A self-assessment screening tool to prioritize patients with mental disorders

Information Systems | Departments of Informatics & Media

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Lastly, this paper would not be possible without the help of the domain expert, Direnc Sakarya. I am immensely grateful for his endless support and tremendous knowledge sharing during the period of this thesis work.
Abstract
Due to the continuous growth of patients with mental disorders, it has been a strenuous job to look after each patient and tailor the appropriate treatments for them on time. The thesis proposes a design science framework in the form of an IT artefact to prioritize the patients with mental disorders, considering the severity of the situation. The IT artefact will be using expert’s knowledge to design a self-assessment screening tool that will evaluate the criticality of a patient’s mental health. This tool will also incorporate the psychometric scale DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure, Adult electronically to determine what will be the next stage in the process of patients’ treatments. The process of prioritizing patients is prolonged and remains to be tedious at the hospital and also there is always a possibility of missing some information while carrying out the job manually. The self-assessment system will serve two goals. It will shorten the initial screening process and also the likelihood of any human error. The system is not meant to replace healthcare professionals but to build a bridge between the patients and the doctors to make everyone’s life more organized. The results indicate that it is possible to create a framework and the relevant prototype with the help of expert’s knowledge that can prioritize patients with mental disorders. It also demonstrates that the system can digitalize DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure, Adult scale to determine possible problem domains for further diagnosis.
**Keywords:** DSM, Mental health, psychiatrist, QOL, Screening tool, primary care, psychometric tool,
Abbreviations

DSR – Design Science Research

DSM - Diagnostic and Statistical Manual of Mental Disorders

IS – Information Systems

OECD - Organisation for Economic Co-operation and Development

QOL – Quality of Life

WHO – World Health Organizations
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1. Introduction

This introductory chapter deliberates the background knowledge of mental disorders and social stigma around it. In addition to that, its purposes are to clarify the problem area, discuss the related work in this field, state the research goals and subsequent research questions, and in the end discuss briefly about expert details, audience, delimitations, ethics related to this study and outlines for next chapters.

1.1 Background

Mental disorders are one kind of health complications that are concerned with emotions, moods, behavior, a sudden change in thinking or sometimes a combination of all these[8]. These types of disorders are generally connected with functioning in certain social, work or family settings. Mental health ensures effective functioning in daily activities such as productive activities at home, school, workplace or social gatherings. It is also one of the foundations of healthy relationships and also is an assistance to adapt to change and deal with adversity [8].

According to World Health Organization (WHO), one in four people in the world gets affected by mental disorders at some point in their lives [4]. Even though the required treatments may be accessible, almost two-thirds of people with a mental disorder never go out and seek help from a professional. WHO also mentioned that social stigma, discrimination and neglect prevent care and treatment from reaching people with mental disorders[5]. We need to understand that mental illness does not discriminate as it can affect anyone regardless of any cultural identity. Psychological scientist Patrick W. Corrigan of the Illinois Institute of Technology rightly said

“The prejudice and discrimination of mental illness is as disabling as the illness itself. It undermines people attaining their personal goals and dissuades them from pursuing effective treatments.” [5].
We need to understand that there is nothing to be ashamed of if someone is suffering from any kind of mental illness as it should be looked at as a medical condition, just like any other health related problems. If we take appropriate actions on time and treat diligently, most of the mental health issues are treatable [8]. Though this area of science is intangible, it’s still continually expanding its bandwidth of knowing more about human brain functions, and treatments to cope with respective mental illnesses gradually.

In Sweden, a few studies showed that the attitude towards mental disorders, psychiatric facilities have changed over the years. There have been several tests performed over time to prove the same and one of those experiments were designed with a set of relevant questionnaire, prepared for a sample set from same community in 1976 and in 2003 between 18–70 years old and it was found that there had been a considerable positive changes over time. More people are aware of the existence of mental disorders and are willing to seek help for the same. So, to support this new era, it has been imperative to improve treatment facilities continuously through robust infrastructure and precise information sharing [10].

According to one Organization for Economic Co-operation and Development (OECD) report, Sweden does not have enough doctors to support people who are mentally ill [13].

"There is a large gap between the care given to those who are seriously sick, and those who suffer from milder problems such as depression or anxiety," Emily Hewlett, from OECD's health division, said in a statement [13].

Also, a few percentages of patients suffering from mental illness receive care from a specialist on time according to the same report, [13]. As discussed earlier, mentally health is not restricted to just one age group, it can occur to any age group at any point of time. That leads to a shortage of doctors due to the rising numbers of Sweden's elderly residents. So, more people require support for their mental health [14].

