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Enhancing Business Continuity Preparedness Through Experiential Learning: Serious Game Approach

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Abstract

This paper addresses the urgent need of ensuring the continuity of both Critical Infrastructure (CI) services and business activities during disasters, emphasizing the strategic imperative for industries and the collective responsibility to safeguard national and global economies. In this regard, the effectiveness of Business Continuity Plans (BCPs) hugely depends on the proper management of the interdependencies between business entities, typically related to supply chain structures and outsourcing strategies. To address this challenge, the paper introduces a Business Continuity (BC) serious game as an innovative learning and training tool. The BC Game (BCG) aims to enhance analytical and decision-making skills of professionals and managers for effective business continuity planning. Simulating real-world scenarios, the game allows participants to gain practical insights, make informed decisions, and observe consequences within a controlled environment. Emphasizing active learning, collaboration, critical thinking, and problem-solving, the BCG equips participants with practical skills for managing BC challenges in real-life situations. The paper details the game architecture, flow, and training modes, emphasizing distinctive features compared to traditional BC training. Tested and validated with a large group of MSc students, the BCG proved effective in improving knowledge of BC concepts and skills in applying BC methods. Anonymous feedback from participants informed further improvements. This contribution to operational resilience, crisis management, and training methodologies in CI and Key-Resource Supply Chain sectors underscores the BCG's potential as an effective tool for collaborative business continuity training.

Keywords: operational resilience, business continuity, coordination, training, active learning

1. Introduction

Critical Infrastructure (CI) plays a crucial role in supporting economic development and its disruption can have severe consequences for security, the economy, public health, and safety. During disasters, the availability of CI services becomes even more vital, as they contribute to community well-being and facilitate recovery efforts. Disruptions of CI have a significant impact not only on other interdependent CI but also on supply chains that utilize the CI (Ouyang 2014). This is even more critical in case of Key Resources Supply Chains (KRSC) - such as food, pharmaceutical or other strategic industrial sectors (Trucco et al., 2017).

The shift from focusing solely on critical infrastructure to a broader perspective encompassing critical entities in European policy (EU, 2022) reflects an acknowledgment of the interconnected nature of essential components beyond traditional physical infrastructure. This broader perspective encompasses key services, organizations, and structures crucial for societal functioning, fostering a more adaptive and comprehensive approach to resilience and security. Ensuring the continuity of both Critical Infrastructure (CI) services and business activities during disasters is not only a strategic imperative for individual industries but also a collective responsibility to safeguard the overall resilience and stability of national and global economies.

Business Continuity (BC) is defined as the capability of an organization to continue the delivery of products and services within acceptable periods at predefined capacity during a disruption (ISO 22301, 2019). The effectiveness of Business Continuity Plans (BCPs) heavily relies on external factors – such as support from public agencies, external resources – and hugely depends on the proper management of the interdependencies between business entities, typically related to supply chain structures and outsourcing strategies. To ensure the efficacy of BCPs, organizations need to align them with their external dependencies and coordinate with other entities' BCPs.

This paper aims to explore the challenges encountered by CI entities and other dependent manufacturing and service industries in achieving business continuity, and introduces a Business Continuity serious game as an innovative learning tool that helps organizations in addressing these challenges. The BCG was developed with the aim to provide an engaging and interactive learning experience that enhances understanding, skills, and decision-making capabilities in the field of Business Continuity Management (BCM). The game aims to simulate real-world scenarios and challenges related to BCM, allowing participants to gain and apply knowledge, make informed decisions, and observe the consequences of their actions within a safe and controlled environment. By immersing participants in a serious game, the aim is to foster a deeper understanding of BCM principles, strategies, and good practices and gain practical insights into the complexities of BCP. The game encourages active learning, collaboration, critical thinking, and problem-solving, ultimately equipping participants with the practical skills and insights necessary to effectively manage BC challenges and make decisions in real-life situations.

The structure of the paper is as follows. Section 2 presents the major challenges in ensuring business continuity for CI entities and dependent business organizations. It also discusses the major advancements in the field and key lessons learned. Section 3 introduces the Business Continuity Game (BCG) by explaining its purpose and the methodology used for its development and validation. Section 4 deeper explores the BCG architecture and logic by specifying its learning objectives, explaining the flow of the game, demonstrating the inputs and outputs, and showing the playing modes. The section ends by highlighting the BCG's distinctive features and benefits. The testing and validation process and the received feedback are summarizes in Section 5 before concluding.

