

Development of the Portfolio Management Game 2.0

Master Project

UNIVERSITY OF ZURICH - DEPARTMENT OF BANKING AND FINANCE

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1. Introduction

During their studies, students in the field of Banking and Finance learn a lot about asset management practices and theoretical business management aspects. To provide these students with an opportunity to apply their knowledge and understanding of the portfolio management process in practice, the Department of Banking of Finance offers the seminar "Advanced Portfolio Management Game (S)" every fall semester. During the seminar, students play a simulated game ("Portfolio management SIM") in which they cooperate in teams to steer a bank's portfolio management and investment strategy as well as its business management of investment funds. Competition among the different student teams should make the learning process entertaining.

According to the Department of Banking and Finance, the game has the following key learning goals:

- Students practice how money can be invested in financial markets in a systematic fashion.
- Students learn what factors make financial market forecasts possible and what limitations the applied models have for forecasting.
- Students learn which factors are relevant for the success (performance) of investments and can distinguish between factors that promise short-term and long-term success.

The game focuses on a structured investment process (as visualized in Figure 1). The process covers the steps from getting to know different customer types of the bank, selecting a suitable long-term Strategic Asset Allocation (SAA), adjusting it in the Tactical Asset Allocation (TAA) according to the status of the economy, and finally selecting appropriate titles matching the SAA and the TAA in the depot realization. In addition to these steps, the teams also decide on key business decisions like the salary to pay their employees and how much dividends to pay their shareholders.

The currently used version of the "Portfolio management SIM" is both technically and didactically outdated. It was initiated in 2005 and initially developed by the Department of Banking and Finance at the University of Zurich in cooperation with the Swiss bank Julius Baer as well as the simulation development company game solution ag. Rapid technological development since that time enables new perspectives and possibilities in the field of game-based learning, which lead to the ideation of for this master project.

The herein described master project (further referred to as the "pfm-game" project) aims to redesign and reprogram the existing "Portfolio management SIM" such that it is state-of-the-art from both a technical and didactical point of view. The project team assembled from students of the Departement of Informatics and supervisors from both the Departement of Banking and Finance (DBF) and Departement of Informatics (IFI) decided to cooperate on a modern version of the Portfolio Management Game.

The previous experience of the students in developing web applications, as well as their interest in analyzing financial processes and developing this game provides a solid foundation for the project. By re-developing the application, the Department of Banking and Finance wants to create a simulation of

1. Introduction

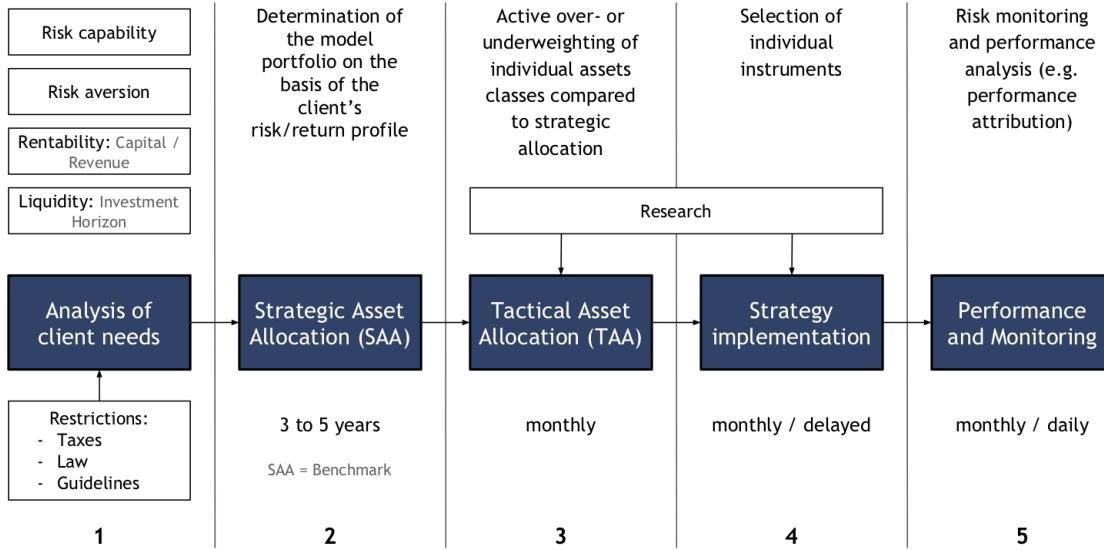


Figure 1: Overview of the structured investment process; own depiction based on figure as created at the DBF.

a typical portfolio management process that helps the students in their learning process by strengthening their practical decision making based on their theoretical knowledge.

The first section of this report (Section 2) provides an overview of the "pfm-game" project and its scope and main goals, as well as a comparison with the existing "Portfolio management SIM". Section 3 summarizes the approach to designing the new application by means of interviews, observation of games, and requirements engineering. The first technical section of this report (Section 4) then describes the main components of the technical application architecture and provides further references for interested readers.

A large part of this work that stays mainly in the background has been the implementation of a Python model that scores and evaluates the team decisions and handles large numbers of time-series. Section 5 describes these efforts and how they integrate with the overall game such that future development could easily improve on the current version of this project. Section 6 then provides an overview over all key application interfaces and shortly summarizes their main intent and properties. As a final conclusion, Section 7 summarizes the progress made in this project as well as what is already planned and what could be imagined for future development.

2. Project Overview

The focus of this project lies in the development of an improved version of the old "Portfolio management SIM". The old version, having been created in 2005, has several critical pain points that should be accounted for in the new project. To provide a general overview of the areas in need of improvements, we first shortly provide an overview of these problems. The following sections then focus on the project overview and procedures as well as the main goals and project scope.

2.1. Major Issues in the Old Version

As previously mentioned, the old version of the game needs to be revised. According to the involved members of the DBF, the development of a new simulation game intends to enhance different existing elements while also introducing new features:

- Specially configured hardware was necessary to play a game with the old application, as it required the installation of a native Windows application without networking capabilities. After each round of a game, the supervisors had to export the decisions of the students onto memory sticks. The contents of these sticks then had to be transferred to a central device with administrative access (on the same windows native application with game master access) in order to calculate the results for a period. Especially due to this reason, only a limited amount of teams could play the game simultaneously. Through the transformation into a web-based environment, the simulation can be used independently of time and location, whereby the number of participants can be scaled to higher numbers. It is therefore also conceivable that the simulation could be offered not only to students at the Department of Business, Economics, and Informatics but also to students of other faculties and in larger environments.
- Due to the use of real historical financial market data in the previous simulation, students can improve their success by researching past share prices. This means that it is not necessarily the students who invest the money in a scientifically meaningful way who score best, but those who carry out the best research. A simulation shall enable the use of randomized data simulated by mathematical processes before the execution of a period. On the one hand, this would improve fairness in the simulation. On the other hand, it would also show that it is not possible to forecast financial market data precisely. This simulation is not directly part of this project but it should be possible to integrate with a future simulation without major issues.
- Students should be shown that the forecasting ability on financial markets is limited and that the investment of funds should, therefore, be based on fewer, theoretically sound principles. With simulated data, it would be clear that misconduct can lead to short-term profits, but that systematic behavior is decisive for success in the long term (across multiple independently randomized periods)

2. Project Overview

2.2. Project Focus and Goals

The main focus as summarized by the DBF team should lie on the following items and characteristics:

- **Usability:** The different game sequences within the market model should be well-designed and comprehensible for the game master and the players.
- **Scalability:** Design a well functioning game that can be played with a smaller and larger number of students (potentially even scaled up to an assessment level course).
- **Modularity:** Basic and an advanced version(s) and settings allow the game to be used on different levels of study.
- **Key Characteristics**
 - The game should be self-explanatory and intuitive.
 - A brief and concise game documentation is to be created (part of the project report).
 - The game contains at least the useful components of the old game.
 - Informative innovative graphical output (as self-explanatory as possible) for the instructor (based on the current Excel-evaluation and further ideas we provide in advance) and students (see “Teilnehmerbericht” of the old game and a depiction of performance-attribution).
 - New market model created by the Department of Banking and Finance in an Excel spreadsheet which will be the base for the implementation of the authors.

2.3. Project Procedure

The pfm-game project was initiated and originally planned by the project management team of the DBF. The specifications for the implementation were defined in cooperation with the developers. Furthermore, a student from the DBF was given the task to prepare an economic model for the data simulation in form of a master thesis, with the goal of being able to integrate the model with the pfm-game project later on.

In the next phase, the architecture was conceptualized according to the main project goals and plans for requirements engineering were created according to best practice procedures as discussed with the supervisor from IFI. During the requirements engineering phase, user stories and initial mockups were created in cooperation with the DBF team, incorporating collected knowledge from user observations, interviews, as well as other means of data collection (further described in Section 3).

The main development phase was then started with an initial architecture implementation as well as a focus on continuous integration and automated testing for critical API resources. An initial prototype of the application was developed with mock asset data, as real data or market modeling were not yet available or defined by the DBF team. Once a market model was available in an Excel format, the focus of the project was set on implementing the model as a Python service. The model was then integrated with the existing application prototype and first efforts were made to integrate the entire

2.3. Project Procedure

application with real historical data.

The integration achieved during the course of this project is based on historical stock prices. Due to open issues in the simulation project that still remain, an integration with simulated data or industry sector portfolios was not yet possible. However, this integration is planned for the near future. Towards the end of the project, an initial model validation and application testing phase followed. During initial validation of the model, some issues that require further definition and thoughts by the DBF team were already uncovered and will be amended in future releases.

3. Methodology

3. Methodology

During the requirements engineering phase of the project, different approaches, methods, and experiments were applied to form an understanding of potential improvements compared to the old version. This section is dedicated to a summary of these applied methods alongside their major results and how the development of the application was directly influenced by them.

3.1. Requirements Engineering

A typical requirements engineering process serves as the base of our engineering approach. By defining initial user stories in coordination with the DBF team, we were able to find a common ground for important feature sets as well as define acceptance criteria for these feature sets. As is natural in a development project, these stories were amended over the course of the process, as it was found that some requirements were more or less important than initially thought. A listing of all created user stories for both the initial version as well as future development is available in Appendix A. The state of all acceptance criteria is already marked in the corresponding boxes.

3.2. Interviews with Professionals

The structured portfolio management process is a theoretical best practice that is to be conveyed in approachable form to students participating in the new game. As the main goal is to prepare students for the experiences they will have in their working life, it was necessary to extend this theoretical best practice with some more practical information, as we had no practical experiences of the structured portfolio management process.

Due to our work for the DBF before this project, we were able to set up interviews with some professional portfolio managers. As preparation of these interviews, we have created a set of questions (Appendix B) that would aid in understanding their daily tasks and their approach to the overall process. We held interviews with two portfolio managers from different banks, namely:

- Roger B., UBS
- Sandro B., Zuercher Kantonalbank

Due to the confidentiality in banking institutions, we were restricted to perform short interviews without observation. During these interviews, both interviewees have described their job and their daily tasks while being able to refer to the game, as they had played it during their studies. Additionally, we were provided with some screenshots of the internal UBS application, which later on strongly guided our design of the depot realization interface. The major results of these interviews can be found in Appendix B.

Interviewing the professional further allowed the extension and validation of a previously created work model that was largely based on assumptions and inputs from the DBF team. This work model is shown in Figure 2.

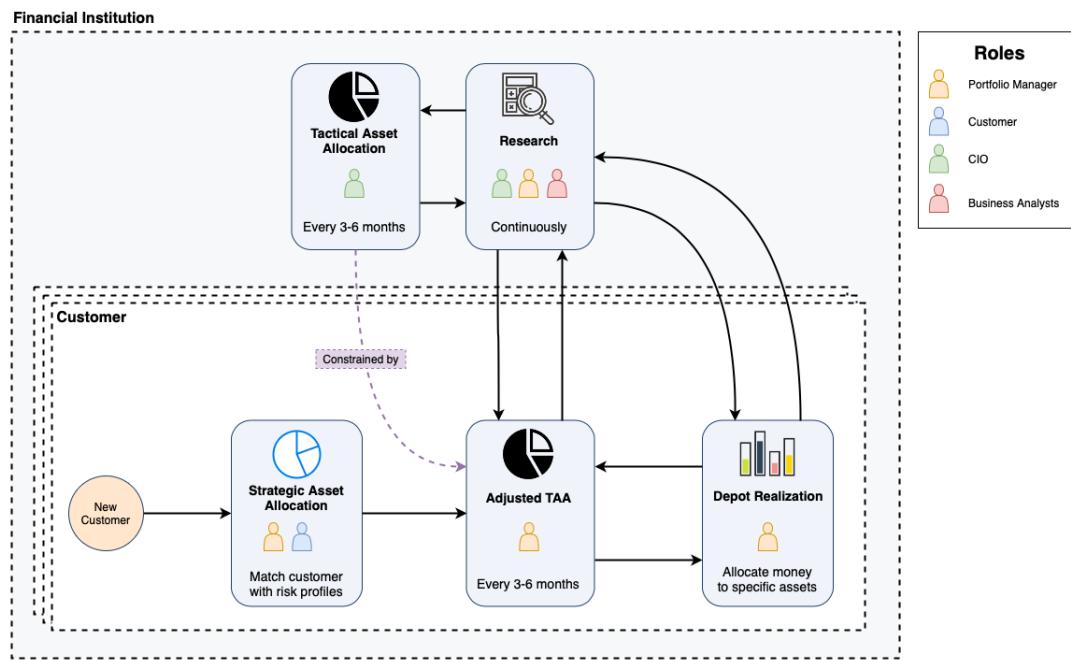


Figure 2: Work Model of a Professional Portfolio Manager

3.3. Observation of Participants

Over the course of our project, we were able to attend two real executions of the old portfolio game, during which we observed the teams during their works and spontaneously asked questions where appropriate. The two groups that were observed were quite different, as they had different levels of practical experience:

- Participants of the executive education program with current job positions in Banking and Finance related companies, meaning that participants had some practical experience with the concepts in the game.
 - Participants of the “Advanced Portfolio Management Game (S)” master seminar in the early fall semester, wherein most master students were assumed to possess only theoretical knowledge of the concepts.

During the former execution of the game, the simulation itself was played during three days of a seminar. A group of about 30 participants played in groups of three and four. The authors had the chance to observe the groups during their decision-making process and ask them directly for feedback. Additionally, the seminar management collected final feedbacks as well as ideas for further development.

This execution of the game was overall very helpful in guiding the initial requirements engineering, as the experienced participants were very clear about their major frustrations with the old application. This lead to many ideas for refinements and features that were incorporated into the user stories and successfully implemented in the new application. Some of the notes compiled during this process can be found in Appendix C.

3. Methodology

For the latter instance of the game, recording software was installed on the computers provided by the DBF, such that all teams could be followed along in their game progress. These recordings were then used to validate the assumptions of user behavior. As the old application required many media breaks (some information was handed out on paper), we were not able to follow these external discussions (without additional sound recordings).

3.4. Experimental Game with Students

Alongside the two executions of the game that we were able to observe, we further managed to set up an experimental setting in cooperation with the DBF team. In this experimental setting, two bachelor-level students with basic knowledge in Finance and two master students with advanced theoretical knowledge of portfolio management played two periods of a supervised game. They were handed out screenshots of the major screens, on which they could annotate everything that came to their mind or that they did not understand. Teams were allowed to ask theoretical questions that were then noted on the corresponding screenshot. The annotated sheets were later converted into a digital aggregation that is appended in Appendix C.

