ASSIGNMENT OF BACHELOR'S THESIS

Title:	Feasibility Study of Portal to Provide Knowledge about Supersymmetry to Experts
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Instructions

The aim of this project is to perform a feasibility study on creating a portal to provide knowledge about Supersymmetry. After its theoretical discovery for elementary particle physics about 50 years ago several hundred searches for Supersymmetric particles have been performed to establish Supersymmetry experimentally. Almost weekly new experimental information about search results for Supersymmetric particles are published.Tasks:
1) Gaining information about the requirements for a portal from experts on Supersymmetry (interviews with theorists and experimentalists).
2) Reviewing the sources of information and developing a concept of how to transfer the information into a database.
3) Outlining of the portal design (UI, wireframe).
4) Proposal for a technical realization.
5) Evaluating the usefulness, expectable costs, and benefits of the portal and giving an outlook for the implementation.
Evaluating the usefulness of an extension for the general public.

References

Will be provided by the supervisor.

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Prague March 4, 2020

FACULTY OF INFORMATION TECHNOLOGY CTU IN PRAGUE

Bachelor's thesis

Feasibility Study of a Portal to Provide Knowledge about Supersymmetry to Experts

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January 6, 2021

Acknowledgements

Declaration

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In Prague on January 6, 2021 . . . .

Citation of this thesis

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Abstract

This bachelor thesis is a feasibility study of a web portal closely focused on a theory called Supersymmetry and its research. The theory is very attractive theoretically as it solves fundamental shortcomings of the Standard Model of particle physics. After its theoretical development for elementary particle physics about 50 years ago several hundred searches for Supersymmetric particles have been performed to establish Supersymmetry experimentally. However, despite many experimental searches the theory is not proven. Almost weekly new experimental information about search results for Supersymmetric particles is published and there is no web portal focused on Supersymmetry, which would automatically collect and categorize these articles. Scientists spend much research time looking for the new experimental results. This thesis contains a proposal for a web portal on Supersymmetry, which will have an automated filling database and categorizing system. The feasibility study contains a brief explanation of the concepts of Supersymmetry. Also, the thesis contains a theoretical framework of the analysis that allows the reader to better understand the analyzed resources and time, situation analysis, design of technical solutions, design of the web portal, wireframe and testing of the web portal. The feasibility of a web portal project on Supersymmetry is evaluated positively. The usefulness of the Supersymmetry web portal, resources and time expectation of this project are detailed. Furthermore, requirements are collected and a situation analysis is performed. The roadmap of the project, the detailed implementation plan and recommendations of possible technologies are developed. The wireframe and possible design of a Supersymmetry web portal is created. The testing techniques are recommended. In addition, an analysis is conducted on the subject of usefulness for the general public.

Keywords feasibility study, web portal, Supersymmetry, ATLAS, CMS, CERN, LHS, SWOT, FURPS+, Python, Flask, Firebase, Adobe XD

Abstrakt

Tato bakalářská práce je studií proveditelnosti webového portálu zaměřeného na teorii nazvanou Supersymmetry a její výzkum. Teorie řeší základní nedostatky standardního modelu částicové fyziky. Po teoretickém vývoji fyziky elementárních částic před 50 lety bylo provedeno několik stovek hledání supersymetrických částic, aby bylo možné experimentálně stanovit Supersymetrii. Přes mnoho experimentálních hledání však teorie není prokázána. Téměř každý týden jsou zveřejňovány nové experimentální informace o výsledcích vyhledávání supersymetrických částic a neexistuje žádný, zaměřený na Supersymetrii, webový portál, který by tyto články automaticky shromažďoval a kategorizoval. Vědci tráví hodně času hledáním nových experimentálních výsledků. Tato práce obsahuje návrh webového portálu o Supersymetrii, který bude mít automatizovanou plnicí se databázi a kategorizační systém. Studie proveditelnosti obsahuje stručné vysvětlení konceptů Supersymetrie. Práce také obsahuje teoretický rámec analýzy, který umožňuje čtenáři lépe porozumět analýze zdrojů a času, situační analýze, návrhu technického řešení, návrhu webového portálu, wireframu a testování webového portálu. Realizovatelnost projektu webového portálu o Supersymetrii je hodnocena pozitivně. Užitečnost webového portálu, zdroje a časová náročnost tohoto projektu jsou podrobně popsány. Dále se shromažďují požadavky a provádí se situační analýza. Vypracovává se plán projektu, podrobný navrh implementace a doporučení možných technologií. Je vytvořen wireframe a možný design webového portálu. Doporučují se testovací techniky. Kromě toho je provedena analýza na téma užitečnosti pro širokou veřejnost.

Klíčová slova studie proveditelnosti, informační portál, Supersymetrie, AT-LAS, CMS, CERN, LHS, SWOT, FURPS+, Python, Flask, Firebase, Adobe XD

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Introduction

In the entire history of mankind, knowledge has been what has always improved a person's life, even if at first glance we did not always know how to apply it. People are always eager to learn something new about this world and structure the information.

Over time, due to the number of scientific papers in a certain field of science, it becomes difficult to understand them. Also, due to the large number of sources of information, it becomes difficult to find the information we need. It is to solve these problems that a narrowly specialized web portal is needed.

The result of this work is mainly intended for non-commercial use by particle physicists world-wide with interest in the search for experimental evidence of Supersymmetry like a preparation to implementation of Supersymmetry web portal. The project is intended to identify the strengths and weaknesses of creating a web portal for Supersymmetry, based on which one can decide whether to implement it. This thesis may also be of interest to others, who are interested in creating a narrowly specialized web portal efficiently and inexpensively.

My choice of the project is due to my aspiration for scientific discoveries and my intent to facilitate research for scientists. Moreover, I have been seeking to gain experience in creating a non-profit project.

This thesis discusses possibilities of implementation of a web portal on Supersymmetry for scientists.

The aim of the bachelor's thesis is to offer the best way to create a web portal that will provide research information to experts in the field of Supersymmetry.

The first chapter is an executive summary of the project.

The second chapter provides a brief explanation of the concepts of Supersymmetry and an overview of its research and future plans.

The third chapter aims to acquaint the reader with the theoretical framework needed to understand the other chapters of this work.

The fourth chapter provides an analysis of the current situation. This chapter describes the process of collecting requests in interviews and their analysis. The chapter provides a roadmap, based on which the work estimate is calculated. The chapter explains the future advertising of the portal and usefulness of the web portal to a general public.

The fifth chapter describes the implementation process in detail and provides selected technologies and patterns for future implementations.

The sixth chapter aims to describe the design of the web portal and the layout of the pages.

The seventh chapter provides the reader with the information on how the future portal will be tested.

In the final chapter conclusions are given.

CHAPTER 1

Executive summary

1.1 Assignment

Many scientists spend much time on finding current and past information about Supersymmetry (SUSY). The data without suitable categorization does not allow to easily find it. Almost weekly new experimental information about search results for Supersymmetric particles is published. The goal of this project is to find the best way to create a web portal on Supersymmetry, analyze the time, resources and benefits of the portal, create a technical realization proposal and outline the web portal design.

1.2 Analysis

The creation of a web portal is evaluated positively. The project could be implemented in one stage over about 100 days at the costs of about 400 kCZK. The cost of the project is calculated with an approximate rate of 375 CZK / hour and an 8-hour working day with five days a week. Only implementation costs are counted. HW and SW costs are not included in the implementation costs. The maximum deviation of the estimate is $\pm 35\%$. The scope of the project allows its implementation as a part of a the bachelor or master thesis. The main benefits for the users include: simple search (all information stored in one place, automatic search for new articles, completeness), a unique categorization system (automatic categorization) and clarity (experts can look at past and current research, and can predict future research). Based on a statistical analysis, it is estimated that there is also interest from the general public in a web portal on Supersymmetry.

1.3   Technical realization proposal

The technical implementation consists of two parts:

- Web portal: a software product that takes articles or links from a database and displays them to the user in a browser.

- Filling database: a software product that will search for new publications about Supersymmetry in publication sources, assign an article to the correct category based on the use of NLP algorithms, and store links in a database.

1.4   Web portal design

As part of the project, a modern and minimalist wireframe, and the design of the Supersymmetry web portal are created. Emphasis is placed on usability, simplicity, uniqueness and independence of other web portals. Figures 6.1, 6.2 and 6.3 show a Home page of a Supersymmetry web portal design. A Sign Up page and a Sign In page are shown in Figure 6.4. The search articles page and Admin page are shown in Figure 6.5 and Figure 6.6, respectively. Figure 6.7 demonstrates the design and wireframe of the Learn More page. All pages are created in Adobe XD.

Supersymmetry

The Standard Model of particle physics has worked beautifully to predict what experiments have shown so far about the basic building blocks of matter, but physicists recognize that it is incomplete. Supersymmetry is an extension of the Standard Model that aims to fill some of the gaps. It predicts a partner particle for each particle in the Standard Model. The search for SUSY particles is highly motivated in three aspects 1) gauge coupling unification, 2) dark matter candidates and 3) naturalness (light Higgs boson mass) [2]. Supersymmetric particles should appear in collisions at the LHC if the theory is realized in Nature [3].

This chapter aims to acquaint the reader with the basics of particle physics, the Standard Model, CERN, LHC and two of its particle detectors – ATLAS, CMS.

2.1   History

In 1966 the theory of Supersymmetry was proposed by Hironari Miyazawa in the sense of a relation between mesons and baryons. However, it was ignored because this Supersymmetry did not touch on spacetime, that is, it concerned internal symmetry, and was broken badly [4].

The next stage was in 1971 and 1972, when supersymmetry was rediscovered by three independent groups of scientists J.L. Gervais and B. Sakita (1971), Yu. A. Golfand and EP Likhtman (1971), D.V. Volkov and V.P. Akulov (1972) in the context of quantum field theory, a new type of symmetry of spacetime and fundamental fields, which unifies spacetime and internal symmetries of microscopic phenomena and establishes a relationship between elementary particles of different quantum natures and fermions [5].

Finally, in 1974 Julius Wess and Bruno Zumino identified the characteristic renormalization features of four-dimensional supersymmetric field theories and in 1977 the first realistic supersymmetric version of the Standard Model by
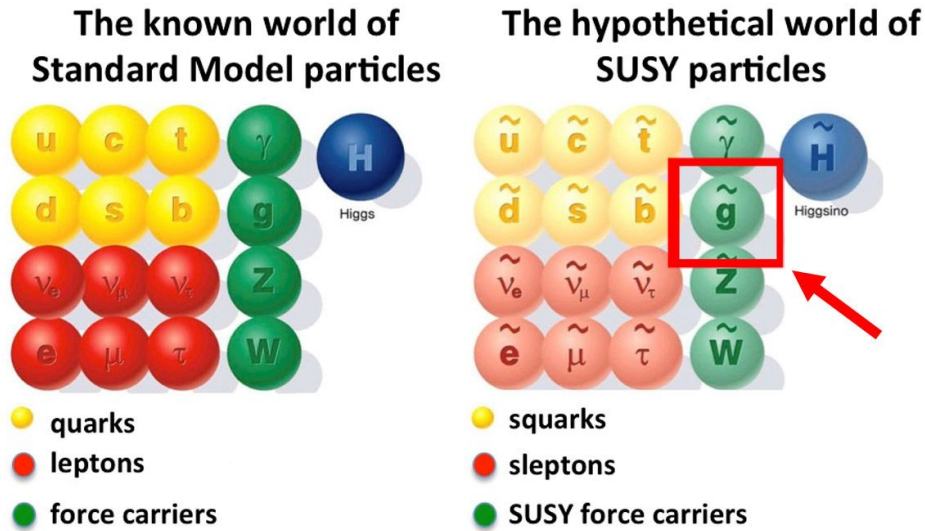
Figure 2.1: Standard Model and MSSM [7]

Pierre Fayet was proposed known as the, Minimal Supersymmetric Standard Model [6].

