Global Bike Go: SAP-Based Mini Business Simulation Games

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Abstract: Education Service Providers try to support lecturers by offering standardized teaching and learning environments (TLEs). With the help of Bloom's taxonomy, learning environments can be described and modified by creating, adding, or adjusting learning objectives and activities. The paper shows one possible way to adjust SAP S/4HANA TLEs for the individual learning setup. The suggestion is to use mini business simulation games (BSGs) to enhance learners' motivation. These games can tap into the general play instinct, impart knowledge in a playful and practice-oriented approach, give the possibility to try things risk-free and use the positive aspects of game elements for learning success. Exemplary, the idea and implementation of *Global Bike Go: Explore Sales* as one BSG is presented. Besides the game procedure, the systemic game architecture is elaborated to emphasize flexibility and reusability on the implementation side. Even though game aspects in learning arrangements could enhance the learning itself, gamification is not the Holy Grail for good learning setups. There is a need e.g. to keep the initial motivation up and to impart the knowledge, not just seeking rewards or simply playing the game without taking any learning success out of it.

1 INTRODUCTION

Due to ubiquitous digitalization and rapid IT progress, the demand for Enterprise Resource Planning (ERP) systems is increasing, as they represent a success factor for companies (Sarferaz, 2023). Consequently, trained personnel are obviously essential. However, the number of job vacancies increases in many countries at the same time and the shortage of skilled workers limits the growth of companies (Gartner, Inc.). This makes it important to focus on education and training but the challenge is to use suitable concepts to convey process and application knowledge in heterogeneous ERP education (Brehm et al., 2009; Leyh et al., 2012; Leyh, 2017; Winkelmann and Leyh, 2010). In this field, SAP plays a key role as one of the leading ERP software providers.

Education Service Providers (ESPs) try to support lecturers and trainers (Prifti et al., 2017) by offering standardized teaching and learning environments (TLEs) consisting of a system, a model company, and teaching materials (Häusler and Bosse, 2018). Exemplary ESPs in the SAP domain are the SAP University Competence Centers (UCC). They provide curricula with theoretical and practical materials as well as supporting tools and services besides essential access to software, platforms, or infrastructures. In the field of ERP teaching, the case study method is prevailing until now (Leyh, 2017; Leyh et al., 2012) but faces limitations in generating motivation and providing incentives (Häusler et al., 2021) but also in reaching sufficient levels of cognitive learning according to Bloom's Revised Taxonomy (Anderson and Krathwohl, 2021).

This leads to the following research question (RQ): **How can an existing SAP-based TLE be extended to cover additional learning objectives and increase intrinsic motivation?**

Various investigations have shown that educational games can bridge these gaps (Fischer et al., 2017; Hamari et al., 2016; Jacob and Teuteberg, 2017; Lukita et al., 2017) via more involving learning

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environments, self-effective learning options, and fun elements. A well-known and established collection of business simulation games (BSGs) in the field of ERP systems is ERPsim, which has been used in education since 2004 (Hwang, 2018; Léger, 2006; Léger et al., 2010; Leyh, 2017; Utesch et al., 2016). But what if existing BSGs do not fit into the highly individualized TLEs of lectureres? ERPsim, for example, is widely but differently used all over the world (Häusler et al., 2024). The reasons can vary, e.g. how the educational area is structured, and which teaching methods are mainly used there. Regarding the games themselves, the scope, as well as scale (number of scenarios), complexity, or learning objectives are crucial aspects. However, causal research should not be part of this work, instead, it will be about additional, flexible possibilities on the lecturers' side.

2 BACKGROUND

The following section examines the background and introduces the exemplary research subject. First, an outline of BSG theory is given. Bloom's Taxonomy, including its two-dimensional matrix, is then briefly introduced. It provides the basis for classifying and describing an exemplary TLE. In this way, the actual and target states can be compared.

The approach of this paper is to show a feasible option to individualize, flexibalize, enrich, and extend TLEs by adding suitable learning objectives and activities for the respective setting with the help of Bloom's Taxonomy. Mini BSGs could be one option for implementing the desired extensions. This method is exemplary, though not the only one to take. The use of game elements in learning scenarios is widely examined. To date, no final, definite evaluation of the gamification approach as a whole has been conducted and likely never will be, due to the variety of TLEs, content, time scope, methodologies used, the lecturer's role, and the different teaching and learning types (Martí-Parreño et al., 2016; Vergara et al., 2023; Zahedi et al., 2021). Besides the uncertainty of the game elements' impact, it seems quite secure that they have a positive one on the motivation of learners, even if gamification should be critically viewed.