2. Major Challenges in Business Continuity Management for Critical Infrastructure and dependent businesses

Various challenges exist in achieving effective business continuity. The increasing complexity of CI systems, characterized by intricate networks, intertwined supply chains, and diverse stakeholders, poses significant hurdles in understanding and managing the numerous interdependencies and potential cascading effects of disruptions (Petrenj and Trucco, 2023). The integration of emerging technologies further complicates the landscape, by increasing interconnectivity between physical and digital systems. These interdependencies cause propagation of disruptions from one sector across others, affecting the overall availability of essential services. Addressing this complexity requires a comprehensive analysis of the interdependencies within and between different infrastructures and sectors to pinpoint potential points of failure and cascading effects (Sun et al., 2022). It means that enhancing the resilience of CI is insufficient if dependent industries/businesses are not well prepared and if the dynamic nature of interdependencies is not adequately considered when developing BCPs across all these organizations.

Adding to the challenges, emerging risks continually reshape the CI landscape. For example, the increasing frequency and sophistication of cyber threats (Aldasoro et al., 2022) present significant challenges in protecting critical systems, safeguarding data, and maintaining operational continuity. Additionally, the impacts of climate change introduce new challenges in assessing and mitigating risks to CI. For example, the Panama Canal is facing a drought crisis, which disrupts the canal crossings. The record low rainfall in 2023 caused water levels in the locks to drop to an all-time low, forcing the operator to reduce the capacity down to 40%-50% of full capacity by February 2024, with a significant impact on the global supply chains (NYT, 2023). Pandemics, as demonstrated by the COVID-19 crisis, have also highlighted the need for robust BCP plans to ensure the continuity of essential services and minimize disruptions in the face of public health emergencies (Riglietti et al., 2022).

Furthermore, resource constraints compound the challenges faced by organizations. Limited financial, technological and human resources hinder the implementation of robust BCP strategies, necessitating investments in infrastructure upgrades, redundancy measures, training programs, and specialized personnel. This limitation generally reflects in the quality of risk assessments, the lack of comprehensive BCP plans that extend beyond the boundaries of a single organization, and in poor validation of the planned resilience measures. This can be particularly problematic for smaller organizations or those operating in economically disadvantaged regions.

An additional layer of complexity is the organizational culture within public and private organizations, which plays a pivotal role in overcoming BC challenges (Steen et al., 2023). Establishing a resilient culture necessitates proactive leadership, employee engagement, and a shared understanding of the importance of BCP throughout the organization. However, market pressures often prioritize operational efficiency and service delivery over BCM. Increasing awareness about potential risks and instilling a proactive mindset toward BCP presents a formidable challenge, demanding comprehensive training programs, awareness campaigns, and regular exercises to enhance preparedness and response capabilities across the entire organization.

2.1. Advancements in the field and key lessons learned

In the dynamic landscape of Business Continuity Planning (BCP), several key trends are shaping the way organizations prepare for and respond to disruptions. Firstly, the integration of advanced tools and technologies, such as artificial intelligence (AI), machine learning (ML), and data analytics, into BCP processes. This integration aims to elevate risk assessment, incident response, and recovery capabilities by leveraging the power of intelligent algorithms and real-time data analysis. These enhancements enable organizations to identify critical processes, dependencies, and prioritize resources more effectively in their BCP efforts. Another critical focus is on Supply Chain Resilience (Riglietti et al., 2022), emphasizing the need to assess and enhance the robustness of supply chains. Strategies include identifying vulnerabilities, diversifying suppliers, and implementing contingency plans to mitigate disruptions.