1.2 Problem Area

As stated earlier, most of the mental disorders can be diagnosed and the technology is getting evolved rapidly to support the complexity underneath [8]. However, there are not enough doctors available and that caus-
es significant healthcare access problems in Sweden. The prolonged queue system has dragged Sweden down from European ranking despite having technological advanced systems. This extreme waiting time in Sweden has been a problem area for a long time. According to a report, published in OECD, some researchers inspected waiting times across 11 countries using statistics from a 2010 Commonwealth Fund Survey in ‘Health at a Glance 2011’. They discovered more patients waiting longer for meeting a specialist in Sweden along with Canada and Norway. In all three of these countries, at least 50% of patients who were surveyed for the research, had to wait 4 to 6 weeks to see a specialist [16]. This research paper will address this wait time problem for mentally ill patients by creating a framework to prioritize patients with different criticality level.

1.3 Related Work

This research paper is motivated by Spiegel and Nenh’s article on an expert system supporting diagnosis in clinical psychology [1] and Lochan’s research paper [15] on a general screening tool for mental disorders. Spiegel and Nenh used DSM-III and DSM-IV criteria to categorize mental disorders where Lochan used MINI instrument along with domain expert’s knowledge to design the screening tool as an artefact of a design science research. Both of their works are highly relevant for determining the category or categories of mental disorders from which a person may be suffering from.

In this research paper, however, the focus is not just about finding out the problems areas of mentally ill people but also prioritizing based on their overall mental health condition irrespective of what disorders they are suffering from. This is done with the help and thorough supervision of a domain expert.

1.4 Research Goals

The research goal is to create a robust framework and a prototype version for the same to prioritize patients with mental disorders. After consulting with a psychiatrist from Akademiska Sjukhuset, Uppsala, I have found that there might be a problem of assigning right priority to a person, and
the people with severe mental problems might lack cognitive abilities to provide adequate data related to their mental health after first inspection at primary care. There is definitely the need to catch individuals with high-risk conditions such as suicide. The proposed prototype is not going to substitute any kind of clinical evaluation. This self-assessment test about various mental health conditions may not only support clinicians but also strengthen the person’s active contribution in the healthcare processes. The current process may sometimes take weeks to estimate and the person has to wait during this time. As stated earlier, this is due to the shortage of doctors in all subsidiaries of Sweden. Based on the urgency level, the person gets an appointment with a specialist at the hospital. The research will focus on making the whole process from ‘going to the primary care’ to ‘meeting an appropriate specialist’ organized within a shorter time than with the current practice.

The research will produce a framework that will serve two research goals. First, it will identify which mental disorders may be present and second; determine the person’s immediate condition, so without delay prioritization occurs. With this solution, mental health care will not only serve the mentally ill people in a more organized way but will also be able to customize a timely and appropriate solution.

**DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure technique, Adult** will be used to assess which disorder(s) a person is possibly suffering from. This DSM-5 psychometric tool is used to identify mental health domains that are essential to use while performing different psychiatric diagnoses. It is intended to help clinicians recognize problem domain areas of a person. The DSM-5 psychometric tool is discussed in section 3.1.1.

The other part of this research is about designing a customized technique with the help of domain expert to regulate a person’s priority list. Thus, the primary care can take actions quickly and prioritize if a person’s case is severe.

The objectives of this research aim is to augment new knowledge that will also add value to the researchers or mental health interest groups who use the existing information system of mental health knowledge. Anyone who visits a the primary care facility, will be asked to take the test by clinicians. The test results will only be visible to the respective clinicians from health care and based on the result, they will decide the
further course of actions needed. For example, sending the person to a specialist right away if the priority is 1 with the report of the problem domains and other relevant details from the test.

1.4.1 Research Questions

This thesis paper focuses on two research questions:

1. How is it possible to digitalize a widespread psychometric scale as a screening tool to determine the possible problem domains of mentally ill patients?

2. How is it possible to use a domain expert’s knowledge and experiences along with information systems competences, to create a tool to prioritize mentally ill patients?

1.5 Audience

The artefact is specifically intended to be used by people at the primary care facility, in private rooms. After discussing with the expert, it has been decided that this tool will be used at the discretion of the clinicians of primary care to restrict certain unforeseen possibilities (for example, possible change in a person’s mental health after going through the test questions or to avoid prank test takers.).

1. The test is advised to be taken by the individual mainly because there will be sensitive information and the person may not be comfortable to share that with anyone else.