The main goal of this experiment was to gain an understanding of the behavior and problem-solving approaches of players with different levels of experience. This would later allow to tailor the new implementation of the game to these specific needs and to potentially include features that could be activated depending on the level of knowledge of the participants.

Over all of the observations with students, a work model from the student perspective was progressively created, refined, and validated. This work model is shown in Figure 3.

3.5. Design and Iterative Prototyping

Initially, we approached design as a separate step preceding development by designing multiple screens based on defined work models, the collected observations and the defined user stories. Using a sketching software, basic screen mockups and layouts for the student process (including the SAA, TAA, depot realization and business administration steps) were prototyped. As we realized that the game does not only consist of screens from a student perspective but also many more from an admin perspective, we decided to start implementing the screens by prototyping in an iterative fashion.

By combining all known requirements and forming a tight feedback loop with the DBF team, we managed to iteratively create an application with the most important UI concepts implemented and already received positive feedback regarding the user interface.

During the design process, multiple important UI decisions had to be defined, such as how to model the game session management or the student decision process. Based on the knowledge about user goals and behaviors when using the respective screens in the old application, we iteratively designed for an optimal solution. For example, By defining a timeline for the game management screen, the administrative user always gets a direct overview of the state of the game. The timeline builds the base

3.5. Design and Iterative Prototyping

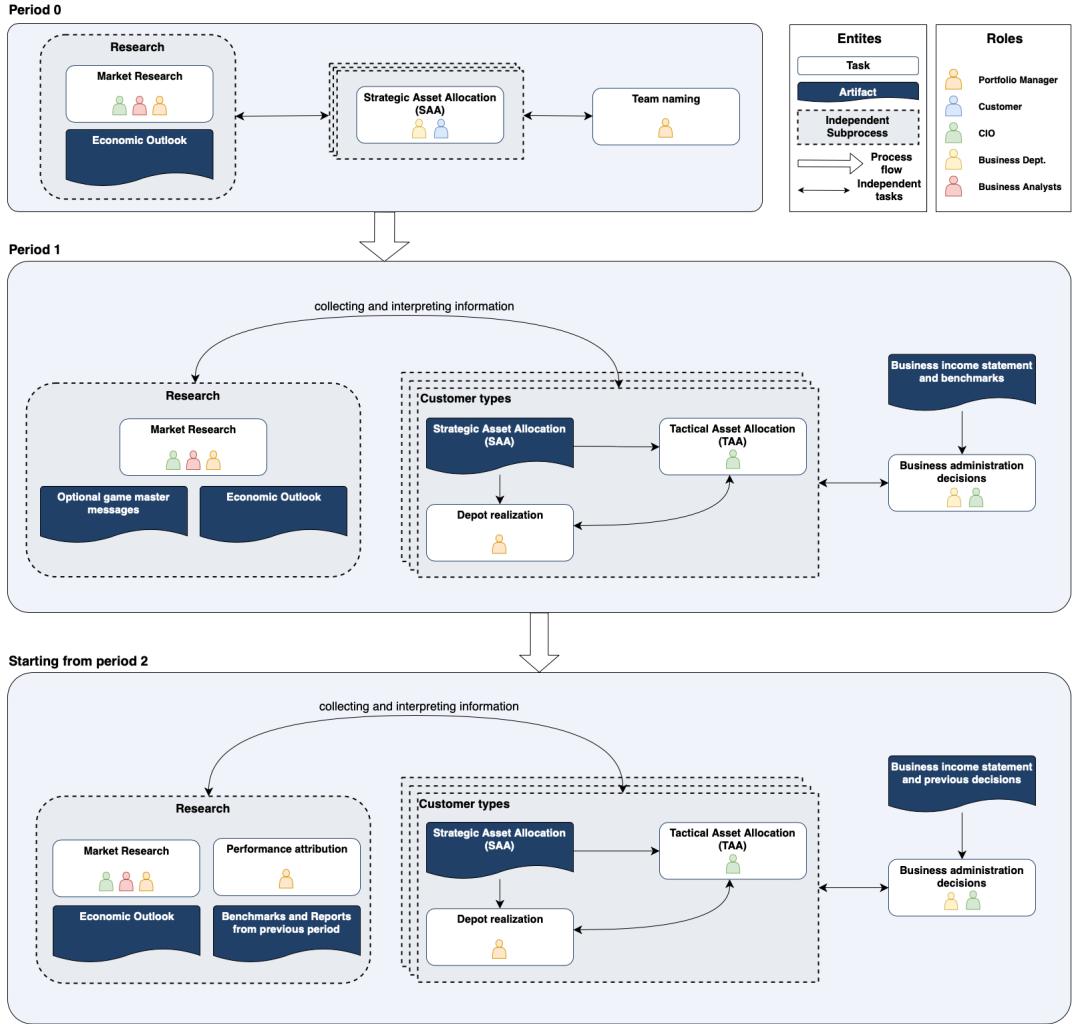


Figure 3: Work Model of a Student Participant

of the game detail screen, while other visualizations or forms within this screen are shown depending on the state of the game.

Taking the student process as another example, we decided to depict the main process steps on the top game navigation bar next to a submission button, where it always available to the user. Each processing task (SAA, TAA, depot realization, business administration) has its own progress state marked by a colored icon. Additionally, switching of customer types was built in a menu located on the left side of the screen. This menu is available for all steps within the process and is dynamically extended for other purposes like filtering within the depot realization screen.

4. Architecture

Providing a state-of-the-art architecture and setup is one of the main goals of the new pfm-game project. As a general direction, moving to a web-based application was defined early on as a replacement for the previous decentral solution. This section is thought to provide a sufficiently technical but still abstract overview of the application architecture, providing further references where necessary.

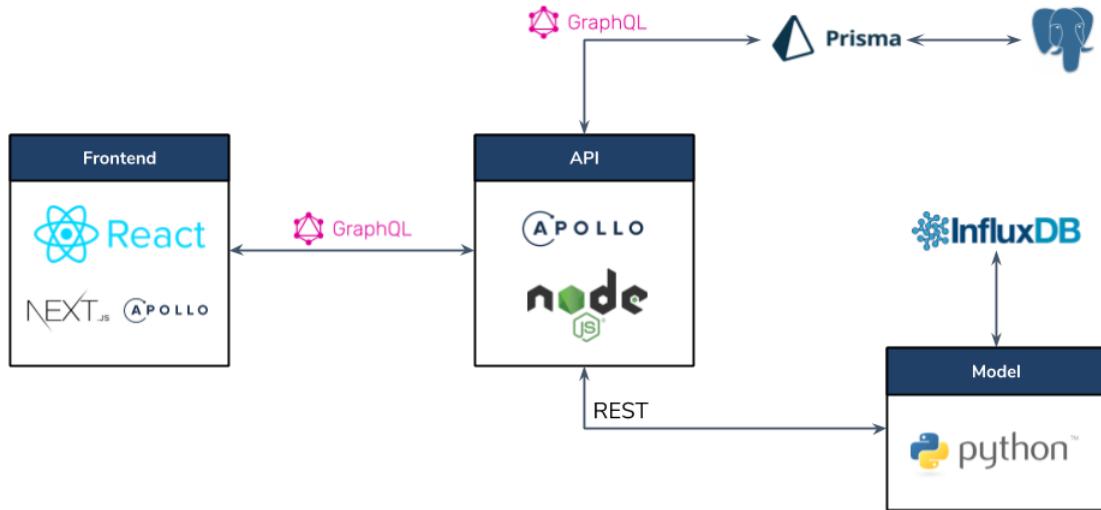


Figure 4: Proposed pfm-game architecture

4.1. Frontend (pfm-react)

Repository: <https://git.ibf-devops.ch/wb/pfm-game/pfm-react>

The application frontend is structured as a single-page application for use in web browsers optimized especially for Google Chrome. Contrary to the native Windows application of the old game, this allows for effortless setup and resolves many problems with manual data transfer (either via USB for game data or on paper for reporting). The single-page app paradigm has become more and more popular with frameworks like React, Angular, and Vue being used by millions of developers. As such, our implementation of the game is based on the latest versions of the ReactJS and NextJS framework.¹

4.2. GraphQL

Traditional web applications have been using the RESTful paradigm for a long time. In a RESTful application, different types of entities are accessible on different endpoints and using different methods. For example, a GET request on a /customers endpoint could return a list of all customers.

Contrary to this, GraphQL is a new way of fetching data in a declarative fashion. The project has been initially developed at Facebook, was open-sourced in 2015, and has become widely used since

¹See <https://reactjs.org/> and <https://nextjs.org/>

that time. The key concept, declarative data fetching, can be summarized as an API response having the same structure as the corresponding request. Additionally, all communication using GraphQL is bound to a single endpoint, as the response depends solely on the content of the request.²

If we wanted to request a list of users from our GraphQL API, we could make an exemplary request as can be seen in listing 1. The corresponding example response is shown in listing 2.

```
{
  users: [
    {
      email: "rolandschlaefli@gmail.com",
      username: "roland"
    },
    {
      email: "pascal_zehnder@outlook.com",
      username: "pascal"
    }
  ]
}
```

Listing 1: GraphQL request

```
{
  users: [
    {
      email: "rolandschlaefli@gmail.com",
      username: "roland"
    },
    {
      email: "pascal_zehnder@outlook.com",
      username: "pascal"
    }
  ]
}
```

Listing 2: GraphQL response

This new approach to data fetching allows us to fetch data directly where it is needed. For example, specific details regarding a user might be fetched only when a form is shown to edit these data. Furthermore, as requests using GraphQL only contain the fields that were actually requested (and not every field available), the data fetching consumes fewer resources and therefore fetches data within a shorter timeframe.

4.3. API (*pfm-api*)

Repository: <https://git.ibf-devops.ch/wb/pfm-game/pfm-api>

Any application wanting to consume API data using GraphQL needs a special endpoint that supports this format. As such, our application backend has to support GraphQL as its main communication language. There are some popular server-side frameworks for this case, including an official reference implementation maintained by Facebook. A combination of a NodeJS server integrated with the Apollo Server framework serves as a good basis for our GraphQL endpoint.³

The core responsibilities of the API are handling the authentication and authorization of requests, structuring the main business logic into services (such as account-, game-, model-, play- and scoring-service), handling all communications with the market model, as well as managing the Prisma database access layer for data persistence.

4.4. Prisma

Repository: <https://git.ibf-devops.ch/wb/pfm-game/pfm-api>

²See <https://graphql.org/>

³See <https://nodejs.org/en/> and <https://www.apollographql.com/docs/apollo-server/>

4. Architecture

The Prisma database access layer is a middleware that sits in between the API and a Postgres database. The Prisma instance provides a single GraphQL endpoint with which database entities can be created, deleted, updated, or read. Additionally, Prisma handles everything related to database management, including schema creation, migrations, and maintenance. The underlying database schema is defined using a GraphQL schema language, using which types and relations can be modeled.⁴

4.5. Model (pfm-model)

Repository: <https://git.ibf-devops.ch/wb/pfm-game/pfm-model>

While the API provides services for all the persistence and input related logic, the model is responsible for everything related to the actual calculations and computations for the game. This includes everything from extracting available assets from the InfluxDB time-series database to scoring teams based on many input parameters.

The model is structured into several Python modules that can be accessed by the API using specialized REST endpoints. The model is not connected to the main application database and performs all of its calculations in a stateless manner (except that it fetches historical asset data from the specialized InfluxDB instance). This allows for keeping the API logic at a bare minimum, moving most of the logic into the modules.⁵

4.6. Simulation (pfm-model)

Repository: <https://git.ibf-devops.ch/wb/pfm-game/pfm-model>

The portfolio management simulation is a project that was taken on during the course of a Master thesis at the Department of Banking and Finance. Even though the simulation was executed as a separate project, the project goals are tightly coupled: the results of the simulation project are planned to be integrated into the game application in the near future.

With said integration, it would be possible to pseudo-randomly generate new asset time-series with which a game could be played, instead of basing the entire game on historical data. By tuning some parameters, game masters could then influence the generation of said time-series to e.g. simulate a period of recession.

The simulation project is structured as a collection of Python modules that incrementally build from raw asset data, over sector portfolio generation, and up to simulated asset time-series. Due to the coupling of the project, we provided support for the deployment and infrastructure setup and developed a Python REST API for the project. Additionally, some parts of the InfluxDB data hydration scripts had to be reimplemented due to inefficiencies and incompatibilities.

⁴See <https://www.prisma.io/>

⁵See <https://falconframework.org/>

Further details are described in the thesis related to the simulation project. As such, we do not describe any further details here.

4.7. Continuous Integration

To support development efforts over the course of the pfm-game project, a key factor has been the setup of a successful continuous integration and deployment pipeline (CI/CD) at the beginning of the project. Due to previous positive experiences with CI and other DevOps paradigms, we decided that each subproject should be continuously integrated and deployed to a staging environment, where we could test it in a realistic environment. Additionally, on tagging the repository with a new version, a container is prepared and built for deployment to a production environment. This has been a great driver of efficiency over the course of the project.

Deployment in the pipelines is achieved by bundling all services into a Docker container that encompasses all its dependencies and can be deployed to any environment with a running Docker engine. For example, even though the Python market model makes use of many Python packages and dependencies, all that is necessary is packaging it into a container as provided by the official Anaconda distribution and installing some extra dependencies. This container can then be downloaded to a local machine without needing to install the Anaconda environment or any dependencies. Similarly, the container can be deployed to a production Kubernetes cluster without the need for any modifications. This means that if the container runs in a local Docker environment, it will also run on a production Docker environment, as it is, in fact, the exact same container definition.

4.8. Testing

Another important advantage of using a CI/CD approach is that tests can be run on each commit, providing fast feedback on any code changes (“fail fast”). The API endpoint of the application is tested against an exhaustive integration test suite that covers an entire game with multiple teams and several periods. The API is tested in conjunction with the model, which also ensures that the stateless model service can still be used to play a game successfully. In addition to providing fast feedback, these tests also prevent a failing version of the API from being deployed automatically.

