



# Problem Solving Skill Shortage

## Designing Digital Business Innovation Lab

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# 1 INTRODUCTION

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The present project "Problem solving skill shortage" took place as part of the *Designing Digital Business Innovation* course at *Politecnico di Milano* in cooperation with the company *Zucchetti* in the second semester of the academic year 2019/2020.

This report aims to document and explain the project methodology, analysis, and outcome in detail. Therefore, the problem with its context as well as the overall goals is defined in the next section. It will be followed by introduction to the *Zucchetti* Group, the methodology used and the description of the project procedure and organizational aspects in detail. The following analysis will deepen the insight into problem solving skill as a demand of companies and serves as preparatory work for our solution approach in Chapter 5. Finally, the report will give a concluding summary of the findings and suggest future directions.

## 2 PROBLEM SETTING AND CONTEXT

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"Problem-solving" is the soft skill with the greatest shortage compared to the

demands of companies. But it could also be strong demand from companies for "smart" people and the real shortage is the lack of "intelligence". As mentioned in the report of QS 2019 Global Skills Gap Report, problem-solving skill is the biggest problem of Human Resources in the modern era because it is challenging to find and detect the problem-solving skill.

*Zucchetti* is the largest producer of software for HR in Italy, their programs have a procedure for candidate selection and for continuing training of employees. The open questions to which we seek answers to improve for these HR products are:

**Q1.** *Is it possible to teach "Problem Solving" as required by companies?*

**Q2.** *If it is partially teachable, is it possible to select the candidates with the highest attitude towards "Problem Solving"?*

**Q3.** *Can Artificial Intelligence provide tools and methods to improve a person's natural problem solving skills?*

These were the questions/goals we were addressed and tried to solve within this project. Validity is at the top of what we consider when developing solutions for these project questions. Therefore, while searching for solutions, an intensive literature review is planned on solutions that are academically approved or accepted in the industry.

### 3 ZUCCHETTI GROUP

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First of all, before presenting the analysis it is crucial to have knowledge of the Zucchetti Group in order to develop a better fitting solution for the company. For this matter, it's vital to align our solution with Zucchetti's vision and also, to reach our final goal, that is to enhance the company even further.

Zucchetti was born in 1978 in Italy and didn't take long to operate all around the world with its innovative services. Zucchetti is a B2B company that achieved excellence by selling IT solutions to their customers, guaranteeing them competitive advantages and a reliable partner. Zucchetti Group has a wide collection of products and services provided, offering software and hardware solutions for all types of operations requested by their customers, amongst them, we can highlight: HR, business management software, BI & analytic, safe and security and a lot more.

Specific to our project, we are going to explore Zucchetti's HR solutions since it is the section of the company in which our project is going to impact. Our group is trying to provide a new type of assessment and teaching solution to employees, by trying to create new methods which were not previously used by the company. Particularly to their HR products, Zucchetti already has solutions to administer new

employees, and as they state, they are constantly looking for new talents. For this reason, our objective is to complement Zucchetti's HR sector by implementing tools to check people's problem solving skills. Equally important are their training solutions, which need to be up-to-date in an always changing world. Once again, the focus is to complement an already valid mechanism by introducing one new feature to it, that is the teaching of complex problem solving skills.

Last but not least, it is important to mention that our meetings with the company had the presence of Gregorio Piccoli, Chief Technology Officer & Board Member at Zucchetti. His presence proved to be certainly helpful because of his deep technical and management experience in the development of software solutions, guiding us throughout the project providing us valuable knowledge.

### 4 APPLIED METHODOLOGY

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This section will describe the project steps followed by our team, the specifying tools and methodologies used in order to achieve the final solution.

In the beginning of the project, a rough schedule of the project steps was made to organize ourselves, which can be seen in group work, reviews and most important, the milestones.

In the first phase, the team had to do a great amount of literature reading in order to gather some useful information to first attack this problem since most of the members were not familiar with problem solving skill (PSS) and how to assess it. For this reason, the first two weeks of the project were dedicated to acknowledge how the current situation of assessment of PSS is and, additionally, why companies are struggling to find a valid measurement system. Later to that, we had the kick-off meeting with Zucchetti, held by Mr. Piccoli, which we were hopeful that he would show us some light and, also, point out what he was expecting from us. As a result of that meeting, we had an objective well defined and, now, we were able to filter what we currently had read in the articles to focus on a solution. Without delay, we organized ourselves to establish goals to reach throughout the time frame available to deliver the final solution. Therefore, we used two main software to coordinate the project, first one was **Google Drive** which is appropriate to organize and share important documents and, additionally, the second software was **Trello**, a tool that is certainly convenient in order to organize schedules, assign tasks and set milestones.

After the first research phase and group meetings, we came up with an agreement that the MicroDYN and MicroFIN frameworks were the best solutions and fit perfectly to our purpose,

henceforth we started a deep dive in those solutions. Notably, these methods were already acknowledged by several studies, therefore we could reliably adopt them for our solution. To certify this approach, we presented this idea to Mr. Piccoli in our second meeting with him, who was genuinely looking forward to seeing more about the Minimal Complex Systems (MCS) and the related frameworks. Consequently, we contacted the *German Institute for International Education Research* to have access to the *CBA item builder*, which is a software that perfectly matches our needs. The CBA item builder is a tool that makes it possible to create MCS in a truly simple coding language, additionally it offers algorithms aiding the evaluation of the assessment results, making it possible to customize our own assessment. With all these in hand, we needed to start using already acknowledged methods to expose our ideas and to consolidate it, which will be better detailed on the Analysis Chapter.

Working further on these ideas, we defined our solution's **Vision, Mission and Purpose** to establish our principles and goals firstly. Secondly, we defined that we were going to apply a **Market Driven Approach** since the project started with the observation that the market has an unfulfilled need for PSS. To better understand the current situation and the expected situation for an assessment method of CPS we used the



**Re-positioning Map**, to clarify that we are going for an innovative approach different from the traditional ones. Furthermore, in order to define what would be the best solution for the market, we had to understand the current situation of this industry and the market. Consequently, we used frameworks such as **Internal and External Analysis** to develop our **SWOT Matrix**. As a result, our group was able to establish where our solution could create value. Then, we tested our solutions with an **Expert Opinion Questionnaire** based on **Lean Startup Approach**. Since our solutions are validated and adjusted according to the feedbacks, we applied the **Value Proposition Canvas** to explicit the relationships between the solution and the Zucchetti's HR customers. Later on, the

**Business Model Canvas** was drafted to figure out how all the operations were going to be executed. By illustrating a **Customer Journey**, we explained the possible routes that the customers may find in the process of acquiring our solution. Finally, thinking of the next steps of the development of our solution, we drafted the **Gantt Chart**, listing the milestones that will be set for the project in the future. Equally important is the draft of the **Strategic Plan**, that allows to have a visualization of the project in a long term perspective. In conclusion, technical and managerial information will be given to Zucchetti in order for them to implement the reliable and valid measurement system.

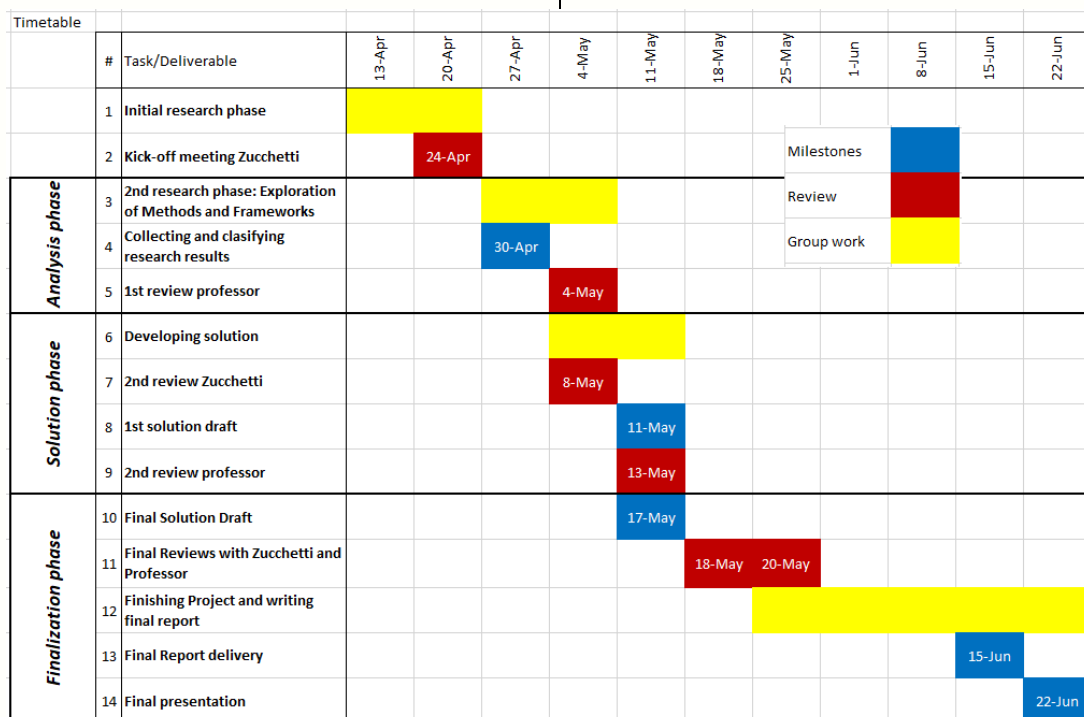


Figure 1- Gantt Chart

## 5 ANALYSIS

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The following section describes the current situation, external analysis based on the findings of PEST and an extensive literature review in the context of problem solving methods, construct and formal frameworks of CPS (complex problem solving).