2. A person can complete this test with the assistance of their close relatives or guardians in case they have any disability and not capable to take the test by their own.

3. Patients’ should be above 18 to be able to take this test.
1.6 Expert Details

I decided early on that I wanted to develop a system within the domain of mental health care. My supervisor Dr. Pacaci already knew Dr. Direnc Sakarya (i.e. domain expert). After a few initial email communications, he agreed to help and shared the domain knowledge with me to build the framework and the prototype. Based on his credentials, he was a perfect fit as a domain expert for my thesis topic. Dr. Sakarya has been working since 2005 in the field of psychiatric and has acquired extensive knowledge mostly working in Sweden. He has also worked in USA and Turkey. He has done research training at Harvard School of Public Health Care and supervision in Children’s Hospital Boston in 2010, with Fogarty Icohtra scholarship. Currently he is affiliated with Department of Neuroscience, Uppsala University as a researcher and working at the Affective Disorders Unit at the Uppsala University Hospital as a psychiatrist [12].

1.7 Delimitation

Some delimitations have been considered during the process of completion of this research paper and they are as follows:

1. There will not be any real life clinical testing for this tool. It will be reviewed and validated by the expert.

2. The customized scale for prioritizing patients may be best suitable for Sweden because there is only one expert for this project and he is working at the psychiatric department in Uppsala, Sweden and his experiences have been acquired from working with patients in Sweden. However, DSM-5 scale is widespread, so there won’t be any change in regard to use outside Sweden.

3. The framework is more suitable for Swedish psychiatric system as it has been designed with the help of an expert who acquired his experiences mostly working in Sweden. However, the core idea, can be abstracted and be useful irrespective of any country.
1.8 Ethics

Other than properly citing the references, no ethical action was taken into considerations. Because, there was no human subject involved during the process of whole period of this thesis paper and there is also no future plan for testing or evaluating the system on human subjects. There will be testers, i.e. Expert, Examiner, Developer who will be examining the system. And this is for evaluation purpose whether the system is behaving the way it should. There won’t be storage of any real personal data. The system will only store test data, generated by testers during the evaluation phase.

However, ethical issues must be considered if it is going to be implemented for real patients at the primary care as a part of future research.

1.9 Outlines

The remainder of this thesis is presented according to the following outline:

2 - Methodology
The backbone of any thesis is the methodology section and this thesis is no different. This research paper was carried out with the help of a Design Science Research (DSR) framework in regard to DSR knowledge and an artefact. This section will also present the process of data collection and briefly mentioned the technique for evaluation.

3 – Design and Implementation
The section will start with conceptualizing the framework with the help of DSR knowledge and will be followed by system development as prototyping of the artefact.

4 – Results
The results are described in this section. The outcomes of two research questions are mentioned separately. And in the end, a few test results are mentioned.

5 – Evaluation and Discussion
After getting the results of the research question, the evaluation process will begin in this chapter. The first part of the evaluation is conducted on
data collection and the second part will be made on the prototype. The expert will evaluate both and provide feedback. There will be discussion after each evaluation. In the end of this section, there will be evaluation and discussions of all test cases that are mentioned in the Result section.

6 – Conclusion and Future Advancements
In this chapter, a conclusion will be drawn from the results and evaluations. There will be a brief mention of reflections and limitation of the paper. Finally, the future research scope of this thesis paper will be discussed.
2. Methodology

This chapter demonstrates the methodological approach which is referred as a theoretical background of how the research is carried out. It also deliberates the data collection technique and a short introduction to overall evaluation process.

2.1 Foundation

Design Science Research (DSR) in information systems (IS) solves problems by developing something tangible, something that can be measured. A prototype in the form of an IT artefact is a prominent example of that [19]. DSR produces several artificial entities such as constructs, models, methods, and instantiations of the prototype or design theories while undergoing the process [18].

As mentioned in the earlier section 1.4, the idea behind the thesis is to create a framework for designing and implementing a screening tool to build a more efficient infrastructure to address the problem of prolonged queue system and serve people in more organized way. The framework will comprise two different techniques and each of them has its individual goal to fulfil. However, both are co-related while deciding on a people’s case.

The first technique is to identify the course of actions of person’s treatment, as in what are the main problem areas. To achieve this goal, ‘DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure’ for adults will be used. This is a widespread psychometric tool designed by American Psychiatric Society [20].

