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*Title* **"FortFantastic" business simulation as a tool for research**

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*Abstract* Although business simulations enjoy increasing popularity in leadership education and development, their application in leadership research (likely due to the low availability of well-developed, complex simulations) is making slower progress. However, high degree of realism, adjustable settings and control over the modeled context and restrictions make simulations a useful tool of research. In the present work we introduce "FortFantastic" – a gamificated team-based simulation – and discuss the possibilities of its' application to study leaders' behaviors and effectiveness while leading virtual teams. We provide the description of this tool, its' advantages and the possibilities of its' application in research.

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## 1. Introduction

Leadership education and leadership development literature has demonstrated the effectiveness of business simulations in learning (e.g., Burch et al., 2014), assessment, and development of leadership skills (e.g. Siewiorek et al., 2012). Indeed, business simulations increase participants' engagement (Buil et al., 2019), enhance their feeling of competence during an action (Ryan & Deci, 2000), and stimulate them to reflect on their own actions and behaviors (Siewiorek et al., 2012). Findings within aviation, military, business and medicine industries, where simulations are most often applied for identification and development of non-technical skills, such as leadership skills (Salas et al., 2009), additionally show that simulations are effective in training with respect to using "algorithms, communication, teamwork, situational awareness and decision-making", to preparing for practice, and to applying the acquired skills in critical situations in practice (Marker et al., 2019, p.1).

The use of business simulations *in leadership research* has increased during the last decades (Ceshi et al., 2013), but still remains a relatively rare endeavor. Remarkably, that over the period of 21 years Gist et al. (1998) could identify only eight research papers (from 5,985) in five most important academic journals in the management research field that were based on interactive behavioral simulations. During the last 25 years the use of business simulations in leadership research slightly increased, but overall remained scarce. Nevertheless, some few business simulations, such as, for instance, the simulation by McCall and Lombardo (1982), have established themselves as a valid tool of leadership research (e.g., Truninger et al., 2020; Stewart et al., 2008; Hough & White, 2003; Santora, 1996 are using the simulation by McCall and Lombardo), thus, signalizing the interest of academic community to this research method.

Why is the use of simulations in research limited? As compared to other methodological approaches, they allow building in mechanisms, interactions, and feedback loops to study the effects of interest under high degree of realism. However, firstly, higher realism comes at the cost of higher complexity. Simulations are comprehensive, they require high time- and effort-investments. Hence, their application within the frame of only one research project lowers the appropriateness of their

development. Secondly, experimenters typically develop simulations for specific contexts and purposes. Thus, the resulting simulations often become too specific which limits their applicability to other settings. In the present work we introduce an interactive, complex, and realistic business simulation ("FortFantastic"), which is applicable in different contexts and research fields and allows to study various aspects of leadership and teamwork.

"FortFantastic" is a game-based team simulation in which multiple teams of at least three individuals virtually operate a theme park. This simulation can be conducted either partly virtually at one location (with computers in the laboratory), or virtually with geographically spread teams. Each team is managed by a formal team leader. Together with their teams, leaders take strategic and operational decisions to maximize their business profits (that proxy leader's effectiveness) as well as to outperform their competitors. Team members have access to individual, role-specific information that may be relevant for solving specific, dynamically generated team tasks. The leader's role implies aligning the actions of team members with the organizational goals and continuously adapting them to the changing environmental conditions. Leader's actions, performed under pressures of competition and time, have a direct effect on teamwork and influence business efficiency. Business profits are calculated with the simulation software and offer a reliable quantitative measure of team performance. The built-in mechanisms and configurable settings ("manipulations") within this simulation allow to study multiple facets of leadership and their influence on virtual team performance.

The purpose of this work is to revisit the role of business simulations as a fruitful research method and to consider its' potential for leadership, behavioral, communication and other related research. This paper first discusses the definition of leadership in the virtual context, the use of simulations in research and how the simulation can specifically contribute to closing the methodological gap in leadership research. Further we provide the exemplified simulation structure, discuss built-in indicators, mechanisms, processes, possible interventions, and the overall technological implementation. Additionally, we briefly overview the naturally occurring phenomena, such as decision-making, communication in teams, power, anonymity, team climate, the use of

telecommunication technologies etc. Finally, we discuss possible areas of application of the simulation "FortFantastic" in research.

## 2. Leadership as captured by "FortFantastic"

### 2.1. Definition of leadership in the context of virtual team work

What is leadership and how it can be studied using simulations? Leadership cannot be easily codified. We can only make sense of actions performed by leaders and the reactions of employees, and, based on observed actions, "glue a label" on leadership (Sprenger, 2012, 31). However, we cannot *see* leadership and just motivate/explain specific actions from the perspective of an "assigned" leadership label. Sprenger (2012) argues that there are only few rules and no regularities that would be universally true. However, one of them is the fact that leadership is a social phenomenon and requires acceptance by employees in order to achieve set purposes.

Leadership is based on the ability of an individual to set the goals as well as to direct and control a group of people to achieve these goals (e.g. Hicks & Gullet, 1975; Pastoors et al., 2019). The way it is done depends on decision-makers themselves (e.g. their personality, attitudes, values) and their followers (e.g. receptivity to the influence) as well as on a specific context. The role of leaders can be particularly seen in managing work processes, in communicating with employees and bonding them to the organization, as well as in developing trust, creativity and work motivation of the staff. Leadership competence has cross-sectional nature as it includes a number of methodological (e.g. analytical thinking, organization or decision-making skills), social (e.g. empathy, team competence, conflict management) and personal (goal orientation, self-reflection, responsibility etc.) competences and skills (Pastoors et al., 2019).

Globalization, the increasing decentralization of organizational forms, growing diversity of the workforce, and new forms of work design increase the dynamics and complexity of business environments. Recent information and communication technologies (ICT) developments have contributed to the growth of virtual team work. Therefore, leaders have to react to a variety of new challenges they have never dealt with before. They have to organize virtual team work (Bell &

Kozlowski, 2002; O'Leary & Cummings, 2007), build trust with employees sometimes in the absence of face-to-face communication (Avolio et al., 2000; Breuer et al., 2016), and find out what characteristics (skills, capabilities, traits, leadership styles etc.) are essential for the performance of their virtual teams (Hambley et al. 2007). We understand virtual teams as geographically spread teams of individuals who communicate with each other via telecommunication channels while working towards a common goal. All virtual team members can send and receive signals and messages only via telecommunication channels. Thus, *how* leaders communicate (e.g., with respect to the frequency, content and style) plays an important role in taking influence on team members and directing their efforts towards the achievement of set goals.

Two main forms of virtual team organization can be distinguished: network structures, shared responsibility approaches, horizontal leadership structures (e.g., shared leadership), vertical hierarchical structures (e.g., hierarchical structures, directive leadership). Both shared leadership and directive leadership approaches have been shown to be related to team performance in a virtual context (e.g., Hoch & Kozlowski, 2014).