### 5.1 CURRENT SITUATION

In order to contribute to the increase of the collaboration of the whole workforce, Zucchetti offers HR Portal, a profiled portal available via web from desktop and mobile for the HR department, the managers and the employees.

Zucchetti has a perception of the company as to where each element (employees, managers, external collaborators, guests) is connected and part of a unique management system. For this reason, Zucchetti created specific tools for the assessment of different skills in the companies, which is a platform with a unique database that integrates all the processes involving people. Since the HR side and acquiring the correct skill is the main focus of the project, we can analyse the application of the tools in HR:

- Manage employee's data, training, medical exams and deadlines in a unique database
- Enable the access only to the personnel specifically qualified in training and safety.

Zucchetti uses a system called Logica to measure candidates' problem-solving ability. The difficulties of the questions in Logica vary according to the correct answer rate of the candidate. Right or wrong answers given over a period of time affect both the difficulty of the questions and the duration of the test. The system operated in the background makes these calculations and adjustments in numerical ways. Even though the method of Zucchetti seems effective and common in the industry, the success rate of the tools can be low in terms of assessing problem solving skills, which is the reason Zucchetti conducted this research.

As can be seen, the solution of Zucchetti in HR takes the company with all departments and offers an improved solution to connect all the actors. However, it is lacking in the areas subject to measuring or teaching the desired real skills such as problem solving skills, that's where the main improvement is targeted. Since Zucchetti uses AI only for small adjustments in the assessment tasks, it could be a reference point for improvements. The more suitable measurement & teaching tools and AI could reshape the solution of the company from many different dimensions.

### 5.2 EXTERNAL ANALYSIS

Goal of this analysis is to understand the environment. In this case, the PEST method is used. This methodology is used as a tool by companies to track the environment

they're operating in. In addition, if they are planning to launch a new project/product/service, the tool is also useful. PEST acronym stands for factors such as: Political, Economic, Social, and Technological. In this section, factors that affect the Assessment and the Training solution will be examined. It should also be noted that the current COVID-19 pandemic is very influential and affects many factors.

- Political Factors: According to Eurostat, which is the statistical office of the European Union, European Commission currently revised some of the existing guidelines for employment policies for member states. Changes are done for the following guidelines:

Guideline 5: Boosting the demand for labour

Guideline 6: Enhancing labour supply and improving access to employment, skills and competences

Guideline 7: Enhancing the functioning of labour markets and the effectiveness of social dialogue

Guideline 8: Promoting equal opportunities for all, fostering social inclusion and fighting poverty

Especially changes in the 6th guideline emphasizes the importance of the need for a proper tool for assessment of complex problem solving in the hiring process.

- Economic Factors: COVID-19 has changed the economic situation. UNDP stated that in its article called "COVID-19 Socio-economic Impact" (2020) "The COVID-19 is affecting societies and economies at their core. While the impact of the pandemic will vary from country to country, it will most likely increase poverty and inequalities at a global scale, making achievement of SDGs even more urgent."

Since COVID-19 reduces the strength of the economies, demand for hiring will eventually reduce. However, this situation also leads demand for better hiring assessment.

- Social Factors: The United Nations stated that everyone's social life is affected by COVID-19. The UN categorized the main segments of the population and summarized their situations. These mentioned segments by the UN are: older people, people with disabilities, youth, and indigenous people.

In the youth part of their statement called "Everyone Included: Social Impact of COVID-19" (2020), UN specifically mentioned about employment, which is cited as "In terms of employment, youth are disproportionately unemployed, and those who are employed often work in





the informal economy or gig economy, on precarious contracts or in the service sectors of the economy, that are likely to be severely affected by COVID-19."

- **Technological Factors:** Innovations in areas such as AI, Big Data, Cloud Computing have led the development of many variant technologies. Variants of these main technologies are also used in the employment field. The problem of the advanced technologies are: first, they are unfamiliar to the companies, second, new technologies could cannibalize the already existing ones.

### 5.3 LITERATURE REVIEW

In order to answer the research questions, we have conducted literature review in terms of problem solving tools, construct and formal frameworks of Complex Problem Solving (CPS).

#### 5.3.1 Problem Solving Definition

Quoted from University of Waterloo, "True problem solving is the process of applying a method – not known in advance – to a problem that is subject to a specific set of conditions and that the problem solver has not seen before, in order to obtain a satisfactory solution".

#### 5.3.2 Problem Solving Tools

In order to teach the problem-solving skills, we analyzed the methods in academic literature and the industrial world. The analyses of a variety of methods led us to

determine which ones are useful for our methodology. These are the methods we found: Business Model Canvas, Value Proposition Canvas, Fish Bone Diagram, Six Hats Method, Lateral Thinking, 5 Whys, TRIZ, A3 Thinking, PDCA (Plan Do Check Act), Kaizen, Toyota Method (for problem-solving), FMEA, SWOT, Pareto Chart, Root Cause Analysis (RCA), CATWOE, and Visual Understanding Environment (VUE) but we mainly focused on specific methods that we exploited.

#### **PDCA (Plan Do Check Act) Cycle:** The

PDCA cycle simply follows the steps of typical scientific method: Plan is developing a hypothesis and experimental design; Do is conducting the experiment; Check is collecting measurements; Act is interpreting the results and taking appropriate action. The PDCA cycle follows these steps:

The Plan step, in which the problem-solver thoroughly studies a problem or opportunity to understand it from as many viewpoints as possible, analyses it (quantitatively, if possible) to find the root causes, develops one or more ideas to remedy the problem or seize the opportunity, and devises a plan for implementation.

In the Do step, the plan is put into action as immediately as is possible and prudent.

The Check step involves measuring the effects of implementation and comparing them to the target or prediction.

Act refers to establishing the new process, solution, or system as the standard if the results are satisfactory, or taking remedial action if they are not (Kondo & Ishikawa, 1994).

**Lateral Thinking:** Lateral thinking doesn't follow a specific methodology, it solves problems by using an indirect and creative approach, with justification that does not appear immediately and cannot be achieved through traditional step-by-step logic. Lateral thinking is an alternative way of thinking developed against natural, logical and mathematical thinking. When we are trying to solve a problem, we tend to go for the solution that is direct, the easiest or the one that comes first to the mind. Usually this is not the most optimal way and in many cases, we can't see other possible alternatives out there. Lateral thinking helps to understand there are more than one solution to every problem, and you just have to look at the problem from a different angle or question the assumptions or goals set (Funke & Greiff, 2017).

**Root Cause Analysis:** The root cause can be defined as the main reason behind any problem. In case the root cause is detected and eliminated, the recurrence of the problem caused by the root cause will also be prevented. The process performed to identify the root causes underlying the problems is called "Root Cause Analysis". As a result of root cause analysis, the answer to the question of why

the problem occurred as well as what the problem is and how it occurred, is revealed. Understanding why the problem is occurring is necessary to be able to provide suggestions for preventing recurrence of the problem in the future. There are different levels of causes. While symptoms are the signs of existing problem and the first-level causes directly lead to a problem, higher-level causes lead to first-level causes. Chain of cause-effect relationships that create the problem. Which can be called the root cause (Andersen & Fagerhaug, 2006).

**Fishbone Diagram:** Fishbone Diagram is a graphical technique to show the several causes of a specific event or phenomenon and is used to search and show possible causes of a known problem. The cause-and-effect diagram is essential for a process that is necessary to explicitly display the causes by classifying and translating them (Coccia, 2018).

**5 Whys:** 5 Whys technique is used for troubleshooting, quality improvement, and problem solving, but it is most effective when used to resolve simple or moderately difficult problems. It may not be suitable if you need to tackle a complex or critical problem. Because it is designed to solve simple problems and cannot diagnose problems with multiple causes (Ohno, 1988).

**Six Thinking Hats:** The Six Thinking Hats Method is used to present and systematize

thoughts and suggestions in a certain order. "Hats" refer to a symbol used to separate thoughts. As the colour of the hats changes, the thoughts symbolized by the colour are expected to be transferred in a certain order. Each hat defines a certain type of thinking (De Bono, 2017).

Blue hat is concerned with control, organization of thinking process and the use of other hats. *"What problem am I facing?"*

White hat is neutral, objective. Concerned with facts and figures. *"What potential solutions exist based on the facts, stats, and data I have collected?"*

Red hat reflects the emotional point of view. *"Intuitively, is this the right solution to this problem?"*

Black hat is sombre, serious, cautious, careful. It points out the weakness in an idea. *"How is this likely to fail? What is the drawback to this way of thinking?"*

Yellow hat is sunny, positive, optimistic. *"How can I best approach this problem? What positive outcomes could result from this action?"*

Green hat represents creativity and new ideas. *"Could this be done in a different way? How can I think outside the box about this?"*

### **5.3.3 Construct of Complex Problem Solving**

Whether PSS is represented by the construct of intelligence and the factor

reasoning or if it is an independent construct of its own is a repeatedly and lively discussed question. Following the study of Wüstenberg et al. (2012) and corresponding studies as described in Chapter 6, CPS can be seen as an independent construct with explained variance beyond the intelligence construct. According to Greiff (2013), the construct of Complex Problem Solving (CPS) is divided into the 'knowledge acquisition' and the 'knowledge application' phases.

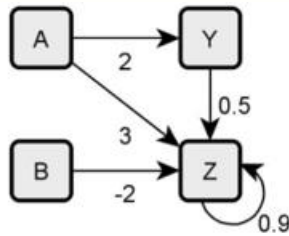
### **5.3.4 Formal Frameworks**

There are 2 formal frameworks for Complex Problem Solving, namely Linear Structural Equations (LSEs) and Finite State Automata (FSAs).

