A SERIUOS GAME FOR TESTING BUSINESS CONTINUITY PLANS IN A MANUFACTURING FIRM

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ABSTRACT

Disaster management and Business continuity are now new emerging topics for companies all over the world. Several international standards have been defined in order to support companies in developing their own Business Continuity Plans. The aim of this paper is to propose a framework for designing Business Continuity Games (BCGs) in the manufacturing sector. The proposal is based on applying lean concepts in the BCG design process. An application in an automotive firm supplier is proposed to validate the framework.

Keywords: Business Continuity Management, serious game, game design, manufacturing firm

1 INTRODUCTION

Companies after the disruptive event of Japanese earthquake are now facing with new strategies for analysing impact on their business due to unexpected disruptive events. According to an organizational point of view, potential effects on business activities usually regard (Business Continuity Institute, 2010):

- a loss of productivity, which could easily causes a loss of revenues;
- an increased cost of working (e.g. overtime costs to recover lost production);
- a loss of company reputation: which could influence the overall business of a company.

Business continuity management (BCM) is now a new emerging topic for companies all over the world; thus, the BCM could be defined as a process which aims to actively ensure operational continuity, for preserving competitive advantage (Herbane et al., 2004). Applying an effective BCM strategy could support both a faster recovery process and an efficient reputation protection; furthermore, developing an efficient BCM could also provide a more effective knowledge of critical processes in an organization.

The operational tool for applying BCM in an organization is the Business Continuity Plan (BCP): it aims to identify potential threats of an organization and build internal capabilities to respond to these threats in order to safeguard the interests of key stakeholders, reputation, brand and value-adding activities.

Designing an effective BCP is a complex task due to several factors: one most important is that accidental disruptive events may cause serious threats against the business of a single firm; however, impacts could increase as the whole supply chain may be involved. Furthermore, different sources have to be evaluated in the BCP: sources generating a disruptive event could be very different, i.e. from natural causes to human actions. Wing Lam (2002) suggests a classification of threats based on the specific source type; the three proposed categories are:

- *Technology threats*: this category refers to an unavailability of such a technology due to natural disasters (such as flooding) as well as plant failures, such as fire, power, systems and network failure, systems and network flooding, vandalism, and sabotage;
- *Information threats*: this category includes threats derived from a lack of information due to several conditions including hacking, natural disaster, fire, etc.;
- *People threats*: this category mainly refers to personnel unavailability due to illness, recruitment shortfalls, resignation, weather, transportation, etc..

Developing effective BCPs allow organizations to recover quickly and to reduce impacts of disruptive events (Herbane et al., 2004); international standards have been recently defined for designing and applying BCPs in companies. The most recent standard for BCM is the ISO 22301 (2012): similarly to other management systems, this framework is based on the well know PDCA (Plan, Do, Check, Act) cycle. It affects all step for designing and managing a BCP in an organization; one critical phase is the verification phase where the designed BCP has to be "verified" continuously by companies.

The paper aims to support company managers in both developing and testing its own BCP by applying a serious game as an "arena" for testing company BCP by a "real" simulation experience. Furthermore, the game will also provide to company managers constructive feedbacks for improving the overall efficacy of their BCP.

Thus, after a brief review about the application of serious games in disaster management introduced in section 2, a methodology for developing a Business Continuity Game is proposed in section 3. Finally, an application in a real case study is proposed in section 4.

2 SERIOUS GAMES IN DISASTER MANAGEMENT: A BRIEF ANALYSIS

Serious games are widely applied since several years for testing and communicating such a topic in the business environment: the recreational element raises the degree of involvement, thus allowing players to act rather genuinely (Boyle et al., 2011). Modern theories suggest that learning is most effective when it is active, experiential, situated, problem-based and provides immediate feedback. serious games are effective since they potentially improve the acquisition of knowledge and cognitive skills (Wouters et al., 2013).

The approach of serious gaming combines amusing methods and notions as well as game technologies (Ruppel, Scatz, 2011) in order to interlace two requirements which may seem apparently incompatible: the need of entertaining- typical of ordinary games - and the need of training and enhancing the behavior of players in the long haul. The latter need is disclosed by the use of the adjective "serious" to stress the learning objective underlying the game (Crookall, 2010).