5. Market Model

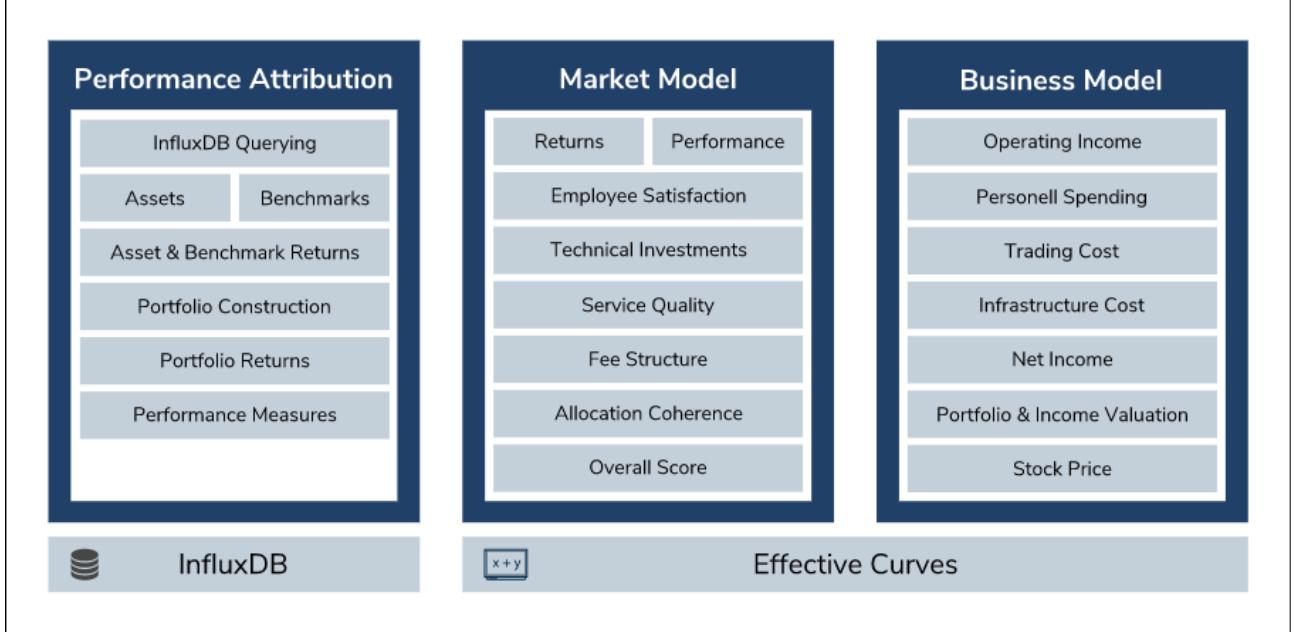


Figure 5: Market Model Overview

The pfm-game market model is a module that produces period results based on the business decisions and portfolio allocations of teams participating in a given game. During the execution of a game, the market model is executed once per period once the game master decides to complete a period and send a period scoring request. The market model is separated into several subcomponents that, when applied in sequence, produce results for the given period of the game as presented in Figure 5.

5.1. Data and Data Ingestion

The underlying data driving all portfolio-related calculations in the market model is comprised of several hundred time-series that are stored in InfluxDB, a database specialized in time-series management. The majority of these time-series describe asset prices or return indices (i.e., asset prices normalized by the payment of dividends and other interest) as extracted from the Thomson Reuters Datastream platform. Further relevant time-series are based on macroeconomic data extracted from the FRED (Federal Reserve Economic Data) database. These data are used to calculate portfolio and benchmark returns as well as parameters of an economic forecast.

The above-described data can be extracted from Datastream and FRED and ingested into an instance of InfluxDB automatically by means of a Python module that was created as an extension to the *PFM-Simulation* project. Data to be ingested is defined inside an assets.csv file in the following CSV format, described in Table 1.

During processing of the CSV definition of all assets, the module will incrementally extend existing time-series with new data up to the current day. Time-series that were not previously available will

Name	Symbol	Start Date	Market	Data Type	Asset Type	Currency
SWISS BOND AAA	SWBND3A	29.12.2006	Switzerland	RI	BONDS	CHF
NESTLE 'R'	S:NESN	01.01.1973	Switzerland	RI	EQUITY	CHF

Table 1: Exemplary assets in a valid assets.csv definition format (optional columns omitted)

be stored as a new series in full-length. As not all assets are available at all times, the game will dynamically decide about the assets to show as potential investments based on their availability and the historical dates of the period.

5.2. Performance Attribution

The performance attribution module is the first module in the sequence of model calculations that are applied to an incoming period scoring request. This module handles everything from extracting the relevant time-series from the database to computing key performance measures on constructed portfolios.

5.2.1. InfluxDB Querying

As can be seen in Figure 5, one of the most important responsibilities of the performance attribution module is handling all data querying from the InfluxDB time-series database. Based on the incoming depot allocations of teams that participate in a game, the module fetches all necessary asset and benchmark series from the database.⁶

5.2.2. Asset & Benchmark Returns

To be able to continue with portfolio construction further in the sequence, all extracted time-series need to be converted into series of returns. All computations later in the sequence will be based on these relative return measures and not on any absolute values of the time-series.⁷

5.2.3. Portfolio Construction

With returns being available for all assets and their corresponding benchmarks, the performance attribution module then constructs portfolios for each team. Each team will have created one portfolio allocation for each customer type that is enabled for a specific period. The module will account for this by constructing as many portfolios per team as there are customer types.⁸

In addition to building portfolios for all depot allocations of the current period, the performance attribution module also computes a benchmark portfolio for each asset portfolio. These benchmark portfolios are based on the strategic asset allocation of the corresponding team and customer type.

⁶See pfm-model/api/modules/performance_attribution/influx.py

⁷See pfm-model/api/modules/performance_attribution/returns.py

⁸See pfm-model/api/modules/performance_attribution/portfolio.py

5. Market Model

As the strategic asset allocation is defined once per game (during period zero), the composition (but not the returns) of these benchmark portfolios stays the same over the course of the entire game.

5.2.4. Portfolio Returns

Once portfolios have been built for each combination of teams and active customer types, returns need to be calculated in the same way that returns were calculated for the assets previously. To compute a portfolio return, the separate asset returns need to be weighted by the amount of money that has been invested in each asset. For example, if a team were to invest 10% of their total assets under management in one asset and 20% in another, the latter would influence the overall portfolio returns twice as much as the former.

5.2.5. Performance Measures

Upon completion of all previous returns calculations, the returns of assets, benchmarks, and portfolios can be combined into many useful performance measures that characterize a portfolio in different ways and allow for an easy performance comparison between teams. Table 2 provides an overview of all of the measures made available by the performance attribution module.

A byproduct of these calculations are the new assets under management for a customer given their portfolio returns, as well as the new asset positions that a portfolio is composed of after application of returns. For example, if one team invested 50% in one asset and 50% in another, the new positions after returns might be 45%-55% if the latter asset outperforms the former.⁹

5.2.6. Major Outputs

The results of the performance attribution module are then compiled into a suitable format and passed on to the market model module, which handles the integration of these results with business decisions as well as the grading of performance measures according to efficient curves.

5.3. Market Model

The market model module is the second module in the sequence of calculations and builds upon the results of the performance attribution module. It ingests these results as well as business decisions of all teams for the current period and performs several grading procedures based on all of these data. The final output of the module consists of several index and subindex values that, e.g., describe the employee satisfaction on a range from 0 to 10. The market model module is based on the Excel formulation created by the DBF and was extended by the ability to handle multiple customer types as well as integration with the other modules.

As the market model is comprised of many individual calculation steps and formulas, we will not go deeply into technical specifics of single formulas. Instead, we focus on the overall structure of the module and its main subcomponents as well as how the underlying effective curves (i.e., formulas) can be parametrized and fine-tuned.

⁹See pfm-model/api/modules/performance_attribution/kpi.py

Name	Description
Variance	The variance of portfolio returns
Standard Deviation	The standard deviation of portfolio returns
Variance Benchmark	The variance of a benchmark portfolio
Standard Deviation Benchmark	The standard deviation of a benchmark portfolio
Beta	Systematic risk (volatility) of a portfolio compared to the overall market
Tracking Error	Divergence between the price behavior of a portfolio and its benchmark
Sharpe Ratio	Excess return per unit of total risk
Traynor Ratio	Excess return per unit of systematic risk
Jensen's Alpha	Difference between portfolio return and expected return according to the Capital Asset Pricing Model (CAPM)
Information Ratio	Measures abnormal return that could be diversified away by holding an index portfolio
Selection Performance Attribution	Portfolio performance attributed to the individual investments
Tactical Performance Attribution	Portfolio performance attributed to the asset allocation (asset types and markets)
SAA Violations	The number of times that an ideal SAA has been violated by a given portfolio
TAA Discrepancy	The relative deviation of a given portfolio with respect to its corresponding TAA

Table 2: Portfolio measures as calculated in the performance attribution module.

5.3.1. Effective Curves

To facilitate the grading of arbitrary values on a scale of zero to ten and allow for additional parametrization, formulas that we call effective curves are applied. These formulas most often follow the general schema of computing the market average and, based on a comparison with specific portfolio-related values ($\Delta = \text{value} - \text{value}_{avg}$), calculating a positive or negative deviation from a base value (e.g., $5 + \Delta$).

A simple example for an effective curve could be:

$$\text{index value} = 5 + \frac{\Delta}{20000}$$

where the value would be constrained to lie within $[0, 10]$. More complex variants apply different functions based on the domain of the delta value. As a specific example, the full returns index is computed as follows (if the delta value is positive):

$$\text{returns index} = 5 + \log(1 + 10 * |(\text{return} - \text{return}_{avg}) * 100|)$$

5. Market Model

If the delta were negative, the result of the logarithm calculation would simply be inverted to its negative value.

Parametrization To allow for easy parametrization of the effective curves, they have been extracted into a single file as lambda functions.¹⁰ An example of such a function is the salary index as shown in listing 1. The salary index takes a list of salaries and computes an index for each team (within [0, 10]).

```
ix_salary = lambda salary: utils.ensure_index_borders(
    (salary - salary.mean()) / 20000 + 5
)
```

Listing 1: Salary index as a Python lambda function

5.3.2. Overview of Market Model Indices

The market model encompasses many effective curves and intermediary values. Many of these values are highly dependent on other previously calculated values. Figure 6 shows the dependencies and interconnections between all the major input values in the market model, as well as how the final score index and the number of customers are calculated from these input values. Table 3 shortly describes each major index and its significance.

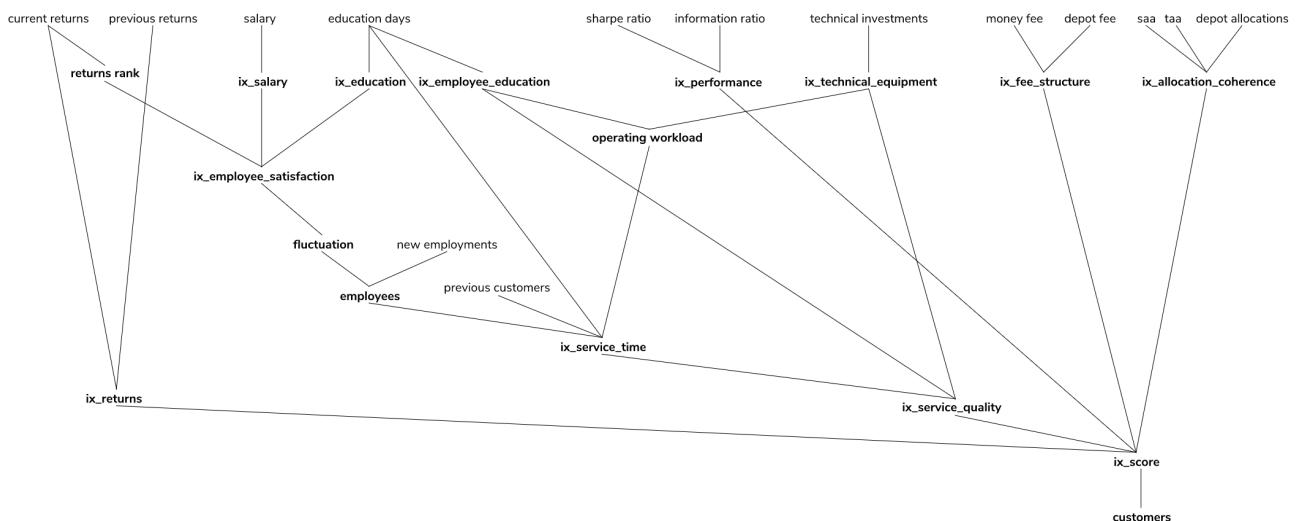


Figure 6: Overview of market model dependencies; resolved from top-to-bottom with computed values in bold; large-scale depiction can be found in the appendix

5.3.3. Major Outputs

Next to the score index encoding the overall satisfaction of customers with a team's management decisions, it further enables the calculation of customer flows in between teams. Highly scoring, successful teams will earn customers that other teams will lose. The final customer count adjusted by

¹⁰See pfm-model/api/modules/market_model/effective_curves.py

Name	Description
ix_returns	How portfolio returns compare against competitors
ix_sharpe_ratio	How well the sharpe ratio compares against competitors
ix_information_ratio	How the information ratio compares against competitors
ix_performance	Combination of performance indices
ix_salary	How satisfied employees are with their salary
ix_education	How satisfied employees are with their education
ix_employee_satisfaction	How satisfied the employees are with overall working conditions
ix_employee_education	How much employee education boosts efficiency
ix_technical_equipment	How appropriate the IT infrastructure is after depreciation
ix_service_time	How appropriate the time spent for customer service is perceived
ix_service_quality	How well overall customer service is perceived
ix_fee_structure	How well the all-in management fee is perceived
ix_allocation_coherence	Number of SAA violations and relative TAA discrepancy
ix_score	Combination of all indices into an overall rating

Table 3: Description of all major indices calculated in the market model module

growth is one of the most important outputs of the market model, as it will allow for further model calculations regarding the overall state of the business.

5.4. Business Model

As the third and final module in the chain, the business model is responsible for all calculations relating to the overall success of a team's banking institution. It calculates a complete income statement with operating returns and expenses as well as equity, dividends, and a final stock price. Next to the number of customers and score index, the stock price serves as another measurement of the overall score of a team's bank.¹¹

Gross Income The gross income of a company includes all revenue earned by goods and services sold. Applied to the scenario of a bank in our game, the gross income can be calculated from the number of customers, assets per customer, and the fee charged for managing said assets. In the case of multiple customer types, the gross income is the sum of all fees for each separate type.

Personnel Spending Personnel spending is based on the number of employees and computed by combination with additional factors like salary and social expenses, education days per employee, and staffing decisions (hire/fire and temporary staff).

¹¹See pfm-model/modules/api/business_model/effective_curves.py for an overview of all effective curves

5. Market Model

Trading Cost The trading cost of a bank is comprised of a fixed trading cost based on the number of employees as well as a variable trading cost that varies with the number of transactions made by a bank. A transaction is defined as a single change in an investment position, e.g., a change from a 10% investment to a 20% investment.

Infrastructure Cost A bank's infrastructure cost has two subcomponents: the cost of a workspace needed for each employee and the cost of depreciation on technical investments of previous periods. The value of technical investments before depreciation is a combination of the previous value after depreciation and the current investments into technical infrastructure.

Operating Income and Equity The equity of a bank is calculated from the operating income (gross income minus all spending) and the equity of the previous period. Based on the payout ratio as defined by the team, dividends are paid to the bank's shareholders and subtracted from the equity. This equity after dividends will be used as an initial value for the computations in the next period.

Stock Price As a final measure, the stock price of a bank measures the confidence of shareholders in the current future success of the bank. The calculation is based on the valuation of all portfolios managed by a bank as well as the valuation of the overall income, equity, and dividends, and the corresponding deltas from the previous period.