2.1 Business Simulation Games

BSGs are an educational teaching method that enhances existing learning methodologies in various contexts (Jacob and Teuteberg, 2017). The key aspect of BSGs lies in simulating real-world business processes, thus allowing participants to engage with a virtual world that goes beyond merely theoretical learning. This simulation-based approach enables learners to experience and act within a risk-free environment that mirrors reality, which is conducive to experiential and active learning (Ulrich, 2002).

BSGs comprise four fundamental elements: a model, a simulation, roles, and a set of rules. The model encapsulates the game's structural framework, temporal sequence, and overarching guidelines for play. The simulation acts as a proxy for the system or circumstance under examination, which is usually strongly abstracted for ease of interaction. Within the context of BSG, this simulation typically manifests as a market environment with one or more competitors.

In addition to several game rounds, a BSG comprises an introduction and evaluation (La Guardia et al., 2014). In the introductory phase, all necessary content-related and organizational information is communicated, and the game rules are explained. After the introduction, participants dive into the game world. During individual game rounds, four phases reoccur for players: concrete experience, reflective observation, abstract conceptualization, and active experimentation and testing. Concrete experiencing describes perceiving the constantly changing system in each round. During reflective observation, participants question and analyze the altered circumstances created by the simulation. Abstract conceptualization involves forming and testing hypotheses about the existing system and the effects of possible actions on it (Ulrich, 2002).

Finally, the course of the game rounds is systematically analyzed and reflected upon together with the game leader. This aims to reinforce the respective learning objective of the BSG among the participants so that, ideally, the acquired skills can be transferred to the real world. This debriefing is essential for the successful implementation of simulation games (Ulrich, 2002).

2.2 Bloom's Taxonomy

"In life, objectives help us to focus our attention and our efforts [...]. In education, objectives indicate what we want students to learn [...]" (Anderson and Krathwohl, 2021). Hence, it is about how to support the learners in achieving them. Curriculum implementers oftentimes face externally given objectives and have to design learning environments aligned with these objectives. Frameworks like *Bloom's Taxonomy for Learning, Teaching, and Assessing* may help lecturers with this creational process. The revised version can be represented in a two-dimensional table as shown in Figure 1.

The Knowledge Dimension	The Cognitive Process Dimension					
	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual Knowledge	**Objective 1** Acitivity 1	**Objective 1** Acitivity 1,2				
Conceptual Knowledge		**Objective 2,3** Acitivity 1,2	Activity 3,4			
Procedural Knowledge		**Objective 3** Activity 1,3,4	**Objective 4** Acitivity 3,4	Activity 4		
Meta-Cognitive Knowledge						

Object. 1: Know SAP Terminology
Object. 2: Understand SAP Concepts
Object. 3: Able to Explain a Business Process
Object. 4: Able to Perform a Business Process

Activity 1: Learning in Lectures from Slide Set
Activity 2: Performing Exercises
Activity 3: Processing Case Study
Activity 4: Solve Challenge

Figure 1: Bloom's Taxonomy and one possible representation of an SAP S/4HANA TLE.

The first dimension represents a hierarchy of cognitive processes that build upon one another. *Remembering* involves the basic recall of facts, terms, concepts, or procedures, whereas *understanding* requires comprehension and interpretation of the meaning. *Applying* entails using knowledge in new or familiar situations to solve problems, execute tasks, or perform actions. *Analyzing* consists of breaking down complex matters into smaller components to identify relationships, patterns, or structures. *Evaluating* involves making judgments about the quality, value, relevance, or effectiveness of information, arguments, or outcomes. *Creating* represents the highest level of cognitive processes, which involves generating new ideas or perspectives through synthesis, reorganization, or transformation of existing knowledge. The knowledge dimension complements the cognitive process dimension. It focuses on different knowledge types that learners develop. Learning outcomes can be categorized based on their content. In the cells of the table which represent intersections between both dimensions, learning objectives can be placed (explanation follows in the next subsection). Based on this, the educator can design activities to match the objectives. At best, several categories should be covered for a sustainable learning outcome.