2.2   Standard Model and MSSM

The term "Standard Model" was coined by Abraham Pais and Sam Treiman in 1975, but its development took place from 1954 to 2012. It was last added in 2012, with the discovery of Higgs boson. The Standard Model describes all fundamental forces, known to mankind, except for the gravitational force and classifies all known elementary particles. At present, no experiment has found contradiction to this model, but particle theorists are nevertheless unhappy with this theory. Most features of the SM that are technically allowed but nevertheless theoretically unsatisfying can be removed by the grand unification theory. However, there is a so-called "hierarchy problem", which points to a large discrepancy between aspects of the weak force and gravity [8]. There is no scientific consensus on why, for example, the Higgs field should either be zero, or it should be as big as the Planck Energy, 10,000,000,000,000,000 times larger than it is observed to be [9]. Several physicists try to solve this problem and one of the theories that provides this solution is Supersymmetry.

MSSM – is a model predicts that each of the particles in the Standard Model has a partner. Supersymmetry pairs fermions with s-half integer spin particles and integer spin particles. Every particle in the Standard Model has a super partner not discovered yet. It is shown in Figure 2.1. Many theorists

predict that the discovery of these particles is equivalent to discovering such particles as dark matter because the lightest supersymmetric particle are stable and electrically neutral, and interacting weakly with the particles of the Standard Model and it is exactly what dark matter must do [3].

2.3   CERN and the LHC

The European Organization for Nuclear Research was officially founded in 1951 by 12 states. In 1954, the laboratory of CERN astride the Franco-Swiss border near Geneva was established [10]. Although the name implies that the organization is engaged in nuclear research, today CERN is better known as a center dedicated to particle physics. Often people name CERN as the European Laboratory for Particle Physics.

Currently, the main goal of CERN is to provide the particle accelerators and other infrastructure needed for high-energy physics research. Thanks to this a lot of experiments have been performed within the collaboration of various groups of scientists.

A particle accelerator is a machine that accelerates particles, like protons to high speed and energy by the use of electromagnetic fields. A collider is a type of particle accelerator in which particles smash either onto a target or against other particles circulating in the opposite direction. CERN has eight accelerators and two decelerators but LHC is the largest and the most powerful one. It is hosted in a 27 kilometer long ring. It boosts particles up to a speed close to that of light, and they collide with other protons. These collisions produce particles, like a Higgs boson, which was found by the use of LHC in 2012. By measuring their properties, scientists improve our understanding of matter and how its world works. The particles cannot be observed directly. There are detectors for this purpose. LHC has four detectors: ALICE, ATLAS, CMS, LHCb. Currently, only ATLAS and CMS are engaged in research in the field of Supersymmetry [11].

2.4   ATLAS and CMS

The LHC has two general purpose detectors ATLAS and CMS that detects particles resulting from the collisions in the LHC. They investigate the Standard Model to extra dimensions and particles that could be a dark matter candidate. The difference between detectors is their technical solution and technical design. Experiments and detectors are called the same [12], [13].

2.4.1   ATLAS

The ATLAS detector is the largest detector ever built. Groups of particles collide in the detector making collision debris in the form of new particles.

These particles fly out of the collision point in all directions. The detector has six subsystems, that record all information needed by scientists around the collision point. ATLAS uses an advanced decision system to tell the detector which events to record and which ones to ignore [12].

2.4.2 CMS

The CMS detector has the form of a cylindrical coil of superconducting cable, because it was built around a huge solenoid magnet. It generates a magnetic field 100,000 times stronger than the Earth magnetic field. Interesting is the fact that it was constructed in 15 sections at ground level before it was transferred to the cave [13].

2.5 Current research

The LHC is in 2020 closed for an upgrade. It is one of the planned shutdowns within the program, which aims to increase luminosity by a factor of 10 by 2027. Luminosity is a parameter that says to scientist how much data the experiments can gather to allow them to observe rare processes. During 2021, the planned shutdown will end and the experiments will begin again. However, this does not mean that research is not currently carried out. As part of the operation of the LHC, a lot of data has been collected and currently is being analyzed by scientists [14].

2.6 The future

As shown in Figure 2.2, the LHC will work until the end of 2036 with several pauses to develop and deploy new technical tools, which will then increase the quantity and quality of the delivered proton-proton collisions. But the end of 2036 does not mean the end of research. There is currently a proposal for a Future Circular Collider – a collider that will be almost 4 times more powerful and as many times larger than the LHC as shown in Figure 2.3. The Future Circular Collider will increase the limit on energy and intensity, which will increase the quality of research. Therefore, there is also much potential to discover Supersymmetry in the future.
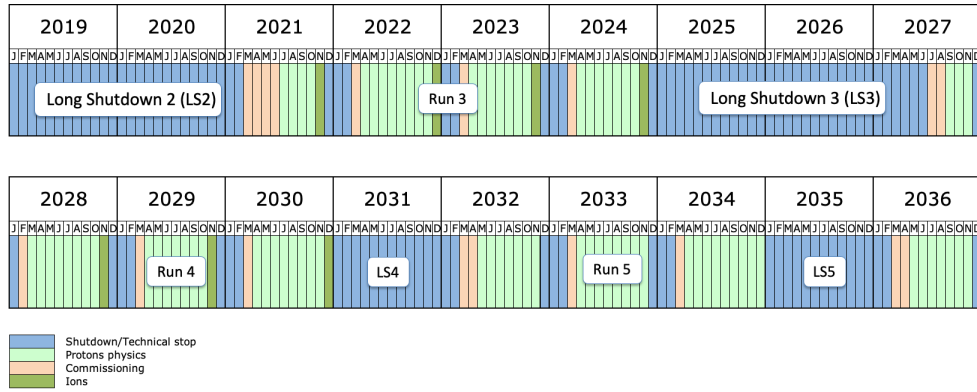
Figure 2.2: Longer term LHC schedule [15]
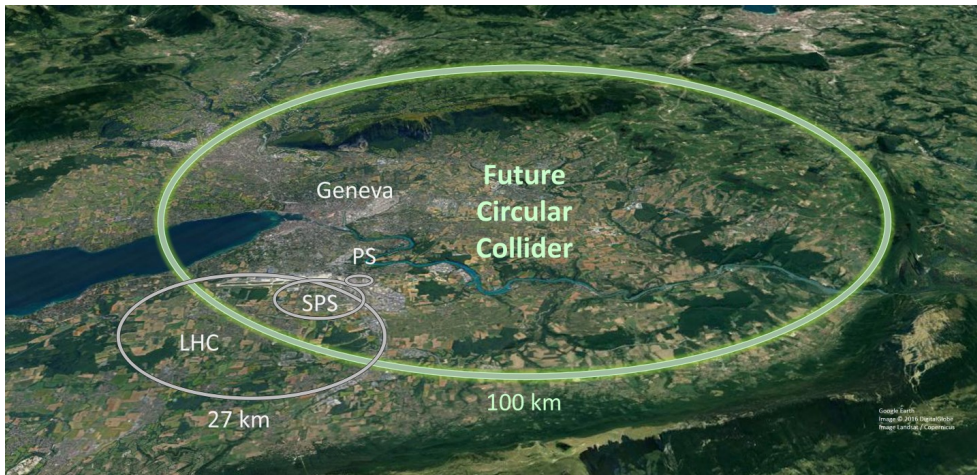
Figure 2.3: A schematic map showing where the Future Circular Collider tunnel is proposed to be located [16]

Theoretical framework of the analysis

This chapter presents the research part of this work. Here are definitions of terms and an overview of analytical procedures that are relevant to this work. It also lists cases that are useful for researching solutions to the topic of the work.

3.1   Feasibility study

First, there is a need to explain one of the basic concepts of this work to understand what to expect from the work, and what is not.

A feasibility study is an assessment of the practicality of a proposed project or system [17]. A feasibility study aims to objectively and rationally uncover the strengths and weaknesses of an existing business or proposed venture, opportunities and threats present in the natural environment, the resources required to carry through, and ultimately the prospects for success. A well-designed feasibility study should provide a historical background of the business or project, a description of the product or service, accounting statements, details of the operations and management, marketing research and policies, financial data, legal requirements and tax obligations [18]. A feasibility study in general, can be divided into categories:

- Profit

- Non-profit

Typically a feasibility study has this structure:

- Executive summary

- Tasks

- Situation analysis

- Requirements analysis

- Target market analysis

- Vision of the solution

- Risks

- Roadmap

- Financial plan

- Conclusion

Its structure is only a recommendation, because for some projects only some chapters are important and others will have less impact or will be omitted, and there are different work structures. For example, some managers add a chapter on environmental impact, which in case of this project is not relevant and therefore, will not be discussed. The following chapters discuss the methods and technique that will be used to analyze and determine the chapters for this work.

3.1.1 Profit feasibility study

A feasibility study for a commercial project. In other words a feasibility study is designed to provide an overview of the primary issues related to a business idea. The purpose is to identify any "make or break" issues that would prevent business from being successful in the marketplace [19].

3.1.2 Non-profit feasibility study

A feasibility study for non-commercial project. In essence, this is the same as the profit feasibility study, but serving non-profit organizations and not expecting profit, or not making it the main goal. A non-profit feasibility study should be conducted during pre-campaign planning. Often it serves as the basis to make a request for donation for the project. This bachelor work is done just for the project, that does not expect a profit. Since, it is a non-commercial work, there is no need to calculate the profit of the project. It can focus on the rest of its aspects and work them out in more detail.

3.2 Project

The concept of project is mentioned in the sections above. The concept of a project is ambiguous and in different industries its definition may differ. For example, one of the definitions: A project is a temporary effort made to create

a unique product, service or certain result [20]. But in the case of this work, a different concept is used – the one created by Professor Kerzner:
A project is any unique sequence of activities and tasks that has:

- a specific goal, which is to be fulfilled by its realization

- defined start and end date of execution

- a framework for drawing the resources needed for its implementation [20]

From this concept it follows what criteria it must comply with in order to consider this work a project and what this work will be filled with.

3.3   Situation analysis

Situation analysis refers to a collection of methods that managers use to analyze an organization's internal and external environment to understand the organization's capabilities, customers, and business environment [21]. As part of the situation analysis, information is collected on the strengths and weaknesses of the project, its opportunities and threats; it indicates the company's strategy about regarding the product. The situation analysis of this work consists of one analytical method and the most comprehensive SWOT analysis [22].

3.3.1   SWOT

SWOT Analysis	POSITIVE / HELPFUL to achieving the goal	NEGATIVE / HARMFUL / RISKS to achieving the goal
INTERNAL Origin facts / factors of the organization	**Strengths** Good things, maintain them, build on them and use as leverage	**Weaknesses** Bad things, remedy, change or stop them
EXTERNAL Origin facts / factors of the environment in which the organization operates	**Opportunities** Good things for the future, prioritize them, capture them, build on them and optimize	**Threats** Bad things for the future, put in plans to manage them or counter them [23]

Table 3.1: SWOT matrix overview

SWOT analysis is one of the most important, most universal, and most extensive technique for strategic analysis of a company or project. As part of this analysis, it identifies Strengths, Weaknesses, Opportunities, and Threats. To clarify each concept, see Table 3.1. With the correct identification and subsequent evaluation of the result, it influences the choice of the right strategy, which can have a big impact on the success of the project. It typically looks like a table of 2 rows and 2 columns, as it is in Table 3.1. Creating a SWOT analysis of a project can be simple, however its strengths lie in the flexibility and practicality. There are 4 strategies to choose from after evaluating the result of the SWOT analysis:

1. MAX-MAX – Maximize strengths to take advantage of maximum opportunities

2. MIN-MIN – Minimize weaknesses to eliminate threats

3. MIN-MAX – Minimize weaknesses to maximize opportunities

4. MAX-MIN – Maximize strengths to eliminate threats [24]

All strategies are equal but with a different focus, and a manager determines him or herself which ones to choose. Much depends on what will be better for the company at this point in the analysis. SWOT analysis is not a 100% solution to all problems, it provides, just for a part of the picture.

3.3.2 FURPS+

Requirements can be functional or non-functional, at the same time some requirements can be classified as technology-specific or technology-independent. Different categories lead us to inevitability of classification that will allow us to think about different aspects of project requirements. FURPS is a technique to validate the prioritized requirements after understanding of client's needs and necessities [25]. Its technique was devised by creator of Hewlett-Packard Robert Grady and goes by the acronym FURPS+ which represents [26]:

- Functionality

- Usability

- Reliability

- Performance

- Supportability

Figure 3.2 shows the description for each item.