Linear Structural Equations (LSEs) describe a framework for modelling linear relations between quantitative input variables, such as the influence of coffee consumption and alertness. On a formal level, LSE systems contain a set of input variables (which can be set by the problem solver) and a set of output variables (whose values may linearly depend on other output or input variables) as well as linear relations among these variables. In dynamic systems, an output variable may also influence itself, called eigendynamic (Funke, 2001).

An example of such Linear Structural Equation is shown below.





$$Y_{t+1} = 2 \times A_t;$$

$$Z_{t+1} = 0.9 \times Z_t + 0.5 \times Y_t + 3 \times A_t - 2 \times B_t;$$

Figure 2 – Linear Structural Equation

In this figure, structure of a linear system with two input variables (A and B), two output variables (Y and Z), and the relation between them is shown with arrows. Formulation of the given linear system is presented below. (Funke, 2001).

In contrast to LSE systems, Finite State Automata (FSA) systems are useful for describing relations between qualitative variables, for example, the discrete state changes triggered by the buttons of a mobile phone or a ticket vending machine (Buchner & Funke, 1993). An FSA contains a limited number of states  $S$  (e.g., “on” and “off”) and a limited number of interventions  $X$  (e.g., buttons) as well as a function that specifies the state following each possible other state and/or intervention.

### 5.4 CUSTOMER PROFILE

As a preliminary work for the Value proposition canvas, this last section is focused on the analysis of the customer profile, more precisely the customer jobs and the associated gains and pains. In order to outline the canvas, we put ourselves in Zucchetti’s HR specialists’ as well as their HR customers’ shoes to better

understand their feelings about the current solutions. As said previously, in order to better understand how our product is going to create value to the customers, it is pivotal to analyse Zucchetti’s market. By gathering this valuable information, it is possible to assess the customers’ pains and gains, which can be seen from the figure.

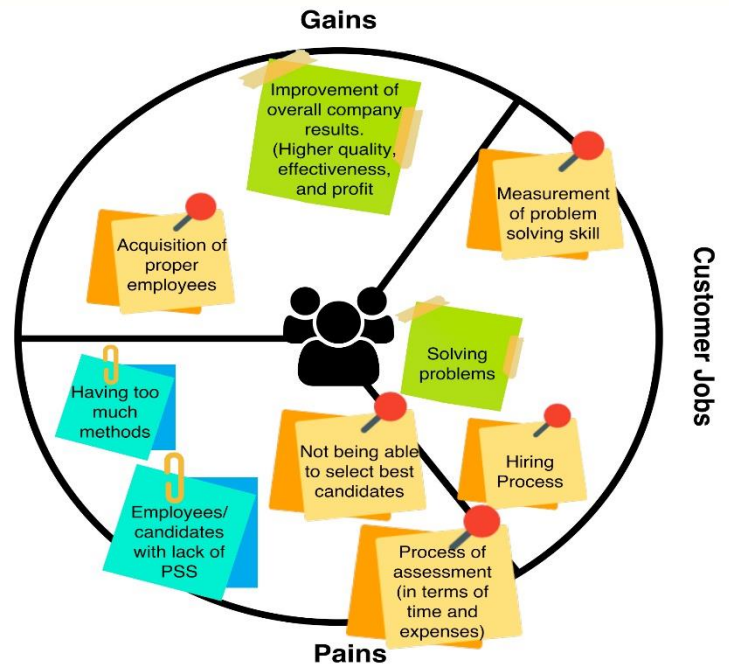


Figure 3- Customer Profile

Colour code: Assessment (Yellow), Training (Blue), Both (Green).

In the first place the customers need to solve problems on a daily basis. Therefore, they require competent personnel, for which they need to hire personnel with high PSS firstly. Unfortunately, they are not able to measure PSS in a proper way yet. Notably, the obvious problem that companies are facing is their dissatisfaction with their lack of problem solving skills from their employees, which is the largest gap of all skills, stated in the QS Skill report. Not only do they lack problem solving skills from their current staff but,

also, they are not able to filter candidates with this particular skill, which makes their selection process not optimal for this matter.

Secondly, it is analysed how the same customers could benefit from a method that is able to assess and enhance PSS of their workers. The first benefit identified is a better candidate selection. Being able to efficiently select new employees with this particular skill would decrease the gap previously mentioned. In the long term, the customer is going to benefit by having better overall results, with an improvement in profit, quality, and effectiveness.

## 6 SOLUTION

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Analysing the scientific literature, it is found out that the problem solving skill is not necessarily related with "intelligence", and complex problem solving (or dynamic decision making) and general intelligence are independent variables (Dörner & Kreuzig, 1983). Also, it is validated that implementing inductive reasoning training has shown positive results in terms of improving CPS skills (Klauer & Phye, 2008). Therefore, the first research question (Q1) of this project can be answered as "Yes, the problem solving is teachable as required by companies." In this chapter, both the solution for measuring candidates' problem solving skills in the hiring process (Q2) and the solution for improving employees' ability in this context with AI (Q3) will be explained.

### 6.1 SOLUTION FOR MEASURING PROBLEM SOLVING SKILLS

There are two main approaches to assess complex problem solving skills of individuals, the first one is using semantically rich ad-hoc simulations of complex microworlds such as Tailorshop simulation. The Tailorshop simulation is a complex task whereby users manage a company for 12 months with the goal of maximizing the company value (Funke et al., 2011). The other one is formally constructed artificial systems such as MicroDYN and MicroFIN which are based on the concept of MCS (Minimal Complex Systems). Instead of using just one large problem like the Tailorshop simulation that has greater complexity, it is decided to use minimal complex systems (MCSs) since they allow the variation of difficulty, customization and also proven to be more reliable than single task testing, based on the findings of the literature review.

MicroDYN comes from the formal framework called linear structural equation systems (LSEs) and requires the identification of linear relationships between the input and output variables in small dynamic systems with varying degrees of complexity. It yields good psychometric properties and shows sufficient validity.

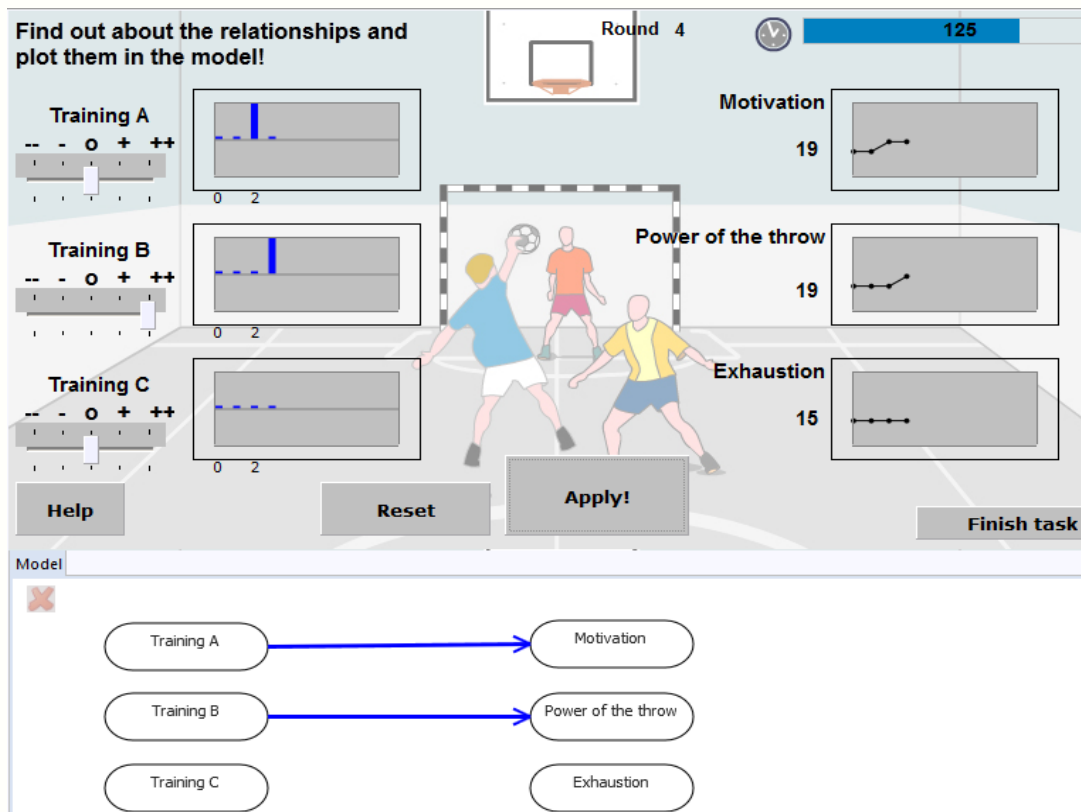


Figure 4 – MicroDYN Example: Handball Training

The figure above shows an example of MicroDYN task called as Handball Training [20]. The user interface of a typical MicroDYN application contains several inputs, outputs and an activation (a.k.a. apply) button. The user is able to manipulate the inputs to understand the relations to the outputs. When a participant is working on a MicroDYN Application they go through three main phases.

First is called rule identification, when a user is freely exploring the system and trying to make mental connections between inputs (in this case Training A, B, and C), and outputs (in this case Motivation, Power of the throw, and Exhaustion).

Second phase is rule knowledge, when the participant is expected to reflect their mental relations into the application by drawing lines between input and output variables where he/she feels there is a connection between each other. The user has three minutes up to the end of this phase.

Third phase is called rule application. This is the phase where the user is asked to reach a given target by changing the inputs and outputs accordingly and clicking on the apply button. The user has two minutes to complete this phase.

On the other hand, MicroFIN is based on the formal framework of Finite State



Automata (FSA) and requires the problem solver to identify transitions of state in small simulated systems, within a variety of backgrounds. In addition to MicroDYN it allows the simulation of qualitative relations and therewith real-world problems.