6. Application Overview

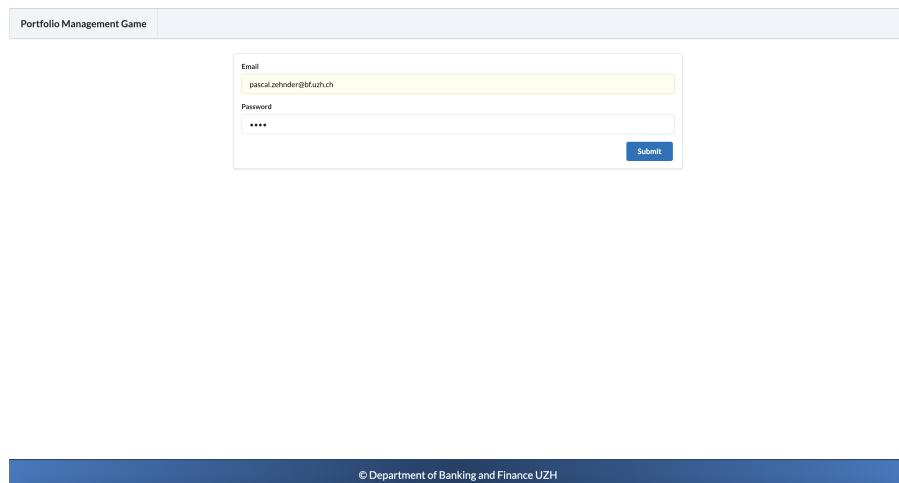
Having introduced the foundational principles as well as the application and market model architecture in preceding sections, this section provides an overview over the major interfaces that are available in the game. The new implementation can be separated into three major categories of views:

- **Administration Views:** The administrator views can only be accessed with a previously created and authorized user account. New users can be created from the corresponding view in the administrator environment.
- **Team Views:** The team views are only accessible for teams that have been created in a game that is at least in a planned state.
- **Reporting:** The reporting screens are visible to both administrators and teams of a game, as they share the same information. It is planned to differentiate the displayed information based on the role of the user in future extensions. Administrators could e.g. be able to display additional details and team decisions.

6.1. Administration Views

6.1.1. Administrator Login

An administrator needs to have a login to access administrative functionalities. After entering his game master credentials on Figure 7, the administrator is authorized and redirected to the game overview.



A screenshot of a web-based administrator login form. At the top left, it says "Portfolio Management Game". Below that is a login form with two input fields: "Email" containing "pascal.zehnder@bfuZH.ch" and "Password" containing "****". To the right of the password field is a blue "Submit" button. At the bottom of the page, there is a dark blue footer bar with the text "© Department of Banking and Finance UZH".

Figure 7: Administrator Login

6.1.2. Game Management

Game Overview The landing page the administrator is redirected to after a successful login is the game overview (Figure 8). It serves as a control center, as multiple games can be maintained simultaneously by a single game master. Some instant information identifies the current progress of the game within the list, such as game name, short game id or the current phase of the game.

6. Application Overview

The screenshot shows the 'Game List' section of the application. It displays two entries:

- Executive Finance Education 19**: Status: Completed (Period 4), Last Update: 5.1.2019 14:07:45, Details button.
- Team Game**: Status: Running (Period 0), Last Update: 4.1.2019 10:08:44, Details button.

Figure 8: Game Overview

Game Creation When creating a game the administrator needs to define some parameters by filling out a form (Figure 9) structured into three steps. By pressing on the “next”-button, the administrator will be led through the form. Some tooltips help users to understand the purpose of the input to provide.

The screenshot shows the 'Game Creation' form. It consists of three main sections:

- Game Details**: Game Name: Advanced Portfolio Management Seminar, Game Identifier: apm19, Game Description: HS19.
- Period Settings**: Number of Participating Teams: 8.
- Customer Types**: Initial Customer Types: Balanced, Initial Customer Count: 2500.

A 'Next' button is visible at the bottom right.

Figure 9: Game Creation

Game Initialization The game detail for each game may be accessed over the game overview list, as seen in Figure 8. As the game creation may be done in advance we have split the game creation from the game initialization (Figure 10), such that final adjustments of the game may be done just before the start of the game.

The screenshot shows the 'Game Details' section of the 'Advanced Portfolio Management Seminar' game. It includes:

- Initial Customer Types**: Balanced.
- Initial Customer Count**: 2500.

A 'Initialize Game' button is visible at the bottom right.

Figure 10: Game Initialization

Team Overview For each team participating in a game, a random password is generated on game creation. To view a list of all team credentials, the administrator can open the team overview as seen on Figure 11.

The screenshot shows a table titled "Team Overview - Advanced Portfolio Management Seminar". It lists 8 teams with the following data:

Team Name	Login	Password
Team 1	team1	sspJ6i24
Team 2	team2	JQY0dDu
Team 3	team3	JUlnqGd9
Team 4	team4	jBZK6GYi
Team 5	team5	bD33FyNl
Team 6	team6	ubW1bfug
Team 7	team7	E18uSbzN
Team 8	team8	VytNIDtH

Figure 11: Team Overview

Game Start After starting a game, the students or teams are able to start with their period zero decisions. Administrators are able to give their participants some guidance with messages that will be visible for the teams in their report section. Figure 12 shows a game that is still planned and may be started in a next step.

The screenshot shows the "Game: 'Advanced Portfolio Management Seminar'" page. It displays the following information:

- Game Identifier: apm19
- Initial Customers: 2500
- Simulation Type: Historical
- Period Length: 30 days
- Start Date of Period: 2007-01-01

Below this, there is a timeline showing "Period 0 (SAA)" from 2007-01-01 to 2007-01-31, followed by "Period 1", "Period 2", and "Period 3".

In the "Economic Outlook" section, there is a "Report" link and a "Messages" section with a button to "Add new message". A "Start Period" button is located at the bottom right.

Figure 12: Game Start

Running Period Zero When a period is running, the game detail screen shows an overview of the submission state of all teams (Figure 13). The period can only be finished once all teams have submitted a decision. The administrator is further able to get an insight about the SAA decisions of teams.

Initializing Period One After completing period zero, the administrator can continue to initialize the second period of the game (Figure 14), which is called period 1. This is the first period that allows students to actually invest and make business decisions. Additionally, new customer types for the next period and other settings could be defined in this phase of the game once period one has been played. New customer types may be added for the next period while all existing ones are not removable. A new customer type has the initial number of customers as defined in the game creation form. Future developments will include additional simulation settings on this screen, which is why the process is separated in two parts (initialization and starting). The simulation would then run between initialization and starting, after which simulation results could be previewed on the starting screen.

6. Application Overview

The screenshot shows the 'Portfolio Management Game - Administrator' interface. On the left, a sidebar contains links for 'Users', 'Games', 'Entities', and 'Teams'. The main content area is titled 'Game: "Advanced Portfolio Management Seminar"'. It shows game details: Game Identifier: apm19, Initial Customers: 2500, Simulation Type: Historical, Period Length: 30 days, and Start Date of Period 0: 2007-01-01. Below this is a timeline with five periods: Period 0 (SAA), Period 1, Period 2, Period 3, and Period 4. The first period is highlighted in green. A table below the timeline shows a 'Balanced (SAA)' portfolio with asset allocations: Money Market (USD) 10%, Bonds (CHF) 20%, Bonds (USD) 10%, Equity (CHF) 35%, Equity (USD) 10%, and Equity (JPY) 15%. The sidebar also lists 'Team 1' and 'Team 2' under the 'Teams' section.

Figure 13: Running Period Zero

This screenshot shows the same interface as Figure 13, but the timeline has changed. The first period is now green, indicating it has been initialized. The 'Initialize period' button is visible at the bottom right of the timeline area.

Figure 14: Initialize Period One

Start Period One After initializing the next period of a game, the administrators can define some messages (same as in period zero / game initialization, Figure 15). On starting the next period, teams can then define their decisions as described for the previous screen.

This screenshot shows the interface after the first period has been initialized. The timeline shows Period 0 (SAA) and Period 1. The 'Start Period' button is located at the bottom right of the timeline area. The sidebar and game details remain the same as in the previous screenshots.

Figure 15: Start Period One

Reports For the presentation of the team results in between two running periods, a reporting screen is accessible to the administrator. A detailed description can be found in Section 6.3, as the teams access the same reports as the administrator of that running game.

6.1.3. Entities Administration

Assets All assets are visible within this page which are available for all game masters, as visible in Figure 16. They can be synchronized with the InfluxDB database to reflect the current contents of the database. When synchronizing those assets, they will be updated for all users.

Mnemonic	Name	Market	Sector	Asset Type	Available From	Available Until
SWBON3B	SWISS BOND BBB	Switzerland	-	Bonds	2006-12-29T00:00:00.000Z	2018-12-31T00:00:00.000Z
RGAL1T3	GLOBAL GOVERNMENT E-ZONE 1 - 3 YEARS	Europe	-	Bonds	2003-01-01T00:00:00.000Z	2018-12-31T00:00:00.000Z
SWBND3A	SWISS BOND AAA	Switzerland	-	Bonds	2006-12-29T00:00:00.000Z	2018-12-31T00:00:00.000Z
RGAL10P	GLOBAL GOVERNMENT E-ZONE 10 + YEAR	Europe	-	Bonds	2003-01-01T00:00:00.000Z	2018-12-31T00:00:00.000Z
SWB2A1A	SWISS BOND AA-A	Switzerland	-	Bonds	2006-12-29T00:00:00.000Z	2018-12-31T00:00:00.000Z
RGAL3T5	GLOBAL GOVERNMENT E-ZONE 3 - 5 YEARS	Europe	-	Bonds	2003-01-01T00:00:00.000Z	2018-12-31T00:00:00.000Z
RGAL5T7	GLOBAL GOVERNMENT E-ZONE 5 - 7 YEARS	Europe	-	Bonds	2003-01-01T00:00:00.000Z	2018-12-31T00:00:00.000Z
RGAL710	GLOBAL GOVERNMENT E-ZONE 7 - 10 YEARS	Europe	-	Bonds	2003-01-01T00:00:00.000Z	2018-12-31T00:00:00.000Z
RC1AA1M	EQUITY CORPORATE (EXCLUDING BANKS) A RATED	Europe	-	Bonds	2003-01-01T00:00:00.000Z	2018-12-31T00:00:00.000Z
RC3BBLM	EQUITY CORPORATE (EXCLUDING BANKS) BBB RATED	Europe	-	Bonds	2003-01-01T00:00:00.000Z	2018-12-31T00:00:00.000Z

Figure 16: Assets Administration

Asset Types A table showing all asset types that may be edited is the landing page of this entity. By editing a specified asset type, the administrator can change some characteristics of its type, such as info text as shown in Figure 17.

Name	Display Name
MONETARY MARKET	Equity Markets
Edit Entry	
Name	EQUITY
Display name	Equity
Info text	Holding equity signifies ownership in a corporation and represents a claim on part of the corporation's assets and earnings.
Order	3
Submit	

Figure 17: Asset Types Administration

Currencies The currencies may be edited in the same manner as the asset types. By submitting changes, the displaying name or symbol of the corresponding currency will be edited.

Customer Types An overview of all available customer types is provided for the administrator. For each customer type, the ideal strategic asset allocation and the ranges for currencies and asset types (both dimensions) can be modified. Additionally, the info bullets and the displaying name may be modified. Figure 18 shows the embedded allocation table with its ranges and the customer type's ideal SAA.

6. Application Overview

	Money Market	Bonds	Equity	Alternative Investments	Total	Min.	Max.
CHF	5	5	20	5	35%	30	80
USD		5	15	5	25%	5	35
EUR		5	15		20%	5	35
JPY			5		5%	0	20
EMD		5	10		15%	0	20
Total	5%	20%	65%	10%	100%		
Min.	0	10	40	0			
Max.	20	40	80	25			

Figure 18: Customer Types Administration

Sectors A short overview of all sectors which are used in the asset page when synchronizing all assets.

6.2. Team Views

6.2.1. Team Login

When accessing the landing page, a team has to input a game short id as provided by the administrator. Afterward, the team has to log in with valid credentials to participate within a game (Figure 19). Teams are informed about possible inconsistencies when logging in on multiple devices and submitting their current decisions.

Figure 19: Team Login

6.2.2. SAA

In period 0, which represents phase 1 of the game, the teams define their SAA for all customer types which are enabled by the administrator of the specific game (Figure 20). The teams need to fulfill the type and currency constraints for all dimensions to submit their decisions. Supportive graphs in form of pie charts help the teams to decide about the share of the two dimensions. Additionally, the players can name their team on the top left corner of the screen, but do not have to do so. The progress of each customer types is visible in the left sided menu.

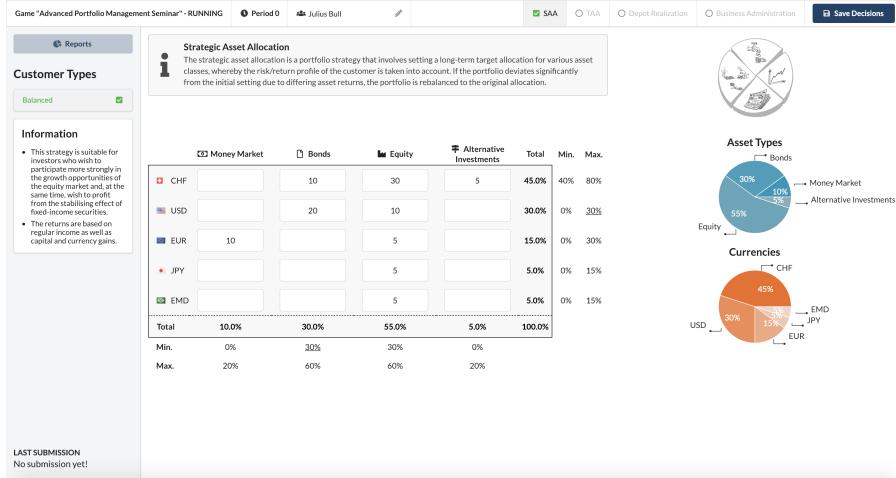


Figure 20: SAA Decisions in Period Zero

6.2.3. TAA

Starting from period 1, a team has to complete multiple decisions separated into four pages. Strategic asset allocation is fixed and not editable for a customer type which was defined at the beginning of the game. When the administrator defines a new customer type for an upcoming period, the teams have to allocate both SAA and TAA for the new customer type. For each step within this process, a progress state helps the teams to understand the state of each step. For saving their decisions, all four steps have to be completed. In the bottom left corner, the submission state may be seen.

For the tactical asset allocation, the teams can deviate from the SAA based on their expectations on changes in the overall market. Equal to the strategic asset allocation screen, teams change the input within the table and get illustrative support with two graphs, displaying the allocations for both dimensions of the table (Figure 21). Initially, the inputs from the strategic asset allocation are loaded, whereas the students can adjust them to market changes. Arrows within the total summation of each asset type or currency show the status of being within the range of the current customer type.