The "+" should not be forgotten. Its means that one must remember concerns such as [26]:

Characteristics	Description
Functionality	Include feature sets, capabilities, and security.
Usability	Human Factors, overall aesthetics, consistency, and documentation
Reliability	Frequency and severity of failure, recoverability, predictability, accuracy, and mean time between failures (MTBF).
Performance	Processing speed, response time, resource consumption, throughput and efficiency.
Supportability	Testability, extensibility, adaptability, maintainability, compatibility, configurability, serviceability, installability, and localizability.

Table 3.2: FURPS model [27]

- Design requirements

- Implementation requirements

- Interface requirements

- Physical requirements

This work will concentrate on FURPS characteristics and give small attention to "+".

3.4 Analysis of time, resources and expected costs

Part of each feasibility study is an analysis of time, resources and costs, which expects to be used for the implementation of this project. Of course, all calculations are expected, but may exceed some of these values (on average, projects go over budget by 27 percent of their intended cost [28].). However, proper analysis and planning will reduce the likelihood of overshooting. In the feasibility study it is necessary to mention the resources that are needed. Typically these are indication of a profession, time estimates in MD (1 MD = 8 hours of work) and total costs; it is usually in the name of the country where this project will be implemented (This work expects implementation of the project in the Czech Republic, and therefore, all prices will be stated in CZK). As the project is not profit-oriented, it will not calculate the overall profitability.

3.4.1 PERT method

In project management, PERT is used to identify the time it takes to finish a particular task or activity. It is a system that helps in proper scheduling and coordination of all tasks throughout the project. It also helps in keeping track of the progress, or lack thereof, of the project [29]. PERT chart displays the total project with all scheduled tasks shown in sequence. The displayed tasks show which ones are in parallel, those tasks that can be performed at the same time [30].

The PERT technique includes several steps:

1. Detect activities (tasks) and milestones for these activities

2. Find out the correct sequence of activities

3. Construct a network diagram (graphical representation of a sequence of activities)

4. Count the time for each activity

5. Find the critical path

6. Update chart after the project gets progressed

For item Four the formula 3.1 [31] will be used:

$$ET = \frac{O + 4M + P}{6} \tag{3.1}$$

where

- ET – An expected time of one activity

- O – Optimistic time (the shortest time when task can be done)

- M – Most likely time (the completion time of the highest probability)

- P – Pessimistic time (the longest time when can be done)

This helps to bias time estimates away from the unrealistically short timescales normally assumed.

To count total time spent on the project formula 3.2 [31] will be used:

$$\sum_{i=1}^{n} ET_i \tag{3.2}$$

where
n – the length of the longest path in the chart (critical path)

In item Five the term "critical path" was mentioned. The critical path is the path in the graph connecting the beginning and end of the project and containing all activities that do not have time in reserve.

Critical activities must be given special attention because they are more likely to be delayed throughout the project.

Therefore, the standard deviation of the project is introduced. Standard deviation of time: the variability of the time for accomplishing an activity (σ_{et}) or a path (σ_{ET}) [31]:

$$\sigma_{et} = \frac{P - O}{6} \tag{3.3}$$

$$\sigma_{ET} = \sqrt{\sum_{i=1}^{n} \sigma_{et_i}{}^2} \tag{3.4}$$

For probability theory and statistics this is real because PERT distribution of every activity is the four-parameter Beta distribution. For us it means, that one of the biggest advantages of the PERT method is that it allows us to estimate the time at which the project will be completed with probability "x" (T_c). For this formula 3.5 can be used [31]:

$$T_c = P(X = x)\sigma(Pr) + \mu(Pr) \tag{3.5}$$

where

- $P(X = x)$ – table value of distribution function ($\Phi(x)$)

- $\sigma(Pr)$ – total standard deviation of the project

- $\mu(Pr)$ – average project duration

3.4.2 Estimation of project costs

Financial analysis is one of the most important parts of a feasibility study, which will ensure the success of the project with a correct and accurate calculation. A project with a financially poor design may not get funding. A correct and accurate calculation will ensure that the actual costs do not exceed the estimated costs. To do this, it must use the most accurate method for estimating the cost of the project. Usually, not only the cost of the project is calculated, but also its profitability, which is not relevant in case of this project, as the project is non-commercial.

Theoretically, the cost estimate of a project can be determined in two ways, either by a 'top-down' or a 'bottom-up' approach. But it is also possible to use an estimate according to the rates of individual sources or a parametric estimate [32]. To calculate the total costs in this work, the PERT method from the previous chapter, and the 'bottom-up' method will be used, as best

suitable for the goals of this project and serving as the most accurate for this type of project. The project is not long-term and therefore it does not expect inflation.

3.4.2.1 'Bottom-up" method

Bottom-up estimation is a method that uses as much detail as possible. The project is divided into tasks so that the most accurate estimate can be made. After dividing the project into tasks, a task and resource description will be created for each of them. Then the cost for each activity must be decided. An estimate of the total cost of the project is then obtained by summing the individual estimates for all the tasks. The method is more accurate than the others, but it also requires more work.

3.4.3 Gantt chart and roadmap

Gantt chart is a chart that illustrates a project schedule. It shows a schedule of project activities or tasks. Gantt charts show which activities are ahead of schedule or delayed [32]. Modern Gantt charts can also link the resources used to the activities that have consumed those resources. This notion is important because it is used to create roadmaps of a project.

The project roadmap is a graphical, high-level overview of the project's goals and deliverables presented on a timeline. Unlike the project plan where details are fleshed out, the roadmap should be simple and free of minutiae. This makes the project roadmap a useful tool for managing stakeholder expectations, as well as for communicating plans and coordinating resources with other teams [33].

3.5 Market and competition analysis

To perform a comprehensive analysis of the project, its strengths and weaknesses, opportunities, and threats from a competitor. It is necessary to precisely define the market on which the result of this project will be oriented.

The market is defined as the value or volume of goods or services aimed at satisfying specific customer problems. If the target market is defined incorrectly the project will have severe shortcomings. With too narrow a market definition, there is a significant narrowing of potential users and at the same time there is a possibility to overlook competing companies, which may pose a threat to the existence of this project. On the contrary, with a too broad definition of the market, there is a possibility of losing the customer in favor of a more narrowly focused company [34].

For each project, especially for a non-profit one, it is necessary to monitor the competition in order not to lose its market position or establish development potential. Competitors must be channeled not only quantitatively but

also qualitatively. Investigation of competitors strengths and weaknesses can correct the basic concept. Competition can be direct (products which perform the same function) and indirect (products which are close substitutes for one another).

3.6 Risk

Risks is important chapter of the feasibility study, which cannot be forgotten. At every stage of the project, there are a lot of risks that need to be paid attention to in order for the project to turn out successful. For success, it is necessary to describe and predict all risks that may occur during the project. For the risk, one should record the condition, the responsible person, the probability of occurrence, the impact, the risk mitigation plan, the crisis plan, severity. Several systems are used for risk quantification, which are described in the Figure 3.3 and Table 3.4.

Risk Category	Extended categories
Technical	Requirements, Technology, Interfaces, Performance, Quality, etc.
External	Customer, Contract, Market, Supplier, etc.
Organizational	Project Dependencies, Logistics, Resources, Budget, etc.
Project Management	Planning, Schedule, Estimation, Controlling, Communication, etc.

Table 3.3: Standard risk categories [35]

The Severity Global interpretation	Description
Critical	Risk must be reduced in all circumstances
Major	Risk must be reduced if it is reasonably practicable to do so
Minor	The risk is tolerable. Risk controls should be undertaken if it is cost-effective to do so
Negligible	Risk is acceptable

Table 3.4: Risk priorities [1]

3.7 Natural language processing

Currently, NLP is used in almost all modern projects. NLP is a subfield of computer science and artificial intelligence concerned with interactions between computers and human (natural) languages. It is used to apply machine learning algorithms to text and speech [36]. Much progress has been made in this field over the last few years. In this work, the analysis of the natural text written in English by a person will be used for dividing the article into categories. For the purposes of this work, only some out of many existing algorithms are used. In the following sections this will be discussed.

3.7.1 Text Lemmatization and Stemming

Any text for grammar purposes always contains different forms of the same word, or words that have a similar meaning; for example drive, drives, driving. The goal of both stemming and lemmatization is to reduce inflectional forms and sometimes derivationally related forms of a word to a common base form [37].

They are one of a kind of normalization. Stemming usually refers to a crude heuristic process that chops off the ends of words in the hope of achieving this goal correctly most of the time, and often includes the removal of derivational affixes. Lemmatization usually refers to doing things properly with the use of a vocabulary and morphological analysis of words, normally aiming to remove inflectional endings only and to return the base or dictionary form of a word, which is known as the lemma [37].

Stemming does not understand the difference between the context of words and sentences, and therefore cannot find the difference between words that have a difference in meaning when used as different parts of speech. Lemmatization can do it, but it will require compensation by slowing down the speed and adding difficulty to its implementation.

3.7.2 Stop words

Stop Words is one of a kind filter. It is used so that at the beginning or the end of the text analysis, all words that belong to the word track set will be removed from the text.

Word-noise, like conjunctions and commonly used words (e.g. "a", "the", "is", ...) should be identified in the text. To improve the quality of machine learning, these words need to be removed. There is a package of basic stop words, but this is not a universal solution and it depends on the needs of the project.

3.7.3 TF-IDF

The words with the highest frequency of properties, correspondingly, increases the value in most of the text analysis algorithm. This is not the best solution because the word with the highest score does not have to have a large "information gain" for us, whether to compare with less frequent or specific words. There is a TF-IDF algorithm to improve this situation.

TF-IDF, short for term frequency-inverse document frequency is a statistical measure used to evaluate the importance of a word to a document in a collection or corpus [36]. The points of the word are credited for its frequent occurrence in the document, but then compensated by the number of documents that contain the word, which really gives a more deliberated result. It will use this method in the project during word analysis in the abstract to divide the article into categories. This method will ensure that the unique words for each category will have a greater effect on the division. For this purpose the formula 3.6 can be used [36].

$$W_{x,y} = tf_{x,y} \log{(\frac{N}{df_x})} \qquad (3.6)$$

where

- $tf_{x,y}$ – frequency of x in y

- df_x – number of documents containing x

- N – total number of documents

3.8 NoSQL database

NoSQL Database is a database that, unlike standard relational storage and retrieval of data, does not use tabular relations. For example, storage can be implemented as key-value stores or documents stores.

Strengths and weaknesses of NoSQL databases enumerate in next two chapters [38].

3.8.1 Strengths of NoSQL

- Uninterrupted access/high availability

- Scalability

- Security and flexibility

- Using cloud computing and storage

- Freedom to choose

3.8.2   Weaknesses of NoSQL

- Porting the applications

- No normalization, unions or joins (not recommended for relational data)

- Lost updates

3.8.3   Firebase

Firebase is an online cloud service, created by Google, which provides a lot of interesting, powerful products that simplify work for developers. Certainly not every project or company can afford to create, support and maintain their online service and database and therefore this service is useful for small projects.

3.8.3.1   Firebase Realtime Database

The Firebase Realtime Database is a cloud-hosted database. Data is stored as JSON (Figure 3.1) and synchronized in real-time to every connected client. When cross-platform apps are built with iOS, Android, and JavaScript SDKs, all clients share one Real-time Database instance and automatically receive updates with the newest data.

This product can be praised for a long time for secure access to the database directly from the client-side code or for the fact that the data is persisted locally. But the most important is that the database is updated in real-time and the data is stored in the cloud, which reduces the costs and possible problems with the implementation of the home service and database. Update in real-time means that every time a user changes data, in the order of milliseconds, the change will take effect for all users who are currently connected to the database. One of the advantages of this database is that one has to pay only for the place to be used. [39].

3.9   Adobe XD

Adobe XD is a powerful, collaborative, easy-to-use platform that helps users and his teams create designs for websites, mobile apps, voice interfaces, games, and more [40]. This program also allow users to create and reuse components. The interface is unloaded, which is a great advantage for beginners, for example, before the Photoshop. Sketch can be an alternative for Adobe XD. Currently, it is possible to generate html and css files from the Adobe XD file, which is especially useful for frontend developers and the speed up of work. However, this generation is not ideal, and the developer has to cope with this limitation.

```
 1 ▾ {
 2 ▾   "array": [
 3        1,
 4        2,
 5        3
 6      ],
 7      "boolean": true,
 8      "color": "gold",
 9      "null": null,
10      "number": 123,
11 ▾    "object": {
12        "a": "b",
13        "c": "d"
14      },
15      "string": "Hello World"
16    }
17
```

Figure 3.1: JSON format

3.10   Search engine marketing

SEM strategy – is a marketing strategy with the help of search engines such as Google, Yandex, Seznam, Bing, etc [41]. The Internet continues to evolve at a rapid pace and is becoming much more cost-effective and cheaper than standard types of advertising such as television and paper. In addition, this work is about a web portal, which also says a lot about the type of advertising that must be used.