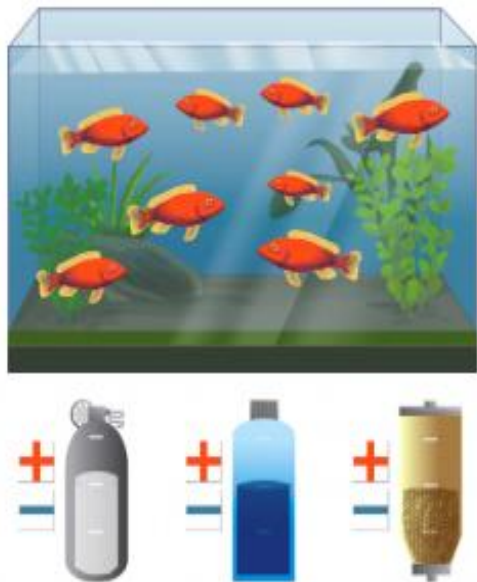


Figure 5 – MicroFIN Example: Fish-o-mat

The figure above represents a MicroFIN example called as Fish-o-mat [21]. As can be seen from the figure above, the three containers at the bottom are the input variables while the aquarium is the output.

Similar to the MicroDYN, MicroFIN also has phases, but limited to only two. The phases are rule identification that allows exploring the system freely, and rule application to reach a goal state. This is because the specific relations between inputs and output are not feasible.

Also, for both MicroDYN and MicroFIN applications, the difficulty can be easily increased and decreased by changing the number of inputs & outputs, as well as

the number of relations between them. This allows a great flexibility for the assessment of complex problem solving skills.

Based on the aforementioned frameworks (LSE and FSA), the recommended assessment will include 5 MicroDYN and 5 MicroFIN tasks to be solved within 50 minutes. Each task will consist of 2 parts which are knowledge acquisition (3 mins) and knowledge application (2 mins) phases. The time limitations were set based on the findings of the extensive literature review which will be described in the "Proof of Concept" section.

### 6.1.1 Evaluation Criteria

The user will be evaluated from both knowledge acquisition and knowledge application phases. Therefore, each task will generate 2 scores for the 2 phases explained.

#### 1. Knowledge acquisition score:

- How many actions did the user make?

Computer generated log file is useful to understand if the participants are following VOTAT strategy which describes the separate variation of input variables ("Vary One Thing At a Time") for analysing the causal structure of a system. The strategy refers to the control-of-variables strategy in scientific inquiry: which is the optimal strategy for exploring MicroDYN tasks (Samuel Greiff et. al., 2016)

- How correct is the user's end result? [-1:1]

The knowledge acquisition score for the correct model was calculated by subtracting the proportion of missed or falsely identified causal relations (i.e., out of 5 possible) from the proportion of correctly identified causal relations (i.e., out of 4 possible). For example, when the system is correctly drawn without mistakes the resulting score is 1 ( $4/4 - 0/5 = 1$ ). (Frensch and Funke 1995). So, formula for the calculation becomes:

$$\frac{\text{Chosen True Relation}}{\text{All Possible True relations}} - \frac{\text{Chosen False Relations}}{\text{All Possible False Relations}}$$

## 2. Knowledge application score

- How many actions did the user make?

This can be extracted by computer generated log files. All actions the students performed (i.e., clicking "apply", moving sliders, or drawing arrows) are stored in computer-generated log files.

- How long did it take the user to reach the goal state?

How many seconds did the participant use, compared to the average time used for that question?

With this approach the assessment procedure achieves:

- Variation of difficulty
- Reliability and empirical validity
- Customizability, according to the company's requirements
- Data base for AI solution
- Good psychometric properties
- Quantitative, comparable results

### 6.1.2 Proof of Concept

When adopting an existing methodology, it is crucial to consider the validity and the reliability of this approach. The following figure shows the main findings from literature review.

Title (Author, Year)	Survey	Main Findings
Dynamic Problem Solving: A New Assessment Perspective (Greiff et al., 2012)	n=114, n=140 students	<ul style="list-style-type: none"> <li>• Proven internal structure and construct validity</li> <li>• Excellent reliability estimates</li> <li>• Multiple tasks are increasing the validity and reliability</li> </ul>
CPS - More than reasoning? (Wüstenberg et al., 2012)	N=222 students	<ul style="list-style-type: none"> <li>• Internal consistencies and reliability estimates of MicroDYN were good</li> <li>• Results are independent from prior knowledge</li> </ul>
A multitrait-multimethod study of assessment instruments for complex problem solving. (Greiff, S. et al., 2013)	N=339 students	<ul style="list-style-type: none"> <li>• Strong correlation between MCS tests: high convergent and construct validity</li> <li>• Proof that MCS is addressing demands, not captured by intelligence/reasoning construct (=independent construct)</li> </ul>

Table 1 – Literature Review Findings



As a result of the good test results of the MCS and the conversion of the worldwide PISA study from paper to computer assessment, the measurement of problem-solving skills with MicroDYN and MicroFIN was even applied successfully in this large-scale assessment (N > 510.000 students in 2012 (OECD, 2014)). The following table illustrates other test results.

In summary, the studies mentioned show that CPS can be regarded as an independent construct apart from intelligence/reasoning and that the methodological approach (MCS) is internally and externally valid and reliable.

Furthermore, several academic studies are investigated to examine the validity and reliability of the proposed evaluation criteria. For instance, based on a MicroDYN assessment consists of 9 tasks to be solved within 45 minutes by 1476 students, it is validated that the computer generated log files are useful to identify 3 key behaviours (eg. time, intervention frequency, non-interfering observation) that affect the overall CPS performance (Samuel Greiff et. al., 2016). Therefore, it is recommended to use these log files as an evaluation criteria.

The relationships between these 3 key behaviours and CPS are appointed:

1. Students who spent neither too little nor too much time on the CPS tasks showed the best overall performance on average → Non-linear relation

2. Students who had a low intervention frequency during problem exploration were more likely to perform better in the CPS tasks → Linear & quadratic relation

3. Students who engaged in non-interfering observations in the dynamically changing CPS tasks showed better performance → Linearly positive

## 6.2 SOLUTION FOR TRAINING EMPLOYEES

As discussed and agreed with Zucchetti on the fact that the problem solving is also a collaborative process, it is recommended to send the MicroDYN/FIN tasks to employees with a collaborator. The collaborator will help the employees with the predefined questions regarding the tasks as shown below. Thanks to these collaborative tasks, the employees will frequently practice their skills which will eventually improve their CPS abilities.

Furthermore, in order to improve problem solving skills, several proven methods and tools (eg. TRIZ, FMEA, Kaizen, A3 thinking and so on) were analysed. Then, we developed our own problem solving algorithm which can be applied to any given problem to ease the process. The algorithm follows a PDCA logic (plan-do-check-act) and includes 8 steps, respectively:

1. Problem Definition: As Albert Einstein once said "If I were given one hour to save the planet, I would spend 59 minutes defining the problem and 1

minute resolving it", we also believe that a well-defined problem is much easier to solve, and this should be the first step of the process.

2. **Impact Measurement & Data Collection:** All the factors that are impacted by the issue or potential change is listed according to the data collected. Then, Critical Success Factors (CSF) and Key Performance Indicators (KPI) are identified, respectively.
  3. **Goal Setting:** Goals are significantly important since they provide a sense of direction. SMART refers to **S**pecific, **M**easurable, **A**chievable, **R**ealistic, and **T**imely goals which takes all the aspects of these elements into consideration and increases the possibility of achieving them.
  4. **Root Cause Analysis:** Here, the aim is deep understanding of the root causes that should be addressed to solve the problem. Fishbone Diagram, Pareto and 5 Why are the methods that can be used in this phase.
  5. **Countermeasures Listing:** All the possible solutions are sorted out and alternatives are generated. This helps to identify the best solution and also the actual complexity of the problem.
  6. **Feasibility Analysis:** The practicality of all the solutions listed is examined in terms of financial and technical aspects to find the best solution/s.
- Thanks to Zucchetti's feedback, a sub-

cycle between the feasibility analysis and countermeasures listing is added. If a solution does not seem "feasible" according to the feasibility analysis, the process goes back to the previous step to think of other possible solutions.

7. **Implementation:** The chosen alternative is implemented and modified according to the feedback from trials and errors with an incremental approach.
8. **Continuous Control:** In this cycle, established ongoing measures (eg. KPIs) are monitored. The long-term results are also evaluated based on the solution.

In each step, the methods/tools which can be useful are also encompassed as shown below.