### 2.2. Measuring leadership within different research designs

Given such a fuzzy definition of leadership, leadership research has developed a number of survey-based tools that capture the perceived characteristics of leadership. The Multifactor Leadership Questionnaire (Bass & Avolio, 1990; Avolio & Bass, 2004) is one of the most well-established and well-validated instruments to measure transformational (based on charisma, inspiration and intellectual stimulation) and transactional (based on exchange relationships) leadership styles. Some studies extend the application of survey-based methods not only to measuring leadership characteristics, but also to evaluating leader's efficiency (Fisher et al., 2020). Such strong reliance on perceived measures of leadership constructs is often criticized for its' subjectivity of measurement.

Because it is often not possible to sidestep using surveys, some leadership scholars alternatively imply multiple measures of leadership characteristics (Liden et al., 2015), work with instrumental variables, such as physical characteristics, stable individual differences or geographical

distance (Eva et al., 2019; Antonakis et al., 2010), or use methods of empirical analysis, such as experimentally randomized instrumental variable approach (Sajons, 2020) that are designed to cope with perceived measures of leadership. However, even given the robustness of results, this research does not base the analysis on *real actions* of leaders (Fisher et al., 2020).

Experimental designs help to minimize endogeneity concerns (e.g. reverse causality or subjectivity in leadership measurement) while explaining the observed relationships between leadership and effectiveness criteria (De Cremer & van Knippenberg, 2004; Wang et al., 2014). This provides a fundament for developing leadership theories (Podsakoff & Podsakoff, 2019). Laboratory experimental designs are often criticized for the lack of realism and limited generalizability of findings to real leadership environments, because they are applied in artificial settings and only to a limited extent reflect the complexity of social processes (Podsakoff & Podsakoff, 2019; Zaccaro & Horn, 2003). Field experiments and quasi-experiments allow for less controlled environments and more realism, but usually on the cost of lower internal validity (Podsakoff & Podsakoff, 2019).

Simulations can also be used to generate new knowledge and to study causal relationships. They confront participants with fictitious situations (in contrast, laboratory experiments try to most accurately reproduce the target real-world system) in a constructed setting to analyze the real behaviors and outcomes of possible conditions (Lean et al., 2006). The mapping used in simulations is more abstract and formal (Guala, 2002). However, (behavioral) simulations "maintain the element of human choice" (Gist et al., 1998, 253): they involve human participants in the simulation itself and allow free behavior and *real decision-making* within it (McCall & Lombardo, 1982, 533). Contextual factors, such as tasks or the framing, engage individuals in an experience which is characteristic of that found naturally in organizations (Gist et al., 1998, 253; Keys & Wolfe, 1990). McCall and Lombardo (1982, 540) highlight the value of behavioral simulations as a research tool to study "many organizational issues because variables of interest can be built in".

Simulations are also able to incorporate more complexity in the research design than it would be possible with other research methods. Harrison et al. (2007) highlight the value of simulations in studying organizational and human behaviors in dynamic and complex systems, which allows gaining

additional theoretical insights through developing theories and exploring the results of their testing.

The possibility to construct and exactly determine built-in mechanisms and processes with respect to the purposes defined by the experimenter (Guala, 2002) allows high degree of control over various parameters in simulations which reduces the number of alternative explanations of specific relationships and increases internal validity of research. Moreover, simulations include the possibility of manipulating individual behaviors and actions. This possibility is ensured, for instance, through working with different samples (e.g. teams of more or less experienced managers), different simulation instructions (e.g. to exercise transformational or transactional leadership styles), team communication options (e.g. degree of anonymity, or communicating per chat versus with the use of video conferences), varying team structures (e.g. with or without team manager, or with or without double staffing of specific team roles) as well as through changing simulation settings (e.g. the duration of the simulation). These characteristics make simulations useful tools for studying various aspects of leadership (e.g. actions, behaviors, communication styles) at the intersection of multiple disciplines (e.g. economics, psychology, sociology).

The goal of the present work is to pose “FortFantastic” as a tool for research, which is adaptable, interactive and sufficiently complex to induce authentic behaviors of participants. Due to the built-in competition framework, taking part in the simulation results in a high degree of participants’ engagement and genuine commitment. The web-based team simulation relates leader’s characteristics to an objective measure of his/her effectiveness (profits of the virtual theme park) under conditions what are perceived as realistic.

## 3. “FortFantastic”: An overview

"FortFantastic" was initially developed in a paper-and-pencil format as a leadership development tool and is already being used as a training tool in several organizations. Simulation parameters, “challenges” to the participants (i.e. critical situations requiring emergent actions) and the built-in mechanisms programmed depending on decisions/behaviors of participants are based on experience from managerial practice. The feedback of participants and own observations on participants’ actions

and reactions are used to improve and advance the simulation as well as to adjust it to changing environmental conditions.

The growth of information and communication technologies is challenging the reality leaders have to cope with. Modern leaders more often lead virtual teams, in many cases without having met any team members personally. “FortFantastic” has been converted into the digital format in which leaders and team members are allowed to communicate via the simulation platform (including chat, audio- or video-conference) or other available communication channels such as email or phone. Team members, if necessary, may completely remain anonymous (e.g. if they use chose not to provide their real names or use video chats).

In "FortFantastic," multiple virtual teams are tasked with running a theme park by focusing on a dynamic process of troubleshooting that requires coordinated teamwork and collaborative process innovation. The simulation is conducted in several intervals called “seasons” (the duration of each season can be adapted). Between “seasons” there are short “winter” breaks that allow virtual teams to discuss and optimize their processes.

Each of three departments of the theme park “FortFantastic” - Control Room (CR), Operating Business (OB) and Technical Support (TS) must be run by at least one person. The role of Park Manager (PM) is optional and can be added if necessary. No other hierarchies are built-in in the simulation, such that all roles and individuals have equal responsibility for the team success. In case of the minimum team size of three individuals, each individual performs a distinct role as a CR expert, an OB officer and a TS specialist respectively. However, the simulation allows double-staffing as well.

Figure 1 illustrates the division of roles and tasks in the team, role-specific documents available to every individual, and the directions of information exchange in the team. Team members have access only to the role-specific information, which may become relevant for solving dynamically generated business challenges and needs to be forwarded to the team. Geographic distance forces individuals to interact via telecommunication channels (video- and/or audioconferences, chat, telephone calls etc.) available on the virtual simulation platform.

*** Figure 1 here ***

A CR expert has access to the Main Control Room Operating System (MCOS) of the park. He/she monitors the infrastructure, forwards error messages to TS, imputes solution codes, and implements activities such as advertising, maintenance or capacity upgrades chosen by OB. TS identifies solution codes for resolving technical infrastructure problems. For the detailed description and examples of individually available documents see Figures 2 to 6.

*** Figures 2-6 here ***

By design, PMs' are not assumed to solve operational tasks and do not have access to any exclusive information relevant for this process. That is why their role is optional and is rather interesting in the context of implementing innovation and change processes. The key responsibility of the PM is to ensure the overall business efficiency. During the simulation he/she has access to the monitoring system, which compares all relevant data of both teams in real time. Depending on this information (available on the park dashboard, see Figure A2), PMs constantly streamline operational behaviors to minimize downtime of park attractions. The operational incident handling process, strategic business decisions, and virtual team dynamics (influenced by leader's communication with the team and the chosen leadership style) transparently determine the park's bottom line. Equipped with comparable sets of resources the two teams compete for the highest profit.