Serious games are widely applied for training purposes, such as to describe, or demonstrate an issue, a situation or a process in complex environments (van der Zee, Holkenborg, Robinson, 2012). However, few applications of serious games could be outlined for BCM: in this context, serious games may provide a test environment to guarantee a proper performance in crisis circumstances, which often require dynamic decisions under time-pressure. Responding in a timely and effective way can reduce deaths and injuries, prevent secondary disaster, and reduce the economic losses (Massaguer, et al., 2006, Di Loreto et al., 2012).

Thus, several previous games developed for disaster management are based on simulation models (Connolly et al., 2012). One example is the "Serious Human Rescue Game (SHRG)" developed by Ruppel and Schatz (2011). This game applies simulation models to provide a virtual environment for developing rescue tests in burning buildings: the main purpose is to evaluate the effect of building condition on human behavior during the evacuation process. The "DRILLSIM game" applies a multi-agent simulation for assessing each role in the disaster response process for a building evacuation (Massaguer et al., 2006). Furthermore, the game called "Zero Hours", developed through a collaboration between the Chicago Health Department, the U.S. Centers for Desease Control and Prevention and the University of Illinois, allows to manage by a simulation game a mass anthrax attack; the scenario game called "Hazmat: Hotzone", rolled out by Carnegie-Mellon University's Entertainment Technology Center, simulates a fire with the aim to test the first response of firefighters in Pittsburgh and New York City; "Ground Truth", developed by the Department of Energy's Sandia National Laboratory, simulates a chemical tanker truck leak.

BC24 - an online incident simulation game - consists of a single scenario game involving a flood, a supply chain failure and impending reputational consequences (Business Continuity Institute, 2013).

As BCM is now applied in several different contexts, serious game for BCM have been developed in both production and service sectors. One example in the service sector is the so called "CODE RED: Triage!" developed by Wouters, van der Spek, Oostendorp (2009): it aims to train medical first responder emergency personnel to perform a triage after an explosion in the subway.

As described previously, simulation based models are also applied to compare different scenarios in disaster management aiming to train organizations. One example is the Flu Pandemic Game, a training tool developed by the UK Department of Health (2009) to help staff, managers and voluntary organizations to develop their own BCPs. Its main purpose is to train players about the impact of a possible cough pandemic on their organization by simulating the consequences this flu could have on the firm.

3 DESIGNING A BUSINESS CONTINUTIY GAME: A PROPOSAL

A framework for developing a Business Continuity game (BCG) in the manufacturing sector is proposed as follows. The aim is to provide managers of manufacturing firms with guidelines for building their own BCG for supporting an effective BCM process.

Before defining the game design process, a characterization of firm features according to the BCM process has to be outlined. As BCM is a relatively new topic, not all firms are nowadays provided with a reliable BCP in order to promptly react to unexpected events. Thus, three starting conditions which could affect a firm have been outlined as follows:

- class A: firms which have already adopted and implemented a BCM system based on international standards;
- class B: firms which have developed their own BCM process, usually based on unstructured processes;
- class C: firms which have not yet applied any BCM system.

One critical phase for Class A firms regards the full verification process required by the international standard: firm managers have to check procedures designed in previous phases: thus, for these companies, the prosed BCG could be an effective tool to control the effectiveness of their BCP.

For Class B firms, the proposed game could be used as a bottom-up approach to improve their BCP effectiveness, rather than a top-down one which is usually more rigid and less effective. One relevant result provided by the BCG application is the knowledge sharing about recovery procedures between all firm managers thus allowing an effective analysis of their coordination degree. Feedbacks provided by the BCG development will allow to harmonize the current procedures in a unique BCP.

Finally, class C firms can also effectively apply the proposed methodology as a support tool for developing their own BCP: in this case, the game application could be more problem-solving oriented, as the firm has to start to develop its BCM strategy.

After analyzing the type of organization, the general framework for designing BCG is proposed in Figure 1.

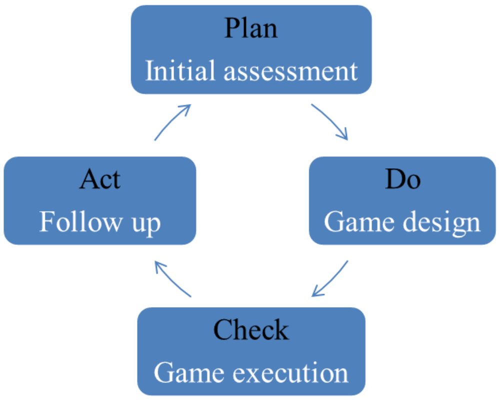

Figure 1: The PDCA application for the BCG design process

The framework is based on three main processes: initial assessment, game design, game execution; a detailed description of each step is proposed as follows.

