learning	Suitable (as baseline)

Finally, the findings regarding the applicability of BGS within pandemics or combinations of business DM scenarios follow the analyzed literature findings. BGS-based learning could (1) provide more knowledge as compared with a theoretical learning approach (Salas et al., 2009), as the practical approach provides the missing hands-on knowledge and generic skills (Mayer et al., 2011) and, at the same time, requires the participant to be far more involved with the subject to evaluate the optimal solutions and achieve the maximum game score (I. Buil et al., 2018). BGS-based learning could (2) achieve sustained motivation as compared with a theoretical learning approach (Isabel Buil et al., 2020; Lin et al., 2018; Moran et al., 2018; North-Samardzic and de Witt, 2019) by means of the BGS gamification properties stimulating cognitive (Gatti et al., 2019), generic, and soft skills (Kim et al., 2018). BGS-based learning could (3) improve self-esteem (Arias-Aranda and Bustinza-Snchez, 2009) and leadership (Henriksen and Børgesen, 2016) due to the development of teamwork, collaboration, and negotiation skills (Hernández-Lara et al., 2019a; Hernández-Lara et al., 2019b) required for the next generation of business management staff. BGS-based learning could (4) ensure decisions have a global impact in the same fashion as in the real-life business environment (North-Samardzic and de Witt, 2019; Xu and Yang, 2010), leading to a broader perspective as compared with a theoretical learning approach, where BGS can accommodate any kind of subject matter and academic curricula (Faria et al., 2009; Greco et al., 2013; Pascual-Miguel et al., 2016; Thavikulwat, 2004). Finally, BGS-based learning could (5) examine BGS historical timeline scenarios where the participant has to carry the mistakes made in the previous business exercises (Kim et al., 2018) as well as act as diligently as possible to amend those errors and recover the business control, which could provide a far more immersive and realistic

perspective of the business lifecycle as compared with a theoretical learning approach (Hamari et al., 2016).

5.1.2. Practical implications

The practical outcome of this study is to set the baseline of a novel framework regarding the use of BGS that can be easily adopted within any company or academic institution by promoting an active and dynamic teaching innovation process for the service company leaders, immersing them in the real DM process of the business life cycle within generic or pandemic scenarios, from a holistic perspective (from internal decisions to environmental factors within a historical timeline), while at the same time building a gamified experience where all participants compete for optimal financial results.

In addition, this teaching innovation process (1) consolidates both theoretical and practical knowledge within real-life business scenarios and uncertain environmental factors, such as economic recessions or unexpected pandemic crises such as COVID-19. This process (2) promotes and pushes self-guided learning as well as relating all concepts within the academic curricula, providing a broader vision and knowledge. In addition, the process (3) fosters excellence in teaching talent and leadership for employees and entrepreneurs; (4) easily aggregates patterns based on risk index, age, incomes, employment status, and year, among others; and (5) provides new KPIs and metrics such as year-over-year, generation-over-generation, or curricula adherence.

5.2. Research limitations

Although there is satisfactory support for the proposed hypotheses, this study can be considered only a small step regarding the use of the BGS in DM and education in a pandemic context, as it inevitably opens up new discussions. Despite the authors' good intentions, statistically speaking, the sample used for the validation of the hypotheses might not reflect the whole reality of the universe of BGS applicability, or perhaps the participant opinion could be considered slightly biased due to the environment—primarily academic—where the data were collected; or perhaps there are some shortcomings regarding the appropriateness of the construct creation where the variable number should have been increased at the expense of generating more workload on the participant.

In addition, since the research was built upon a significant number of previous investigations, inevitably those errors were carried over. To compensate for this effect, as it could never be entirely eradicated, these research findings have been cross-referenced against multiple comparable sources and studies; nevertheless, this approach could not be extended to all questions, as at this date and time, the pandemics and BGS literature is fairly new. Fortunately, thanks to the academic and scientific community, some studies may be proven inaccurate, whereas others may be proven correct in the future.

This investigation concentrates on the positive aspects of the BGS, but to obtain the complete picture, all the analyzed literature must be turned upside down; many irrelevant or opposite facts would also need to be examined. One example would be motivation and engagement, where investigations normally highlight how they are achieved and describe their effects on participants but often neglect the underlying factors that cause participants to become demotivated or not committed regarding the analyzed topic. Consequently, companies may not consider the application of the BGS at all, as it may not be their top priority, and they may not have the resources to deal with the testing and validation of the scenarios. Companies and academic institutions could consider its use extremely useful due to the demonstrated benefits, but may discard it due to the economic aspects, which are not implicitly covered.

The authors would also like to elaborate on the limitations inherent to the use of the BGS. Some of them are considered largely dependent on technology and software implementation. (1) The real simulation capacity may be considered limited under some scenarios and may not be able to simulate or add all the desired environmental constraints to the equation. (2) The outcome may appear positive; however, under real-life conditions, it may be seen as the opposite, perhaps related to software errors or environment simulation shortcomings. (3) Low confidence could lead management to avoid risky decisions, but overconfidence may be even more dangerous, as according to financial laws, the higher the risks are, the higher the wins or losses are, and by delegating the decision to an automated system, part of the calculation process is lost and therefore not all the risk is perceived. (4) An expert point of view will always be required to review, fine-tune, and approve the solution before applying it blindly to the real business, as the BGS and DSS/ESS software will always have some limitations or software glitches.

5.3. Lines to follow

One of the possible future lines to follow would be exploring the regression aspects, if any of the constructs can be considered predictors, along with their load factors, to understand the extent to which such a feature is applicable. An alternative line to follow could be enhancing the data quality by means of (1) expanding the study target participants (universe) to the rest of the academic institutions beyond the University of Alcalá, as well as actual companies that not only could provide more realistic ground information but also make it more accurate. Another alternative is (2) expanding the study over a period of time to establish a temporal benchmark of academic institutions and digital HRM businesses requirements regarding pandemics, DM, and the evolution of education aspects from year to year or any other relevant period. The last alternative is (3) exploring new constructs and bringing into the picture more factors that could directly or indirectly influence the applicability of BGS to companies or academic institutions.

However, of more scientific interest would be the analysis of actual BGS within companies and academic institutions to determine the difference between the impact projected by this study and the actual impact generated on the real-life scenario. This could open new possibilities to analyze the factors that could lead to the success or failure of BGS from the company, institution, and student point of view, which would inevitably create at least three new research areas covering each of the constructs and numerous raised questions: (1) digital HRM and simulating pandemics block; (2) DM process block; and (3) education aspects block.

CRediT authorship contribution statement

Maria Teresa del Val Núñez: Writing – review & editing. **Antonio de Lucas Ancillo:** Writing – review & editing. **Sorin Gavrila Gavrila:** Writing – original draft. **José Andrés Gómez Gandía:** Writing – original draft.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

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