## 4. Construction, possible manipulations and measurement

"FortFantastic" allows to study the effects of different leadership characteristics (e.g. leadership styles, leader's personality, communication with team etc.) on virtual team performance. For instance, with respect to leadership styles, the simulation can be used to study leadership from both the network perspective (shared leadership, servant leadership with the moderating role by leaders) and the hierarchical perspective (directive leadership, charismatic leadership with the general top-down approach). In case the optional Park Manager role is not used, we observe self-coordinating virtual teams, which can be studied in the context of self-organization, team processes, informal or emerging leadership. Leader's effectiveness or team effectiveness can be measured in terms of profits (calculated depending on team operative and strategic decisions) or problem-solving efficiency

(measured by the average problem-solving time). Through the combination of the simulation with additional survey instruments, it is possible to measure diverse perceived leader's and team outcomes, such as perceived leader's or team effectiveness, team potency, commitment etc. "FortFantastic" can be also used to study leadership. In the following we will describe the most important features and phenomena which may occur during the simulation as well as provide some ideas for research with this tool.

### 4.1. Built-in parameters and mechanisms

The key process most relevant for team performance is how fast and efficiently virtual teams solve technical and commercial problems that challenge the normal functioning of the theme park. Virtual teams need to maintain the infrastructure, invest into new infrastructure, care about the number of visitors, customer satisfaction and take strategic decisions about the future course of development. Simulation includes a number of parameters on internal organization of the virtual business and team processes (e.g. the process of problem solution, information availability and flow) as well as a number of built-in configurable external parameters (turbulence/stability of the environment, competition, time pressures) which may influence team work. The design of the simulation, the roles in the team are developed to map processes and challenges in the virtual team work.

As Figure 1 explains, every team member has access only to an individual piece of information which is or may be relevant for solving team challenges. This requires information exchange between team members. This set-up stimulate discussions, encourages collaboration, information sharing and team processes, but can be also used to analyze the issues of withholding relevant information and free-riding (in case of double-staffing scenario, with more than one person working in one department).

Leaders' effectiveness (or virtual team performance) is objectively measured in form of generated theme park profits. Profits are calculated with the help of the simulation software and take a number of parameters into account (e.g., visitors number, availability and financial returns from

specific attractions) that, in turn, can be influenced by the team. More effective teams are generally expected to demonstrate better performance.

One of the key parameters is availability of attractions. As technical challenges happen, certain attractions do not function at all or have only reduced capacity (e.g. of 80%) to welcome visitors. If the team needs much time to repair attractions and the resulting availability of attraction in the park becomes low, the number of visitors will decline, which will negatively influence park turnover and profits.

The second parameter used for the calculation of turnover is customer satisfaction. At the beginning of the simulation it equals to 75% (teams should have possibilities and incentives for improvement), but continuously varies depending on the availability of attractions and costly team actions (e.g. marketing campaigns). Customer satisfaction data is based on a daily representative survey among the visitors of the park. This information is used to update the moving average customer satisfaction of the last 100 days. This information is available to the CR expert.

Finally, the third parameter – appeal – is the sum of the appeal (attractiveness) of all attractions in the theme park. Every attraction has a pre-defined and fixed value of the appeal (available in the Attraction master data table in Figure 5). Likewise, many activities in Activity Cards can change the value of appeal. One built-in process is the long-run decrease of appeal (of 2 % p.a.) which has to be dealt with by teams.

In addition to solving technical challenges, teams should keep costs under control. Teams are faced with fixed (fixed costs per day) and variable (variable costs per user) operating costs which are available from the Attraction Master Data. Due to inflation teams have to deal with continuously growing overhead costs (2% p.a.). Additional system costs, induced by the team (e.g. buying solutions, asking for an expert advice or penalty for false solutions), reflect team efficiency. In the ideal case they are fully avoidable if teams solve problems efficiently. The higher these costs, the more inefficient is the teamwork.

A unique characteristic of Fort Fantastic is the constant evaluation of the efficiency of implemented measures by comparing their costs and returns. Negative results show that the return of

the measure is lower than the money spent, i.e. a specific measure is ineffective. System costs on the Dashboard and the efficiency indicator on the control room screen help teams to make more informed decisions and adjust their business operating strategies.

### 4.2. Configuration possibilities

The complexity and the dynamics of the simulation can be controlled by configuring the number and speed of challenges that arise, as well as the time available to solve a given problem.

Leadership styles may interact with environments. Network leadership perspectives (e.g. shared or servant leadership) have been shown to be positively related to performance in more complex and turbulent environments, while hierarchical leadership styles may be well effective in stable environments. Through observation of simulation participants' behaviors and varying the degree of uncertainty/dynamism it is possible to study what individual characteristics/behaviors and team actions are key while adapting to changing environmental conditions.

A strong functional division of labor in the team challenges the formal leader and enables exploring his/her ability to assert him-/herself as a leader of the team and the value added modern leaders are able to generate to their organizations. An additional (implicit) challenge is that some roles within a team (CR) allow more functional control over processes and are more predisposed for leadership positions. Informal leadership can emerge alongside formal leadership. In the case of informal leadership, formal leader may opt for dual/shared leadership option with a high or low overlap of responsibilities and decision-making areas. This is analogue to the realities of the modern business world characterized by the reliance on the highly qualified personnel (partly with more professional expertise than leaders have), the growing delegation and autonomy of employees, and increasing share of teleworking and virtual teams work. In this sense, the leader faces a challenge to motivate and inspire the team, and to implement innovation and change. "FortFantastic" allows to skip the role of the manager. Thus, leadership can naturally occur in the team.

The same team roles can be assigned to several (instead of only one) individual. In this case the team consisting of three departments becomes more complex as it includes sub-teams. With this respect one can study team process, such as labour division, task coordination, communication.

Due to its' virtual nature, it is not possible to fully control whether individuals truly follow the instructions with respect to the use of communication channels. However, the instructor can consciously make participants aware of the broader spectrum of these channels, and actively encourage them to use them or, alternatively, instruct individuals to take part anonymously (i.e. without providing their names, phone numbers or any other personal information to other participants). In the optional feedback survey after the simulation, it is possible and recommended to control for the channels used beyond those observable on the simulation platform.

### 4.3. Naturally occurring phenomena

Task interdependence (the situation in which team members have individual information which only in combination with the relevant information pieces from other team members can lead to the successful completion of group tasks) has been consistently shown important for teamwork particularly in virtual teams, as it allows to reduce the "distance" appearing due to the high work autonomy of single virtually-working team members (e.g. Hertel et al., 2004). Other studies have shown that task interdependence is also related to performance (e.g., Rico & Cohen, 2004; Grabner et al., forthcoming). Thus, Rico and Cohen (2004) find a positive effect of high task interdependence coupled with synchronic communication on virtual team performance. Task interdependence is characterized by high necessity of information exchange and, thus, stimulates team communication and discussions. Teamwork naturally occurs during the simulation as individuals are forced to collaborate in order to achieve higher team performance.