Considering the current practices adopted by organizations to ensure business continuity (Alcantara et al., 2017), they often focus solely on internal processes and resources, largely neglecting broader aspects like the supply chain, relations with local partners, or infrastructure services within the scope of BCP. Recently, there has been a growing global recognition of the need to extend BCP implementation guidelines to the district level. Coordinated BCP efforts and frameworks promote collaboration among stakeholders to ensure the continuity of business for an entire area. Referred to as Area Business Continuity Management (Area BCM), this concept, outlined by the Japan International Cooperation Agency (JICA), provides a framework for coordinated damage mitigation and recovery efforts involving stakeholders such as individual enterprises, industrial area managers, local authorities, and critical infrastructure. The goal is to ensure the business continuation of an entire area (Baba et al. 2014). Area BCM necessitates an inter-organizational approach throughout the entire cycle, encompassing Business Impact Analysis (BIA) that considers interdependencies, consequences of cascading effects, selection of recovery strategies, and collaborative BCP development. It is noteworthy that vulnerabilities often reside with suppliers deep within the supply chain tiers, and these may not be readily apparent. Coordinated BCP efforts significantly enhance supply-chain visibility and bolster the resilience of links throughout the entire supply chain.

Lastly, as a legacy of the COVID19 pandemic, the resilience of workforce has gained importance, adapting BCP strategies to accommodate an increasingly remote and distributed workforce (Jasgur, 2023). Workforce resilience focuses on ensuring the continuity of operations and secure access to critical human resources through fostering a strong culture of resilience, raising awareness, and promoting employee engagement at all levels of the organization.

In summary, effectively addressing the resilience of CI and other dependent businesses demands a collaborative, multi-sectoral approach that involves CI operators, manufacturing and service business organizations, government agencies, regulatory bodies, academia, and various stakeholders. In particular, there is a need for continuous research, knowledge sharing, and the development of sector-specific good practices. Drawing from the experiences and lessons learned in implementing BCM, several key insights emerge.

Top management commitment and support are paramount for the success of any BCM initiative, acting as anchor points to integrate BC practices into organizational culture. Employee involvement and awareness are vital components of successful BCM, requiring ongoing training to equip team members with the skills needed for effective BCP execution. Regularly testing and exercising Business Continuity Plans (BCPs) is imperative to validate plans, identify improvement areas, and ensure preparedness for specific CI system scenarios. A thorough Business Impact Analysis (BIA) is essential to understand interdependencies and potential cascading impacts, while supply chain continuity planning (ISO 22318, 2015) helps organizations identify risks, assess vulnerabilities, and develop strategies to respond to disruptions effectively. Business Continuity due to SC risks can be achieved only through a proper evaluation of internal resilience capabilities, the capabilities and limitations of other links in the supply chain, and the different roles played by the enterprise in the (different) supply chains it belongs to (Birkie et al., 2014). BC Planning and Management is nowadays recognized as a good practice for supply chain resilience and focal companies tend to expand BCM requirements to their critical suppliers (Alcantara et al., 2017).

BCP is an ongoing process that requires review and maintenance of documents, expansion of scope to take account of new threats and organizational changes and the promotion of awareness. BCP is a central part of a comprehensive risk mitigation strategy, as it aligns with the organization's risk profile, focusing on acceptance, avoidance, reduction, or transfer of risks.

Collaboration and partnerships with stakeholders (Trucco and Petrenj, 2017), including governmental agencies, private sector organizations, and emergency response entities, are recognized as good practices for fostering BCM. This involves establishing effective communication channels and information-sharing mechanisms to enhance joint preparedness planning, coordination, and mutual support during incidents, ensuring a comprehensive understanding and management of the interdependencies.

3. Methodology

The methodology adopted to design and validate the BCG is the following:

1. **Literature review** about the main concepts related to BC (definitions, approach, methodologies) was used to ensure a solid foundation.
2. **Selection of the disruptive event**. Due to the increase of natural disasters on a global scale, the choice was to simulate an earthquake, which is a contemporary and relevant choice. The information about intensities, infrastructures structural vulnerabilities and possible damages was collected from literature and through consultation with an expert from the domain.
3. **Selection of the target companies**. The choice was to develop a simulation game for a manufacturing company, an electricity distributor and a logistics provider. The covered sectors reflect a diverse range of industries, enhancing the applicability of the simulation. The companies were modelled based on the collected information about real companies in the identified sectors (e.g., typical organizational structure, infrastructures and assets needed, key suppliers). This approach also allowed us to identify the main characteristics of the target companies and used them as an input to develop realistic stories for the BCG.
4. **Development of the simulation model**. The software selected to develop the models was Simulink. For each target company, a simulation model was created to replicate the main business functions, activities and assets, so that the simulation is able to calculate financial impacts over time following an earthquake, and to return the final net losses. The offered recovery solutions and their parameters, as pieces of BC strategy, were modeled as input variables that can be set by players. The impact of the BC strategy on company's performance in the disruption scenario is calculated through overall financial losses.
5. **Calibration**. By running test simulations with specific combinations of selected solutions, the parameters of the game (e.g. insurance price, costs of BC solutions) were set to make the game as realistic as possible and accurately reflect the complexities of real-world scenarios.
6. **Development of the GUI**. The development of the graphical user interface (GUI) to interact with the simulation model serves as a practical tool for players to engage with the game. The GUI development followed the user-friendly design principles and guides users through all the steps of the game providing interactive dashboards for the Business Impact Analysis (BIA), for setting the BC strategy (simulation inputs) and browsing through the outputs (tables, graphs, etc.). The GUI is directly linked to the Simulink model and it is used to run the simulation
7. **Testing and Validation**. An MVP (Minimum Viable Product) version of the BC game was tested and validated with a group of 44 MSc students at Politecnico di Milano University (Italy) who provided valuable feedback.

4. The Business Continuity Game (BCG) structure and experience

4.1. Learning Objectives

The serious game is designed to achieve several key learning objectives related to Business Continuity Planning (BCP) and its elements.

- Players will develop a solid understanding of the fundamentals of Business Impact Analysis (BIA), gaining knowledge and skills in identifying critical processes, dependencies, and potential impacts of disruptions.
- The game emphasizes the importance of comprehending and managing dependencies both within and outside the organization, extending to critical infrastructure services and supply chains.
- Participants delve into different recovery options, assessing their suitability for specific scenarios, and engage in the evaluation of costs and benefits associated with various recovery strategies.
- Through multi-criteria decision-making, players learn to make informed choices, ultimately contributing to the development of robust Business Continuity Plans (BCPs).
- Furthermore, the game challenges participants to consider external interdependencies and potential cascading impacts of individual disruptions, compelling them to align their BCPs with the recovery parameters of the organizations they depend on, fostering a coordinative approach to business continuity.

4.2. BC Game logic and flow

Participants assume the role of a Business Continuity Manager within the serious game. They are responsible for managing the company's BCP efforts and ensuring the organization's resilience in the face of earthquake

scenarios. This role-based approach allows participants to step into the shoes of a BCM professional, providing a hands-on experience and fostering a deeper understanding of the challenges involved.

There are three companies involved in the game (Figure 1):

- **An auto-parts manufacturer** ('Carware') located in Europe, in a region highly exposed to seismic risk. To maintain the continuity of its business and avoid revenue losses, Carware is implementing a BCM system and, in particular, is evaluating a series of BC solutions that could be adopted with the aim of restoring its activities as soon as possible in case of disruptive events.
- **A major electricity distributor** ('Eldy') in Europe serving different categories of users. Among CI, electric power is a cornerstone of modern economies since it is present in the daily lives of citizens and spans across all sectors of economy. In addition, a majority of CI systems depend on a reliable delivery of electricity. For this reason, it is fundamental that, in case of disruptions, electricity companies are able to restore the service in the shortest possible time and reduce the duration of power outages.
- **A major logistic provider** ('LP') in Europe who offers a wide range of logistic services to businesses and households, always guaranteeing fast and reliable deliveries. It is fundamental for LP to become more resilient and be able to maintain its services even in case of disruptions.

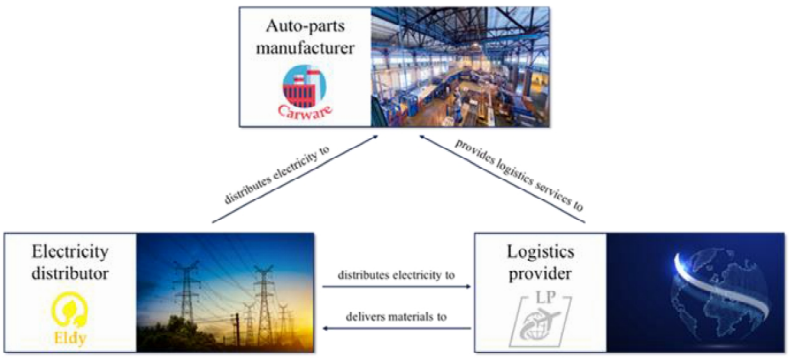


Fig. 1. BC Game companies and their high-level relations.