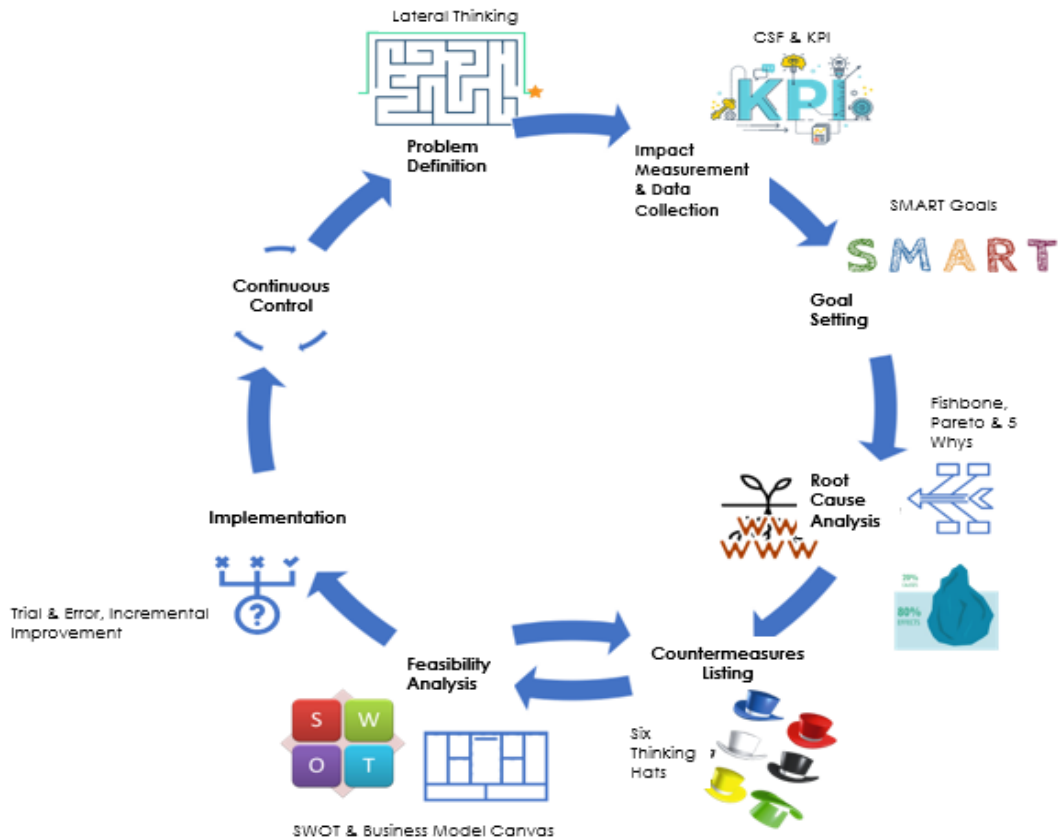


Figure 6 – Problem Solving Algorithm

It is also recommended to develop a virtual personal assistant (chatbot) powered by AI which is embedded in *Zucchetti's ZConnect Enterprise Edition* product. The chatbot is a pop-up in the right corner of the screen and the purpose is to guide employees to go through the steps in the problem solving algorithm explained above.

If the employee is going through the feasibility analysis and carrying out the Business Model Canvas, the chatbot will direct the employee to the *Business Model Canvas Filler* which is also powered by AI that we developed as a minimum viable

product (MVP) for the project which can be seen in Annex.

### 6.2.1 Business Model Canvas Filler (MVP)

As mentioned in our solution for teaching, we strongly believe that learning management tools such as business model canvas, value proposition canvas or SWOT analysis help employees to understand and solve problems with ease.

To be able to accomplish that goal we have decided to use artificial intelligence to teach employees how to use such helpful tools. With this objective in mind, and with help of Gregorio Piccoli, we have

developed an AI that helps users decide which cell to put the given sentence, as a proof of concept. The algorithm that is used for natural language processing is based on Martin Porter's stemming

algorithm. This stemmer was very widely used and became the de facto standard algorithm used for English stemming and Dr. Porter received the Tony Kent Strix award in 2000 for his work on stemming.

### The Business Model Canvas Filler (MVP)

<b>Key partners</b> • suppliers	<b>Key activities</b> • production	<b>Value proposition</b> • increasing brand awareness	<b>Customer relationships</b> • crm	<b>Customer segments</b> • sme
	<b>Key resources</b> • Intellectual property • human resource		<b>Channels</b> • social media • television	
<b>Cost structure</b> • raw material costs • salaries			<b>Revenue streams</b> • Field sales	

More than one optimal cells found, optimal cells are=[Cost Structure, Revenue Streams]

Auto ▼
Add sentence

Developer Data

Figure 7 – Business Model Canvas Filler (MVP)

As shown in the figure above, the auto mod decides where to put the info automatically and gives suggestions to the user when there is more than one optimal option.

In the case of multiple optimal cells, as shown, the user can choose from the list manually to put it in a specific place.

The dropdown menu lists the following options:

- Auto (selected)
- Key partners
- Key activities
- Value proposition
- Customer relationship
- Customer segments
- Key resources
- Channels
- Cost structure
- Revenue streams

Figure 8 - Business Model Canvas Filler/2

### 6.2.2 Expert Opinion Questionnaire

Based on Lean Startup Approach, a questionnaire focused on HR people is design to analyse and test the validity of our approach to the problem. The first part of the questionnaire is about the assessment of problem-solving skill, there is no clear consensus about our idea but it is clear that problem-solving skill is important for HR. Some expert opinions revealed that our method can measure problem-solving skills, while others emphasize that it can measure more general features like IQ. In the second question, the applicability of the problem solving algorithm is investigated and it was stated as useful for solving problems but it could need some adjustments. In the last part of the survey, the connection between AI and problem-solving skill is examined, all of the participants stated that it would be helpful to employees during the problem-solving processes such as application of similar solutions to future projects, update itself with new methods, etc.

### 6.3 IMPLEMENTATION

To illustrate the project's schedule from the first group meeting to developing a commercialized version of the proposed solution, a Gantt chart has been created. Even if the project ends at the end of June 2020, some further suggestions for the company are also included in the Gantt chart. The aim is to give Zucchetti a suggestion on how they can move

forward. The chart is updated according to Zucchetti's feedback.

Gantt Chart has five main phases which follow each other subsequently.

1. Analysis: this part refers to document research and ideas about the project. Analysis time frame contains milestones from the first meeting to the completion of the analysis.
2. Design: this phase has three parallel tasks. Defining keywords to database, software design, and interface design are the tasks done for this phase.
3. Development: this phase refers to building the solution. Development of assessment modules, AI algorithms are the main tasks. Depending on visualization of assessment modules and AI algorithms this phase's tasks are also related to the design part.
4. Testing: essence of this phase is to find missing details before the solution's implementation.
5. Implementation: On site installation and support plan for the system are the tasks should be done in the implementation phase.

The Gantt chart is represented in Annex.

### 6.4 SWOT ANALYSIS

In order to evaluate the solution's competitive position and to develop a strategic plan for future implications, a

SWOT analysis was conducted. As a preliminary step, an external and internal analysis was done.

#### 6.4.1 Internal Analysis

An internal analysis is an exploration of organizations' competency, cost position, and competitive viability in the marketplace. In other words, internal analysis is executed to understand the organization's way to achieve competitive advantage. So, conducting an internal analysis often incorporates measures that provide useful information about your organization's strengths and weaknesses.

Competitive Advantage can be investigated in two sub advantages: differentiation advantage and cost advantage. Thus, the internal analysis can examine the proposed solution's validity in terms of those sub advantages.

Differentiation Advantage:

- Disadvantages: Solution needs time for adaptation. Since it is new users should spend time for getting used to it. Another disadvantage of the solution is the need for different assessments for measuring different personal traits. In the same way, the disadvantage for the training part of the solution is the time requirement. In other words, training of already existing employees is crucial but it requires time.

- The proposed assessment tool is scientifically proven and it could be a complementary tool for Zucchetti's already existing hiring process.
- The gamification of the assessment, whereby the user can experience entertaining while evaluating its problem solving skills, can create benefit.
- The AI collaborator is going to help by guiding employees during the project to solve complex problems

Cost Advantage:

- Zucchetti Group is capable of developing the proposed solution with its internal sources without requiring extra sources.
- Zucchetti also takes advantage of cost avoidance, especially the cost incurred from the hiring process.

For a better visualization of the SWOT analysis, three colours have been used to identify the different parts of the solution. Yellow is used for assessment, blue for training, and for the cases which involve both assessment and training green colour is used.

Outcomes of the SWOT analysis are represented in the figure below.



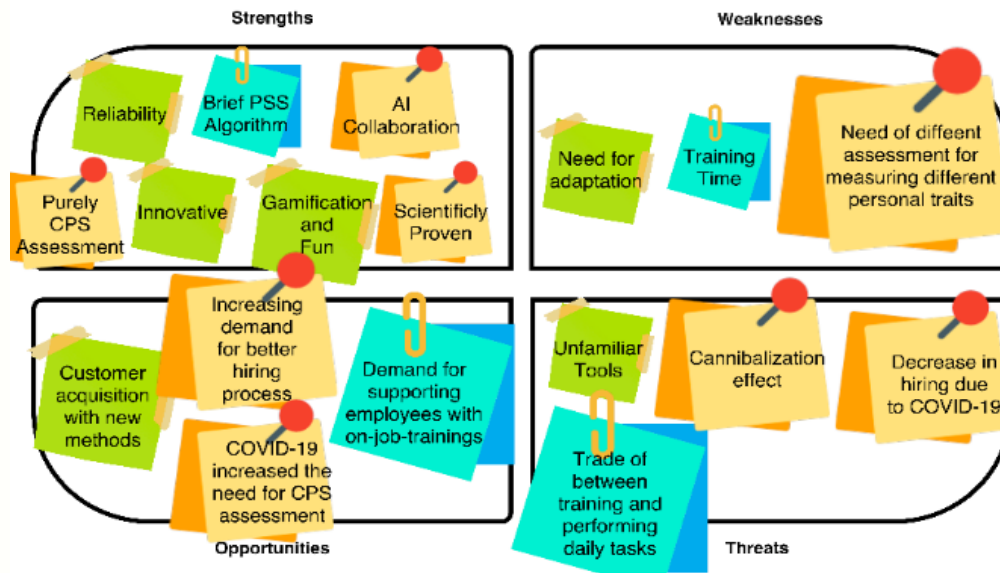


Figure 9 – SWOT Analysis

## 6.5 VALUE PROPOSITION CANVAS

To convey visually the proposed solution's offerings, a value proposition canvas (VPC) has been constructed. The value proposition is the main part of the Business Model Canvas which will be presented in the next section.