2.3 SAP S/4HANA TLE

To make this taxonomy more tangible, the *"Introduction to SAP S/4HANA"* TLE of the SAP UCC Magdeburg serves as experimental object. The model company included is a bicycle manufacturer called *Global Bike*. The TLE gives a comprehensive overview of integrated business processes while covering different taxonomy dimensions. For each of the S/4HANA modules – like Sales and Distribution (SD), Materials Management (MM), and Production Planning (PP) – there are associated ready-to-use teaching and learning materials: Slide Sets, Exercises, Case Studies, and Challenges. They are just named here but will be explained later on. One possible taxonomy representation for this TLE could be the exemplary matrix which is depicted in Figure 1. The learning objectives listed are typical in this area but do not correspond to any objective standard due to their subjective nature.

As can be seen in the matrix, objective 1 is mostly about remembering and understanding factual knowledge, whereas objectives 2 and 3 support understanding conceptual as well as procedural aspects. Objective 4 would therefore be located in applying procedural knowledge. Subsequently, lecturers could assign activities according to the learning objectives. Slide sets are used to provide theoretical basic knowledge about the respective business process (and their transition to SAP terminology) as well as the required master and transactional data concept. The exercises mostly give learners an insight into the IT system and the relevant applications, but without creating any data. In the introductory case study, the participants perform a well-described business process on their own in the system. The main aim is to provide the learners with a broad knowledge of how to interact with the system. Mostly each case study includes a challenge where the learners can apply the acquired knowledge in a similar but slightly different process without precise instructions.

The matrix is highly individualizable and dependent on the particular curriculum. The role of the lecturer is decisive (Anderson and Krathwohl, 2021) and the learning arrangement is of great importance (Kern, 2003). Especially when using third-party materials, the objectives must be clearly defined and the activities need to be planned on this basis. This makes it even more important for ESPs to offer adequate curricula, solutions, and services that match the lecturers' needs and support their individual TLE. But what if they have unique requirements or identify gaps respectively potentials in their matrix? Using Bloom's Taxonomy model, this results in two possibilities. On the one hand, additional activities can be defined with different teaching methods, but aiming at the same learning objectives. For example, ERPsim ("learning of ERP and business concepts while making decisions") could replace case studies

and challenges because of the same purpose. On the other hand, additional learning objectives could be defined that support or extend the original ones. If these objectives are not achievable with the existing activities (ESP materials or solutions), additional activities need to be defined here as well. Both possibilities result in the need for ESPs to increase the variety of new, innovative solutions and possibilities offered while meeting the demands of educators.

To enrich the taxonomy matrix for this use case, the TLE is extended based on the gaps that the SAP UCC Magdeburg has already identified by gathering feedback from the user community. In addition to the four learning objectives depicted in Figure 1, two more could be defined to cover a broader range.

- Additional learning objective 1: Get to know the S/4HANA system (login, Fiori Launchpad, Fiori tiles, etc.) and take the first guided steps since ERP systems are very complex.
- Additional learning objective 2: Understand simple market mechanisms and economic backgrounds.

To answer the first part of the RQ (how to cover additional learning objectives), further activities imply the design of new or adaptive solutions. However, ESPs are facing challenges in this regard (Häusler et al., 2024), e.g., development costs. A flexible, scalable, and therefore cost-efficient approach would be ideal to handle individual community requirements. The more flexible the solution, the easier it is to integrate into individual TLEs. Looking at the second part of the RQ (how to increase intrinsic motivation), many publications demonstrated that a game-based approach can foster motivation. By bringing both aspects together, the individual BSG as a service approach seems promising (Häusler et al., 2024). This is a step towards adaptive ERP education.

3 A GAME-BASED EXTENSION

As part of the so-called *Global Bike Go* initiative by the SAP UCC Magdeburg, the S/4HANA TLE (version 4.0) was enhanced with three simple, independent mini BSGs: *(1) Explore Procurement, (2) Explore Production, (3) Explore Sales*.

They extend the problem- and scenario-based TLE (slide sets, exercises, case studies, challenges) with game-based aspects to expand the offerings for lecturers. The basic ideas were to create a new learning experience with the main focus on simplified business processes and to use gamification elements to improve user engagement and learning success.