Throughout the game, players encounter a series of challenges and are required to complete tasks related to Business Continuity strategy development (Figure 2). They must analyze the vulnerabilities, assess risks, and make informed decisions to define the key BCP strategies and parameters for their company. This includes tasks such as understanding business functions, identifying critical processes or activities, assessing dependencies, selecting recovery options and defining their parameters, and allocating resources. By making these choices and simulating their consequences within the game, participants gain practical insights into the complexities of BCP for earthquake scenarios.

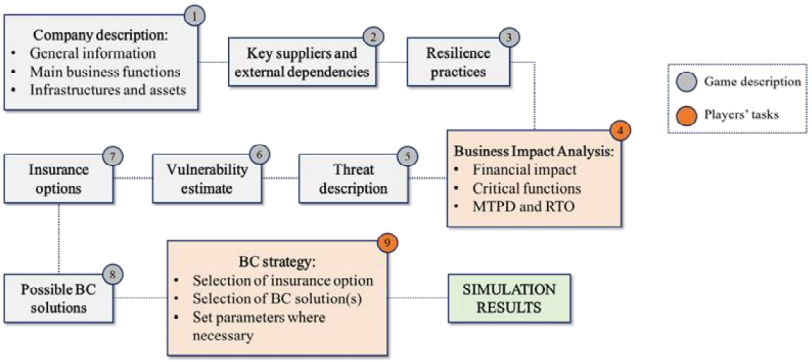


Fig. 2. BC Game flow.

The series of BCG steps and smaller tasks, leads to the final objective, which is the development of the company's BC strategy (Figure 2 – step 9). The strategy is chosen as a combination of BC solutions and their parameters, as shown in the dashboard (Figure 3).

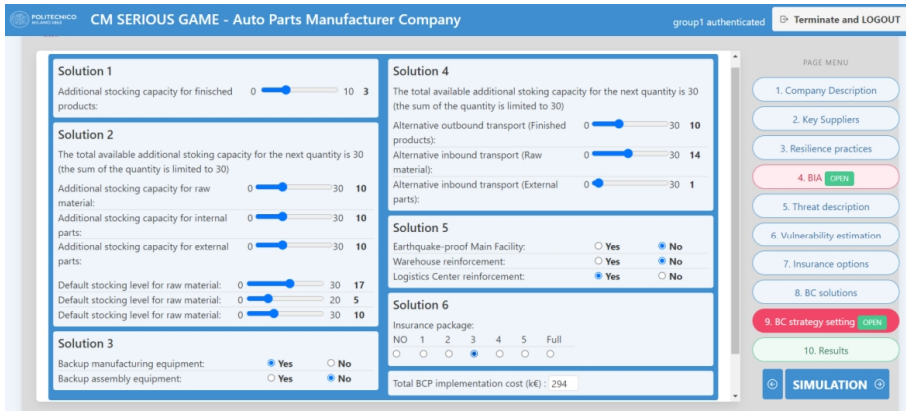


Fig. 3. BCG dashboard for setting the BC strategy and its parameters.

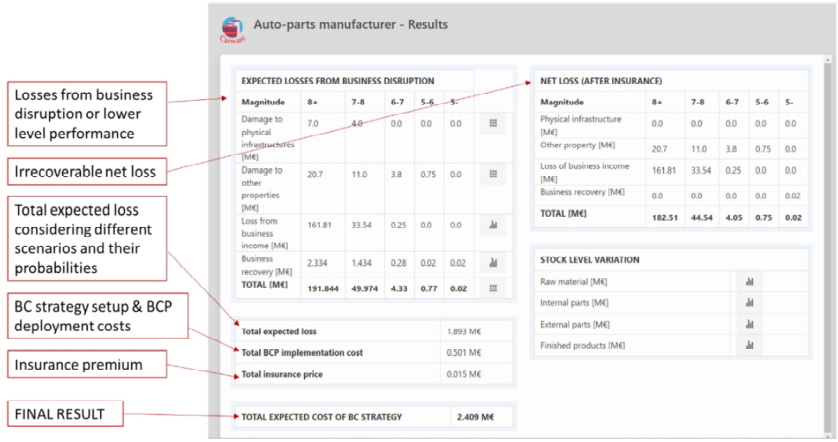


Fig. 4. BCG dashboard for setting the BC strategy and its parameters.