SEO – search engine optimization a process that affects the visibility of a website and increases the quantity and quality of its traffic through search engine optimization. The main goal is always to make the website appear on the first page of the search, because the more often the web appears in the search, the more visitors it has that may be users of Supersymmetry web portal.

Several online services can help in this, which will show us the most frequent sentence searches and show the statistics of the consistency of Supersymmetry web portal. One of the most popular and powerful systems for SEM analysis is Google Analytics. It has a simple interface and a lot of useful functions, such as statistics of the most common geo positions from which clients accessed the web.

All concepts and methods described in this chapter are necessary to understand the following chapters with the practical content of the research.

Analysis of project

4.1 Collecting requirements

This chapter deals with the process of creating requirements for a new web portal on Supersymmetry. The definition of requirements in general determined the cooperation between the contracting authority and the customer. In this case the author of this work is the contracting authority and the supervisor is customer. Establishing a new system always requires cooperation, because the customer understands better his domain and his requirements. The customer can comprehensively define the whole system he needs or specify the direction of thinking that will simplify the understanding of the requirement of the project.

When creating a new system, the author cooperates with the supervisor of this work. The cooperation took place during all activities. In the beginning, an interview took place in the framework of which a basic overview of how the system looks like, its main purpose, its functional and non-functional requirements were obtained. During the cause of this work Skype and personal meetings to place. The basic concept of the web portal was defined, supplemented with new details and constantly improved.

4.1.1 Interview

The supervisor of the project was asked for an interview, in which the basic requirements with the help of questions in the Appendix **B** were collected. After this, an interview with the theorist, Mikuláš Gintner, was performed with the same questions. Based on these interviews the requirements were validated and adjusted. The questions focused on understanding the content of the web portal, possible future extensions, understanding the domain and market (scientific community), motivation of the client, potential users, definition and division of requirements into functional and non-functional.

4.1.2   Definition of requirements

Based on the interview the following requirements for the web portal were
defined:

4.1.2.1   Functional requirements

- **Login and registration**. The system allows login and registration of
  the user to give him the rights to change the category of the article.

- **Category administration** will allow for changing the article categories
  in the system.

- **Category assignment**. The system automatically assigns the article
  categories.

- **Automatic search**. This provides for the automatic search for new
  publications and displays them on the web portal.

- **Statistical history of the publication**. A graph is created to display
  the history developed over time.

- **Life of a scientist**. Videos and articles about scientists that work on
  research on SUSY are collected.

4.1.2.2   Non-functional requirements

- **Simplicity**. The interface should be intuitive to understand.

- **Completeness**. No relevant article should be missed.

- **Modernity**. The system must be built on modern technology.

- **Design**. The system must have an appealing design.

- **One source of information**. The portal should be self standing (it
  does not have to force the user to search for an article on other sites).

4.2   Situation analysis and scientific resources

The current situation is that the user can find the latest experimental results
on the Internet. However, this is complicated by the fact that research in
the field of Supersymmetry is carried out not only by one experiment or or-
ganization, but by many organizations that have their own collider. Some
information is not provided in a user friendly way. Also, historically, each
experiment has its own web portal, which means for users that searching for
results can be complicated and time consuming. Completed experiments must
also be taken in to account. Some of those web portals are no longer supported

and become obsolete. This would complicate the searching for older research results.

The most popular web sites for viewing the results of the latest experiments are the ATLAS and CMS official sites. In the "Public Results" section, there are experimental results related to SUSY. These results can be filtered by Energy, Date, Luminosity, Type of SUSY, Signature and Analysis characteristics.

4.2.1 SWOT analysis

Based on the SWOT analysis, the choice of the MAX-MAX strategy is offered.

4.2.1.1 Strengths

- Automatic saving to the database of new articles.

- All information about SUSY in one place.

- Automatic categorization using Natural Language Processing (NLP).

- Simple and minimalist design.

- Possibility to change the category in response to the expert reactions.

- View of statistics of the development of Supersymmetry in time.

- Comprehensive information in the field of Supersymmetry.

- Basic information not only for experts but also for those interested (general public).

- Life of scientist that work on SUSY research.

4.2.1.2 Weaknesses

- Naturally, the users need to decide to switch to the new web portal instead of the resource which they are accustomed to.

- Categorization may not work adequately in the beginning because the NPL requires time to learn.

- The benefits of the web portal will be less than expected.

- The database might be incomplete with respect to some information the user is searching for.

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4.2.1.3   Opportunities

- There is no web portal focused particularly and exclusively on Super-symmetry.

- Research in the field of Supersymmetry will be carried out for many years ahead.

- The web portal give the possible to enhance the Supersymmetry user community.

- The web portal will provide categorizations that are not on other web portals that provide information about SUSY.

- Interest in Supersymmetry researching is growing which allows to predict an increasing value of the new portal.

- Most existing web portals do not follow the current trend in the development of web portals.

4.2.1.4   Threats

- There is a possibility for the experimental evidence to excludes Super-symmetry.

- The portal might not receive the expected number of users to make it worthwhile.

- Some of the existing portals will upgrade their design or add competitive functionality.

- In case of a change on the website where the portal download information, it is necessary to change the program for downloading information. This will increase maintenance costs.

4.2.2   FURPS+

The chapter with Collecting requirements describes the requirements which were categorized as functional and non-functional. This chapter applies the FURPS+ method, and thus, validates the prioritized requirements.

4.2.2.1   Functionality

- **Login and registration**. The system allows login and registration of the user to give him the rights to change the category of the article.

- **Category administration**. It will be possible to change the article categories in the system.

- **Category assignment**. The system automatically assigns the article categories.

- **Automatic search**. This provides for the automatic search for new publications and displays them on the web portal.

- **Statistical history of the publication**. A graph is created to display the history developed over time.

- **Life of a scientist**. Videos and articles about scientists that work on SUSY research are collected.

4.2.2.2   Usability

- **Internet browser**. The web portal must be accessible in all of the most used browsers with the latest versions.

4.2.2.3   Reliability

- **System availability**. The portal must be functional 99% of its operating time, downtime must be minimal.

4.2.2.4   Performance

- **System response**. The system must respond to the user request within 3 seconds.

- **Traffic**. The portal must withstand around 1,000 people connected at the same time.

4.2.2.5   Supportability

- **Help desk**. Notification of exceptional events by electronic mail.

- **Service contract**. Service contract with a supplier that requires a warranty to resolve errors.

4.2.2.6 +

- **Modernity**. The system must be built on modern technology.

- **Design**. The system must have appealing design.

- **Language**. Only the English language version will be available.

- **Upgradebility**. Simple upgrade to a new technology or language if it becomes available.

- **Security**. Robot registration and login protection.

- **Copyright**. Portal must follow all copyright rules.

4.3 Market and competition analysis

As the portal is scientific, it follows that it is intended for scientists and the general public who are interested in experiments and science in the field of Supersymmetry. There are currently no portals of a similar format on Supersymmetry. However, competition can be with portals that have been around for a long time, and people are used to them. ATLAS [42], CERN Document Server [43] and Arxiv.org [44] can be the competitors. Each of these portals have an extensive database, and they are among the first ones to publish new articles on Supersymmetry. However, the size of the database and its broad focus make it difficult to find the necessary experimental results. The solution is to create a narrowly focused portal.
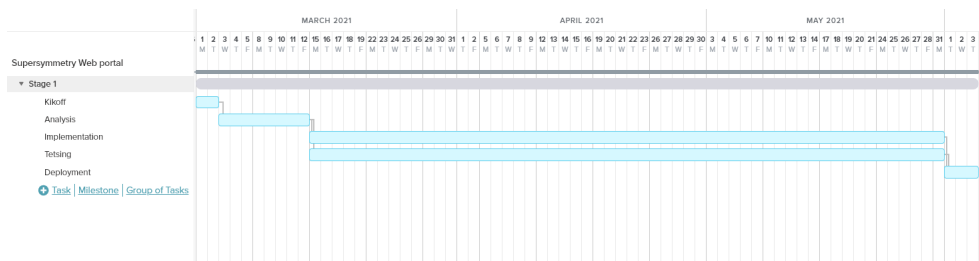
Figure 4.1: Roadmap of the project

4.4 Potential number of users

As the web portal will be focused on experts, user estimates will be focused on them. ATLAS has around 3,000 scientists [45] and CMS [46] has around 4,000 scientists and other employees. In the field of Supersymmetry, around 1,650 people research on both detectors. The value is calculated by multiplying the typical current number of scientists working on a specific SUSY analysis (15 researchers) by the number of difference analyses in one experiment (55 for ATLAS), thus 825 in total. One would expect a similar number for CMS.

According to SEO requests for the April, May, June of 2020, the search results for the keyword Supersymmetry in google.com is as follows: 107, 99, 111 times/per month, respectively. For keyword SUSY, it is: 36, 66 and 47, respectively [47].

The SimilarWeb site traffic analysis tool shows that the CERN document server visits amount to about 400,000 times a month by students, researchers and other interested parties and tends to grow [48]. As the search for Supersymmetry continues there is potential for CERN user interesting in the web portal.

The total expected number of users interested in the web portal estimated in Table 4.5.

4.5 Roadmap

Figure 4.1 shows an approximate roadmap of the project. If the project starts later, the deadline will be postponed by the same number of days as the delay.

4.6 Work estimate

The following gives an approximate estimate of how much development time is needed and the cost. The Gantt chart in Figure 4.1 will be used as a basis in which the activities, their correct sequence, the approximate time spent on each of the activities and the critical path are defined. The "bottom up" method is used for the overall estimate of the time spent on the project.

Origin	Estimates
CERN employees	55 * 15 * 2 = **1650**
The SERPSTAT web site traffic analysis [47]	$\dfrac{107 + 99 + 111}{3} + \dfrac{36 + 66 + 47}{3} = \mathbf{155}$
The SimilarWeb web site traffic analysis [48] (gaining 1% percent assumed)	$400000 * 1\% = \mathbf{4000}$
Total	1650 + 155 + 4000 = **5800**

Table 4.5: Estimate potential number of users/per month

Table 4.6 shows the time and cost needed to complete different tasks using the PERT method. The average salary of an experienced developer in Prague is 375 CZK per hour. The contract could be negotiated for the completion of the project with a possible future extension with a self-employed person. In the beginning, the team will consist of one person. Once the development phase begins, the type expands by one tester. There is a second variant of the project cost. It is possible to enter the project as a diploma thesis for students. The time estimates will depends on the student's capability.

Activity	Time	Cost
Kickoff	2 MD	8 * 2 * 375 = 6000 CZK
Analysis	$\dfrac{4 + 4*8 + 12}{6} = 8MD$	8 * 8 * 375 = 24000 CZK
Implementation	$\dfrac{40 + 4*56 + 75}{6} = 56.5MD$	8 * 56.5 * 375 = 169500 CZK
Testing	$\dfrac{40 + 4*56 + 75}{6} = 56.5MD$	8 * 56.5 * 375 = 169500 CZK
Deployment	$\dfrac{1 + 4*3 + 5}{6} = 3MD$	8 * 3 * 375 = 9000 CZK
Total	**124 MD**	**378000 CZK**

Table 4.6: Estimation of the time and cost required to complete all project activities

4.7 Risks

One of the critical risks is incorrect categorization, which must be eliminated over time as the NPL using in this project will continue to improve. The second critical risk is updating the portal-source of information about SUSY, which will cause the immediate need to update the script to search for information. Another critical risk is the probability of not obtaining project funding. This can be fixed by Variant 2 of Chapter 4.6. The last critical risk is not gaining enough of users. To mitigate this risk, the project requires a proper advertising campaign. In summary, all risks can be significantly reduced without losing the benefits of the portal.