3.1 The Initial assessment process

At first, game designers have to carry out a detailed analysis of the current situation affecting the organization from a BCM perspective. The main purpose of this activity is to evaluate and share the knowledge of firm BCM process within the whole organization. The overall game complexity will vary according to firm type (i.e. based on the previous classification). Some tools that could support game designers in developing this step could be:

- Study of organizational chart, to verify the presence of determined roles and responsibilities, from the BCM point of view (business continuity manager, business continuity teams or emergency response teams);
- Direct interviews and questionnaires, to submit to a sample of the whole staff;
- Assessment of documents concerning BCM, i.e. business continuity plan, emergency procedures, certification of the implementation of a standard BCM system; certification of the accomplished training.

Then, other two activities have to be carried out aiming to highlight most critical events for the firms:

1. Developing a documented risk assessment that identifies and evaluates the risk of disruptive events. The risk is weighted according to two dimensions: the probability of occurrence and the seriousness of the event, on the basis of financial loss, loss of reputation, costumer complaints and delay in product release. The outcome of risk assessments provides evidence of the order of priorities of threats to be overcome.

2. Conducting a Business Impact Analysis to identify the products and analyze the functions and the effects that the business disruption may have upon them.

3.2 The BCG design process

The proposed BCG is a role play where each player covers the actual role he/she has within the firm, however he/she has to make decisions in a fake environment. The BCG design process is detailed in Figure 2. The first activity for the BCG design is to define the triggering events – i.e. incidental (or accidental) events starting the crisis -: events are deducted from the previous risk assessment activity.

The output of this step is the so called EVENT CARD processing. The managers of the game could use this tool to outline operational scenarios to the players; it also indicates the typology of accident, date, time and shift and place of area in the area in analysis the involved department. After event definition, game designers, should quantify consequences due to the accidental event on the firm activities, the interruption working activities since all activities are recovered. For this purpose, the game designer has to map the most relevant activities for the emergency management process. For the class A firms, the involved activities and actors are traceable by the BCP; thus, the game designer will set the layout of this process starting from the activities planned within the existing BCP and improving them. For class B and C firms – where BCPs are not fully developed – critical activities have to be evaluated by game designers, based on their knowledge and management skills. Thus, the use of structured tools (e.g. value stream maps) could be effective for carrying put these activities.

Outputs of this phase allow to design the so called SOLUTION CARDS process. These cards represent how each player contribute to solve its specific task during emergency and recovery processes. Inputs are all information concerning the emergency scenario; expected outputs are decisions developed by each player to face with the unexpected event. Suggestions could be introduced by the game designer to help players in their decision making process. Next, escalation parameters are introduced in the game design process. Two parameters have been introduced:

- Escalation factors;
- Random events.

The escalation factor F is defined based on a level of criticality (pi) of each event according to equation 1:

$$F = \sum_{i=2}^{f} pi \qquad (1)$$

where the variable p_i is a binary variable which can have value 1 if the impact of the event is low or value 2 if the impact is high; f is the total number of introduced events. The i-th event (i = 2, 3, …, f) is an unexpected event occurred after an accidental one. The insertion of a set of events f >1 entails the iteration of all the steps pertaining to the process of game design for each event f. Hence, even the escalation factor itself f could be dynamically updated in each iteration.

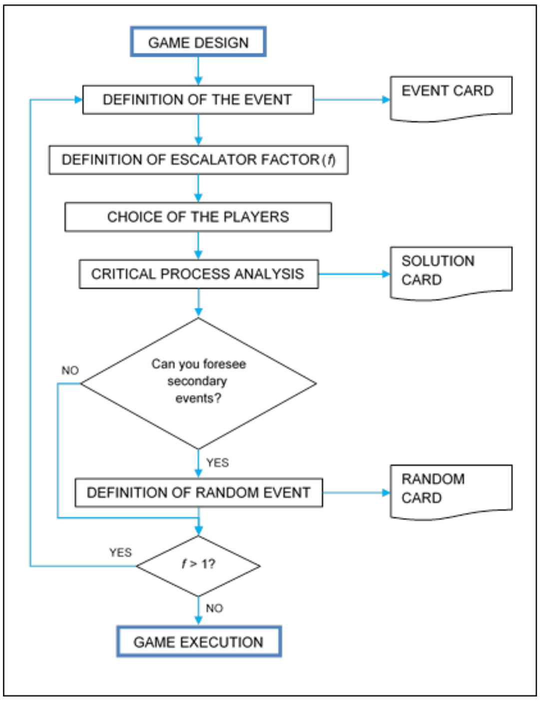

Figure 2: The proposed game design process

The game designer could use the escalation factor to control the game criticality level: thus, by introducing a high number of escalation events, players are forced to manage more severe conditions (e.g. in terms of production disruptions) thus increasing the criticality level of the simulation game.