In each game scenario, different companies (between 1 and 25) compete with each other. The participants (learners) take on business management decisions for their assigned company. They can be assigned individually or in groups. As determined by the lecturer, several successive rounds are played, with one round always corresponding to one month. Before the game starts, the participants familiarize themselves with the respective scenarios, and any comprehension questions are discussed with the lecturer. After completing the last rounds and announcing the rankings of the participants, a debriefing is conducted together with the lecturer. At this point, the course of the mini-games can be recapitulated and analyzed.

The games complement the teaching and learning materials of the MM, PP, and SD modules and depict parts of the business processes covered in the S/4HANA modules. The other materials included in the respective module can be used independently of the games. The name part “Explore” already indicates their low-complex and introductory character. The games can be used as a connector between the theoretical slide sets before taking a practical deep-dive (case study) into a complex business process in the S/4HANA system. The Explore games are only intended to provide a (partial) introduction to business processes, a basic understanding of simple market mechanisms, an idea of the business field of action, and to promote interest in the business processes. However, the assumption is that especially learners from non-specialized/other fields can be provided with a simplified and thus facilitating access to complex economic topics with the help of BSGs. Additionally, one hypothesis is that learners will find it easier to work through the case studies if they have previously mastered the BSG because there is one supplementary point of contact in the sense of Bloom’s Taxonomy matrix. Furthermore, active and playful activities as well as the simulation of real-world processes should lead to an increase in motivation among learners (Häusler et al., 2021; Marinensi and Botte, 2022). Learners are offered didactic variety through the games, which could lead to increased motivation as well. According to Prensky’s mini-games approach recommendation (2008), the BSGs are highly simplified – with at most two input parameters – and consist of easy-to-understand scenarios and rules. Contrary to ERPsim, they have a short duration (45 to 90 minutes in comparison to 3h+ ERPsim) and can be used flexibly, independently, and with different objectives. Due to their low complexity, they can be relatively easily

extended or changed demand-driven, as already elaborated (Häusler et al., 2024).

In general, these innovative learning tools should enable participants to interact with S/4HANA's features and operations within a simulated business environment while continually improving their decision-making and teamwork skills. All games were built and structured similarly. The following exemplarily shows the idea and implementation of *Global Bike Go: Explore Sales* which was developed first. In addition to the game procedure, the systemic game architecture is presented to emphasize flexibility and reusability on the implementation side.

4 *Global Bike Go*: EXPLORE SALES

Global Bike Go: Explore Sales is a simple sales mini-game. The ESP provides the game itself, a scenario document, and instructions. As described in the scenario, groups or individual players compete as bicycle retailers for customers in a shared market. All distributors buy the same bicycles under identical conditions. The products and the perceived quality by the customers are therefore the same. The only difference between the bikes is the sales price set by the players. By analyzing the sales results of the current month (cf. Figure 2) and setting the sales price for the next one, the overall goal is to maximize their profits. After each round, stocks of all distributors are replenished automatically, if the company has a sufficient cash balance. As there is only one input decision parameter, simple market mechanisms (such as demand and supply as well as pricing) could be better focussed on without getting lost in details.

4.1 Game Procedure

The participants make business decisions for the company to which they are assigned in several rounds, determined by the lecturer. Before the game starts, the participants should familiarize themselves with the scenario and discuss any questions with the lecturer. After the game ends, the lecturer should moderate a joint debriefing in which the progress of the BSG is recapitulated and analyzed. To sum up, the game follows one common and recommended scheme: Briefing, Decision-making, Simulation, and Debriefing/Evaluation (La Guardia et al., 2014).

4.2 System Implementation

To get a better understanding, this section explains the technical build. The systemic game architecture is depicted in Figure 3.

As can be seen, the game is fully integrated into an S/4HANA system with a browser-based user interface. The Global Bike Go Framework which is based on the SAP-specific programming language ABAP and the Open Data Protocol (OData) is located in the S/4HANA backend. It is designed in such a way that other mini-games can use the same logic and thus be integrated easily in the future. Besides, to interact with the backend components, the frontend consists of two apps – one for the player and one for the admin – which were developed in SAP UI5 and run in the user's browser (accessed via SAP Fiori Launchpad).