4.8   Advertising the Supersymmetry portal

CERN is a large organization that has been operating for a long time and has its own website where it can launch the advertising campaign of the new SUSY web portal. Some of these web portals are listed below:

- **CERN advertising possibility**. This portal has a news section and could publish an article that informs people about the existence of a new web portal. It could also create new sections with partner web portals and provide a link to the SUSY web portal [49].

- **ATLAS advertising possibility**. At the top of this page are links to collaborations and experiment results. The link to the SUSY web portal could be placed together with other links. There is also a possibility to provide a link directly on the page with the results of the experiment in the section "Other Public Documents & Information" [42].

- **CERN Document Server**. This site could provide a link to the SUSY web portal in the "JUMP TO" section, which has a visible layout and links to other CERN sites [43].

- **CERN YouTube channel**. A link to the SUSY web portal could be provided in the description of the video of the official YouTube channel of CERN and can be advertised by the actor in the video [50].

For better visibility of the portal, SEO optimizations will be performed, to help export the web portal to the first page of google.com. To evaluate the correct optimizations, the Google Analytics tool [51], will be used to provide the user with information on how the traffic of the portal changes during various optimizations. As there is no similar web portal on Supersymmetry, there is the high chance for good visibility of the new web portal proposed for Supersymmetry. Third-party advertising campaigns are a powerful way to make a project recognized. For example, ResearchGate [52] is a popular tool for advertising in the field of science which enables advertising of the portal by video, emails and ads.

4.9 Benefits for experts

The contribution of the web portal must be significant to make it worthwhile to implement this web portal. The main benefits for experts are:

- One unified source of information. Researchers do not have to search for articles on various web portals, which saves search time.

- Completeness. The portal will contain all the necessary information and thus the user will not be forced to look for information elsewhere.

- Automatic search. The web portal automatically searches for new articles about SUSY on publication resources. After that, the information is displayed on the web portal, which allows the expert to always know about new publications without looking for an article on other sources.

- Automatic categorization. Articles found on the Internet are automatically categorized not only in a classic manner, but also by a unique categorization, which has made it easier to search for the required topics.

- Overview. The portal provides an overview of the current state. It will create a structure for many existing researches. The web portal gives possibility to look at the past (find all published articles), and to make a prediction about development in the future.

4.10 Usefulness for general public

During few interviews with people from the public, it was found that most people do not have knowledge and have not heard anything about this theory. This is because the theory is not proven, unlike "Higgs Boson". Therefore, the project will be focused on experts and in case of growing popularity or proving the correctness of the theory the project can be extended. From the beginning of it existence, the portal will contain the basic information about Supersymmetry for the general public. This should help everybody interested to be more knowledgeable about this topic.

Technical realization

This chapter describes one of the possible ways to categorize an article and store information in a database. The implementation is designed to be simple and does not require a large amount of resources. As proof of the concept, a script is attached, which serves to inspire the future implementation of downloading, categorization and storing the link or the PDF of the articles in the database. The second script serves as proof of the concept of retrieving information from the database and displaying it to the user by means of the offered architecture.

5.1 Database filling

The first step in the project is to implement the kernel of the system, which is a script that extracts the necessary information from a source it accepts as a parameter, assigns the correct article categories, and stores it in a database.

5.1.1 Searching articles

There are many services which allow the search in articles by the keyword. These services can be used within this project. This eliminates the need to implement an own automatic article search. For this project, any of the following services may be used, because each of them has an extensive database and advanced search using keywords:

- **Google scholar** [53]

- **Microsoft Academic** [54]

- **Web of Science** [55]

- **American Physical Society Web Sites** [56]

To search for and fill in older articles, the experimental pages can be used (for example **Public results of D0 experiment** [57] and **Public results of DELPHI experiment** [58]), or the **CERN Document Server** [59]. These pages contain a large number of experimental results on Supersymmetry.

5.1.2   Extracting data

One of the requirements is the automatic extraction of data from web pages. This will be provided by either online services such as Webscraper.io or libraries of the selected programming language. For example, the most popular libraries in Python are Selenium, BeautifulSoup and Pandas. An example of a future implementation is one of the scripts written in the Python version 3.7 programming language using the Selenium library, which requires the installation of one of the browsers and a web driver for this browser. The first version of the script was implemented using BeautifulSoup, which is unusable in the case of this project. The main reason is that it tightens the source code of a page that does not always contain all the links, because they are automatically generated by the page that is not in the source code. Taking advantage of this pays off in the case of "hard-coded" pages. The current version of the script has the main URL on ATLAS Public Supersymmetry Search Results that opens in a browser and extracts all links from the page. Then it opens these links in the browser and finds the abstracts of the articles. Subsequently, the categorization algorithm is applied to the abstracts of the articles.

5.1.3   Categorization

The feasibility of categorization is studied with an example of twenty articles. A unique categorization system was created with the help of an article written by the supervisor [2]. The following categories were defined from this article:

- Inclusive production
- Direct sTop production
- Direct sBottom production
- Small mass differences
- Electroweak direct production
- Photonic signatures
- Long-lived particles
- R-parity violation
- Displaced vertices
- pMSSM

The first step is to define the basic keywords. For their definitions, the basic text of the article provided by the supervisor was used, divided into sub-chapters that relate to a specific category. This text must first be modified by deleting Stop Words and then removing numbers and non-text symbols. Stemming or Lemmatization must be applied to the text, which reduces inflectional forms and sometimes derivationally related forms of a word to a common base form, which simplifies future searches in the text and reduces the number of unique word forms that may have arisen due to different word uses.

Subsequently, the application of the TF-IDF algorithm [36] is applied, which calculates the score for each text related to a specific category. The algorithm divides the text into words and calculates a score for each word based on which it will be decided whether the keyword should be used. These keywords are then searched for in the text of the article abstract, which was discovered in the section 5.1.2. The abstract must first be modified for keyword definitions. The proof of concept serves as an example of this process. The input data of the TF-IDF algorithm must be enhanced with the growth of the number of identify articles to improve the search and optimize. Therefore, any new identified articles will go through this algorithm. Similarly, it can be done for any new type of article division.

In case of incorrect categorization, each logged-in user will have the opportunity to influence the change of this category. The user can select a new category from the available ones and send a request to the portal administrator, who can apply this change after consideration.

The algorithm described in this section has been manually tested. Categorized links were manually checked. Problems were found in the current version of the algorithm. A weakness of the tested algorithm is that when articles were included in a category, the algorithm will not check other categories, which may better correspond to the analyzing article. This may cause incorrect categorization. This also leads to the another problem - insufficiently specified keywords. Keywords are not specific enough. The last problem is caused by a lack of keywords. This must be corrected by providing more text and updating this keywords regularly when categorizing a new article.

The test was performed on 40 articles of which 20 articles are presented as examples in Table 5.7. The categories with the highest categorization errors (Direct S-Top production, Small mass differences, pMSMM), which were revealed in the test, must be given more attention when choosing the text for keyword definitions. The entire manual test file is in the contents of the enclosed CD. Of the 40 articles tested, 22 are categorized correctly. The algorithm must be improved during implementation. Overall success of the categorization:

$$\frac{22}{40} = 55\% \qquad (5.1)$$

5.1.4 Storing the articles

For this project, it makes sense to consider what will be saved.

One way is to save the entire text of the article and the images related to it. But this has several disadvantages. First, there is a need for the necessary storage space. However, this is not a major issue because the article together with the pictures will take up to only a few megabytes. A difficulty may arise with the growth of interest and a large increase in the number of research in the field of Supersymmetry. The second issue is the license, on the basis of which the article is published. Since 2014, all newly published articles by CERN are Open Access. For all others, it is necessary to watch whether they are published under CC-BY, which will allow full use of the work in case of reference to the author [60]. This solution will violate the portal request, namely Completeness in section 4.1.2.2. The advantage of storing the full text is the independence of the sources of this data. In case of termination of the portal-source of articles, a copy of the text will remain, which will be fully accessible to the users of the portal.

The second way is to store a links to articles. The lines do not take up much space in the storage and are not covered by the license. However, this solution has a disadvantage depending on the portal-source of articles. In the event of a change of domain, a change of the link by the portal-source or a change on the website, it will be necessary to modify the script for tightening the information to suit the current state. In addition, all links on the SUSY portal will no longer be valid until the modified script is re-run. However, changing the domain or link does not happen often, so this problem is unlikely to occur.

Storing data requires having some database. The project is not commercial and does not have large resources. Therefore, possibility is to use the Firebase cloud, or CERN, or university database. These databases are easy to use because majority of the current programming languages have libraries implemented. Firebase has a free version and requires payment only for the actual storage space used.

5.2 Web portal

In the context of this work, it is possible to consider how to display the article, which will be understandable and familiar to future users. From this it can be deduced that the display of the article must be similarly known to popular services, which were mentioned in section 5.1.1. This means that each article will show hidden or unhidden abstract or a part of it, authors, source of publication, date of publication and tags or categories. A detailed wireframe and application design will be discussed in Chapter 6. Possibly technologies will be discussed in Section 5.4.
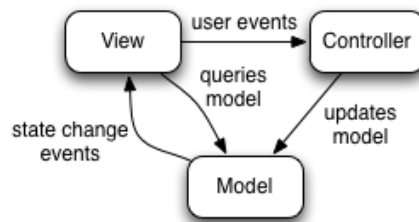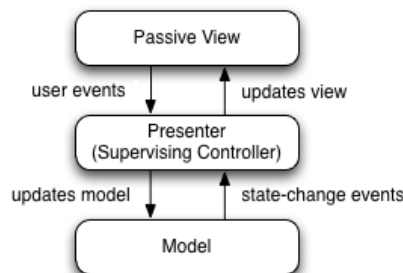
Figure 5.1: Model–view–controller diagram [61]

Figure 5.2: Model–view–presenter diagram [62]

5.3 Software architecture

This section presents a few well-known patterns of software architectures that can be used for implementations. Their advantages and disadvantages will be presented.

5.3.1 MVC

The MVC architecture is divided into 3 independent components, as shown in Figure 5.1. Each of these components has its own zone of responsibility and does not affect the others, which is the main advantage of this model. The Model is the core that controls the business logic, modifies the data, defines the rules of the application. The View is the representation of information in any form. The Controller converts input requests from the user to commands for view or model. The disadvantages are the larger number of technologies that need to be used and the navigation in the code becomes more complex.

5.3.2 MVP

MVP is a pattern that is similar to MVC. It has the same advantages and disadvantages. It has the same description for Model and View. The main difference is the last component, which is called Presenter. The Presenter

controls the communication between the View and the Model. The Presenter retrieves the data from the Model, then formats it for the View, which then displays the data, as shown in Figure 5.2.

5.4   Suggested technologies

It is proposed to use the MVC pattern, as it is implemented in most current popular frameworks and has a large base of information and code. The specific choice of programming language, framework and architectural pattern depends on experience and the choice of developer. This chapter offers a number of the most popular current frameworks and programming languages:

- Flask, Python

- Laravel, PHP

- Spring, Java

- React.js, Javascript

The proof of concept uses one of the offered solutions, Flask and Python, promoting higher speed. Python offers a powerful code base and it is consistent with the language of the script for searching, storing and categorizing the articles.

Category	Code of the url	Right / Wrong category
Direct S-Top production	PAPERS/SUSY-2018-12	Right
Direct S-Top production	PAPERS/SUSY-2018-31	Wrong
Direct S-Top production	CONFNOTES/ATLAS-CONF-2020-015	Wrong
Direct S-Top production	PUBNOTES/ATL-PHYS-PUB-2019-039	Wrong
Direct S-Top production	PUBNOTES/ATL-PHYS-PUB-2018-021	Right
Small mass differences	PAPERS/SUSY-2018-33	Wrong
Small mass differences	CONFNOTES/ATLAS-CONF-2016-076	Wrong
Small mass differences	PUBNOTES/ATL-PHYS-PUB-2018-031	Right
Small mass differences	PAPERS/SUSY-2018-16	Wrong
pMSMM	PUBNOTES/ATL-PHYS-PUB-2016-021	Wrong
pMSMM	CONFNOTES/ATLAS-CONF-2019-040	Right
pMSMM	PUBNOTES/ATL-PHYS-PUB-2017-014	Wrong
R-parity violation	PAPERS/SUSY-2018-09	Right
R-parity violation	PAPERS/SUSY-2017-04	Right
Long-lived particles	PAPERS/SUSY-2018-33	Right
Long-lived particles	PUBNOTES/ATL-PHYS-PUB-2019-013	Right
Long-lived particles	PAPERS/EXOT-2017-32	Wrong
Photonic signatures	PAPERS/SUSY-2017-01	Right
Displaced vertices	PUBNOTES/ATL-PHYS-PUB-2018-033	Right
Electroweak	PAPERS/SUSY-2019-08	Right

Table 5.7: Categorization algorithm test

Web portal design

This chapter presents a proposal for a future wireframe and portal design that meets functional and non-functional requirements. The tool for creating the wireframe and design is Adobe XD. The classic wireframe does not contain any colors and only points to the placement of various screen elements. In this work, it is created together with the design. It is intended for future developers. Creating a wireframe and design is necessary to be able to create the first impression of the application before development starts. Each screen contains a description and explanation of the element layout.