The second technique is to identify severity level of person’s mental health, so primary care can decide which patient needs to be prioritized and which can wait. This way, the problem of ‘prolonged queue system’ can be addressed as primary care would be able to decide quickly whether someone needs to be looked upon right away and tailor the appropriate treatment plan subsequently. This has been designed based on domain expert’s knowledge and experiences. A framework has been created after
evaluating three key factors, i.e. 1. patients suicidal tendency, 2. any previous encounter with Psychiatric Care and 3. patients’ quality of life. We will discuss in more details in the design and implementation section 3.1.

Design science research resonates with two main deliverables which are called design science research outputs. First, it’s the design science knowledge that’s developed as a part of the research. To apprehend better, it is good to identify what form of knowledge this DS research is going to deliver in regard to all possible types of knowledge contribution of DSR.

![Figure 2.1-1 : DSR Knowledge Contribution Framework [27]](image)

Above figure 2.1-1 displays a knowledge contribution framework for DSR [27]. Invention, Improvement, Adaptation and Routine Design can all be different natures of knowledge contribution in any DSR. Invention stands for inventing new knowledge or solutions for new problems where Improvement is about developing new knowledge or solutions for known problems. Adaptation is about adjusting and solving new problems with known solutions where routing design applies known knowledge to known problems. A point to be noted that a single project can comprise more than one kind of knowledge contribution. In order to establish the fact whether any knowledge contribution is significant, it’s essential to be evaluated with respect to the present knowledge in the similar research area and at the same time whether it’s engaging for other individuals [27].
This research is mostly categorized as ‘Improvement’ segment as it is designed to address an existing problem with a new solution. The problem of prioritizing patients already exists; and, the proposed solution will be a new approach.

As DSR knowledge demonstrates in the form of an artefact, this DSR will be closely coupled with the framework provided by Gregor and Jones [18] and will be discussed different aspects of the framework and how they are aligned with the design of this information system. Gregor and Jones’ framework comprises of eight components (6 mandatory and 2 optional), for any information system design theory [20]. The following is a summary of the components with a short description, taken directly from Gregor and Jones’ article: It will be explained in detail in the section 3, i.e. Design and Implementation and section 3.2, i.e. Alignment with Gregor and Jones’ DSR framework.

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Components</td>
<td></td>
</tr>
<tr>
<td>1) Purpose and Scope</td>
<td>Provides a clear description of the purpose and scope of the new theory.</td>
</tr>
<tr>
<td>2) Constructs</td>
<td>Describes all the existing or new entities or concepts relevant to the description of the theory.</td>
</tr>
<tr>
<td>3) Knowledge of Form and Function</td>
<td>Includes the full description of models, frameworks, methods, and/or other abstract artifacts that form the body of the design science knowledge contribution.</td>
</tr>
<tr>
<td>4) Abstraction and Generalization</td>
<td>Is at such an abstract and general level that the artifacts resulting from the theory can change or be changed without affecting the theory.</td>
</tr>
<tr>
<td>5) Evaluation and Validation Propositions</td>
<td>Has been evaluated for its truthfulness, i.e. assertions made based on the theory have been tested in an appropriate manner.</td>
</tr>
<tr>
<td>6) Justificatory Knowledge</td>
<td>Includes references to justificatory knowledge—tacit theory (informal experience-based insights and intuitions), kernel theory—that can provide a reasonable degree of justification of the theory.</td>
</tr>
<tr>
<td>Additional Components</td>
<td></td>
</tr>
<tr>
<td>7) Principles of Implementation</td>
<td>Describes the process for instantiating the theory.</td>
</tr>
<tr>
<td>8) Expository Instantation</td>
<td>Includes an instantiation (possibly situated implementation) that can be used for exposition of the theory and/or for testing the theory.</td>
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</table>

Table 2.1-1: Gregor and Jones DSR framework [18]

2.2 Data Collection

In this section, the different stages of data collections are illustrated.
2.2.1 Preparation

All the four interviews with the expert took place in Akademiska Sjukhuset in Uppsala. It was mostly unstructured and more like discussions rather than interviews. As the goal was to capture an overall idea around what sort of research can add value to mental health care, I wanted the expert to be fully involved in making decisions about the system from the beginning.

During our first interview, we discussed different psychometric scales and the problem areas that existed in this domain. I acquired more insights in the field of psychiatry and started researching on related works that have been done in this area. It was more of a brain storming session.

Our second interview took place after a time span of 15-20 days where we talked about what we could do that would be valuable to the research area and add some values to it. And eventually, we conceptualized an initial idea of what the system should be about.

It was our third meeting which took place around 10 days after the second meeting when we finalized the research objectives and the framework for it.