Leadership can emerge in the team independently of the roles assigned to specific team members. More skilled, charismatic, socially competent participants, or participants with more functional control over processes may profit from their position or innate abilities and naturally take the leaders' role. McCall and Lombardo (1982) point to the fact that the formal leader's position, access

to information and types of problems have an effect on the perceptions of power and influence in the team.

During the simulation “FortFantastic” specific decision-making styles and strategies emerge. The nuances, technical and strategic problems vary in their severity, magnitude, duration and interdependence. This confronts leaders with a variety of problem types (that require coordinating team member efforts) concerning motivational aspects, and ensuring conflict-free environments and team commitment. The leader and the team decide how to organize team communication and problem-solving processes. Some teams may rely on strict role division and focus on their assigned tasks, while other teams may be more helping and agile. This results in the formation of an individual team climate which might positively or negatively influence team performance.

The key characteristic of “FortFantastic” is that it does not only imply sequential, but also simultaneous appearance of business challenges. Thus, managers need to decide how to divide time and effort between them and how to define priorities. This allows to focus scholarly attention on: 1) how problems get recognized or ignored by the team or leader, 2) how team or leader interprets and prioritizes the problem, 3) how relevant information is searched for and combined to solve problems; 4) how solutions are generated and (critically) examined, 5) what actions are taken or not taken, 6) what consequences did solutions have for the future simulation dynamics.

With running more simulation periods (seasons), individuals learn how to manage their roles, team work and make sense of own and others’ actions. Differing the number of simulation runs allows to study different (decreasing) degree of uncertainty on team outcomes and to observe learning effects throughout the simulation.

Teams can alter the simulation by their decisions. No large shocks are programmed. However, teams may make large investments by buying new and costly attractions. If they act inefficiently, this may lead to negative dynamics (high costs and the impossibility to invest in additional activities).

The naturally emerging phenomena such as teamwork, leadership, decision-making styles and strategies can be observed in action, which can be particularly interesting for management, organizational behavior and organizational psychology as well as for sociology scholars. The amount,

the kind, and the quality of communication which is the medium for the development of social linkages and structures, are interesting and promising fields of investigation in communication science or sociology.

### 4.4 Varying settings for research purposes

The advantage of experimental settings is that it is possible to manipulate the variables to study the effects of interest while holding other things constant. Simulations offer similar benefits while not sacrificing the validity and context richness (McCall & Lombardo, 1982). "FortFantastic" simulation conditions can be manipulated in a number of ways and, consequently, it can be used to study a variety of research questions.

***Varying the samples of participants*** in the simulation enables getting insights into different leaders' and team characteristics. Table 1 provides some examples of what treatment-control conditions can be tested with "FortFantastic" on the leader' and team levels with respect to team history, leader's and team characteristics, professional experience and demographics.

Through simulation instructions it is possible to preset managerial strategy or leaders' styles and behaviors.

*** Table 1 here***

***Team size and assignment to roles*** represents another manipulation possibility in the simulation "FortFantastic". It is standardly possible to conduct simulation with three team members per team (with one CR, OB and TS respectively) and (optionally) one manager or to implement double staffing of each of the simulation roles. The investigation of double and plural leadership is possible as well. Finally, team members may be assigned to perform several roles (e.g. managers can be instructed to take some operating tasks of the OB) or roles can be assigned to more individuals (e.g. three TS specialists). Thus, the team size is not the limiting factor in the simulation and can be adjusted to the research purpose.

***Varying session time, switching on/off some challenges to the team, configuring the duration of challenge relevance*** allows for different degrees of complexity and dynamism and can be used to

simulate stable and turbulent environments. This enables studying teamwork and leadership under different environmental conditions. Allowing for longer session times provides participants with the possibility to more effectively adapt to and transform team processes and strategies.

***Varying the number of rounds*** within one session can be particularly useful to study the contexts in that teams have already well understood the simulation principle and established team processes and routines. Does the role of the manager change after the most uncertain and turbulent starting phase? Does the focus perhaps switch from coordinating to motivating and inspiring of team members? The longer the team is playing (team tenure, measured in the number of rounds played together), the higher the clarity about the own role and contributions, the better established are communication, information exchange and division of labour. When conducting simulation over a large number of rounds conflict management, challenging routines, implementing innovations can become of more interest.

***Implementing crises*** in the simulation. No big crises are programmed in "FortFantastic". They can only happen if team members provoke them themselves with extremely ineffective actions. However, if necessary, "FortFantastic" settings allow to strongly increase the number of challenges and reduce the time window in which these technical and business problems can be solved. This can considerably challenge the teams and their leaders and enable observing their behaviors and actions at such extraordinary circumstances.

***Manipulating collaborative work*** can be performed through pre-simulation instructions of some team members. For example, some team managers (or actors playing with the team) can be instructed to behave in certain way. For example, TS specialists or OB operators can be instructed to withhold or delay delivery of the relevant information to the team. Some team members or actors can be instructed to provoke conflicts in the team. Managers can become instructions to lead in more authoritative or democratic ways. Instructors can also manipulate individual behaviors through interventions into the team structure. For example, "ineffective" managers can be degraded, fired, while "effective" managers may be transferred from successful to less successful teams to "transfer" their organizational practice. These manipulations may be useful to study shirking, influence tactics

on difficult employees in the team, or risky strategies and the effects of different leaders' behaviours on team members' actions, team effectiveness and performance.

### 4.4 Output analysis

***Instruction and observation.*** Each simulation is supported by the instructor. He/she observes the team work, and controls the simulation. Due to geographical distance between team members, teams have little insight into the work of their competitors (only via financial indicators on the Dashboard). Instead, simulation instructor can observe behaviors in all teams via the telecommunication channels and the instructor view of the simulation. It is inevitable that observers do not capture the full information (a large part of information can get lost). Moreover, observers do not have influence on the prioritization of problems and how they are handled by the team. However, observers can double check the consistency of reported by team members team-related data and data on leaders.

***Simulation data.*** Simulation data can be saved to record the data about the performance of teams during the whole period of simulation and about the sequence of decisions. Moreover, analyzing these data can provide insights into what (and partly whose) decisions tremendously or less spectacularly contributed to the resulting performance.

***Analysis of team communication.*** Each team establishes specific communication patterns. The data from this communication (e.g. emails, chat messages, phone calls, videos) can be recorded, classified and analyzed e.g. with respect to their degree of anonymity, frequency and content of communication.

***Combination with surveys.*** Simulations can be used in the combination with surveys. Thus, thereas "FortFantastic" offers an objective measure of team performance, leadership styles are not directly quantified in the simulation. Survey tools, such as for example (Multifactor Leadership Questionnaire (Avolio & Bass, 2004)), can deliver more insights into the effects of specific leadership styles on leader's effectiveness. One can also conduct pre-simulation questionnaires to study processes in the pre-/post-format or accumulate archival data about the participants.