6.1 Layout and theme

The whole design of the web portal is unique and was created with regard to current trends in web design. The design was inspired by the well-known works of popular designers [63]. The design was created to comply with the four golden rules of UI design:

1. **Place users in control of the interface**. Searching for an article will allow to easily return to the previous state, web portal navigation is clear and self-evident.

2. **Make it comfortable for a user**. All elements help the user, the interface is simple because it does not contain unnecessary elements or content that does not help the user in any way, all names are understandable and obvious, the portal provides responses to all user actions, the portal does not enter the data already mentioned, it has a modern look and uses clear icons.
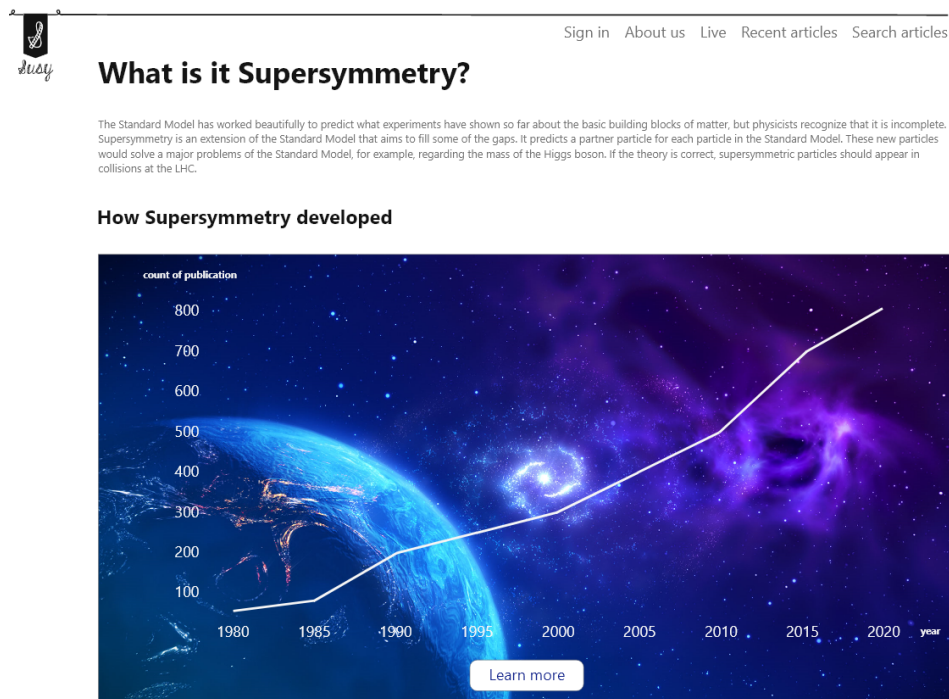
Figure 6.1: Home page, Logo, Menu and Graph

3. **Reduce cognitive load**. The number of actions to complete the goal is minimal, the portal is easy to read because it does not contain overloaded interfaces.

4. **Make user interfaces consistent**. The screen does not contain a lot of information at the same time, the screen elements are where the user expects them to be, screen elements look the same on all screens, screen elements work in the same way throughout the interface [64].

6.2   Web pages

This section describes a possible future wireframe and design of the screens. The design is aimed at both experts and potential visitors from the general public. The screens are available in the Adobe XD project file in the appendix.

6.2.1   Home page

The home page contains 3 main figures, which will be gradually explained in the text. Figure 6.1 shows the top of the Home page, which shows Logo, Menu, and Graph. The Logo was created in this project and it is a common part of each screen. The Logo matches the style of the screens and complement the top

of the screen. The title of the Logo aims to create an informal relationship and add relaxation between the user and the web portal. This is achieved by using the word SUSY, which is informally used by scientists when talking about Supersymmetry. The Logo is also a link to the Home page. It is widespread practice and many users expect this functionality, which accelerates their work.

On the right side the Menu is shown, which is shared with several other screens. The menu consists of a "Sign In" link that redirects users to the Log In page described in section 6.2.2, "Search articles", which redirects users to the Search Articles page described in section 6.2.3. Other links are internal. This means that when user clicks on this link, the user stays on the same page, but his position inside the page changes. The "About us" link leads to the About us section of the main page. For "Recent articles" and "Live", it works analogously.

This is followed by section "What is Supersymmetry?" that contains the basic information about Supersymmetry as a theory. This section is aimed at users who are not experts in the field. The area is designed and will be filled with information for a typical user or a user with a focus on expanding knowledge in Supersymmetry. The text must be short and interesting so that the user remains motivated to find the information himself.

The last part of Figure 6.1 is a graph that shows how Supersymmetry develops over time. The graph shows the growth or decline in the number of publications in this area over time, which may indicate the interest of scientists in this theory and may help to make predictions of future research. The "Learn More" button directs the user to the Learn More page, which is described in section 6.2.5. After clicking on the year on the chart, the Search Articles page will be displayed with the articles that were created in the year that the user choose. The cosmic design was chosen to attract the user's attention.

The following section is outlined in Figure 6.2. This section aims to acquaint users with the latest articles and the latest categories in which articles were published in the field of Supersymmetry. This section speed ups the access to the latest articles, which allows the user to skip the search for the latest articles.

Then follows a section with videos or articles, named "Life of Scientists", which is mostly aimed at the general public. The video can be a simulation of an experiment or an interview with a well-known scientist or any video from CERN's YouTube channel [50]. The link to this video will also increase the popularity of CERN's YouTube channel. The included articles could provide information about Supersymmetry for the general public.

Figure 6.3 shows the "About us" section, which contains brief information about who are the authors of this portal, what CERN does, how the project was created, and how to contribute to this project if a user becomes interested.

The last part of the Home page is the section with a copyright note.
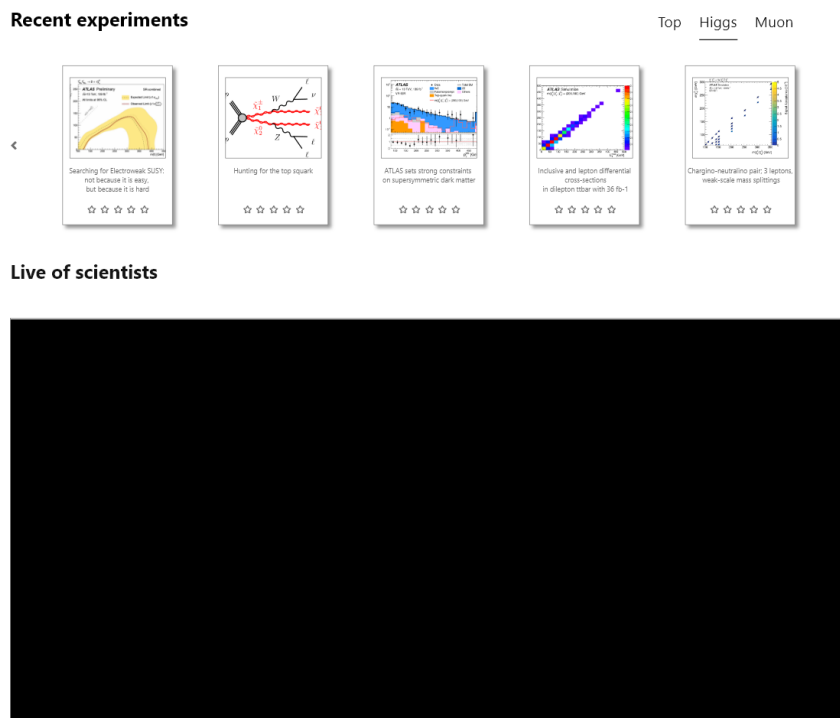
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Recent experiments   Top   Higgs   Muon

Figure 6.2: Home page, Recent Experiments and Life of Scientist

6.2.2   Sign In and Sign Up pages

The Sign In page is shown in Figure 6.4. This page contains the Logo described in section 6.2.1. The design and layout of the elements are the same for the Sign In page and the Sign Up page and therefore only one page is presented in this work. The page defines the basic types of user login using email and password (text boxes and the "Continue" button) or social sites (social network logo on the right side of the area under the button). The page also contains a link to the Sign Up page, which has a link back to this page with the same layout. The design takes the form of a person who gives brief instructions. The same is true for the Sign Up page with the changed instruction. This is done with a focus on establishing communication between the user and the web portal.

▶| ◀)) 0:00 / 10:58
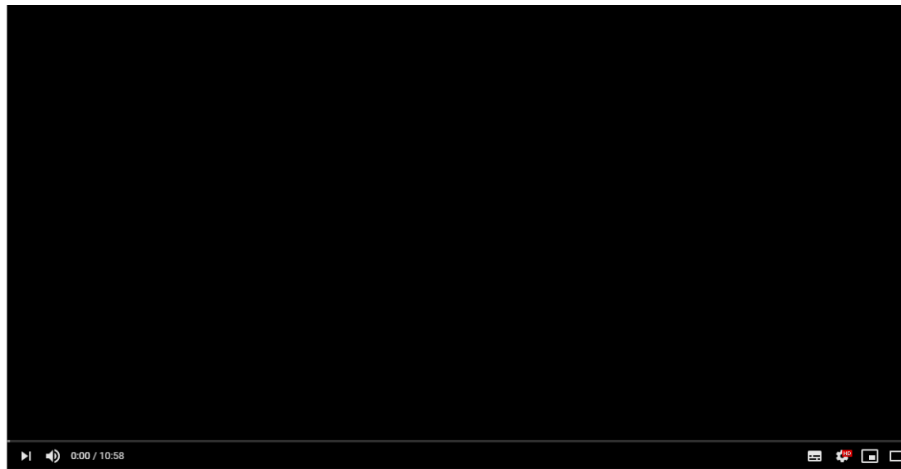
About us

We are a small development team that has created this web portal to make it easy to find new experimental results about Supersymmetry. Here are the latest experiments collected from the ATLAS and CMS detectors. The goal of the portal is to create an amazing resource for scientists. The secondary goal is to attract the public to theories such as Supersymmetry and to science in general.

Copyright © 2020 CERN
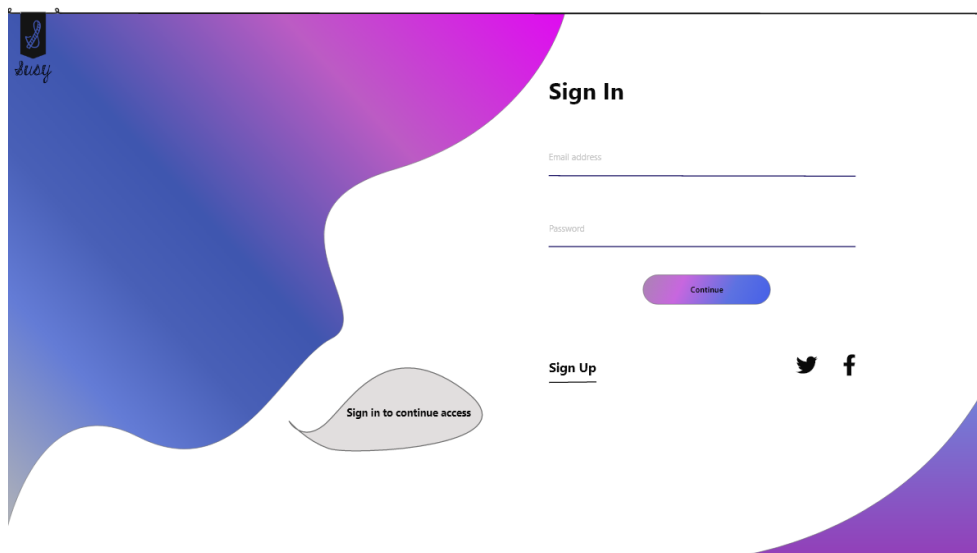
Figure 6.3: Home page, About Us and Copyrighting

Figure 6.4: Sign In page

Figure 6.5: Search articles page

6.2.3   Search Articles page

The article search page is shown in Figure 6.5. The page inherits the Logo and the Menu from the Home page. The default page shows all articles sorted by date. Sorting is available by changing the direction of the arrows and an explanatory title between the fixed search article and the search field.