When the strategy is set and saved, a simulation can be started. In each run, five different earthquake magnitudes are simulated (below 5, 5-6, 6-7, 7-8 and above 8, according to the Modified Mercalli Intensity Scale of Earthquake Severity). The results are presented (Figure 4) showing different categories of losses and expenses/investments, across different scenarios. The final performance is calculated by aggregating the results across different scenarios, each weighted according to its probability of occurrence over 10 years.

Additional insights into the BC strategy performance are given through more detailed tables and graphs. By clicking at the icons at the end of each row of the expected losses, the players can look into the sub-categories of losses, for example damages to other properties (Figure 5, left). They can also examine the accumulation of business recovery costs over time (Figure 5, middle), or follow the levels of stocks (Figure 5, right)

Magnitude	8+	7-8	6-7	5-6	5-
Manufacturing equipment [M€]	10.0	5.0	2.0	0.5	0.0
Assembly equipment [M€]	5.0	2.5	1.0	0.25	0.0
IT infrastructure [M€]	2.5	1.5	0.4	0.0	0.0
Internal parts stock [M€]	1.6	1.0	0.2	0.0	0.0
External parts stock [M€]	1.6	1.0	0.2	0.0	0.0
Damage to other property [M€]	**20.7**	**11.0**	**3.8**	**0.75**	**0.0**

Fig. 5. Examples of detailed tables and charts: Other property damage (left); BC recovery spending over time (middle); Stock level of internal parts over time (right).

The serious game promotes active engagement and collaboration among players. It stimulates discussions around the choices made, encouraging participants to analyze the outcomes, learn from them, and reconsider their decisions. Through the game's feedback and reflection mechanisms, players can reflect on the consequences of their choices, identify areas for improvement, and engage in meaningful discussions to enhance their understanding of BCM principles and decision-making processes.

4.3. BC Game playing modes

There are two modes of game playing:

- **Single player**: A player or a team acts as the BC manager of a company and develop their BC strategy based on provided information. In this game mode, the inbound dependencies on other companies are pre-defined, their BC performance is provided through fixed parameters. The performance is simulated and a discussion session is used to consider possible improvements.
- **Multiplayer** (Figure 6): Three teams/players play the game simultaneously, each acting as the BC manager of one of the three companies. They first develop a BC strategy for their company considering the interdependencies and the estimated BC performance of the companies they depend on. The earthquake scenario is then simulated to understand the BC performance of each company. The simulation is followed by a debriefing session used to compare the actual performance of each company and the implications on the other two dependent companies and performance of their BC plans built on the estimated performances (not actual outputs). Each team has to consider the potential gaps in their BC strategy determined by the BC choices of the other two companies, and the groups should coordinate to align the BC strategies and come up with the best possible joint solution. A facilitated discussion helps in raising awareness of the interdependencies between companies and their BCPs and highlighting the importance and benefits of coordination in BCM and resilience planning.

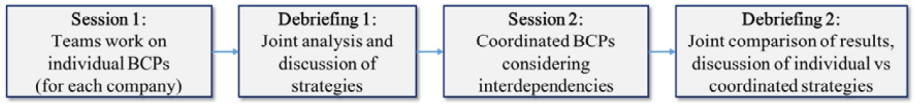


Fig. 6. Full training setup in coordinated (multi-player) mode.

Debriefing sessions play an important role in maximizing the learning outcomes of the BCG. After engaging in simulated crises and decision-making scenarios, debriefing provides a structured forum for participants to reflect on their experiences, share insights, and discuss the outcomes of their decisions. This reflective process allows individuals to gain a deeper understanding of the consequences of their choices and the overall dynamics of business continuity planning. Debriefing sessions serve as a critical learning bridge between simulated scenarios and real-world application. Additionally, these sessions foster open communication, promoting collaborative learning and knowledge sharing among participants. The importance of debriefing lies in its ability to enhance the educational value of the serious game, ensuring that the lessons learned are effectively assimilated and can be applied in the dynamic landscape of BC management.