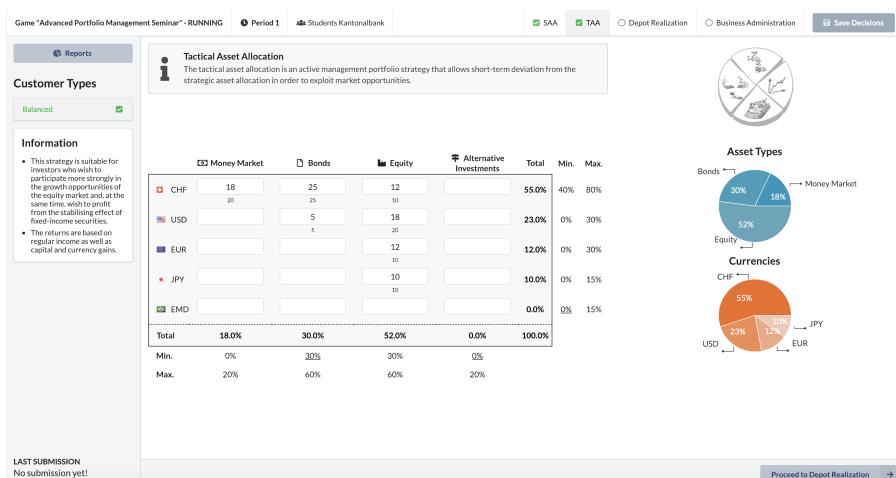


Figure 21: TAA Decisions in Periods > 0

6. Application Overview

6.2.4. Depot Realization

Based on SAA and TAA, the teams finally have to allocate their money in specific assets. By having bar charts on the top of the screen, students have an overview of their SAA and TAA decisions of the current active customer type. A target for the students is to allocate assets such that the yellow realization bar aligns with TAA for each asset type/currency combination. On the top right corner, a short summary of the most important key numbers for the allocations is present. This process has to be repeated for each customer type defined by navigating on the left menu. Equal to the SAA and TAA screen, the progress of the customer types is highlighted with checkmarks and corresponding colors Figure 22.

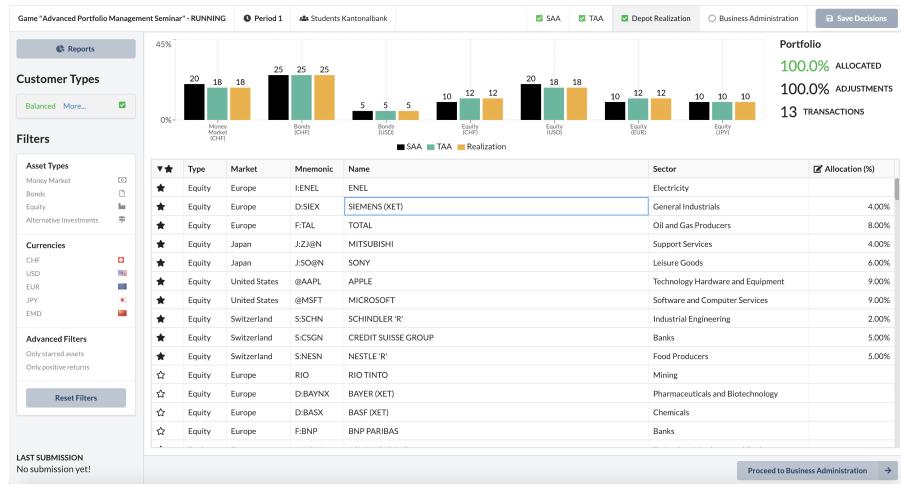


Figure 22: Depot Realization

6.2.5. Business Administration

Business administration decisions are the final set of decisions made in a period (Figure 23). On the left side of the screen, teams can input numbers for four different categories of decisions: conditions & fees, human resources, logistics, and profit distribution. For each input field, an initial value (in period 1) or the previous period value (for all other periods) is displayed next to the input field. On the right side of the page, the balance sheet from the previous period is visualized to inform teams about their business results. Further key information is displayed on top of the balance sheet.

6.3. Reports

Reports are available for both administrators of a game and teams. They explain the results of the different periods of each team and compare them to the results of the other teams. As there are many graphs available, they are structured into multiple tabs. The report section may be filtered by team and by periods to ensure that users can filter out the information that is relevant for them.

6.3.1. Overview

A short overview sets up the report page (Figure 24). A three-dimensional comparison between performance, total earnings, and assets under management should summarize up the investment profits

6.3. Reports

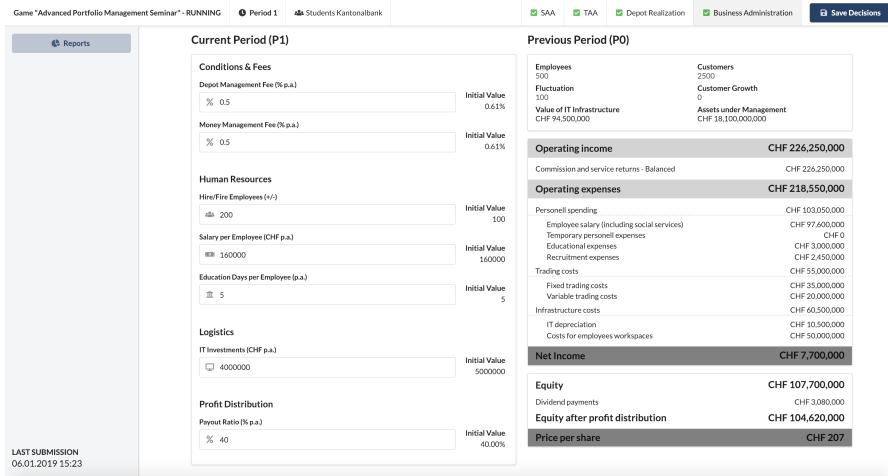


Figure 23: Business Administration

of the teams, where each point represents a team at a specific period. The stock price development of the different teams shows the progress of the stock price over all periods. The best performing team concludes the last period of the game with the highest stock price. On the bottom of those graphs, there is a spider chart for each team describing all of the important indexes within a range of 0 to 10.

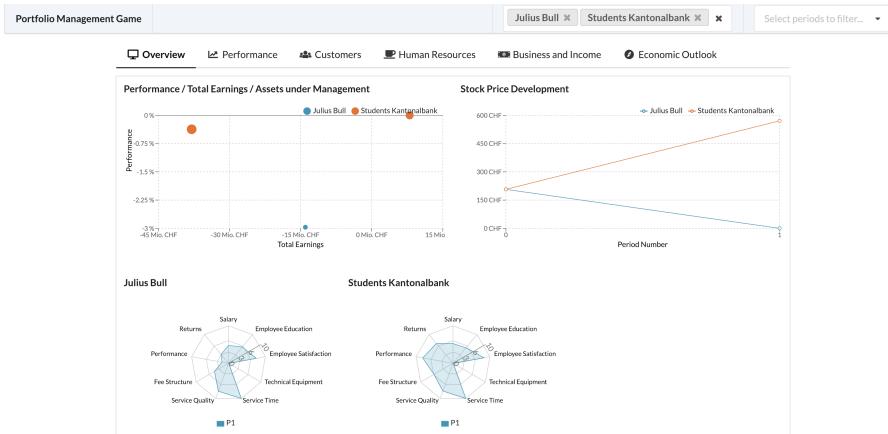


Figure 24: Reports - Overview

6.3.2. Performance

Multiple bar charts describe the performance of the teams for each customer type in each period. Exemplary measures include portfolio return, sharpe ratio, traynor ratio, jensen's alpha, and information ratio. An overview of those charts may be seen in Figure 25.

6.3.3. Customers

Similar to the performance tab, the customer section explains multiple key characteristics of customers for each team and period Figure 26.

6. Application Overview

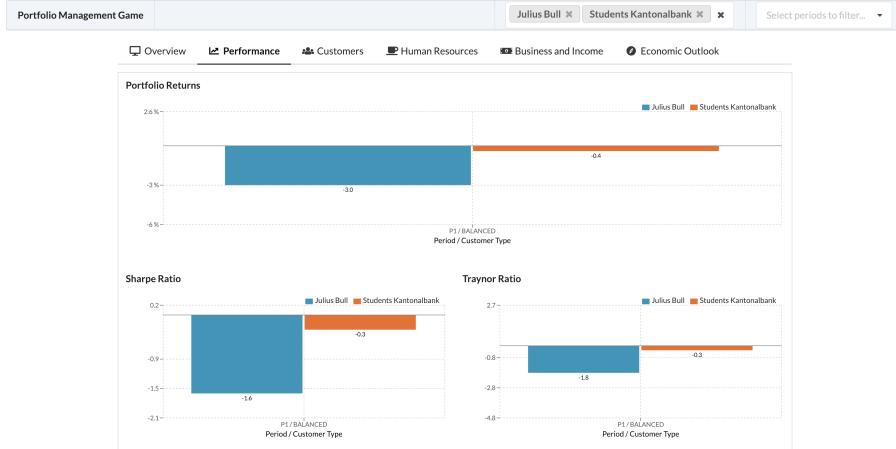


Figure 25: Reports - Performance

- Customer satisfaction index
- Number of customers
- Customer growth
- Assets under management
- Net new money
- Relative TAA discrepancy (volume-weighted)
- Number of SAA violations

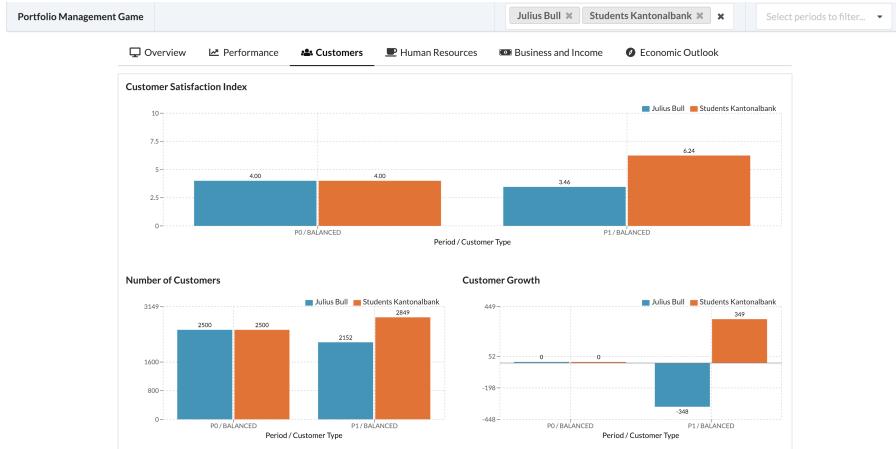


Figure 26: Reports - Customers

6.3.4. Human Resources

Information about human resources (HR) is currently displayed using four bar charts: employee satisfaction index, number of employees, salary index, and education index. Figure 27 shows an exemplary scenario.

6.3. Reports

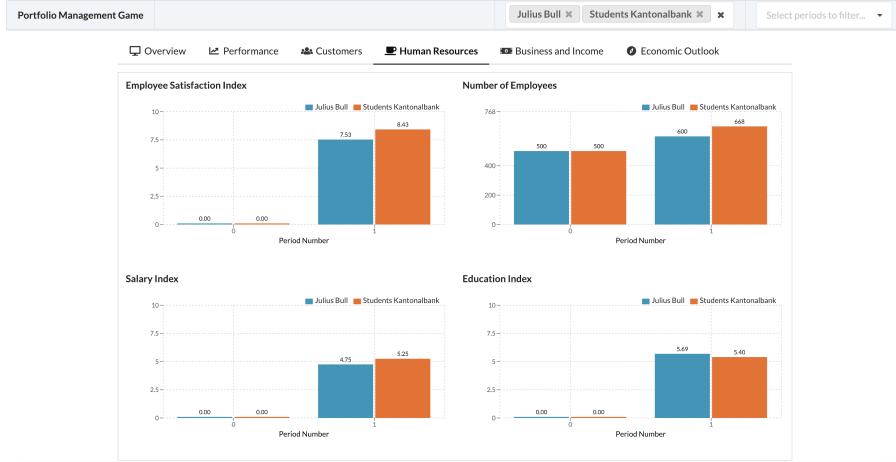


Figure 27: Reports - Human Resources

6.3.5. Business and Income

Starting with four bar charts (Figure 28) this tab explains the results of the teams' business decisions, such as operating income, operating expenses, cost income ratio, and net income. In Figure 29 different teams in different periods can be compared by their balance sheet. The users can either compare previous periods with upcoming of their own balance sheet or compare their own result to other teams in the same period.

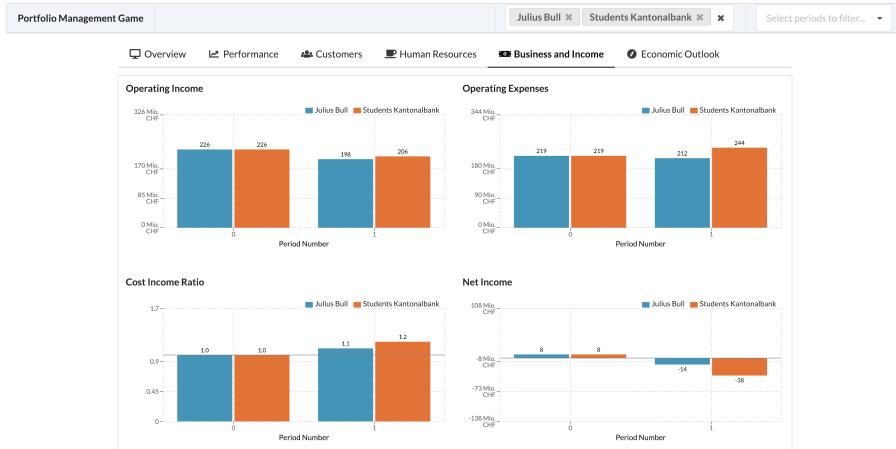


Figure 28: Reports - Business and Income

6.3.6. Economic Outlook

The economic outlook is the only tab that is already accessible starting from period 2, as all other graphs or tabs are only calculated once teams have made their first decisions in period one (Figure 30).