Random events are casual events triggered by the primary accidental event. They can be defined as positive or negative externalities caused by an event, whose effect is either the increase of the level of criticality (with negative impacts) or the facilitation of the emergency management (with positive impacts). Differently from the escalation events, they do not directly modify the operation interruption time.

Escalation factor and random events introduction have been depicted in Figure 2.

For each f main event, the game designer could introduce j random events (j = 1, 2,…, r), whose weight on the impact of the paramount event i is due to the factor R_i:

$$\text{Ri} = \sum_{j=1}^{r} \pm ej \qquad (2)$$

where the variable e_j is equal to 1 if the impact of the j-th random event is low; or it is equal to 2 if the impact is high; ± refers if a negative or positive impact is evaluated.

Hence, if random events are introduced, the level of the thorough complexity of the game is defined by equation 3:

$$C = \sum_{i=2}^{f} pi + Ri \qquad (3)$$

For each random event the game designer ought to set the correspondent random card, later delivered to each player, without any notification, randomly, indeed, during the performance of the game.

3.3 The Game execution

In order to test a first feasibility of the BCG, a trial run, which is a pre-simulation of the game not fully working, could be carried out. The trial run should not be performed by the same players selected for the full scale BCG execution; however it would be suitable to identify different players within the firm sectors for developing this step. During the trial run the game designer has to observe: his/her own task is properly the evaluation of the outcomes. If the trial run is reckoned to be positive, than the actual game will be eventually performed. Otherwise, if the test has not elicited the hoped results, then the game designer will have to, in accordance with the gathered feedback, bring about the necessary changes. Hence, he/she has to iterate all the activities pertaining to the process of game design.

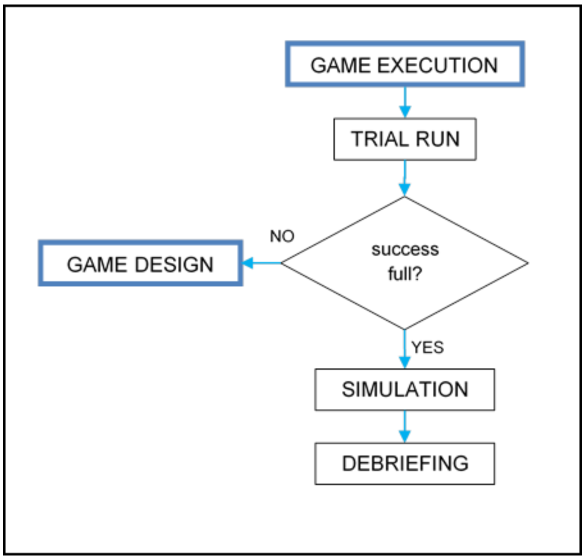

Figure 3: The Game Execution Process

Next, the game execution phase could be carried out: a key role is the game manager team which has to support players in responding to the specific game dynamic. Furthermore, each player is provided with the game kit such as solution cards, and other supporting materials (e.g. BCPs and/or emergency procedures).

The simulation session is structured in *f* round, each one for each main event. Every round is bordered with a deadline to convey the solution.

Within each round, the facilitator is allowed to subject, randomly, the players to one or more random cards, which can be different for each player.

Finally, it would be preferable to plan a debriefing session at the end of the game performance, in order for all the players to deal with their personal suggestions and, moreover, to draw the relative conclusions, concerning the level the firm shows in terms of readiness to tackle such unpredictable circumstances.

4 THE CASE STUDY AT THE BOSCH BARI PLANT

The aim of this paragraph is that of presenting how the framework, deeply illustrated in the previous paragraph, has been applied to build the Bosch Business Continuity Game. The theoretical model has been applied to a manufacturing firm of Bosch Group. The plant is located in South Italy (Bari) and it produces components for the automotive market. Its supply chain is very complex and interconnected; thus, a variation in production rate at Bosch Bari plant could heavily affect the overall company performance (Gnoni et al., 2003; Gnoni et al., 2013).

The production system is based on lean manufacturing principles thus all the manufacturing processes are smooth with an optimal stock of goods which are sufficient just for a very narrowed period of production interruption. Strictly bounded to this premise, the need of adopting an efficient BCM system is necessary.