4.4. Distinctive Features and Benefits

The serious game for business continuity offers a comprehensive learning experience with numerous benefits. It presents realistic and immersive scenarios, mirroring real-world disruptions, and goes beyond theoretical training by providing hands-on learning opportunities. Users actively engage in decision-making processes during

simulated crises, fostering critical thinking and problem-solving skills within a risk-free environment. The game promotes collaborative learning, enabling multiple users to work together on business continuity planning, thus enhancing teamwork and coordination skills. As a cost-effective alternative to traditional training methods, the game eliminates the need for physical resources or logistics, making it a convenient and accessible solution. Immediate feedback on users' decisions allows them to understand the consequences and learn from mistakes in real-time. The scalability of the training can accommodate both small teams and large organizations, making it suitable for businesses of all sizes. Importantly, the serious game aligns with industry standards and best practices for business continuity planning, ensuring that users are well-prepared to meet regulatory requirements.

5. Testing and Validation of BCG

5.1. Participants and Setting

The BCG was tested and validated with a group of 44 MSc students at Politecnico di Milano attending an Industrial Risk Management course, which played the game divided in 16 groups. They played the game on the car-parts manufacturer 'Carware', in the single player mode. The activity was divided into three sessions:

i) Introduction to the BC concepts and methodology (3 hours). This session covered all the theoretical aspects required for the understanding of the BCP process and its steps. This included a set of short exercises to get familiar and practice the main tasks included in the BCG.

ii) Introduction to the BCG (1h) and BIA (2h). The session initiated with an overview of the BCG flow, the explanation of all the steps and players' tasks. The participants the proceeded with the analysis of the company (based on the detailed story provided) and with the development of the Business Impact Analysis (BIA), which is used to estimate the recovery priorities and targets;

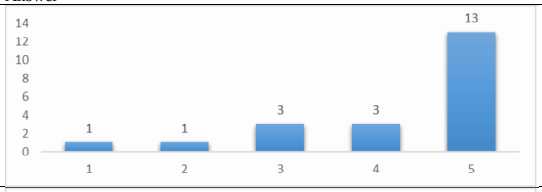
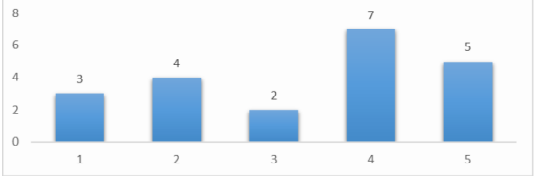
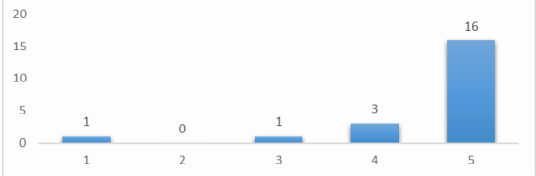
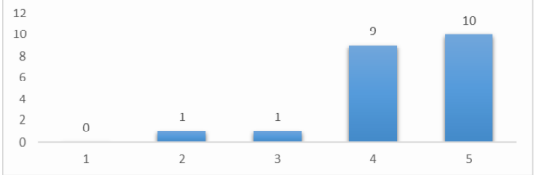
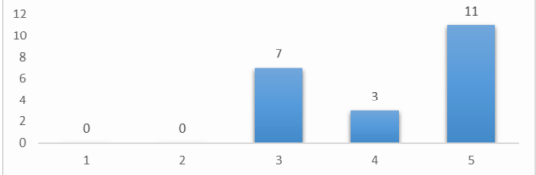
iii) BCP simulation (3 hours). In the simulation session, the participants used the combination of the BIA results and cost-benefit analysis of the available BC solutions to define their BC strategy. There were two rounds of simulations. In the first round, the groups simulated their initial strategies. They were then given time to analyze the performance of their BC strategies by going through the simulation outputs, which allowed them to understand losses across different categories, look into the performance of company's business functions and the changes in the levels of stocks, and to follow the accumulation of investments and losses as the scenario unfolds. They then had an opportunity to revise and improve their BC strategies based on these additional insights, and run another set of simulations aiming to improve the company's overall performance. All the groups managed to enhance their company's BC compared to the first run. The group with the best result presented their strategy and the logic behind it, which was used to guide the plenary discussion and draw the lessons learned.