6. Application Overview

Income Statements Comparison	
Period 1 - Students Kantonbank	Period D - Students Kantonbank
Employees 668 Fluctuation 32 Value of IT Infrastructure CHF 98,650,000	Customers 2849 Customer Growth 349 Assets under Management CHF 20,551,114,965
Operating income	CHF 205,511,150
Operating expenses	CHF 243,651,600
Personnel spending Employee salary (including social services) Temporary personnel expenses Educational expenses Recruitment expenses Trading costs Fixed trading costs Variable trading costs Infrastructure costs IT depreciation Costs for employees workspaces	CHF 139,201,000 CHF 130,998,000 CHF 0 CHF 4,008,000 CHF 4,900,000 CHF 43,400,000 CHF 43,400,000 CHF 0 CHF 60,950,000 CHF -5,850,000 CHF 66,800,000
Net Income	CHF -38,140,450
Equity	CHF 66,479,550
Dividend payments	CHF -15,256,180
Equity after profit distribution	CHF 81,735,730
Price per share	CHF 571
Operating income	
CHF 226,250,000	
Operating expenses	
CHF 218,550,000	
Personnel spending Employee salary (including social services) Temporary personnel expenses Educational expenses Recruitment expenses Trading costs Fixed trading costs Variable trading costs Infrastructure costs IT depreciation Costs for employees workspaces	CHF 103,050,000 CHF 97,600,000 CHF 0 CHF 3,000,000 CHF 2,450,000 CHF 55,000,000 CHF 35,000,000 CHF 20,000,000 CHF 60,500,000 CHF 10,500,000 CHF 50,000,000
Net Income	CHF 7,700,000
Equity	CHF 107,700,000
Dividend payments	CHF 3,080,000
Equity after profit distribution	CHF 104,620,000
Price per share	CHF 207

Figure 29: Reports - Balance Sheet Comparison

Overview	Performance	Customers	Human Resources	Business and Income	Economic Outlook
Macroeconomic Factors	Financial Factors	Other Factors			
Gross Domestic Product	10y Interest Rates	Business Confidence			
gross domestic product (GDP) is the monetary value of all the finished goods and services produced within a country's borders in a specific time period. https://www.investopedia.com/terms/g/gdp.asp	The 10-year Treasury is an economic indicator in a sense that its yield tells investors more than the return on investment. While the historical yield range does not appear wide, any basis point movement is a signal to the market. https://www.investopedia.com/terms/i/investing100014/the-10-year-treasury-yield-explained.asp	The CEO Confidence Survey is a survey of CEOs from a variety of industries in the economy. The survey seeks to gauge the economic outlook of CEOs, determining their concerns for their businesses, and their view on where the economy is headed. https://www.investopedia.com/terms/c/ceo-confidence-survey.asp			
Unemployment Rate		Consumer Confidence Confidence			
The unemployment rate is the share of the labor force that is jobless, expressed as a percentage. It is a lagging indicator, meaning that it generally lags or falls in the wake of changing economic conditions, rather than anticipating them. https://www.investopedia.com/terms/u/unemployment-rate.asp		The Consumer Confidence Index Survey is an index that measures how optimistic or pessimistic consumers are with respect to the economy in the near future. https://www.investopedia.com/terms/c/consumer-confidence-index.asp			
Consumer Price Index					
The Consumer Price Index (CPI) is a measure that examines the weighted average of prices of a basket of consumer goods and services, such as transportation, food and medical care. https://www.investopedia.com/terms/c/consumer-price-index.asp					

Figure 30: Reports - Economic outlook

7. Conclusion

Over the course of this master project, we have managed to set up an initial game that is fully executable against a first iteration of data in an already full-scale time-series database that can handle many more time-series than are currently present. The application contains the most critical administrator features as well as all practical steps that should be present in a structured investment process as depicted in Figure 1.

The application is deployed to an environment that is ready to host a productive instance as soon as required (a productive Kubernetes cluster). The API and model are validated against an exhaustive integration test suite that ensures that no broken backend services can be deployed to a production environment.

As not enough data for a simulated game could be provided, the efforts were focused on developing a game that can be played with historical data. However, the game is easily extendable for the purpose of simulation. Once the simulation feature is implemented, the administrator will be able to choose a game type (either historical or bootstrapped) when creating a new game. Additional inputs in the game initialization screen will allow the game master to parametrize the simulation, while additional outputs on the following start period screen will allow an initial verification of the simulated data.

Next to providing a strong foundation for design and development in this project, the observations and interviews and the generally structured approach to design have in summary established an improved understanding of the requirements and how a simulation game should be approached. This will provide great value for the future development of the game, as the models and requirements created in the course of this project can be further used, refined and validated.

The supervisors from the Department of Banking and Finance are already planning to continue the project with further development in the near future. This project and the herein established baseline understanding have led to many new features and improvements being ideated, many of which were out of the scope of this project but are planned to be implemented afterward. Some examples for future improvements include the integration with further management areas of a bank, the addition of more economic data, the usage of industry sector indices instead of individual assets, as well as many more.

The first chance of the new game to be played in a productive fashion could be during the executive education's final seminar in Summer 2019, which we were already able to attend in Summer 2018 for our first observation purposes. In addition to this seminar and the master level seminar each fall, the DBF team are also already ideating an execution in an assessment level course like "Banking and Finance II".

A. User Stories

A. User Stories

General

ID: GE01	Date: 17.07.2018
Name: One login per team	
Story: As a game master, I want to be able to create one single login per participating team such that the participants are supported in their group work.	
Acceptance Criteria: <ul style="list-style-type: none">✓ Game masters can create team logins by creating a game✓ Teams can log in with the credentials they received from the game master	
Priority: Must have	

ID: GE02	Date: 13.08.2018
Name: Maintaining multiple logins with a single account	
Story: As a team of students, we would like to be able to sign in on multiple devices such that we can perform research and preparations independently.	
Acceptance Criteria: <ul style="list-style-type: none">✓ Multiple login sessions can be maintained with a single team account✓ Teams need to be appropriately informed about the possibility of inconsistencies due to multiple actions taken from different devices	
Priority: Must have	

ID: GE03	Date: 13.08.2018
Name: Game master account creation	
Story: As the responsible person for the seminar I need to create different game master accounts such that multiple persons could overtake the lead of the game.	
Acceptance Criteria: <ul style="list-style-type: none">✓ A game master account can create new game master accounts✓ Multiple game master accounts may be created	
Priority: Must have	

ID: GE04	Date: 16.10.2018
Name: Provisional hand-in of allocations	
Story: As a team of students, we would like to be able to save our current state	

provisionally, such that other members of the team can also see the current state on their device.

Acceptance Criteria:

- ✓ SAA, TAA, Depot Realization and business decisions can be imperatively saved to the database without needing to end the period
- ✓ After saving the state, other members of the team with the same active login can reload their application and see the new state

Priority: Must have

ID: GE05

Date: 31.10.2018

Name: Asset administration

Story: As an administrative member of the DBF I need to have an overview about all assets being selectable within the game and need to be able to synchronize them to a definition.

Acceptance Criteria:

- ✓ Overview about all assets which are currently used in the games
- ✓ A central definition of all assets being used in an outsourced file (e.g. csv)
- ✓ Synchronizing API with a central definition

Priority: Should have

ID: GE06

Date: 31.10.2018

Name: Asset type and currency administration

Story: As an administrative member of the DBF I need to edit information about the asset types and the currencies.

Acceptance Criteria:

- ✓ Editable asset type information (e.g. information text, ordering)
- ✓ Editable currency information (e.g. ordering, symbol)
- ✓ Ordering of asset types and currencies

Priority: Must have

ID: GE07

Date: 31.10.2018

Name: Customer types administration

Story: As an administrative member of the DBF all customer types have to be editable, such that ideal saa and ranges in both dimension can be adjusted. All other information about customer types, such as information text has to be editable too.

Acceptance Criteria:

- ✓ Ideal SAA for each customer type is editable
- ✓ Ranges (min. and max.) for both currency and asset type are editable within one visualization

Priority: Must have**ID:** GE08**Date:** 31.10.2018**Name:** Tooltips supporting unclear input fields or other content**Story:** As a user of the game for both administration or team, I'd like to be always informed about unclarities within a form or other illustrative graphs and paragraphs.**Acceptance Criteria:**

- ✓ Tooltips supporting unclarities for both students and administrators

Priority: Should have

Game Sessions

ID: SE01	Date: 13.08.2018
Name: Game creation	
Story: As a game master, I want to be able to create game sessions (multiple games) such that I can set up an execution of the game in advance.	
Acceptance Criteria: <ul style="list-style-type: none">✓ Game masters can initialize new game sessions✓ Teams can be created based on a number of teams and being assigned to any initialized game session	
Priority: Must have	

ID: SE02	Date: 13.08.2018
Name: Game list	
Story: As a game master, I want to have an overview about all games and an instant information about the key facts of the game (such as current progress of the game)	
Acceptance Criteria: <ul style="list-style-type: none">✓ An overview of all games with instant information of key facts exists✓ Link to the detail page of the game	
Priority: Must have	

ID: SE03	Date: 13.08.2018
Name: Customer profiles	
Story: As a game master, I would like to define and parametrize different customer profiles that students have to work with.	
Acceptance Criteria: <ul style="list-style-type: none">✓ The game master can define any number of customer profiles that students will need to account for✓ There are existing some predefined customer types✓ Each customer profile can be parameterized with regards to their acceptance ranges (upper and lower limits per customer profile)✓ Customer profiles can be enabled only after a certain number of rounds such that it is possible to start games with only one single type of customer (may be parametrized in advance)	
Priority: Must have	

ID: SE04	Date: 13.08.2018
Name: Game execution	
Story: As a game master, I need to be able to explicitly start and continue sessions such that access is controlled and only available during the execution of the game.	
Acceptance Criteria:	
<ul style="list-style-type: none"> ✓ Initialized games can be started by the game master that created them (and only by them) 	
Priority: Must have	

ID: SE05	Date: 13.08.2018
Name: Game parametrization	
Story: As a game master, I want to be able to parametrize games such that I can introduce a reasonable variance between different games and showcase different economic environments.	
Acceptance Criteria:	
<ul style="list-style-type: none"> ✓ Games can be parameterized with respect to the execution of the game ✓ Games can be parameterized with respect to the simulation of stock market data (e.g., length and number of periods to simulate) ❑ Games can be parameterized with respect to the internal market model (i.e., its effective curves and indices) ✓ Games can be set to alternatively use periods of historical data instead of using the stock market simulation (as long as data available) 	
Priority: Must have	

ID: SE06	Date: 13.08.2018
Name: Pausing and continuing sessions	
Story: As a game master, I would like to be able to pause and continue sessions in-between rounds, such that I can account for any unexpected events in a fair manner.	
Acceptance Criteria:	
<ul style="list-style-type: none"> ✓ Running sessions can be paused by the game master after a round is completed if all teams have submitted their decisions such that the students have some time pressure in the game ✓ Paused sessions can be continued by the game master ✓ After continuing a paused session, the next round can be started immediately 	

Priority: Must have

ID: SE07	Date: 13.09.2018
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Name: Game identifier

Story: As an administrator, I need to have a rememberable identifier which i can pass to my students to log in for my specific game.

Acceptance Criteria:

- | |
|--|
| <ul style="list-style-type: none">✓ A rememberable game id can be defined within the game creation✓ Students log in using this game identifier✓ If no custom game identifier is input, a random one will be used |
|--|

ID: SE08	Date: 07.11.2018
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Name: Parametrized Sessions - Scenarios
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Story: As a game master, I would like to choose from different predefined templates that represent different critical points in financial history
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Acceptance Criteria:

- | |
|--|
| <ul style="list-style-type: none"><input type="checkbox"/> Choose from multiple scenario templates within the creation of the game |
|--|

Priority: Nice to have

ID: SE09	Date: 07.11.2018
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Name: Add new customers

Story: As a game master, I would like to have the possibility to add new customers for each Team after a period. This should be voluntary for each period.

Acceptance Criteria:

- | |
|---|
| <ul style="list-style-type: none"><input type="checkbox"/> Game master can add a different number of new customers for each team<input type="checkbox"/> Game master can add a total summation of customers for every team |
|---|

Priority: Nice to have

ID: SE10	Date: 07.11.2018
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Name: Team credentials overview
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Story: As a game master, I need to have access to logins of all teams, such that we can distribute team credentials to our participants.

Acceptance Criteria:
✓ An overview of the game is available right after the game was created
Priority: Must have

ID: SE11	Date: 07.11.2018
Name: Game settings overview	
Story: As a game master, I would like to permanently have an overview about my game settings in my detailed game session page.	
Acceptance Criteria:	
✓ Game settings parameters are available for the administrator permanently during an active game	
✓ Period start and period end should be visible for each active period when defining a historical game	
Priority: Must have	

ID: SE12	Date: 07.11.2018
Name: Team submission state	
Story: As a supervisor, I would like to have a an insight about the teams submission state while being in a running period. Additionally, it would be helpful to see their SAA decisions for all customer types.	
Acceptance Criteria:	
✓ The teams submission state is visualized within a game being in a running period	
✓ SAA for the submitted teams are shown to the supervisor, such that he may check the usefulness of their decisions	
Priority: Should have	

ID: SE13	Date: 10.10.2018
Name: Game phase information	
Story: As a user interface designer, I would love to have a permanent timeline on my game detail view, always informing the administrator about the current state of the game.	
Acceptance Criteria:	

Priority: Should have

ID: SE14	Date: 10.10.2018
Name: Team naming	
Story: As a supervisor the advanced portfolio management game seminar, I'd like that all my teams can name themselves within the application, such that the teams can identify with their login. Additionally, they can use this name for the compulsory seminar end presentation.	
Acceptance Criteria: <ul style="list-style-type: none">✓ Teams can give them their own name	
Priority: Nice to have	

Asset Allocation

ID: AP01	Date: 13.08.2018
Name: Defining a Strategic Asset Allocation (SAA)	
Story: As a team of participants, we need to be able to define an initial strategic asset allocation for the game based on the different types of customers that are available to us.	
Acceptance Criteria: <ul style="list-style-type: none">✓ An SAA can be defined before any of the game rounds are played (period 0)✓ Once defined, the SAA provides a fixed point of reference for further rounds✓ The SAA can be extended to new customer profiles if any are added later on	
Priority: Must have	

ID: AP02	Date: 13.08.2018
Name: Defining a Tactical Asset Allocation (TAA)	
Story: As a team of participants, we need to be able to define our tactical asset allocation at the beginning of each round, so that we can adjust our long-term strategic plans.	
Acceptance Criteria: <ul style="list-style-type: none">✓ A new TAA can be specified for each round of the game and if the SAA is defined within boundaries for all dimensions✓ While deciding on a TAA, the team is kept informed about their SAA and any ranges or game constraints they might not fulfill with their current allocation	
Priority: Must have	

ID: AP03	Date: 13.08.2018
Name: Portfolio realization	
Story: As a team of participants, we need to be able to allocate our funds to specific assets and markets, as we want to achieve the portfolio state we defined in our SAA and TAA.	
Acceptance Criteria: <ul style="list-style-type: none">✓ Teams are able to distribute their funds to different asset categories based on their TAA decisions✓ Teams can choose from different markets and currencies✓ When investing in equity, teams can choose from different sectors of markets or shares from single firms (depending on data)✓ Teams are being appropriately informed about any constraints and ranges that need to be followed, as well as their self-defined SAA and TAA constraints	

- | | |
|---|--|
| <input type="checkbox"/> The maximum deviation of a share should be defined when creating the game by the game master (e.g. max. 10% deviation per share in next round) | |
|---|--|

Priority: Must have

ID: AP04

Date: 13.08.2018

Name: Hedging foreign currencies

Story: As a team of participants, we would like to be able to hedge our investments into foreign currencies such that we are not exposed to currency risks.

Acceptance Criteria:

- Investments in other currencies can be optionally hedged when realizing a depot
- Hedging incurs a reasonable cost

Priority: Should have

ID: AP05

Date: 07.11.2018

Name: Define two phases for the game

Story: As UI designer of the game we would like to define two phases of the game, whereas the first phase defines the initial SAA. In the second phase, the teams can decide on their TAA, their depot realization and other business administration decisions.

Acceptance Criteria:

- ✓ Phase 1 enables the opportunity to define the initial SAA for each customer type
- ✓ In phase 2 the teams can decide on TAA, depot realization or other business administrative decisions

Priority: Must have

ID: AP06

Date: 07.11.2018

Name: Supportive graphs for SAA and TAA

Story: As UI designer of the game supportive graphs for SAA and TAA would be helpful visualizing the allocation of the assets in pie charts, such that the user is informed about their inputs. Two charts should define both dimensions of the students' input (asset types and currencies).