A value proposition canvas has two parts, the right hand side part is related to customers and their expectations and problems, which is described in Chapter 5 as Customer Profiles. The left hand side of the canvas is related to the offered products and services. Thus, the requirements of the potential customer segments are considered and their gains and pains represented. Afterwards, the left part of the canvas is constructed which has parts called gain creators (which correspond to the analysed gains on the right side) and pain relievers (which

correspond to the analysed pains on the right side).

The left hand side of the figure which describes how the proposed solutions will provide value for the customers will be presented in this section.

**1.Products and Services:** As presented in the beginning of this chapter, PSS will be measured by MicroDYN/FIN assessment. For the training part, MicroDYN and MicroFIN tasks with AI collaborator will be sent to employees and also, Virtual Personal Assistant will be available on the internal website to help the employees during problem solving. Furthermore, the Business Model Canvas Filler is introduced as Minimum Viable Product with the training purposes.

**2.Gain Creators:** Assessment can provide a cheap and timesaving hiring process for efficient employee selection. Potential

gains that can be created by the training solution is increasing the ability of employees' complex problem-solving skills. Moreover, as pointed out in Chapter 6, problem solving is also a collaborative process, therefore the proposed Virtual Personal Assistant leverages this characteristic of problem solving.

**3.Pain Relievers:** The proposed assessment solution is proven to be academically reliable in terms of measuring purely CPS as pointed out in Chapter 6. It also allows the outsourcing of the time consuming part of the hiring process which is the process of testing individuals' CPS through various tests and interviews. For the training solution, the proposed problem solving algorithm is a structured and also unified method to be used during the problem solving process.

VPC Canvas is represented below. The same colouring structure is also used.

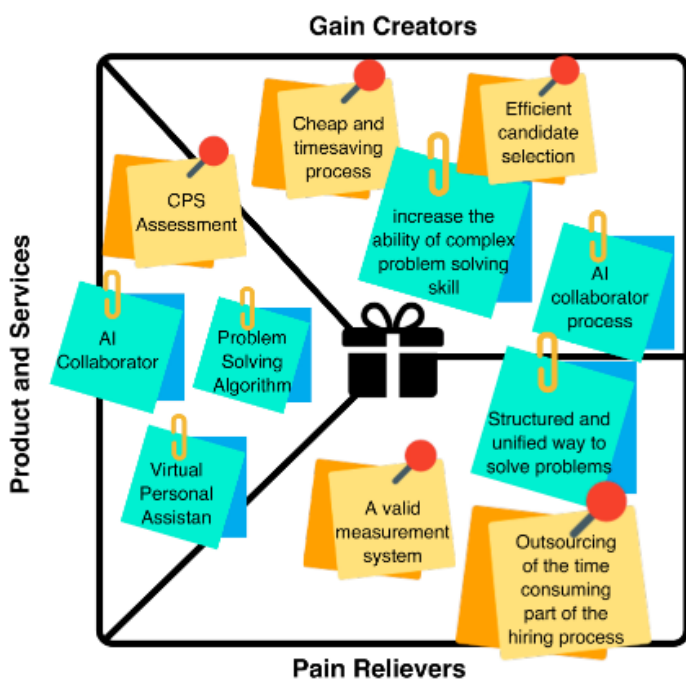


Figure 10 – Value Proposition Canvas

## 6.6 BUSINESS MODEL CANVAS

To break down proposed solution's business model into easily-understood sections, a business model canvas (BMC) is used. BMC is developed in light of previous analysis and features of the proposed solution. There are 3 main parts in the Business Model Canvas which are desirability, feasibility and viability parts as explained below. Since Value Proposition has been introduced, it will not be explained in this section.

Desirability Part includes:

- **Customer Segment:** For assessment, the potential customer segment could be requirement agencies and the headhunters. For training, the potential customer segments could be universities and professionals (professionals are the ones who are dealing with training of already existing employees). Lastly, enterprises could also benefit from both assessment and training.
- **Customer Relationships:** For both solutions, customer relationships are essential. Customer relationships of Zucchetti depends on direct involvement with the customers. Some of the ways could be listed as CRM, customer support, and dedicated sales teams for large accounts.
- **Channels:** To reach customers Zucchetti uses a variety of channels such as: social media, company's website, mail, webinars and seminars.



However, the main channel for Zucchetti is field sales. Beside having online communication, face to face interaction is still very important for the company.

Feasibility Part Includes:

- **Key Partners:** For training, the people who are responsible for the training can be classified as a key partner. For both the assessment and the training, developers and universities can be classified as key partners. Lastly, there is an important issue with one of the key partners which is the German Institute of International Educational Research (GIIER). They own the rights of the CBA Item Builder (which is the tool for developing assessment). Zucchetti might be required to arrange an agreement with them. However, Zucchetti can also develop assessment without getting the license by its own resources.
- **Key Activities:** Development of the solution is key activity. After the development is done, marketing and commercialization activities are

required. All in all, the main key activity is project's management from development to marketing.

- **Key Resources:** Most valued resource is Zucchetti as a brand. Company has its own customer base and resources to develop proposed solutions.

Viability Part includes:

- **Cost Structure:** There are costs related administrative expenses, development cost, server cost, marketing costs, and cost of sales. There is also licensing cost which depends on agreement between Zucchetti and (GIIER).
- **Revenues Streams:** Commercialization of the solution will benefit the Zucchetti as additional revenue stream which could include subscription, as well as training fees. They will also benefit from the additional services such as post sale activities and maintenance.

The Business Model Canvas is shown in the next page.

*Colour code: Assessment (Yellow), Training (Blue), Both (Green).*



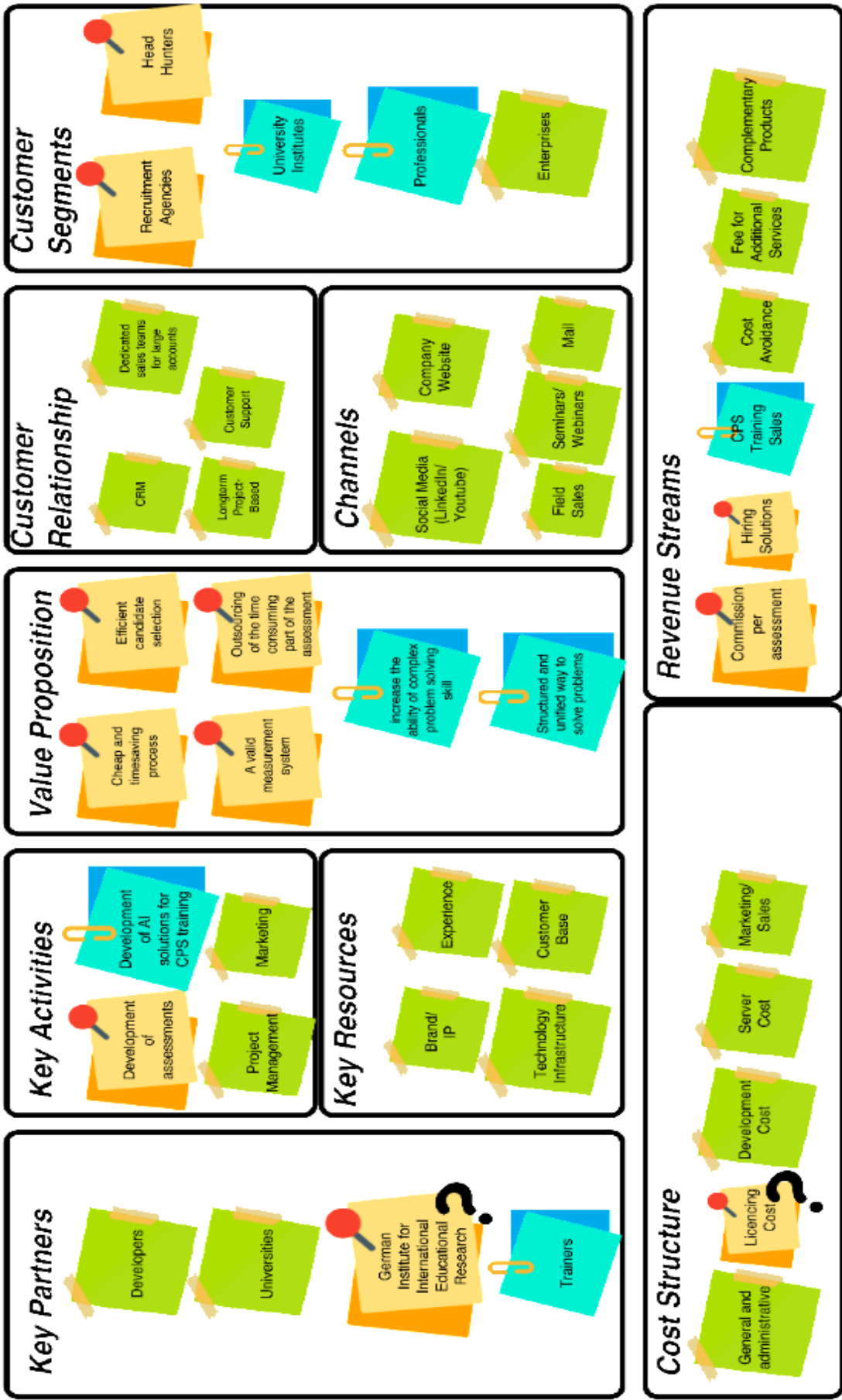


Figure 11 – Business Model Canvas

## 6.7 CUSTOMER JOURNEY

As a part of the customer journey, the key touchpoints for our potential customers are highlighted and three possible routes are shown with blue, black and orange coloured arrows.

On top of widely-used online channels such as SEM, SEO, Website, and Call Center, other important offline channels such as business journals, seminars & fairs are included. We believe that since our business model is a B2B solution, face to face meetings with the company

representatives are very important part of the sales. Therefore, meeting with the managerial personnel of the potential customer companies will improve the conversions much more.