The section above the areas with sorting elements contains filters and searches. Filters consist of controls for each of the article division methods. Figure 6.5 contains an example of a breakdown by year, author and unique categorizations defined in section 5.1.3. In case of the introduction of new article divisions, this section will be supplemented with new filters. When a user clicks on any filter, a drop-down menu with predefined values will appear. There is a possibility to fill in these shelves as in the search box, which is located to the left of the filter and searches in the titles and abstracts of the article with the help of keywords.

The last and largest section of this page is the Search Results section. The results are limited to the filters described in the section above. Each section represents one article. The article consists of the title, author, year of publication, and part of the abstract. All these parts are necessary and speed up the unambiguous identification of the article and its search. The design is minimalist and similar to Google Scholar, so the user quickly gets used to it.

Figure 6.6: Admin page

6.2.4 Admin page

The Admin page is shown in Figure 6.6. The page inherits the design and layout of the element from the Search page, which is described in section 6.2.3. The main difference in the section is that each article is listed on the right. This section allows a user who is logged in with the administrator role to change article categories. A button can be added to delete an article from the database. The administrator section also receives request from users regarding change of category. The button in the lower right corner applies to all changes made by the administrator.

6.2.5 Learn More page

The last of the presented pages is the Learn More page shown in Figure 6.7. The user moves to this page if he clicks on the "Learn More" button on the Home page. This page contains Logo, Copyright notes and two additional sections. One section serves to acquaint the user with the history of the theoretical discovery and development of Supersymmetry. The second section will provide the user with a current prediction of the future development of Supersymmetry. In addition, both sections contain brief and interesting information to engage users in the topic. Both sections contain links to other sources or potential future pages of this portal with more detailed explanations of history or predictions.

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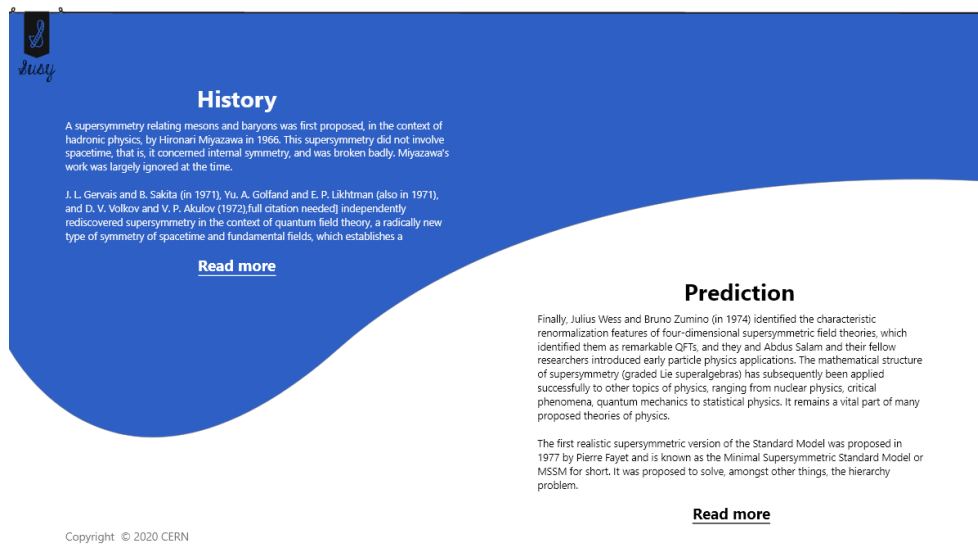
Figure 6.7: Learn More page

6.3 Additional features

If the variant with the display of saving the link to the article is rejected and the option of saving and displaying the entire article is chosen, it makes sense to create a page with an explanation of all terms and abbreviations used in the articles. This page will be like the Search Articles page, described in section 6.2.3, with a difference in search results. The search box seeks for the name of phenomenon or abbreviation and provides detailed information about it to the user or a link to the page where it is explained. Another variant is to display an explanation of the term when the mouse is over a term in the text.

Testing

Each software must be tested because software bugs could be expensive and dangerous. This chapter aims to describe how the web portal on Supersymmetry will be tested. The later the bug is discovered, the more expensive it will be to fix it. Therefore, testing must start as soon as possible. According to the plan in Figure 4.1 testing will be performed in parallel with the software development. This will reduce the cost of the project and the likelihood of technical risks.

7.1 Design testing

Design testing will be done first. Current tools such as Adobe XD allow designer to create a clickable prototype that simulates to some extent the operation of the portal. It is basically a PDF file. When the user clicks on some part of the prototype, the page or part of the page of this prototype will be displayed. This allows the client to see what the product looks like before the start of its implementation. Changes to the project at this stage are the least time and resource consuming.

7.2 Unit tests

Unit testing is a level of software testing where individual units/components of a software are tested. The purpose is to validate that each Unit of the software performs as designed [65]. The Unit test is a trial that checks some small part of large software product. A small part can be considered functions in procedural programming, the class method in object-oriented programming or the whole program. The choice of the size of this small part depends on the developer and the project. The Unit tests are important in case of frequent changes of the application because they can reveal errors that occurred during these changes. As this portal may change in the future in case of extensions

of functionality or modifications will serve to check the correct functioning of the system especially in case of work on the portal by another developer. For example, possible change are the web portal-source of articles. Each technology described in section 5.4 contains a framework for quickly and efficiently creating Unit tests.

7.3 Functional manual testing

Functional testing is a type of software testing that validates the software system against the functional requirements/specifications. The main goal of this type of testing is to verify the proper functioning of some functionality according to predefined inputs and outputs [66].

Manual testing is a type of software testing where testers manually execute test cases without using any automation tools [67].

Functional manual tests will be suitable for the purpose of testing the Supersymmetry portal. The tests verify the basic functionality of every possible use of the system and are suitable for future automatizing.

7.4 Categorization testing

The most uncertain part of the system is categorization, and therefore, it requires special attention. At the beginning, each categorized article must be checked by an expert so that the algorithm correctly calculates the coefficients for keywords. In the case of a poorly classified category, it must be changed and the algorithm will recalculate the word values. To check and train the correct behavior of the algorithm, the expert must prepare training data (known output $\rightarrow$ keyword determination), validation data (known output that the algorithm does not know $\rightarrow$ comparison of expected and real results) and test data (known output $\rightarrow$ success is measured categorization). This data is usually in a ratio of 50:25:25, 60:20:20 or 70:15:15 [68].

Conclusion

This thesis aimed to analyze the feasibility and to find the best way to create a web portal on Supersymmetry, which will provide information about this theory to experts. The focus is on experimental searches for Supersymmetry. As an additive research element, the usefulness to the general public has been studied and analysed.

The first chapter contains an executive summary of this feasibility study.

The Supersymmetry chapter explains the basic concept of the theory of Supersymmetry, the organization CERN, LHC and its detectors necessary to understand other chapters of the work.

The theoretical framework of the analysis chapter explains all the concepts, methods, programs and algorithms that are used in the practical part of this work and that are necessary to understand it.

The Analysis chapter provides a full analysis of the feasibility. Part of the analysis is an interview, definition of the requirement based on the interview, division of these requirements into functional and non-functional, their validation using the FURPS+ method. The market and competition were briefly analyzed and a situation analysis was performed using the SWOT method. The expected number of users, work estimates and costs based on the created roadmaps were calculated. The methods of the advertising portal and its usefulness to the public were investigated. The benefits of the portal outweigh the risks. Therefore, the feasibility and usefulness of the proposed web portal is determined as positive.

The Technical Realization chapter offers ways to create a portal. It starts with filling in a database that has two variants. The first one is to store a link to articles, the second one is to store an entire article in PDF format. The most complex part of this chapter is the article categorization section, which must be properly trained and can use a neural network. It discusses how articles will be presented and technologies and software architectures are recommended.

The Web portal design chapter offers the reader a look at the future layout

of the screen element and the design of the web pages. The chapter also explains the selection of the element design and offers additional features.

The Testing chapter argues the need to test the portal and provides concepts, methods and tools for its implementation.

This thesis provides a detailed analysis and proves that the project is feasible. At the same time, it serves as a detailed proposal for the implementation of the future portal and its design. The project is not limited and can be extended when additional features are required.

Bibliography

[1] Zeng, J.; An, M. *Application of a fuzzy based decision making methodology to construction project risk assessment.* [online], 2007, [cit. 2020-05-27]. Available from: `https://doi.org/10.1016/j.ijproman.2007.02.006`

[2] Sopczak, A. *SUSY (ATLAS).* [online], 2020, [cit. 2020-07-03]. Available from: `https://arxiv.org/abs/1712.10165`

[3] CERN. *Supersymmetry.* [online], 2020, [cit. 2020-06-10]. Available from: `https://home.cern/science/physics/supersymmetry`

[4] Miyazawa, H. *Baryon Number Changing Currents.* [online], 1966, [cit. 2020-06-11]. Available from: `https://academic.oup.com/ptp/article/36/6/1266/1821704`

[5] Gervais, J.; Sakita, B. *Field theory interpretation of super-gauges in dual models.* [online], 1971, [cit. 2020-06-11]. Available from: `https://www.sciencedirect.com/science/article/pii/0550321371903518?via%3Dihub`

[6] Friedan, D.; Qiu, Z.; et al. *Conformal Invariance, Unitarity, and Critical Exponents in Two Dimensions.* [online], 1984, [cit. 2020-06-11]. Available from: `https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.52.1575`

[7] Charitos, P. *Where is Supersymmetry?* [online], 2016, [cit. 2020-06-11]. Available from: `https://ep-news.web.cern.ch/content/where-supersymmetry`

[8] Csaki, C. *The Minimal Supersymmetric Standard Model (MSSM).* [online], 1996, [cit. 2020-06-11]. Available from: `https://arxiv.org/abs/hep-ph/9606414`

[9]   Strassler, M. *The Hierarchy Problem.* [online], 2014, [cit. 2020-06-12]. Available from: `https://profmattstrassler.com/articles-and-posts/particle-physics-basics/the-hierarchy-problem/`

[10] CERN. *About CERN.* [online], 2020, [cit. 2020-06-12]. Available from: `https://home.cern/about`

[11] CERN. *Accelerators.* [online], 2020, [cit. 2020-06-13]. Available from: `https://home.cern/science/accelerators`

[12] ATLAS Collaboration. *ATLAS.* [online], 2020, [cit. 2020-06-13]. Available from: `https://home.cern/science/experiments/atlas`

[13] CMS Collaboration. *CMS.* [online], 2020, [cit. 2020-06-13]. Available from: `https://home.cern/science/experiments/cms`

[14] CERN. *High-Luminosity LHC.* [online], 2020, [cit. 2020-06-13]. Available from: `https://home.cern/science/accelerators/high-luminosity-lhc`

[15] CERN. *Longer term LHC schedule.* [online], 2016, [cit. 2020-06-13]. Available from: `https://lhc-commissioning.web.cern.ch/schedule/LHC-long-term.htm`

[16] CERN. *Future Circular Collider.* [online], 2020, [cit. 2020-06-13]. Available from: `https://home.cern/science/accelerators/future-circular-collider`

[17] Kenton, W. *Feasibility Study.* [online], 2019, [cit. 2020-06-07]. Available from: `https://www.investopedia.com/terms/f/feasibility-study.asp`

[18] Justis, R. T.; Kreigsmann, B. *The feasibility study as a tool for venture analysis. Business Journal of Small Business Management 17.* [offline], 1979, [cit. 2020-05-19].