Acceptance Criteria:

- ✓ Supportive pie charts for SAA and TAA inputs
- ✓ Two charts defining both dimensions of choices (asset types and currencies)

Priority: Should have

Business Administration

ID: BP01	Date: 13.08.2018
Name: Forecasting	
Story: As a team of participants, we would like to be able to generate forecasting reports based on our own estimates, such that we can evaluate our planned decisions without using additional tools (i.e., Excel).	
Acceptance Criteria: <ul style="list-style-type: none"><input type="checkbox"/> Teams can provide estimates for future parameters (e.g., customer counts)<input type="checkbox"/> Based on their estimates and their input numbers, teams can generate a forecasting report that will show them some metrics about their decisions	
Priority: Nice to have	

ID: BP02	Date: 13.08.2018
Name: Income statement	
Story: As a team of participants, we need to be able to see the balance of our accounts (i.e., assets under management), such that we can decide on how much money to spend in different expense categories.	
Acceptance Criteria: <ul style="list-style-type: none"><input checked="" type="checkbox"/> The necessary account balances are transparently visible to teams<input checked="" type="checkbox"/> Income statement displaying result from previous period	
Priority: Must have	

ID: BP03	Date: 13.08.2018
Name: Defining fees and conditions	
Story: As a team of participants, we need to be able to define the fees and conditions we offer to our customers, such that we can optimize our profits.	
Acceptance Criteria: <ul style="list-style-type: none"><input checked="" type="checkbox"/> Fees and conditions can be defined for all customer types	
Priority: Must have	

ID: BP04	Date: 13.08.2018
Name: HR and Logistics	

Story: As developers of the simulation, we need to ensure that teams can distribute their money to different expense categories, such that we can appropriately simulate business-related expenses, like HR and logistic (this list may be expanded due to changes in the simulation model).

Acceptance Criteria:

- ✓ Teams can define their spend on HR-related categories:
 - Employment and suspensions of personal
 - Salary of employees (for each employee)
 - Education days for employees per year
- ✓ Teams can define their spend on logistics-related categories:
 - Investments in IT

Priority: Must have

ID: BP05	Date: 13.08.2018
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Name: Fluctuation

Story: As a developer, we need to ensure that teams must account for fluctuation in their HR expenses, as we want to model a realistic business environment.

Acceptance Criteria:

- ✓ The market model includes fluctuation coefficients
- ✓ Fluctuation is based on several factors:
 - Satisfaction of the employees
 - Workload of the employees
 - Salary / Bonus

Priority: Must have

ID: BP06	Date: 15.10.2018
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Name: Key numbers within business administration form

Story: As a student, I want to instantly know some key numbers, which affect my decisions for the business administration part.

Acceptance Criteria:

- ✓ Key numbers are attached to the balance sheet

Priority: Must have

Evaluation / Simulation

ID: EV01	Date: 13.08.2018
Name: Team performance metrics	
Story: As a game master, I need to be able to assess the performance of teams on several levels, including separate metrics and aggregate measures.	
Acceptance Criteria: <ul style="list-style-type: none">✓ After a completed round of play, different metrics are calculated for each team✓ Some metrics build on a predefined effective curve and result in an “index”✓ Other metrics assess the performance of teams with regards to their portfolios✓ An overall measure aggregates the different metrics and allows a ranking of teams	
Priority: Must have	

ID: EV02	Date: 13.08.2018
Name: Customer satisfaction index	
Story: As developers of the game, we want to build a customer satisfaction index that, based on several key input numbers, calculates the satisfaction of all different customer types for each team.	
Acceptance Criteria: <ul style="list-style-type: none">✓ The customer satisfaction index is specific to each type of customer✓ The customer satisfaction index is calculated based on multiple factors, such as<ul style="list-style-type: none">- Performance of the portfolios of the respective customer type- Risk-adjusted Performance (Sharpe-Ratio, Information-Ratio, ...)- Management fees- Availability of bank employees for consulting (HR)- Matching SAA to customer profile- Matching actual allocation to SAA	
Priority: Must have	

Reporting

ID: RE01	Date: 13.08.2018
Name: Reports for presentation	
Story: As a game master, I want to be able to present an automatically generated comparison (graphs and reports) of individual team performances, such that I can explain some of the typical mistakes and decisions that could have been made throughout the seminar or the lecture.	
Acceptance Criteria: <ul style="list-style-type: none">✓ After completion of any round, game masters can display a comparison report❑ The comparison report includes a sensible means of visualization:<ul style="list-style-type: none">✓ Netto-performance per customer type❑ Netto-performance cumulative per customer type over all periods✓ Tracking error per customer type✓ Customer satisfaction index per customer type✓ Customer count per customer type✓ Assets under management✓ Net-new money✓ Total earnings✓ Total expenses✓ Gain / Loss✓ Cost / Income ratio❑ All in conditions❑ Infrastructure (IT-index)❑ Education-index✓ Human Resources - current count of employees❑ Temporary employees❑ Customer advisory services✓ Employee Satisfaction✓ Service quality index✓ Total index❑ Total index cumulative❑ Benchmark using ideal SAA predefined by game master	
Priority: Must have	

ID: RE02	Date: 13.08.2018
Name: After-period reports for individual teams	
Story: As a team of participants, we want to be able to access our past benchmarks and performance reports, such that we can decide about future actions in an informed way.	
Acceptance Criteria:	

- | |
|---|
| <ul style="list-style-type: none"> ✓ Teams can display their past reports at any time during the game ✓ No information is leaked about the future of the game |
|---|

Priority: Must have

ID: RE03

Date: 13.08.2018

Name: Economic outlook

Story: As a game master, I want to provide the participating teams with an automatically generated economic outlook (including forecasts) that I can customize with some sensible parameters, such that the students can take more informed decisions for the next period.

Acceptance Criteria:

- ✓ The system generates an economic outlook according to a predefined template
- ✓ Key numbers are taken from the parameters that have been defined for the simulation of the next period as well as from some randomization parameter

Priority: Must have

ID: RE04

Date: 13.08.2018

Name: View of the CIO

Story: As a game master, I would like to have the opportunity to provide a custom assessment and directions in my own wording that is provided to the students as the view of their bank's CIO (based on the economic outlook).

Acceptance Criteria:

- ✓ Game masters can provide custom plain text that is shown to the students under the premise of being from their own CIO
- ✓ The CIO assessment can include directions and guidelines as well as interpretations of the economic outlook
- ✓ Voluntary, different roles of the writer could be played, such as some newspaper institutions

Priority: Should have

ID: RE05

Date: 13.08.2018

Name: Visualization of historical stock prices

Story: As a team of participants, we would like to get a historical overview of the stocks in our portfolio, such that we can make reasonable decisions about future investments.

Acceptance Criteria:

- ✓ Teams can access reports regarding the historical development of their stocks

Stock prices are being displayed within a time series of all periods

Priority: Should have

ID: RE06

Date: 13.07.2018

Name: Performance attribution

Story: As a team of participants, we need to have a comprehensive report about the performance attribution of our assets, such that we can decide about further investments.

Acceptance Criteria:

After each period, teams can access their full performance attribution

Priority: Must have

Development

ID: DE01	Date: 12.07.2018
Name: Infrastructure	
Story: As a developer, I need to build my application on an extendable and scalable infrastructure, such that it will be easily maintainable in the future.	
Acceptance Criteria: <ul style="list-style-type: none">✓ The infrastructure is easily extendable by additional services (Docker)✓ Multiple services can be included in the system	
Priority: Must have	

ID: DE02	Date: 13.08.2018
Name: Continuous integration and deployment	
Story: As a developer, I want to have an environment that is continuously integrated and deployed, such that I can always rely on having current feedback and fast failures.	
Acceptance Criteria: <ul style="list-style-type: none">✓ On merges into the master branch, the application is continuously deployed to a staging environment, where it can be tested✓ Integration tests define a potential scenario for testing all functionalities when playing a game✓ On tagging of releases, the application is deployed to the production environment✓ The CI pipeline includes a full test suite for the API of the application	
Priority: Must have	

ID: DE03	Date: 13.08.2018
Name: Code versioning and maintenance	
Story: As a developer, I need to have access to reliable repositories for the application code, such that I can easily collaborate with others on the project and new developers could understand the code.	
Acceptance Criteria: <ul style="list-style-type: none">✓ The application services are stored in separate, modular repositories✓ The repositories are managed by submitting merge requests that contain at least a short (but complete) description of the changes✓ The application backend contains a full integration test suite as well as independent unit tests for each service✓ New developers understand the architecture of modular repositories by creating	

understandable readme files

Priority: Must have

ID: DE04

Date: 13.08.2018

Name: Local game execution

Story: As a game master, I need to be able to easily run the application on my local device, such that it can still be used even in case of network and/or other failures.

Acceptance Criteria:

- The application can be started on any local device with sufficient performance
- Backup datasets can be previously downloaded such that it is not necessary to load the entire stock market database onto the local device
- The application can be started by using simple scripts without extensive IT affinity

Priority: Should have

B. Interview Questions

B.1. Data Collection Template

What method do you plan to collect data?

- Interview along the lines of previously prepared questions in a semi-structured way
- Focus on materials as far as they can be provided by the professionals (screenshots, etc.)
- Focus on their decision and thought process while performing their professional work
- Discussion about their experience with the current state of the game, as far as they have used or seen the current game (additional requirements, didactical potential, etc.)

Possible Questions

- Shortly describe what you do in your daily professional work? How are you involved with portfolio management (more concretely)?
 - Idea: get to know the big picture
- How do you typically go about starting a new project (i.e., create a portfolio for a new customer)?
 - Idea: get an intuition about the beginning of a new process
- Does your portfolio management process follow a relatively consistent sequential path or do you often work on multiple tasks in parallel, switching back and forth?
 - Idea: find out whether the current application is a suitable model of the professional process or whether a more sequential structure is more realistic
- Shortly elaborate on the main steps in your portfolio management workflow and try to use the terms Customer Contact, Research, SAA, TAA, Depot Realization, Performance Attribution.
 - Idea: get them to talk about the steps in our current process and evaluate its appropriateness
 - Find the practical differences to our current process (Customer Analysis, SAA, TAA, ,etc.)?
- What tools do you use in your portfolio management process and how do you combine these tools?
 - Idea: get an idea about their multitasking capabilities and necessities for context switching
 - Excel, specific portfolio management tools (proprietary, etc.)
- Are customers split into different “categories” like “risk-averse”, etc.? If yes, how do you decide about this categorization? And how do you define the reasonable “ranges” for any of these categories?
 - Idea: find out whether the currently defined ranges are reasonable or whether they should be left out for the students to define themselves

- When consulting with a new customer, do you define binding constraints like the Strategic Asset Allocation? If yes, can you deviate from these constraints? Do you adjust these constraints periodically?
 - Idea: find out whether the approach of “locking” SAA for the remaining periods is reasonable
- Do you hedge your investments in foreign currencies based on the profile and preferences of the client?
 - Idea: find out whether the current approach to hedging makes sense

How will you collect data?

- Audio recording (if consent) as well as notes
- Collect additional materials as far as possible (screenshots, etc.)

How do you plan to analyze the data?

- Create partial transcriptions with appropriate summarizations
- Create mind-maps and diagrams modeling a typical professional workflow
- Work towards a valid work model describing the professional interactions
- Improve and validate the models across multiple interviews

What will you plan to show in our August meeting as evidence of your findings?

- A presentation with process diagrams (as far as already possible)

B.2. Interview Notes

Shortly describe what you do in your daily professional work? How are you involved with portfolio management (more concretely)?

- RB: asset management (consulting and execution) for complex high-value clients that might need a lot (daily..) consulting and are mostly very knowledgeable themselves; client advisors handle the small, easy, normal customers, once it gets too involved, clients are directly supported by UBS investment product solutions (IPS); RB involved in a team of two that handles 30 clients in total (>3bn), other single IPS advisors handle around 25 clients.
- SB: A specific part of the portfolio management with a strong focus on bonds, as main work is for companies that provide and manage pension funds and prefer investments with less risk (or are bound to low risk investments).

How do you typically go about starting a new project (i.e., create a portfolio for a new customer)?

- RB: In a first meeting we need to get known the customer and find out his or her risk profile. We then define his strategic asset allocation. After that we expose with the CIOs (Chief Investment Officers) guidelines and boundaries. The CIO defines every 3-6 months a new TAA (Tactical Asset Allocation). Our customer initially brings some money which we can make use of.
- SB: not many “new” customers in a traditional sense, as pension funds are very large customers that a manager only has a few. Traditional process would include checking the risk sensitivity of the customer and defining an SAA, then doing the TAA and depot realization according to own economic intuition.

Does your portfolio management process follow a relatively consistent sequential path or do you often work on multiple tasks in parallel, switching back and forth?

- RB: the management process is clearly separated into the SAA, TAA, and depot realization steps; I can switch back and forth, but this should only be done after several years of experience; the clean process that should be taught is probably almost purely sequential.
- SB: the portfolio management process separates into SAA, TAA, and depot realization...

Shortly elaborate on the main steps in your portfolio management workflow and try to use the terms Customer Contact, Research, SAA, TAA, Depot Realization, Performance Attribution.

- RB: initial customer contact is normally handled by client advisors, but the process goes something like the following:
 - discussing and talking about risk capability/aversion and the preferences of the customer => defining an SAA based on the customer type identified (along the risk-return curve, can go “by the book”); SAA is defined for the long-term (for 6 years, in popular theory)
 - adjusting the defined SAA according to the TAA that has been defined by the bank Chief Investment Officer; TAA is a shorter-term (6-monthly) description of the world view of the CIO; defines how much which markets and asset types should be over or under weighted across the entire bank, deviating from any defined SAA; this should be more clearly separated from the following steps, as it is normally performed by the CIO and is a “given” for any client advisor

- creating a portfolio according to the SAA, TAA, and personal estimates (depot realization); normal approach could be putting half in funds and adding positions in single stocks that match the client's preferences; research is, among other sources, based on internal analyses and ratings that are accessible via internal tools

What tools do you use in your portfolio management process and how do you combine these tools?

- RB: proprietary, internal tools that support the entire process; one tool for the SAA and depot realization parts (see screenshots); this tool is however not integrated with any reporting (i.e., performance, etc.) capabilities, these must be accessed in a different tool; past and future views are not well supported by the asset management tool
- SB: tool contains of different tabs with one tab describing all assets and their characteristics in a table and the other one showing some visualizations

Are customers split into different “categories” like “risk-averse”, etc.? If yes, how do you decide about this categorization? And how do you define the reasonable “ranges” for any of these categories?

- RB: 5 customer types along the risk-return curve (something like stocks, growth, balanced, returns, and conservative); the ranges can be defined with theoretical measures and general best-practice know-how; important to provide these ranges as guidance, as it could be hard to define them (generally predefined by smart people, also for client advisors); for the purposes of the game, more than the existing two customer types probably do not make much sense, as it is just more of the same (no additional learning effect)
- SB: traditionally split into three or five or similar numbers of subcategories. Not in the case of fixed income however, as this is already focused on a single type.

Do you hedge your investments in foreign currencies based on the profile and preferences of the client?

- RB: hedging is not performed that often, as the investment decisions are based on the expectation of making profits; pure foreign currency hedging is possible but very expensive; this should probably be left out of the game, as it does currently not provide any specific didactical use
- SB: lots of investments for fixed income are made in the swiss market. foreign currencies are often hedged to provide protection against currency risk.

Do you have further ideas regarding our portfolio management game?