There are three classes in the Global Bike Go Framework: Two general ones (Game Management and Game Control) and the exchangeable game-specific class. The game management class is responsible for creating, managing, and deleting the game instances, whereas the game control class is used to administer all necessary game-specific metadata and actions. It generates the required data and controls the simulation of the next round. The Game Control is technically implemented as an abstract class that encapsulates methods relevant to all games. It contains the three abstract methods *before_simulation*, *simulation*, and *after_simulation*. These are executed sequentially when a round is simulated and must be implemented by the corresponding game-specific class, in this case

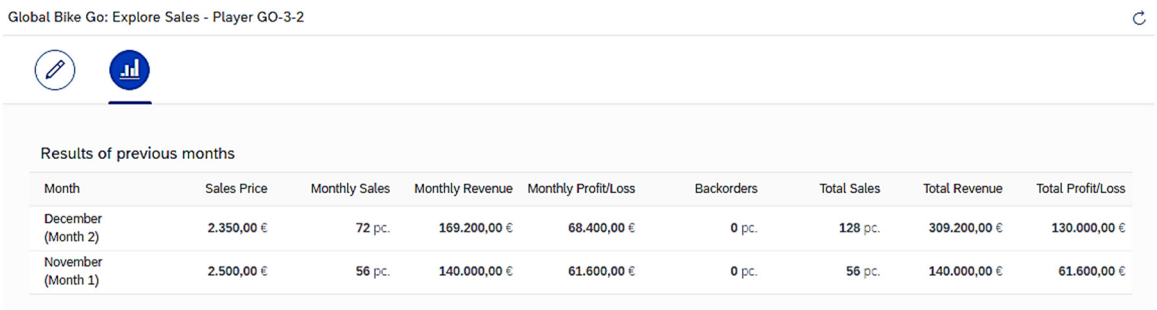

Figure 2: Exemplary results tab from (player's view).

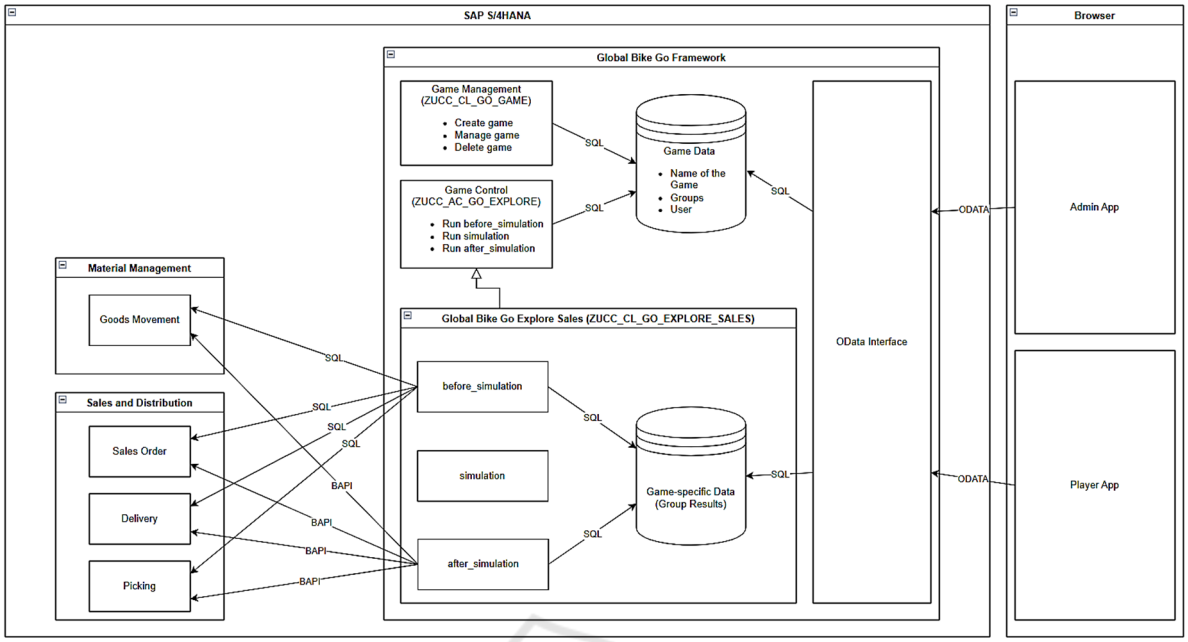

Figure 3: Systemic game architecture of Global Bike Go.