***Peer and multi-rater evaluations.*** Survey-based data may profit from multi-rater evaluation of leaders' behaviors and actions by simulation team members. Here one can address research questions such as

evaluation of leadership styles, or the degree of anonymity, the geographical distance between team members or the existence of prior social relations in the team of participants. Multi-rater assessments (also in comparison to self-evaluations by leaders) provide less subjective evaluation of leaders' characteristics.

***Interviews with participants.*** Interviews with participants or groups of participants can take place to accumulate additional insights into team processes, get feedback, record participant perceptions and reconstruct the decision-making process. These data can be useful to find out what kinds of problems (operational, interpersonal or process-specific) and what decisions (operational or strategic) were in the focus of the team. In exchange for participation a feedback session from the instructor side can be provided. Many research designs focus on collecting data from participants. In contrast to surveys, simulations, such as "FortFantastic" allow to do research more sustainably and generate benefits for the participants in form of feedback as well.

## 5. Discussion: Validity and practicality

In the present work we have discussed the important, but yet underestimated role of simulations in leadership research and presented a team-based simulation "FortFantastic", which is complex, interactive, and adaptable and allows to address various research questions.

Previous research has consistently shown that the main strength of simulations lies in their realism, which increases participants' engagement and enables the researchers to observe authentic behaviors (McCall & Lombardo, 1982; Buil et al., 2019). Moreover, previous research also argues that simulations are not treated like games, where individuals would just play a certain role (McCall & Lombardo, 1982; Gist et al., 1998). The built-in challenges and mechanisms produce pressures on participants thus forcing them to take an active part in the simulation.

Because different simulations are developed for different purposes and for studying different research questions, the validity of a specific situation depends on how it has been used in the analysis. "FortFantastic" allows high degree of control over many parameters and can be efficiently used for studying many aspects of leadership and team work. Its' structure and challenges as well as built-in

consequences of leader's and teams' actions are based on years of managerial practice and feedback from leadership development programs. Participants can be randomly assigned to the roles and are not required to provide any personal data about themselves. Thus, research with "FortFantastic" can be based on full anonymity of participants.

Developing complex simulations is demanding, time-consuming and expensive (McCall & Lombardo, 1982). This is the reason why only few simulations find application in research. They are either too simple, too specific or privately held and very expensive. "FortFantastic" contributes to closing the methodological gap in leadership research to develop novel methods of knowledge inquiry.

The present work presented "FortFantastic" as a valuable tool for future research which is, due to its' completely digitalized design is easy to implement also in geographically separated teams. It is also able to cope with changing nature of interactions between the leader and the team (transition from hierarchical to more flat structures).

"FortFantastic" enables studying multiple facets of digital leadership related to an objective measure of leader's effectiveness (profits of the virtual leisure park) under realistic conditions. The simulation-based tool has high practical relevance not only for the leadership research. It additionally allows application in many disciplines, e.g. within the contexts of emotion-based, behavioral and communication research, as it enables analyzing and manipulating (while changing the dynamism and the uncertainty of the simulated environment) real-time behaviors, reactions and communication styles of leaders and employees.

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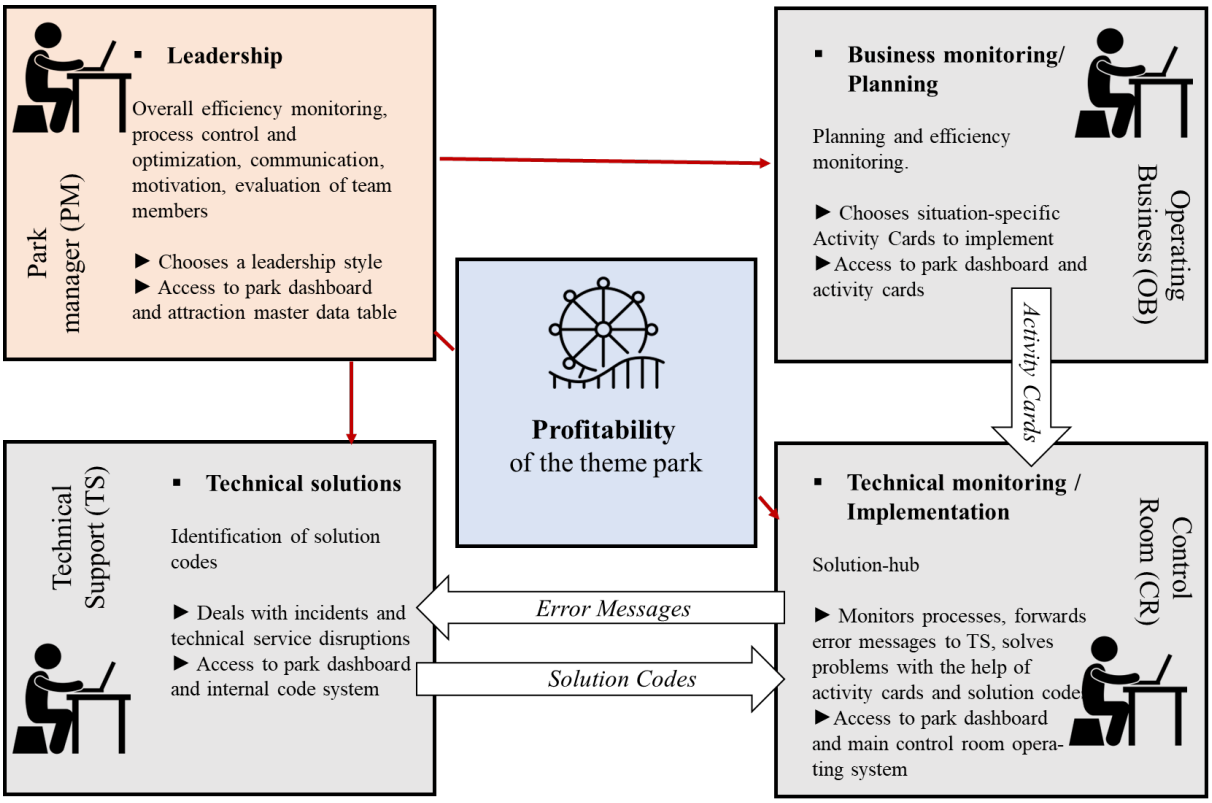
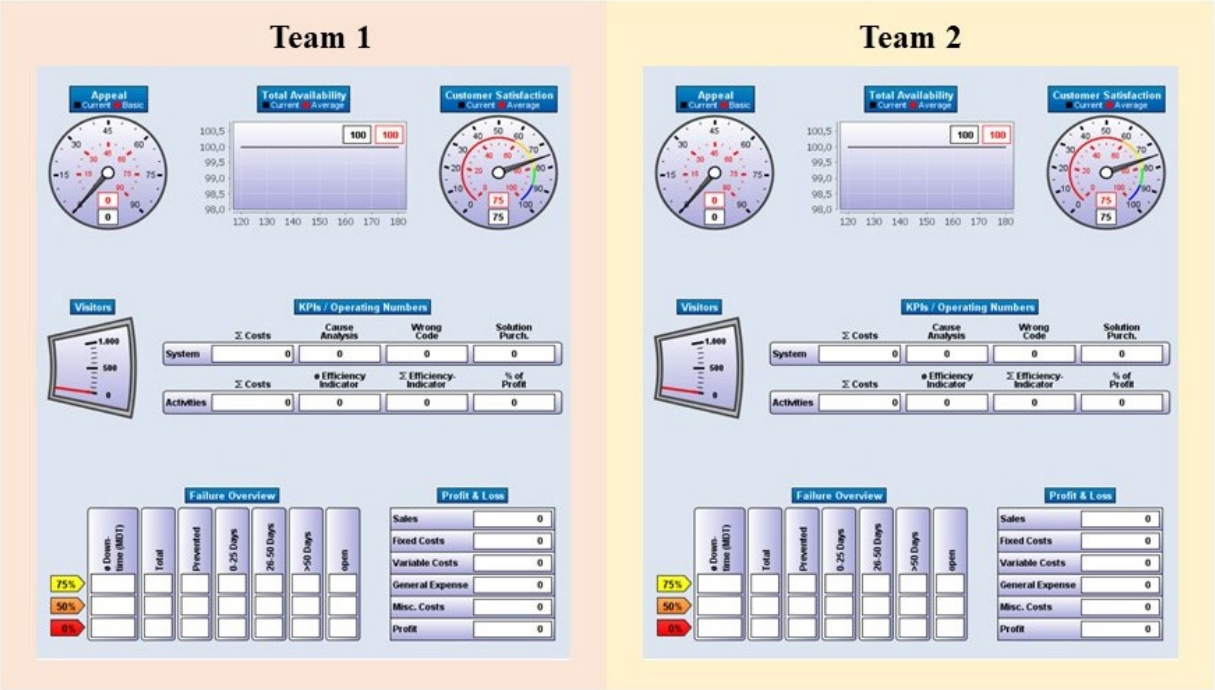
**FIGURES**