Currently since there are no large gatherings allowed in Italy and many other countries due to COVID-19, plus some people may not prefer to meet face to face with the field sale agents, it is recommended to implement and focus on an online negotiation and signing procedure, which may be less effective but more efficient.

Channel		Awareness	Interest	Consideration	Purchase	Loyalty	Advocacy	
Offline	Paid	Business Journal	Seeing an article					
		Seminars	Getting information about product					
		Fairs	Getting information about product					
	Owned	Field Sales		Asking for info	Negotiation with field sales	Contract signing	Maintenance and help during the usage of the product	Recommending the product after purchase
		Call center		Asking for info				
	Earned	WOM	Talking with other professionals	Asking other professionals				
Online	Paid	Social Media Ads	Seeing ad on social media			Follow Zucchetti on social media		
		E-mail	Receiving mail about the product			Subscribing to Zucchetti's e-mail newsletter		
		Search Engine Marketing	Clicking on the product landing page		Comparing with other products			
	Owned	Social Network		Searching for info	WhatsApp negotiation			
		SEO		Searching for info	Comparing with other products			
		Zucchetti Website		Request for info		Online contract signing	Checking for complementary products	
	Earned	WOM	Seeing / hearing about the product	Talking with other professionals				Recommending the product after purchase online

Figure 12 – Customer Journey

## 6.8 RE-POSITIONING MAP

Repositioning maps refer to the major change in positioning for the brand/product. The first position shows the current position according to defined

The current assessment is a well-known and traditional method to measure CPS. Yet, it is not sufficient in terms of measuring purely CPS. Thus, the proposed assessment is an innovative and modern method that is designed to measure purely CPS. Furthermore, it is proven to be reliable according to the scientific researches.

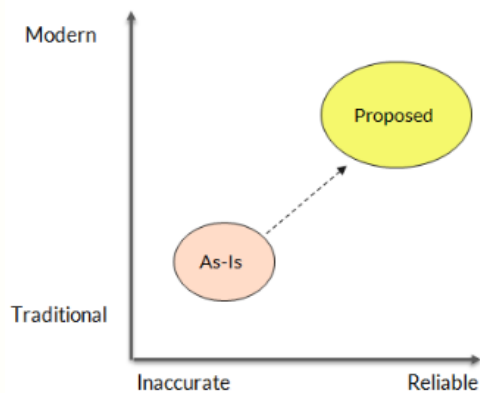


Figure 13 – Repositioning Map

## 7 CONCLUSION

### 7.1 SUMMARY

Within the corporate landscape, problem solving skill is perceived as the most needed but also lacking soft skill. This project addresses this issue, by developing an innovative solution to measure and teach problem solving skills to enhance both the hiring process and the capability

itself. The measuring solution covers a gamified assessment tool using the minimal complex system approach with the corresponding MicroDYN and MicroFIN tools. The teaching solution contains a collaborative AI tool, which helps the user to complete the MicroDYN/FIN tasks. Moreover, it includes a holistic problem solving algorithm and virtual personal assistant which guide users to follow the steps in the algorithm. Last but not least, a keyword based AI algorithm named as “Business Model Canvas Filler” has been developed as a MVP, aiming to guide users filling in the Business model canvas.

### 7.2 LIMITATIONS

Besides the successful evaluation of our project according to the goals set, we need to take a look at the limitations. Not building on previous company knowledge, this project poses an innovative approach to measure problem solving skills in an economic context. While it lays an important cornerstone the proposed solution requires further testing and evaluation, once put into practice. Even though the methods used show great validity and reliability, no primary data in cooperation with Zucchetti was acquired. Despite the secondary data stemming from applied settings in the academic context, we are convinced of the applicability of the methods in this context, it is recommended to validate and ensure this in the next steps.

A further constrain is the partial knowledge about the existing company processes. While the solution may work theoretically, it is important to consider local resources, such as IT components or existing and helpful AI algorithms. Although the scope of the project implied such resources to be available, a careful consideration and coordination of all stakeholders and assets is crucial for a successful implementation. Overall, the project would have benefitted from personal meetings with the project team and the company. Lastly, an extension of the project duration would have enabled further analysis regarding the implementation and evaluation of the suggested solution approach as described in the Outlook.

### 7.3 OUR EXPERIENCE

Last but not least, we want to compare our previous expectations outlined in Chapter 4 to what we achieved throughout this project and see whether they were matched. By the end of this project, most of the phases were accomplished in a very satisfactory manner. We were able to come up with a valid and reliable assessment method of CPS measurement solution that is able to fulfill the initial needs of the project. In addition, the group was also able to develop an algorithm with the purpose of providing a holistic approach of Problem Solving. Moreover, we were able to come with an AI solution that would be

remarkably helpful regarding the teaching of CPS, that is the chat bot which can guide the employee in order to improve his problem solving skills. Furthermore, this chat advises the user to use what is called Business Model Canvas Filler to complement the AI assistance and enhance ever deeper the employee's knowledge.

In summary, all phases followed precisely the deadlines that were previously settled, the meetings with Zucchetti and the mentors were amazingly helpful to enhance our solution and, in the end, all of this project proved to be a valuable experience that all students from the group will carry on for their future careers.

## 8 OUTLOOK

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Based on the Lean Startup approach, a Minimum Viable Product (Business Model Canvas Filler) has been introduced in Chapter 6. We also developed a Strategic Plan which is divided into 4 phases such as for the first 3 months, 6 months, 1 year and the next 5 years including the further developments aimed to achieve in each phase. The Gantt Chart which shows the software development phases in detail has been introduced in the Solution section, therefore the strategic plan will not be covering these steps.



**In three months:**

- Research and minimal viable product development
- Beta versions are planned to be launched

**In six months:**

- Development and implementation of AI powered virtual personal assistant chatbot
- Development and implementation of hiring solution with MicroDYN/FIN tasks

**Until the end of the first year:**

- Social media campaign planned to be launched
- Email marketing will be used to communicate the customer base
- Training existing employees with the suggested solutions mentioned in previous section
- Attending to seminars and webinars to introduce the solution

**Until 5th year:**

- Complementary products might be developed
- Increasing the market share of the services is expected.



## 9 TEAM COMPOSITION

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Dicle Ildan

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Umut Sirvan

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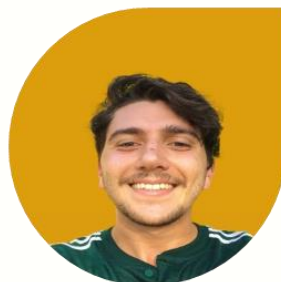
Emre Danisan

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Mehmet Berk Souksu

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Giovanni Previato Roja

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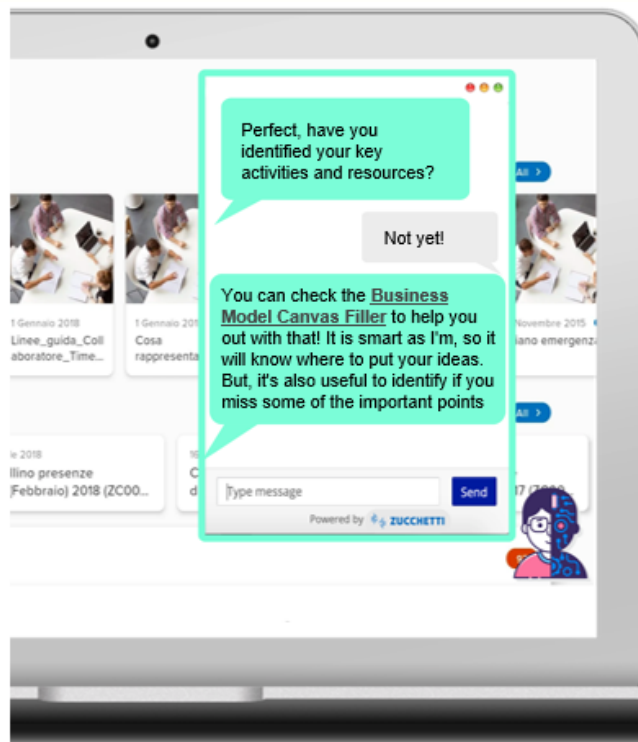
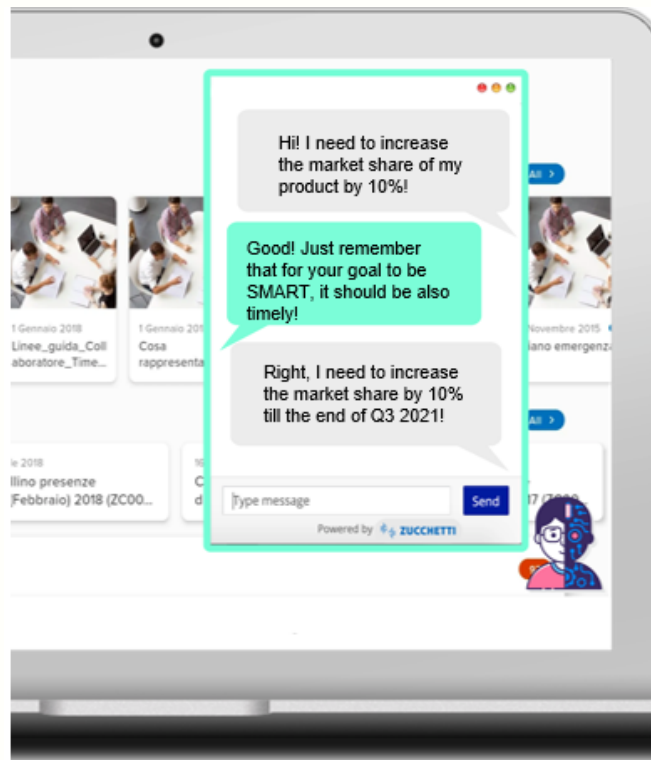
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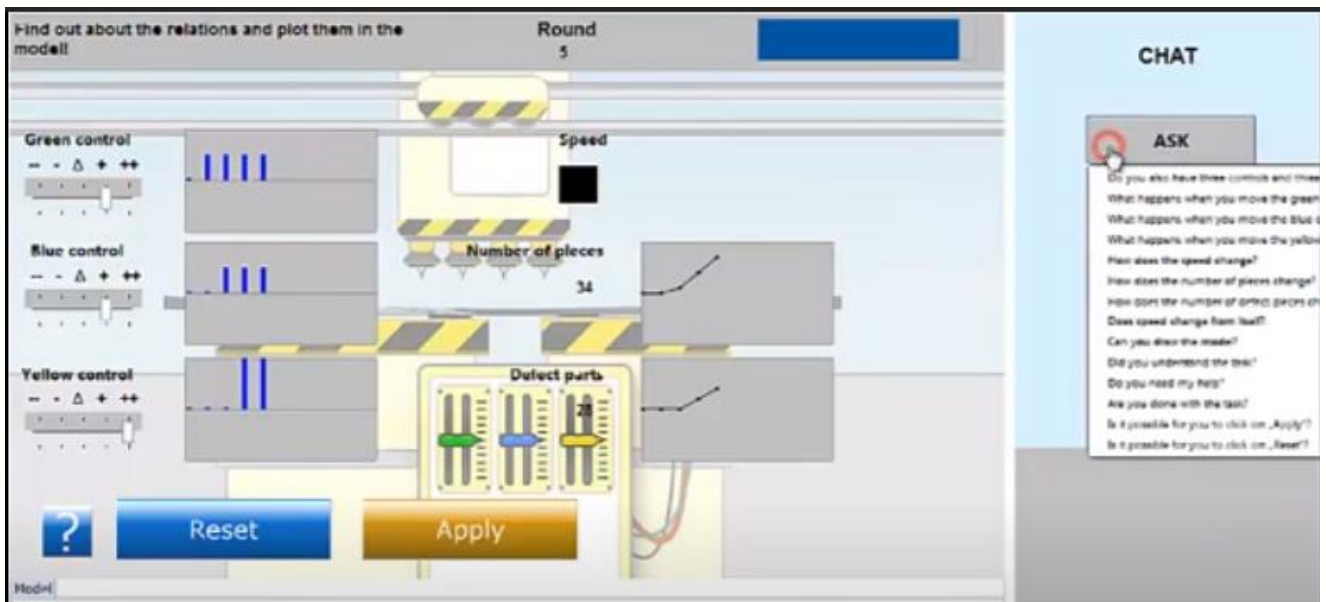
# 10 ANNEX