4.1 The Initial assessment step

The documentation assessment at our disposal shows that only some departments are provided with emergency plans, even though these do not take into consideration the whole of external circumstances that may elicit the interruption of the business, however they are mainly focused on the threats against the IT system. Besides, the direct interviews with some spokespeople of the staff have disclosed that the discipline BCM is only acquainted by top managers and not by members at the operational level. Currently, any suggestion oriented towards the implementation of BCM system has not undertaken yet. This can be traced by the organizational chart where nobody responsible for BCM is included.

Currently the plant is endowed with an emergency procedure focused on the emergency management rather than on the business continuity.

The goal of the game is to integrate the emergency management procedures with ones regarding the business continuity process.

Based on previous proposed classification (see section 3), the Bosch Bari plant belongs to class B companies. Thus, the game application mainly aims:

- Evaluating how management runs an emergency situation and make decisions;
- Evaluating how the organizational structure reacts in order to reduce the weight of the critical business interruptions;
- Highlighting potential deficiencies in the existing procedures;
- Developing a most structured approach towards the Business Continuity Management;
- Harmonizing and complementing the existent procedures in a unique BCP.

Next, following activities have been developed such as:

1. A preliminary risk assessment, where unforeseen events affecting business continuity have to be analyzed. The focus was on external threats derived from natural disasters. By analyzing External Emergency Plan defined by the municipality where the plant is located, game designers have outlined earthquake as the most critical event in terms of both probabilities and consequences (essentially on firm productivity).
2. Business Impact Analysis (BIA), where we were taking into account the several business units traceable in the establishment which are three. In order to ponder the business impact, we verified whether the Plant of Bari was the only one supplier for each brand, as far as Bosch is concerned. This analysis shows that Bari plant is the production site of these products, which are characterized by the lowest MAO (Maximum Acceptable Outage) value.

4.2 The Game design step

The Bosch BCG has been developed based on the previous proposed framework. As earthquake with a 5.4 magnitude. Next, event cards have been defined (see figure 4); they include following information:

- Starting conditions: e.g. date, time, shift when the accident will occur;
- The specific event description;
- The Post-event conditions: in the event of earthquake, we are providing information concerning the condition of the machineries and of the escaped out staff.

Round 1 - Starting Situation

It's 6 p.m., 9th December - The second shift is normally running

Event

5.4 magnitude earthquake

Post event context

- Emergency situation of "class 4" (according to the Procedure Bar-02-04)
- The ERT organizes the mobile accident unit and puts on the alert
- All of the workers escape out of the plant and go to the meeting points situated outside the plant without their personal effects
- The ERT checks that the Emergency Procedure has been strictly followed and that the first aiders provide assistance to the injured associates
- The buildings have withstood the earthquake without having suffered any apparent structural damage

Figure 4: Event Card

4.2.1 The Escalation factor definition

In this phase, game designers have fixed the total number of rounds based on the criticality level to be reached: the total number of run is 3 starting from an earthquake (event 1). Two following events have been introduced such as:

- Event 2: the earthquake has determined the failure of some components of the compressed air line that supplies a determined assembly line
- Event 3: explosion in the proximity of a critical assembly line during equipment restarting.

The event 2 has a low impact on the business interruption (p_2 = 1) as equipment faults are located at the top of the air compressed line which provides service fluids to a not critical assembly line. This assembly line is not critical since other plants of Bosch Group in the world are configured to manufacture that specific products. Furthermore, the time necessary for the maintenance and restoration of the line is quite short (about 48 hours), so the inventory level available in the plant could compensate the temporary production unavailability.

The following round (due to event 3) is more critical as it determines a high impact (p_3 = 2) since the explosion involves the assembly line of a critical item: the time necessary to restart the line is high (at least 1 week) because machines have been damaged both in their hardware and software (e.g. PLC) components. The figure 5 illustrates the timeline of the occurrence of the events and the time lapse they cause.

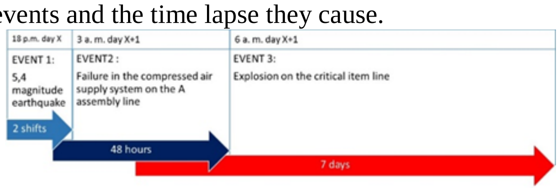

Figure 5: The proposed event timeline

4.2.2 The Player involvement process

The firm top management has decided to fully participate to the game as they are directly involved in carrying out Bosch emergency plan. In detail, during an emergency, the firm top management coordinates the so called Emergency Coordination Committee to manage crisis conditions. During the game, the intervention of this committee is simulated. Main functions involved are: the firm Top manager, Technicians, Human resources, Health Safety Environment, Production, Logistics and Security.