**Figure 1: Distribution of roles and information flows within a team**




*Note:* Authors' own representation of roles, tasks and information flows within the team simulation.

**Figure 2: Park Dashboard**



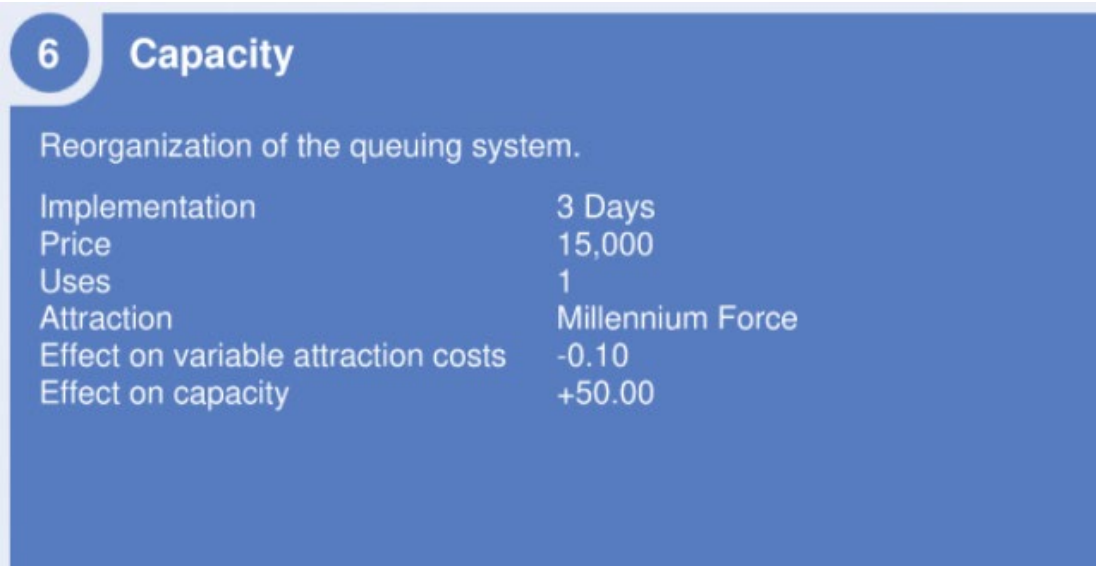

*Note:* The *Park Dashboard* (PD) provides real-time information necessary to monitor team performance and is visible to all members of both teams. Appeal (i.e. attractiveness), availability of park attractions, and customer satisfaction (depicted in the upper part of the dashboard) are three main factors that determine the calculation of the daily number of visitors.

In the middle part of the dashboard, the left scale shows the current number of visitors calculated by the simulation software for the current period ("day"). The Key Performance Indicators (KPIs) on the right side represent the data on the operational performance. These data on system costs (e.g. system charges from "buying solutions") and costs of implementation of Activity Cards result from inputs to the *Main Control Room Operation System* (see Figure 3) performed by the teams during the simulation. Finally, the lower section provides an overview on the time taken to enter Solution Codes (see Figure 6) and a profit-loss calculation (see Figure 7).