- RB (has played the game as part of executive education)
 - before the first period, the only thing being defined should be the SAA, as there are in practice no depot realization decisions before the SAA/TAA have been defined
 - in an easier mode of the game, TAA could be predefined by the game master, simulating the CIO decision; this would leave students with the initial SAA decision, and subsequent depot realization and business-side decisions
 - TAA decision should be awarded much higher importance; it is a very important management-level decision process that influences an entire bank; right now, it is not even clear that this would normally be done by different persons

- when performing TAA, the over and underweighting should be done with notches instead of any percentual number; for example, 3 over/under weighting levels (notches) could be defined; one notch overweight would necessitate one notch underweight in another category
- it was nice to be able to include quite specific preferences by choosing some single stocks and topic-related funds; this would be lost by using only sector level numbers
- one could pose a standard questionnaire to each participant before the game even starts and categorize them into the different customer types as used in the game; teams could then be formed according to these types, allowing for some possibly interesting analyses; are risky people bias towards more risky investments for their “conservative” group of customers? and the other way around?

RB (UBS) Notes

- IPS (Investment Product Solutions)
 - Lösungen mit Produkten an Kundenberatern
 - Eg. Structured Products
 - Vermögensverwaltungsmmandate
 - Lieblingskunde: Kunde mit viel Geld welcher Standardprodukte wählt
 - Advisor Kunden: Komplexe Kunden (High Maintenance, welche sich auch sehr gut kennen) --> sind bei IPS
 - Portfoliomanagement für Privatkunden (normalerweise ein Advisor 25 Kunden)
- Portfolio Management
 - Aufgabe: Asset Allocation (SAA) Gespräch mit Kunden
 - Dann Exposure mit CIO
 - Daraufhin TAA (CIO kurzfristige Prognose alle 3-6 Monate)
 - Kunde wird schlüssig bei Kundenberater (bringt gewisses Geld mit e.g. 10 Mio. CHF)
 - SAA und TAA müssen erfüllt werden
 - Input: SAA soll vorher eingereicht werden (Länder Sektoren und Asset Classes zweidimensional)
- Phasen auseinander nehmen
- UBS Tool kann keine Zukunft: Phasen der Investition
- Rückmeldung und dann Prognose zu nächstem Jahr (Analyse, TAA und dann Proposal = neues Portfolio)
 - Was passierte die letzte 2 Monate, Was meint der CIO, Was soll ich ihm überhaupt in Zukunft vorhersagen?)
- Soll bei CIO Modus für ASsessment das ganze TAA und SAA herausgenommen werden (CIO Sicht?)
- Eher sequentielle Sicht wichtig für Lernprozess (auch bei UBS so praktiziert)
- Aufteilung der Abweichung der TAA von der SAA in 3 notches (übergewichtung und untergewichtung)
- Fonds mit Themen unbedingt behalten
- TAA viel mehr aufmerksamer machen (mehr Stellenwert)
- Fragebogen einführen: Wie investieren? Wieviel Geld kann ich verlieren pro Jahr? Wie viele möchtest du gewinnen? In welche Kategorie gehören die Teilnehmer??? Bevor das Ganze Spiel gestartet wird.
- Kundentypen bei UBS
- Frage ob Hedging überhaupt brauchen?

C. Observation Notes

C. Observation Notes

A number of relevant observations made by the authors as well as the seminar conductors and feedbacks from the participants during the three sessions are summarized in this listing. Please note that in order to fully understand some of the following aspects, the reader should have seen the old version of the simulation:

- **General:** Generally, the participants enjoyed playing the game and regard it as helpful to deepen their theoretical knowledge for example from the lecture "Asset Management: Investments" for Bachelor students. However, they regard the system as outdated and provided the authors with various ideas and critics. Decision data for a starting period 0 will be filled out by participants in Excel for a starting position before the seminar, afterward, they will be saved onto the USB drives for all teams by the seminar conductors. The seminar conductors will let the market model run and save its outcome back on the USB drive. This process is time-consuming and error-prone. In general, the participants think that it is difficult to make a decision in the first round, as too few information is available. More easily accessible comparative figures for the previous year would be helpful. Additionally, the stock selection is based on insufficient knowledge about the different titles.
- **Investment Process:** The given and to be kept bandwidths for the different asset class positions are not optimally placed and have to be looked up frequently. A temporary over-investment during the decision process is not possible and is always disturbed by pop-up windows.
- **Business Administration:** Various decisions regarding marketing, human resources as well as logistics are not very clear as especially in the beginning, the background and previous period information are not completely clear for the participants. The point here is, that a suitable level of abstraction has to be chosen as on the one hand, not every decision that has to be made in reality can be implemented in such a simplified simulation. On the one hand, a suitable number of decisions have to be enabled in order to support an appropriate learning effect.
- **Report:** The reports provided after each round of the game load very slowly and the comparison to other teams is cumbersome. It would be helpful if not only one group member can have the simulation and the reports on their screen. In general, more graphics are desired for better visualization of key aspects.
- **Teamwork:** The enabling of collaboration on several laptops within a team was mentioned many times. With today's web-based technologies, much more implementation options are available.

The observation of the different players, students and practitioners, investment beginners and experts allowed the project team to sense what the strengths and weaknesses of the old game are. Further, it helped to define an impact direction for the new game being developed.

PFM-Game with Students (BA/MA)

23.07.2018

Procedure

Introduction

- Short technical introduction without much background information
- Shortly describe procedures and motivation

Round 1

- Play/observe a round of play without background information
- Collect questions and feedback to assess knowledge gaps
- Annotate the screenshots with knowledge gaps and questions
 - Differentiate between master (2x) and assessment (2x) level knowledge

Round 2

- Maybe show some slides with background info. to get everyone on the same level?
- Play/observe another round of play and extend the annotations where reasonable
- Validate assumptions from first round

Participants

- Team 1: Nik Zaugg (BA)
- Team 2: Ivana Dominikovic (BA)
- Team 3: Melwin Parodi (MA, with Investments course background)
- Team 4: Stephanie Zgraggen (MA, with Investments course background)

Legend

Problems encountered during the process. BA (bachelor students), MA (master students)

General comments.

Feedback and ideas from participants.

Strategic Asset Allocation

General Unclarities

- BA: What is a Strategic Asset Allocation?
 - BA: When and how often is a SAA performed? Only once?
 - How much money do we have initially?
 - Ranges should be embedded in the application instead of using an external presentation sheet.
 - SAA needs to lie within all ranges -> else the TAA can't be adjusted in the next period (unclear in visualization). Should it be visualized or might this help the students to understand the process?

Entscheidungsformular IA - Strategische Asset Allocation

ASSET	What kinds of values are to be entered? Absolute or relative numbers?					Referenzwährung: CHF	Kundentyp: konservativ	Periode: 0	Team: Team Ste
	CHF	EUR	USD	GBP	JPY				
Money Market	0.00	0.00	0.00	0.00	0.00				
Bonds	0.00	0.00	0.00	0.00	0.00				
Alternative Investments	0.00	0.00	0.00	0.00	0.00				
TOTAL	0.00	0.00	0.00	0.00	0.00				

Annotations:

- Top Right:** All the decisions are based on predefined customer type ranges. → validation
- Top Right:** "Lead" by application instead of using a dropdown
- Top Right:** Not obvious that customer "classes" can be and need to be switched.
- Middle Left:** BA: What are Alternative Investments?
- Middle Left:** Give some kind of additional information / hints with tooltips or similar methods.
- Middle Center:** Constraints (and violations) should be shown somehow within the application. → validation
- Middle Right:** BA: What are Emerging Market Dollars? Which countries belong to Emerging Markets?
- Middle Right:** Unclear, how summation is performed. Putting 10% in CHF/Bonds means that 10% of the OVERALL capital are allocated there.
- Bottom Center:** Decisions of the student are based on the currency exchange rate (forecast). Based on that they decide which in which country (or parts thereof) their student

Tactical Asset Allocation

General Unclarities

- **BA:** What is a Tactical Asset Allocation?
 - **BA:** When and how often is a TAA performed? Only once?
 - How big should changes be? => **magnitude**
 - Why can TAA not be performed in the first round? Especially unclear for bachelor students
Keen it or don't even show it in the beginning?

Most points from SAA apply here too.

Depot Realization

General Uncertainties

- Very unstructured, easy to miss stuff.
- Unclear where to start, what are targets? How do the students achieve to split their investments?

unclear: compare SAA

	TAA	CHF	Bestand	EUR	Bestand	Referenzwährung: CHF	Kundentyp: konservativ	Periode: 0	Team: Team Ste
Money Market	0.00	0.00	0.00	0.00	0.00	GBP			
Bonds	0.00	0.00	0.00	0.00	0.00	JPY			
Equity	0.00	0.00	0.00	0.00	0.00	USD			
Alternative Investments	0.00	0.00	0.00	0.00	0.00	TOTAL			
TOTAL	0.00	0.00	0.00	0.00	0.00	Bestand			
Währungsabsicherung	SAA (%)								
Fremdwährung Hedgen?	0.00	0.00	0.00	0.00	0.00				

Do we need to achieve the total of each asset category, or are we able to split percentage of assets to other asset categories? (e.g. from Bonds to Equity)

Must be 100% What happens otherwise?

When are we able to hedge? (Sometimes only possible for specific currencies). When should we hedge? Checkboxes not always clickable.

What is Abs.%? (needs to be summed up to TAA decision asset category)

Scrolling would be helpful how much entries (assets)

BA: What is "all maturities" for bonds?

No one has known that an asset is clickable containing additional information

There are no forecasts for companies, only for sectors. Need to guess...

The new game will only use sectors (coarser granularity).

BA: What are ETFs?

What is VP%?

Achieving correct amount of different asset categories seems better visualized or described into groups (something like an accordion for each category?)

Why isn't it possible to have an overinvestment in the total (percentage) amount?

"Overinvestment" should be temporarily possible => no immediate error if over 100%, but catch in validation.

Include how many entries are charged (and by how much?) such that a bank doesn't have too many (small) transactions => costs incurred for every single transaction.

What is a FoHF? Fund of Hedge Funds.

Conditions and Fees

Entscheidungsformular III - Konditionen

Gebührenmodell: ● all in ■ single tarif

BA: What is the difference between all-in and single tarif?
No one has chosen single tarif (everyone has decided to choose all in).

1 Vermögensverwaltungsgebühr (all in) (%)
2 Vermögensverwaltungsgebühr (single tarif) (%)
Courage (Money Market) (%)
Courage (Bonds) (%)
Courage (Equity) (%)
Courage (Alternative Investments) (%)
Depotgebühren(vom Depotvolumen) (%)

How much is reasonable? Practical? "Normal"?

MA: What is a benchmark for these fees?

BA: What is courage?

MA: When will those custodian fees be charged to our customers?

BA: What is depot volume?

MA: Are 1 and 2 charged cumulatively or separately? 1 only if actively managed, 2 only if passively?

Marketing / HR / Logistics

General Uncertainties

- How much money do participants have available to invest? Some kind of financial sheet should be included.
- What are generally reasonable numbers? How can they be calculated?
- MA: How long are working days?

Entscheidungsformular IV - Marketing & Human Resources & Logistik

Period: 0 Team: Team Ste

MARKETING	
Marketingausgaben Kundentyp konservativ	(Mio. CHF)
Marketingausgaben Kundentyp dynamisch	(Mio. CHF)
Imagewerbung pro Jahr	(Mio. CHF)

HUMAN RESOURCES	
Einstellungen / Entlassungen	(+/-MA)
Jahreslohn pro Mitarbeiter	(CHF)
Bonusanteil vom Jahresgewinn	(%)
Ausbildung (Schulungstage pro Mitarbeiter)	(Tage/MA)

LOGISTIK	
Investitionen in IT	(Mio. CHF)

Difficulties deciding how much (absolute) money to invest if a student doesn't know how much money he/she has.
Is there an initial number of employees? Set to 800 currently.
MA: What about inflation?
What about fluctuation?
Why is there a minimum wage per year for an employee? Set at 75k currently.
What is the effect of IT on overall performance?
How important is education for employees? What effect does it have? How are costs calculated?

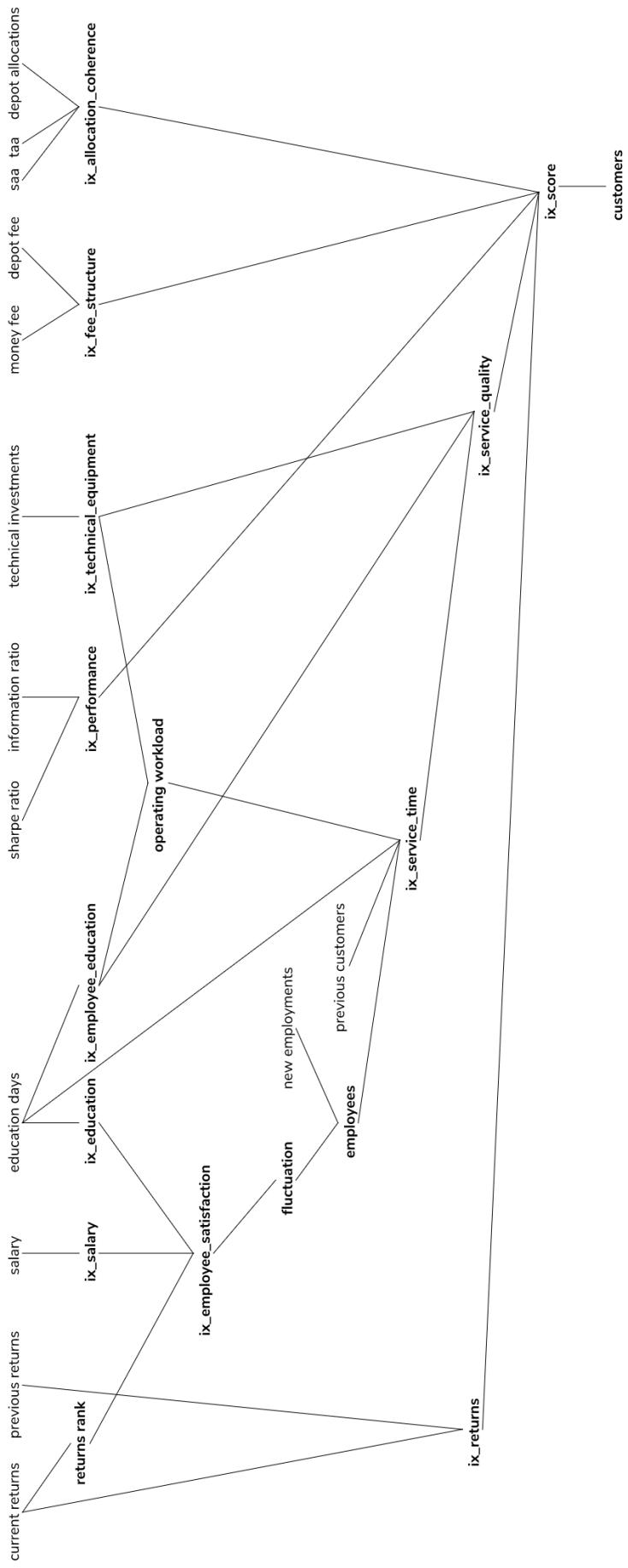


Figure 31: Overview of market model dependencies; resolved from top-to-bottom with computed values in bold