## 10.1 Virtual Personal Assistant / Chatbot – User Interface

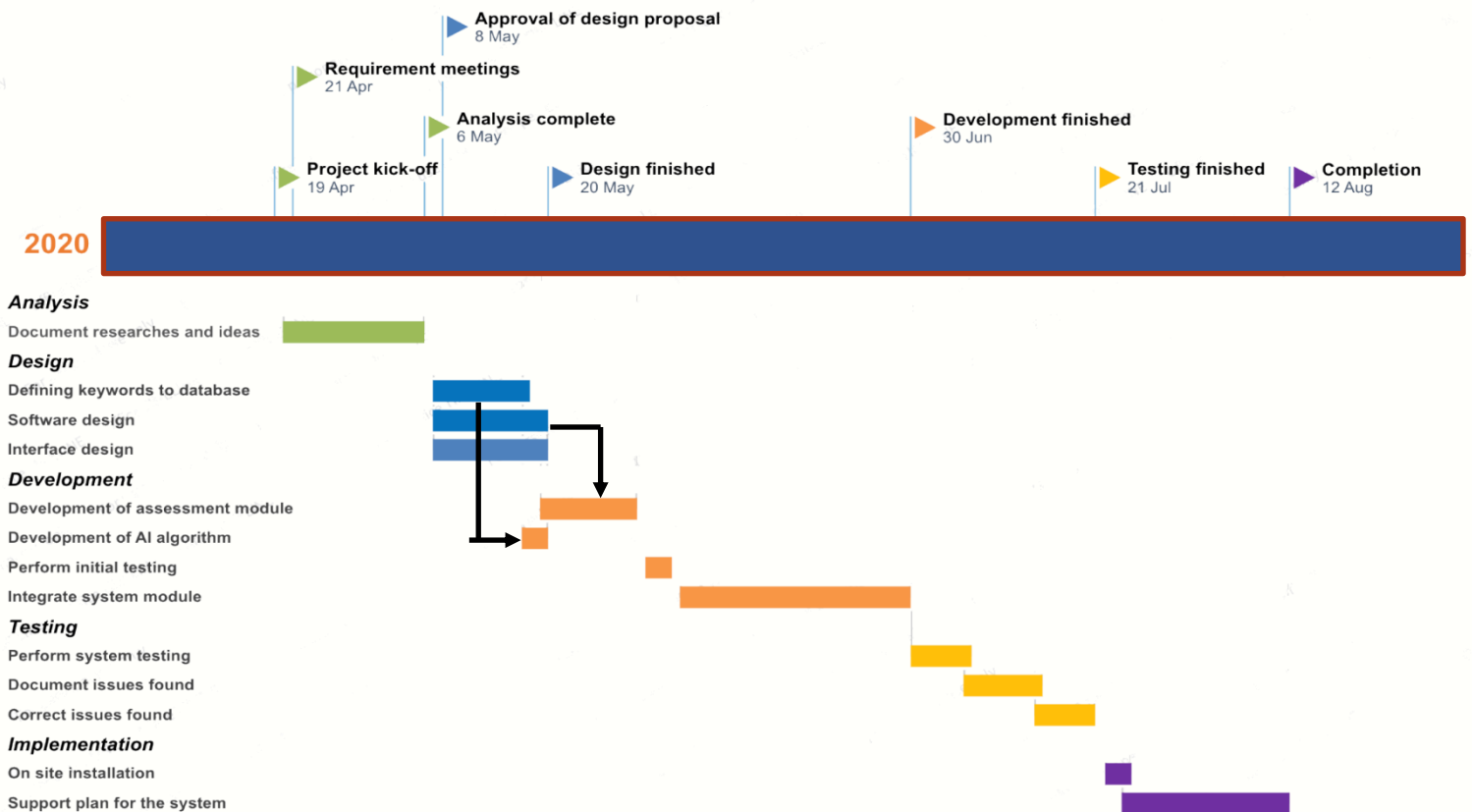




## 10.2 MicroDYN/FIN Tasks with AI Collaborator



## 10.3 Gantt Chart - Implementation



## 10.4 Expert Opinion Questionnaire

### Problem Solving Skills - Assessment and Teaching Questionnaire

Probably your company has the same impression as most of the companies worldwide: According to the QS Skill report of 2019, the biggest skills gap identified by employers is problem solving. Therefore, we developed an academically proven assessment solution and a solution to teach problem solving to employees. We would be glad if you share your ideas and feedback about our solutions. Computer-based gamified assessment, where the candidates have to understand the relations between input and output variables and then reach the targeted output. Please see the videos for an example:

\* Gerekli

#### Example 1

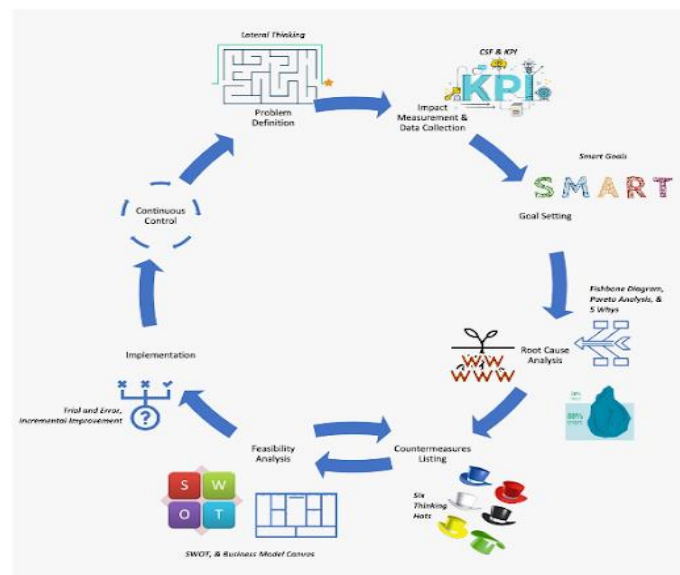


#### Example 2



We also developed a brief problem solving algorithm that can be used to solve any problem as shown below. We want to develop a virtual mentor powered by AI to help the employees' to follow the steps in this algorithm.

#### Algorithm



Which company are you working for? \*

Yanıtınız \_\_\_\_\_

Do you agree that this kind of assessment would be useful to measure candidates' problem solving skills? \*

1 2 3 4 5  
Completely disagree      Completely agree

Comments \*

Yanıtınız \_\_\_\_\_

Do you agree that this problem solving algorithm would be useful to solve complex problems? \*

1 2 3 4 5  
Completely disagree      Completely agree

Comments \*

Yanıtınız \_\_\_\_\_

Do you agree that AI would be helpful to employees during the problem solving process?

1 2 3 4 5  
Completely disagree      Completely agree

Comments \*

Yanıtınız \_\_\_\_\_

We would be thankful, if you could share your opinion about our approach with us. Thank you very much.

Yanıtınız \_\_\_\_\_

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