**Figure 3: The Main Control Room Operation System**

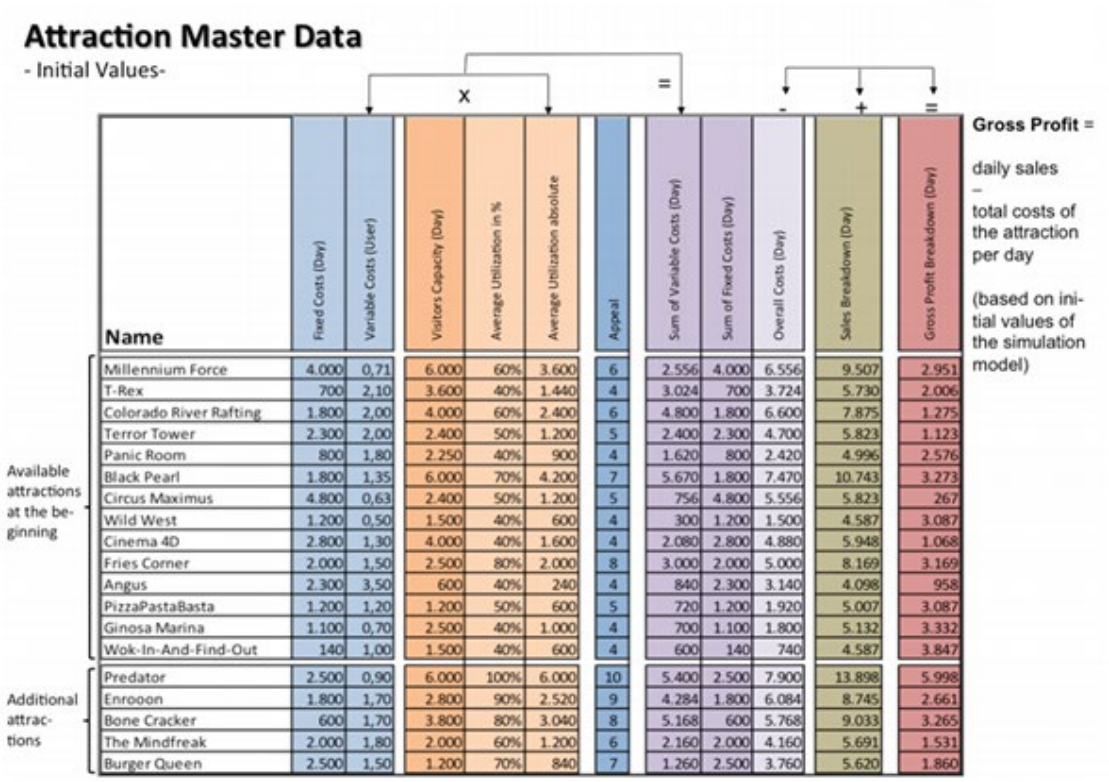

*Note:* The *Main Control Room Operation System* (MCOS) is only visible to the CR. The day-counter in the upper right corner displays the current and the remaining simulation periods ("days"). At the end of each period, the software calculates the average customer satisfaction and displays it to the CR expert in form of a smiley face. The "Purchase" Panel allows to select activities (described in Activity Cards) by entering respective order codes (see Figure 4). In the lower right part of the window, a diagram exhibits the development of profits. On the lower left side of the screen the Panel "Solve Incident" and the message box with system notifications are located. Each notification has a distinct solution code (see Figure A6) which remains unchanged throughout the course of the simulation. If TS fails to communicate the right solution, the team can hire an expert for assistance ("Buy Solution"). The same rule applies if the participant wants to inquire about the cause of the notification ("Cause Analysis") in case of repeating failures or ambiguous message content. The *MCOS* is the operational communication center in which CR needs to forward messages to the appropriate team members (PM or TS) and enter correct solution and order codes into the system.

**Figure 4: Example of an Activity Card**




*Note:* The main responsibility of the OB is to manage the appeal of the park. OB master the challenges during the simulation, by working with *Activity Cards* (about 120 altogether). If a specific attraction is mentioned on the card, the listed consequences and effects are exclusively restricted to this attraction. This can include delivery time, implementation time (during which the attraction will not be available). Every *Activity Card* has a unique order number. In case of the implementation of a certain *Activity Card*, this number must be entered into the respective field in the Control Room system. Some *Activity Cards* may be selected multiple times. The Efficiency Indicator (EI) Value available on the MCOS (Figure 3) shows the profitability of implemented measures.

**Figure 5: Attraction Master Data Table**



**Attraction Master Data**

- Initial Values-

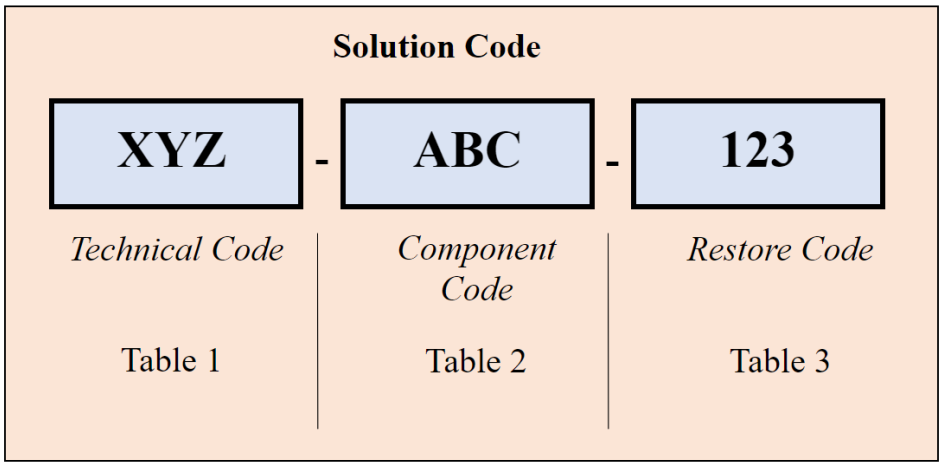
x = - + =

| | Name | Fixed Costs (Day) | Variable Costs (User) | Visitors Capacity (Day) | Average Utilization in % | Average Utilization absolute | Appeal | Sum of Variable Costs (Day) | Sum of Fixed Costs (Day) | Overall Costs (Day) | Sales Breakdown (Day) | Gross Profit Breakdown (Day) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Available attractions at the beginning | Millennium Force | 4.000 | 0,71 | 6.000 | 60% | 3.600 | 6 | 2.556 | 4.000 | 6.556 | 9.507 | 2.951 |
| | T-Rex | 700 | 2,10 | 3.600 | 40% | 1.440 | 4 | 3.024 | 700 | 3.724 | 5.730 | 2.006 |
| | Colorado River Rafting | 1.800 | 2,00 | 4.000 | 60% | 2.400 | 6 | 4.800 | 1.800 | 6.600 | 7.875 | 1.275 |
| | Terror Tower | 2.300 | 2,00 | 2.400 | 50% | 1.200 | 5 | 2.400 | 2.300 | 4.700 | 5.823 | 1.123 |
| | Panic Room | 800 | 1,80 | 2.250 | 40% | 900 | 4 | 1.620 | 800 | 2.420 | 4.996 | 2.576 |
| | Black Pearl | 1.800 | 1,35 | 6.000 | 70% | 4.200 | 7 | 5.670 | 1.800 | 7.470 | 10.743 | 3.273 |
| | Circus Maximus | 4.800 | 0,63 | 2.400 | 50% | 1.200 | 5 | 756 | 4.800 | 5.556 | 5.823 | 267 |
| | Wild West | 1.200 | 0,50 | 1.500 | 40% | 600 | 4 | 300 | 1.200 | 1.500 | 4.587 | 3.087 |
| | Cinema 4D | 2.800 | 1,30 | 4.000 | 40% | 1.600 | 4 | 2.080 | 2.800 | 4.880 | 5.948 | 1.068 |
| | Fries Corner | 2.000 | 1,50 | 2.500 | 80% | 2.000 | 8 | 3.000 | 2.000 | 5.000 | 8.169 | 3.169 |
| | Angus | 2.300 | 3,50 | 600 | 40% | 240 | 4 | 840 | 2.300 | 3.140 | 4.098 | 958 |
| | PizzaPastaBasta | 1.200 | 1,20 | 1.200 | 50% | 600 | 5 | 720 | 1.200 | 1.920 | 5.007 | 3.087 |
| | Ginosa Marina | 1.100 | 0,70 | 2.500 | 40% | 1.000 | 4 | 700 | 1.100 | 1.800 | 5.132 | 3.332 |
| | Wok-In-And-Find-Out | 140 | 1,00 | 1.500 | 40% | 600 | 4 | 600 | 140 | 740 | 4.587 | 3.847 |
| Additional attractions | Predator | 2.500 | 0,90 | 6.000 | 100% | 6.000 | 10 | 5.400 | 2.500 | 7.900 | 13.898 | 5.998 |
| | Enrooon | 1.800 | 1,70 | 2.800 | 90% | 2.520 | 9 | 4.284 | 1.800 | 6.084 | 8.745 | 2.661 |
| | Bone Cracker | 600 | 1,70 | 3.800 | 80% | 3.040 | 8 | 5.168 | 600 | 5.768 | 9.033 | 3.265 |
| | The Mindfreak | 2.000 | 1,80 | 2.000 | 60% | 1.200 | 6 | 2.160 | 2.000 | 4.160 | 5.691 | 1.531 |
| | Burger Queen | 2.500 | 1,50 | 1.200 | 70% | 840 | 7 | 1.260 | 2.500 | 3.760 | 5.620 | 1.860 |