4.2.3 The critical process evaluation in the BCG

Since Bosch belongs to class B, thus lacking a BCP, we mapped the potential activities to be performed in order to tackle the crisis triggered by the earthquake. We used a swimming lane tool pictured in figure 6.

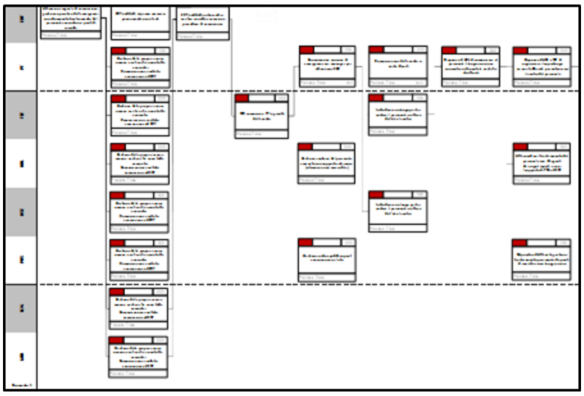

Figure 6: Swimming Lane Tool Map

Game players are outlined in the swim lane, and activities are depicted in the boxes. Each activity corresponds to a valued process time; moreover, links represents the information flows among the actors.

PLAYER	PLANT MANAGER
INPUT	1. The building of the plant has withstood the earthquake (no clear damages, collapses, etc.) 2. The workers gathered in the meeting points (< 1000 persons) have not got their personal effects and therefore they cannot come back home 3. It is necessary to minimize the production losses (max 1 shift) with the aim to resume the production not later than 6 a.m. of the next day
EXPECTED OUTPUT	Coordinate the activities of emergency management through : elaboration of a Recovery Production Plan; maintenance of a proper flow of internal/ external information, interfacing with the administrative organs and police departments
SUGGESTIONS	1. Call the ECC for the emergency coordination 2. Organize the internal/external communication 3. Manage the relations with administrative organs and police departments

Figure 7: Solution Card

Example of solution cards developed for the case study are in Figure 7. While input are the same for all players, the expected output and the suggestions are personalized and formulated according to each player role.

4.2.4 The Random events definition

One random event has been introduced for impacting on event 1: the arrival of press officers at our plant to make some interviews and to document the crisis taking place. This random event has a negative impact with value 1 since it caused the slowing down of the recovery process. The example is shown in Figure 8.

Jolly Event - Starting Situation

It's 4 p.m., 10th December – In the plant there is a state of emergency due to the earthquake

Event

A troupe of a public television's reporters arrives at the plant

Post event Situation

- Having heard the news of the earthquake that involved Bar, the journalists want to report the event and to hold interviews with the top managers
- For this reason they ask the authorization to realize some video to document the emergency situation resulting from the earthquake

Figure 8: Random Card example

After the outline of the equipping assets for the Bosch BCG, the Game execution has been carried out by a trial run: a trial run has been carried out by involving a more restricted group of players. After the trial run development such considerations have been deducted:

- The players were not aware of the procedures;
- The players did not carefully read the solution cards, especially the hints;
- The players promoted a joined work, rather than an autonomous work, in order to find the fittest solution;
- Such solutions suggested by the players, was different by that one hypothesized by the game designers, during the value stream design step.

Thus, few modifications have been carried out such as:

- The mapping of the activities has been modified according to suggestions provided by the players;
- The solution card format has been modified: each player will be given a personal blackboards, where input information and required output have to be pointed out.

Furthermore, a set of key performance indicators have been also introduced to monitor the global effectiveness of the BCG such as: time required by each player in providing output; occurred delay of the overall team player in providing solution for each round; number of suggestion deducted by the game development not yet introduced in the forecast preliminary analysis.

5 CONCLUSIONS

The paper proposes a guideline to design BCGs in the manufacturing sector based on common activities characterizing business continuity plans. The framework proposed has been validated in a real case study regarding an automotive firm: the firm supplies components to final customers as well as to other production sites. Furthermore, the firm applies intensively lean management strategies; thus, business continuity has been outlined as a relevant issue.

The application of the proposed framework has revealed effective as modifications and new emerging issues have been outlined to support firm management in designing a more efficient business continuity plan.

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