Global Bike Go: Explore Sales. Both use the central data memory Game Data via SQL, in which the meta information of the games is stored (such as the name of the game, information about the groups, and the current simulation round).

The data required for the simulations is prepared in *before_simulation*. This means that transactional data is fetched from the corresponding system data tables (e.g. stock level, number of sales), player input values are processed, and, depending on this, further actions are triggered in the system. In this specific case among other things, pricing conditions are updated and material stocks are replenished automatically if necessary. The actual simulation logic takes place in *simulation*. *After_simulation* defines the result storage and the creation of transactional data on the system side. Sales orders, deliveries, and goods movements were created and posted via Business Application Programming Interfaces (BAPIs) using the standard functionalities of the corresponding S/4HANA module (SD or MM). All input values and game results were stored in the Game-specific data memory – read access via SQL. To close the loop, an OData interface is used to deliver the data from both storages to the frontend for all users.

To sum up, the architecture was mainly built component-based. All existing games follow this structure. The high level of reusability reduces future development costs. Another advantage of the modular structure is that individual parts can also be easily exchanged within the games (e.g. away from profit maximization towards other target variables). Anyway, simulation models are controversial in general. For some people it is too simple, some may wish other calculations with the same variables and others would choose a completely different approach. The good thing about modular design, it is relatively easy to adapt or even replace.

4.3 Simulation Model

For the first version of *Explore Sales*, a non-complex market model was created. It is based on two simplified functions: a demand function (maps amount of sales to the selling price) and a price difference function (maps market share to price differences). Figure 4 shows the simplified functions.

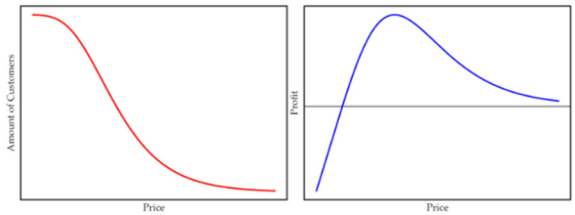

Figure 4: Schematic representation of market model parts.

The demand is a function of the price (left side) which is monotonically decreasing. If this function is multiplied by the profit per piece, the graph of the potential profit has a unique global maximum

representing the optimal selling price for the single-player game. Upon switching to multiplayer mode, the optimal price will shift depending on the set prices per company (simple differential sorting and distribution algorithm). Thirdly, seasonal effects, like public holidays or weather conditions of different seasons, influence the monthly demand and are also taken into consideration. These simple curves bring competition and make the game playable. Surprisingly, they cover a few real-world phenomena like dumping.

5 CONCLUSIONS AND FUTURE WORK

ESPs provide technology, instructions, materials, and service (training) if this is wanted. They support the lecturers to make teaching more attractive, while the lecturers continue to act as implementers. This aspect underlines the big and relevant role the lecturers have which needs to be filled with good didactics and patience. With the help of Bloom's taxonomy, they can modify the learning environment by creating, adding, or adjusting learning objectives and activities. When using a BSG in their TLEs, e.g. Global Bike Go, briefing and de-briefing are crucial; getting to know the game rules and the setup, reflecting and analyzing the played simulation. The so far implemented mini BSGs are all mainly built component-based. This way, further games can be developed faster, easier, and more sustainable by reusing components. Exchanges and adjustments within the games can be adapted with low(er) effort.

Even though game aspects in learning arrangements could enhance the learning itself, gamification is not the Holy Grail for good learning setups. There is the need e.g. to keep the initial motivation up and to impart the knowledge, not just seeking rewards or simply playing the game without taking any learning success out of it.

A first beta use of *Explore Sales* in teaching led to a small study delivering the first findings and generated positive feedback (Häusler et al., 2023). The study setup and practical guidance for educators can be found there. The first small evaluation of the use of the BSG will be extended with the help of the SAP UCC community. This will allow more data to be collected and evaluated to assess the embedding and impact of BSGs. A comparative evaluation with existing serious gaming solutions such as ERPsim at different levels could also be target-oriented. Two more games have already been implemented, which should be presented in further work: *Explore Procurement* and *Explore Production*. The combination of the games should be used following the value chain to assemble the whole picture; the output of one game is the input for the following.

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