[19] Peace, N. *Feasibility study and Entrepreneurial Success: Evidence from Selected Manufacturing Firms in Anambra State.* [online], 2018, [cit. 2020-05-19]. Available from: `https://www.researchgate.net/publication/327100666_Feasibility_Study_and_Entrepreneurial_Success_Evidence_from_Selected_Manufacturing_Firms_in_Anambra_State`

[20] Svozilová, A. *Projektový managment 2., aktualizované a doplněné vydání.* [online], 2011, [cit. 2020-05-20]. Available from: `http://content.ereading.cz/preview?partnerId=1&contentId=4383&format=pdf&filename=projektovy-management_nahled.pdf&forced=0`

58

[21] Definitions.net. STANDS4 LLC. *Situation analysis.* [online], 2020, [cit. 2020-05-21]. Available from: `https://www.definitions.net/definition/situation+analysis`

[22] Bolt, T. *Conducting a SWOT Analysis, Feasibility Study for Your New Business.* [online], 2017, [cit. 2020-06-07]. Available from: `https://lawblog.vilaw.com/2017/08/articles/business/conducting-a-swot-analysis-feasibility-study-for-your-new-business/`

[23] Morrison, M. *SWOT analysis (TOWS matrix) Made Simple.* [online], 2016, [cit. 2020-05-23]. Available from: `https://rapidbi.com/swotanalysis/#IntroductiontoSWOT`

[24] Náplava, P. *Přednáška (4. 10. 2019) - Implementace formou projektu, procesní řízení.* [online], 2019, [cit. 2020-05-23]. Available from: `https://moodle-vyuka.cvut.cz/pluginfile.php/169948/mod_page/content/4/Prednaska02.pdf`

[25] Center of Excellence for Professional Development. *What is FURPS+?* [online], 2014, [cit. 2020-05-24]. Available from: `https://businessanalysttraininghyderabad.wordpress.com/2014/08/05/what-is-furps/`

[26] Eeles, P. *Capturing Architectural Requirements.* [online], 2005, [cit. 2020-05-24]. Available from: `https://www.ibm.com/developerworks/rational/library/4706.html`

[27] Samadhiya, D.; Wang, S.-H.; et al. *Quality models: Role and value in software engineering.* [online], 2010, [cit. 2020-05-24]. Available from: `https://www.semanticscholar.org/topic/FURPS/1703228`

[28] Flyvbjerg, B.; Budzier, A. *Why Your IT Project May Be Riskier Than You Think.* [online], 2011, [cit. 2020-05-24]. Available from: `https://hbr.org/2011/09/why-your-it-project-may-be-riskier-than-you-think`

[29] Corporate Finance Institute. *Project Evaluation Review Technique (PERT).* [online], 2020, [cit. 2020-05-24]. Available from: `https://corporatefinanceinstitute.com/resources/knowledge/other/project-evaluation-review-technique-pert/`

[30] Maserang, S. *Project Management: Tools & Techniques.* [online], 2002, [cit. 2020-05-25]. Available from: `http://www.umsl.edu/~sauterv/analysis/488_f02_papers/ProjMgmt.html`

[31] Lawrence, D. *Program Evaluation and Review Technique: Applications in Education.* [online], 2020, [cit. 2020-06-07]. Available from:

```
https://books.google.cz/books?hl=en&lr=&id=02NGAQAAMAAJ&oi=
fnd&pg=PA4&dq=Program+evaluation+and+review+technique&ots=
e_HNK8tAQU&sig=J2SSVTKLEb2Ak_sq2Z0NgnuTR6c&redir_esc=y#v=
onepage&q=Program%20evaluation%20and%20review%20technique&f=
false
```

[32] Stránská, M. *Techniky pro odhad časové A nákladové naročnosti projektu používané v praxi.* [online], 2008, [cit. 2020-05-26]. Available from: `https://is.vspj.cz/bp/get-bp/student/12890/thema/460`

[33] Wrike, Inc. *What is a Roadmap in Project Management?* [online], 2020, [cit. 2020-05-26]. Available from: `https://www.wrike.com/project-management-guide/faq/what-is-a-roadmap-in-project-management/`

[34] Blažková, M. *Marketingové řízení a plánování pro malé a střední firmy.* [online], 2007, [cit. 2020-05-26]. Available from: `https://books.google.cz/books?id=u13toatW6bEC&pg=PA43&source=gbs_selected_pages&cad=3#v=onepage&q&f=false`

[35] Lavanya, N.; Malarvizhi, T. *Risk analysis and management a vital key to effective project management.* [online], 2008, [cit. 2020-05-27]. Available from: `https://www.pmi.org/learning/library/risk-analysis-project-management-7070`

[36] Yordanov, V. *Introduction to Natural Language Processing for Text.* [online], 2018, [cit. 2020-05-27]. Available from: `https://towardsdatascience.com/introduction-to-natural-language-processing-for-text-df845750fb63`

[37] Cambridge University Press. *Stemming and lemmatization.* [online], 2008, [cit. 2020-05-27]. Available from: `https://nlp.stanford.edu/IR-book/html/htmledition/stemming-and-lemmatization-1.html`

[38] Subramanian, S. *NoSQL: An Analysis of the Strengths and Weaknesses.* [online], 2012, [cit. 2020-06-10]. Available from: `https://dzone.com/articles/nosql-analysis-strengths-and`

[39] Google. *Firebase Realtime Database.* [online], 2020, [cit. 2020-05-28]. Available from: `https://firebase.google.com/docs/database`

[40] Adobe. *Adobe XD.* [online], 2020, [cit. 2020-06-04]. Available from: `https://www.adobe.com/products/xd.html`

[41] Sen, R. *Optimal Search Engine Marketing Strategy.* [online], 2005, [cit. 2020-06-04]. Available from: `https://www.researchgate.net/publication/262161595_Optimal_Search_Engine_Marketing_Strategy`

[42] CERN. *ATLAS Homepage.* [online], 2020, [cit. 2020-07-10]. Available from: `https://atlas.cern/`

[43] CERN. *CERN Document Server.* [online], 2020, [cit. 2020-07-10]. Available from: `https://cds.cern.ch/?ln=en`

[44] Cornell University. *arXiv.org.* [online], 2020, [cit. 2020-07-10]. Available from: `https://arxiv.org/`

[45] CERN. *ATLAS The Collaboration.* [online], 2020, [cit. 2020-10-14]. Available from: `https://atlas.cern/discover/collaboration`

[46] CERN. *CMS The Collaboration.* [online], 2020, [cit. 2020-10-14]. Available from: `https://cms.cern/collaboration`

[47] Serpstat. *Serpstat.* [online], 2020, [cit. 2020-06-25]. Available from: `https://serpstat.com/keywords/index/?search_type=keyword&query=supersymmetry&se=g_us#search_product_google`

[48] Similar Web. *Similar Web.* [online], 2020, [cit. 2020-06-25]. Available from: `https://www.similarweb.com/website/cds.cern.ch/`

[49] CERN. *CERN Homepage.* [online], 2020, [cit. 2020-07-10]. Available from: `https://home.cern/`

[50] CERN. *CERN Youtube channel.* [online], 2020, [cit. 2020-07-07]. Available from: `https://www.youtube.com/c/CERN/videos`

[51] Google. *Google Analytics.* [online], 2020, [cit. 2020-07-10]. Available from: `https://analytics.google.com/analytics/`

[52] ResearchGate. *ResearchGate Scientific Advertising.* [online], 2020, [cit. 2020-06-27]. Available from: `https://solutions.researchgate.net/advertising/`

[53] Google. *Google Scholar.* [online], 2020, [cit. 2020-07-04]. Available from: `https://scholar.google.de/schhp?hl=en&as_sdt=0,5`

[54] Microsoft. *Microsoft Academic.* [online], 2020, [cit. 2020-07-04]. Available from: `https://academic.microsoft.com/home`

[55] Clarivate. *Web of Science.* [online], 2020, [cit. 2020-07-04]. Available from: `https://apps.webofknowledge.com`

[56] American Physical Society. *American Physical Society Sites.* [online], 2020, [cit. 2020-07-04]. Available from: `https://journals.aps.org/search/`

[57] The DØ Collaboration. *The DØ Collaboration's Publications.* [online], 2014, [cit. 2020-07-04]. Available from: `https://www-d0.fnal.gov/d0_publications/`

[58] The DELPHI Collaboration. *DELPHI Papers.* [online], 2010, [cit. 2020-07-04]. Available from: `http://delphi-www.web.cern.ch/delphi-www/pubxx/papers/public/papers.html`

[59] CERN. *CERN Document Server.* [online], 2020, [cit. 2020-07-04]. Available from: `http://cds.cern.ch/`

[60] Creative Commons. *Creative Commons.* [online], 2020, [cit. 2020-10-13]. Available from: `https://creativecommons.org/licenses/by/2.0/`

[61] Google Web Toolkit. *Model–view–controller.* [online], 2020, [cit. 2020-07-05]. Available from: `http://www.gwtproject.org/articles/testing_methodologies_using_gwt.html`

[62] Google Web Toolkit. *Model–view–presenter.* [online], 2020, [cit. 2020-07-05]. Available from: `http://www.gwtproject.org/articles/testing_methodologies_using_gwt.html`

[63] Dribbble. *Dribbble web page.* [online], 2020, [cit. 2020-07-06]. Available from: `https://dribbble.com/`

[64] Babich, N. *The 4 Golden Rules of UI Design.* [online], 2019, [cit. 2020-07-06]. Available from: `https://xd.adobe.com/ideas/process/ui-design/4-golden-rules-ui-design/`

[65] Software Testing Fundamentals. *Unit Testing.* [online], 2020, [cit. 2020-07-09]. Available from: `http://softwaretestingfundamentals.com/unit-testing/`

[66] Guru99, Inc. *What is Functional Testing? Types & Examples (Complete Tutorial).* [online], 2020, [cit. 2020-07-09]. Available from: `https://www.guru99.com/functional-testing.html`

[67] Guru99, Inc. *Manual Testing Tutorial for Beginners: Concepts, Types, Tool.* [online], 2020, [cit. 2020-07-09]. Available from: `https://www.guru99.com/manual-testing.html`

[68] Jiřina, M. *Neuronové sítě.* [online], 2020, [cit. 2020-07-09]. Available from: `https://courses.fit.cvut.cz/BI-ZNS/media/lectures/bi-zns-10.pdf`

Acronyms

CERN European Organization for Nuclear Research

CSS Cascading Style Sheets

CZK Czech koruna

DB Database

HTML HyperText Markup Language

JSON JavaScript Object Notation

LHC Large Hadron Collider

MD Man-Day

MSSM Minimal Supersymmetric Standard Model

MVC Model–view–controller

MVP Model–view–presenter

NLP Natural Language Processing

NoSQL Non Structured Query Language

PERT Project Evaluation Review Technique

TF-IDF Term Frequency–Inverse Document Frequency

SDK Software Development Kit

SEO Search Engine Optimization

SEM Search Engine Marketing

SQL Structured Query Language

SUSY Supersymmetry

UI User Interface

URL Uniform Resource Locator

Interview questions

1. What purpose should you use the website for? What are its benefits for you?

2. What categories would you like to filter experiments?

3. Would you like to see on the web only theory and experiments, or maybe also biography and pictures of scientists working on it?

4. What competitors do you know in addition to the Atlas and CMS?

5. What are the 3 characteristics for the website of SUSY that are important for you?

6. Will visitors of the website need something special? Several languages for example.

7. Do you want to exclusively implement automatic filling, or also manually adding articles?

8. Why do you think the user must use our website? What special features / content it will contain?

9. Will you need a mobile application in the future?

10. In the future, would you like to see on the website not only information about SUSY?

11. To attract the public we could make simulation of experiments or add scientists popular video. How do you treat it?

12. Do we need the system of likes and comments?

13. According to my observation, all articles about experiments have the same structure. Is it true?

14. What else do you think?

Contents of enclosed CD

```
readme.txt ...................... the file with CD contents description
design ............. the directory of Adobe XD project and pdf of thesis
    prototype.xd ........................... the Adobe XD project file
    prototype.pdf ....................... the prototype in pdf format
src .................................... the directory of source codes
    thesis ............. the directory of LaTeX source codes of the thesis
    proof_of_concept.py .... extracting, categorizing and storing articles
      script
    web_portal ................ the directory of web portal source codes
text ....................................... the thesis text directory
    thesis.pdf ........................... the thesis text in PDF format
```