**Gross Profit** = daily sales – total costs of the attraction per day (based on initial values of the simulation model)

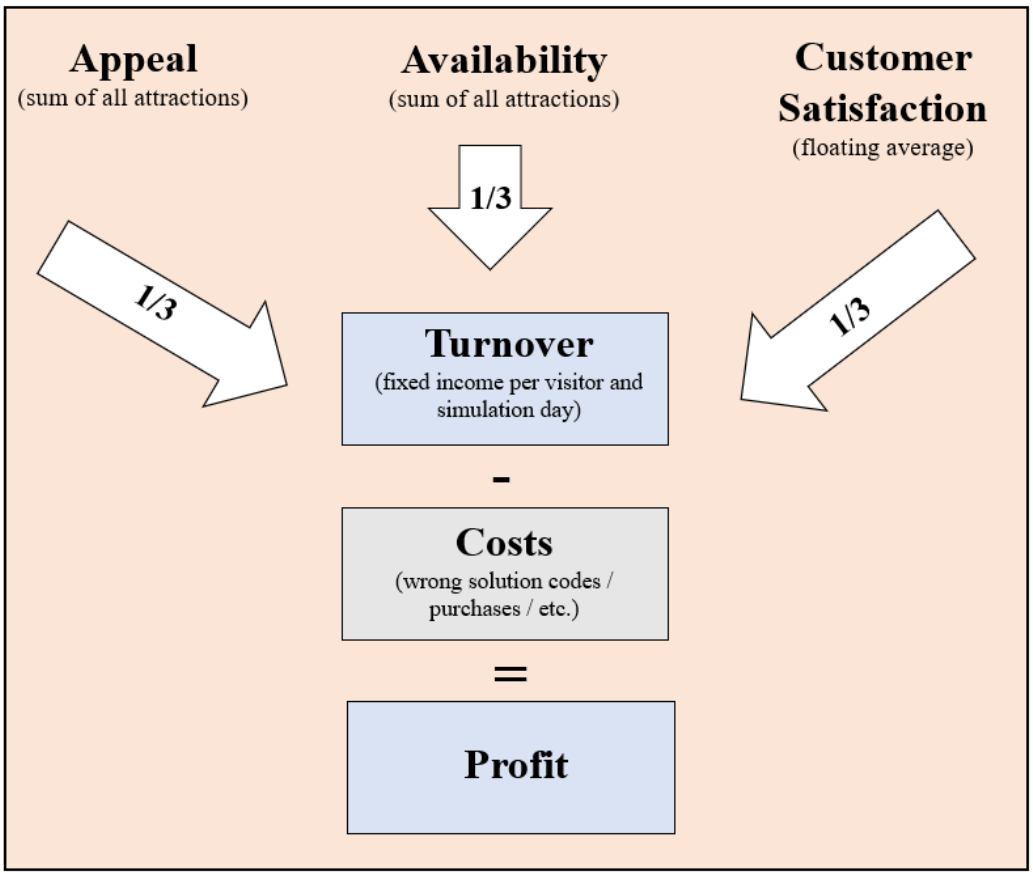
*Note:* The *Attraction Master Data Table* is only available to the OB and contains stem data (e.g. fixed and variable costs, attractions appeal, average sales and gross profit) on all attractions available at the beginning of the simulation (in the upper part of the table), and on five attractions that can be purchased during the simulation. At the beginning of the simulation, the start value of customer satisfaction is set to 75%. For this value, the last column lists an exemplified calculated gross profit for each attraction, which can be used as an approximated indicator for profitability.

**Figure 6: The Internal Code System**




*Note:* The main task of the TS is to identify *Solution Codes*, which are required to handle incidents or technical service disruptions displayed at the *Main Control Room Operation System*. Based on the received information, TS is supposed to identify the correct solution and to return the solution to CR, who will enter it into the system. The solution code always consists of a 3x3 character sequence which is a result of combining the Technical Code, the Component Code and the Restore Code. Three tables are needed to generate the solution code. They build on each other, and require the sequential solution process.

**Figure 7: Profit Calculation**




*Note:* The park's turnover is based on three dynamic variables: appeal (i.e. attractiveness), availability, and customer satisfaction. “Appeal” sums up the appeal levels of all attractions. The “availability” is derived from the combined availability status of all attractions. Disruptions lead to the reduction of the attractions’ availability and negatively influence the “customer satisfaction”. Together, these variables define the number of visitors per “simulation day” who spend a fixed amount of money (turnover). The costs of operating business (incorrect solution codes, activity cards used and purchases) are subtracted from this. The resulting profit reflects the effectiveness of the team operational behavior which is influenced by team efforts towards reducing failure recovery time and the effectiveness of activity cards implementation by the team.

**TABLES**

**Table 1: Possible manipulations of treatment and control conditions at the leader and the team level**

| | Leader characteristics | Team characteristics |
|---|---|---|
| Skills, experience | • Experienced versus inexperienced<br>• High technical versus managerial expertise<br>• High tenure versus low tenure in the current managerial position<br>• Managerial position in the real life versus non-managerial position<br>• High performers versus low performers | • Employees from routine-task and complex-task environments<br>• Teams of highly skilled professionals versus lower qualified employees<br>• Teams with on average higher versus lower education etc. |
| Personality traits, behavior styles (including leadership styles) | • Charismatic/authoritative leaders versus moderating/serving/responsibility-sharing leaders<br>• Narcisstic versus altruistic leaders<br>• Leaders with high versus low social skills<br>• Extraverts versus introverts | • Teams with jobs allowing for more versus less autonomy<br>• Teams with high versus low average sociability<br>• Variations with teams with different degree of creativity, innovativeness, optimism, adaptability etc.)<br>• Variations of team compositions based on different constellation of personal characteristics |
| Demographic characteristics | • Young versus old<br>• Female versus male | • Team members' age-based variations in team constellations<br>• Gender variations (female versus male teams; females-dominated mixed teams versus males-dominated mixed teams, mixed teams versus not gender-mixed teams) |
| Team history, background | • Manager worked with the team before versus unknown before manager<br>• Managers from high-technology agile team structures versus managers from more structured environments | • Teams with zero versus non-zero history<br>• Teams with short versus long team tenure<br>• Background variations (team members from different departments in separate or mixed teams) |

Source: Authors' own representation.