5.2. Participants' Feedback

Following the sessions, students were invited to complete an anonymous online questionnaire focused on the BCG and its online user interface. The collected feedback, consisting of 21 responses, facilitated the evaluation of the learning experience and outcomes. Additionally, this feedback will serve as valuable input for refining and enhancing the game in future iterations.

The questions focused on the clarity of the game, the usability of the platform and the significance in terms of learning objectives, using the Likert-like scale ranging from 1 (very bad/inadequate) to 5 (very good/excellent). The evaluation results are shown in Table 1 below. The respondents found the descriptive information clear, with minor clarifications suggested. The platform is user friendly, only a minor issue was encountered with a specific operating system installed on one laptop. The participants evaluated the BCG as very useful for improving knowledge and understanding of BC concepts and methodologies. The overall experience related to the BC game was also highly positive. While also evaluated positively, the major room for an improvement is in providing a more detailed task explanation and additional guidance on how to perform individual tasks.

Table 1. BCG evaluation responses from an online anonymous questionnaire.

Question	Answer
Was the descriptive information of the company clear?	
Were the tasks assigned within the game (i.e., BIA, BC strategy setting) well-defined and understandable?	
Was the platform user-friendly?	
Was the game useful for improving your knowledge and understanding of BC concepts and methodologies?	
How do you rate your overall experience related to the BC game?	

A further feedback was collected through two open-ended questions, which asked for suggestions for possible improvements of the descriptive information of the company and of the user interface of the platform.

The suggestions for improving the Business Continuity Game (BCG) contain several key points. Respondents suggested a more detailed explanation of company types to align Business Continuity (BC) actions effectively with the priorities (such as fast resumption of work and minimizing losses). The feedback also emphasizes the importance of clearer explanations regarding existing resilience practices and their contribution. On the other side, there are opinions that the case description was lengthy, requiring a lot of focus to keep track of all the details over the two sessions, which could be improved by a different split of the descriptive material, providing only the relevant part of the story at each session. Therefore, a balance must be found between adding more details to the certain aspects of the company and shortening the story by removing irrelevant descriptions. Some participants found it challenging to grasp how to approach Business Impact Analysis (BIA), evaluate risks and strategies. This indicates a need for a more detailed guidance on those tasks, or, as respondents suggested, providing a case with solutions to enhance understanding before working on the case independently. Overall, these insights provide valuable guidance for enhancing the effectiveness of the BCG.

The suggestions for improving the BCG user interface (UI) also provided valuable insights for refinement. Respondents recommend clarifying that running simulations does not commit them to final decisions, especially for those unfamiliar with such tools. The platform's clarity is acknowledged and the UI's ease of use is praised. However, there is a desire for more insights (e.g. additional graphs about performance of each business function) along with explanatory notes for each graph to improve understanding. Finally, there was a suggestion to improve

the simulation speed (currently around 20 seconds per run) since it seems to be slow, and increase the capacity for running more simulations in parallel (currently up to 5).

These suggestions collectively offer a roadmap for upgrading the BCG and its UI, ensuring a more user-friendly experience and enhanced learning.

6. Conclusions

The paper contributes to the fields of operational resilience, crisis management, and training methodologies in the CI and Key-Resource Supply Chain sectors by presenting a novel simulation-based serious game as an effective tool for collaborative business continuity training. The testing and validation of the BCG confirmed its usefulness for improving knowledge and understanding of BC concepts and methodologies.

Besides the foreseen improvements to the current version of the BCG, as highlighted from the participants' feedback, there are other possibilities to enhance the effectiveness by focusing on customization and relevance. One key avenue for advancement involves adapting BCG to different industries and organizations, ensuring that users receive training directly aligned with their specific business sector and its distinct challenges. This customization would optimize the learning experience, making the scenarios, decision-making processes, and resilience strategies more applicable and meaningful to participants. Additionally, the introduction of alternative disruption scenarios represents could further tailor the training by simulating the most relevant hazards and threats that organizations face. This would ensure that participants engage with scenarios that closely mirror their real-world challenges, fostering a deeper understanding of diverse risk landscapes and preparing them for a broader spectrum of potential disruptions. It is important to tailor BC training to individual needs while keeping up with the evolving nature of risks and threats in the modern business environment.

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