I jotted down every important detail that we talked about during our meetings and based on the discussion of third meeting, I started designing the framework and got it verified from the expert as well. Once I got a go ahead on the framework, I started working on the prototype and in the mean time I was in touch with the expert extensively over email and every step of the way he reviewed and agreed to proceed on the next step. I also adhered to some changes, proposed by the expert.

Finally, after completion of the prototype, I requested the expert to perform a thorough review on overall system during our fourth meeting.

2.2.2 Process:

The data collection process could be measured in two-fold steps. First part of data collection was accomplished from DSM-5 too where the guidelines from the inventor, i.e. American psychiatric society were strictly followed as it is a well-established scale [20]. The guideline is fairly straight forward and easy to implement.
The second section had been very challenging as this research paper was meant to create a new framework to identify the criticality level of people’s mental health. It took several unstructured interviews and emailing back-forth with the expert over the course of 4 months as discussed above. This area of science is not quite concrete, and the expert implicitly acquired the knowledge through his experiences over time. So, to discuss freely and in details, unstructured interviews had been conducted, followed by planning and coding to materialize and finalize the final framework. After these phases of interviewing, discussing, planning, designing and coding, the current design was proposed.

2.3 Evaluation

The evaluation methodology was a two-steps process. The first step would be evaluating overall knowledge that is used to design the framework. The second would be an overall review, made by the expert. The domain expert will evaluate the framework and the IT artefact whether it has been implemented as per the discussion and whether the result is coming out as it should. Evaluation will be discussed more thoroughly later in the ‘Evaluation’ section.
3. Design and Implementation

This chapter focusses on the planning and implementation of the framework and respective prototype. It discusses every component that has been used to design the framework and how the prototype is built on that. Lastly, it displays the relation between the theoretical DSR framework with its implementation.

3.1 Conceptualizing the framework

This section describes how the framework was built and what are the components were needed to conceptualize the design.

3.1.1 First research goal- Screening possible problem areas

The design of the framework has been set on two different goals. First one was very straightforward as it is from the established psychometric scale. The questions below enquire about things that might have bothered the person during the past two weeks and for each question, person needs to select the best possible associated value[20].

- Questionnaire and scaling system

As shown in table 3.1-1, DSM-5 scale consists of 23 questions that incorporate 13 different psychiatric domains. There are one or multiple questions asked to evaluate each of 13 domains. Please find below brief description for each domain. They are also mapped with the problem domain column in table 3.1-1.

1. Depression: It is one of the common and serious medical disorders that negatively affects how you feel, act and the way you think. It
can be treatable with proper care from a specialist of healthcare [31].

2. Anger: It involves “an emotional state that varies in intensity from mild irritation to intense fury and rage”, according to Charles Spielberger, PhD, a psychologist who is an expert in the study of anger. When someone is angry, heart rate and blood pressure go up, along with the person’s energy hormones, adrenaline [33].

3. Mania: It causes changes in a person’s mood, energy and ability to function in different social settings [31].

4. Anxiety: Anxiety is a general reaction to stress and sometimes alert us to forthcoming dangers. Anxiety disorder involves excessive fear or anxiety. Anxiety disorders are the most common mental disorders that affect nearly 30 percent of adults at some point in their lives [31].

5. Somatic symptoms: This involves a person having excessive thoughts, feelings related to the physical symptoms such as pain, shortness of breath etc [31].

6. Suicidal ideation: It is also known as suicidal thoughts. It generally arises when a person experiences more pain and sadness than they can cope with [35].

7. Psychosis: It is described as an impaired relationship with the reality. People who experiences psychosis, may have either hallucinations or delusions [35].

8. Sleep problems: It involve problems with the quality, timing and amount of sleep which cause problems with functioning properly in daytime [31].

9. Memory: It involves neurological damage to the structures of the brain, that leads to hindering the storage of new memory and, retention and recollection of existing memories. Alzheimer’s disease is one kind of memory disorders [32].

10. Repetitive thoughts and behaviours: It is a kind of anxiety disorder that affects people in a way that they experience repetitive thoughts
and behaviors that upsets them. It may include different kind of behavioral patterns such as arm or hand-flapping, jumping, finger-flicking, spinning or twirling, head-banging and complex body movements [36].

11. Dissociation: It involves problems with person’s memory, emotion, identity, behaviour and sense of self. It can eventually disturb any area of normal mental functioning [31].

12. Personality functioning: It involves with an ongoing pattern of varying moods, and behaviour in different situations. It often results in impulsive actions and problems in difficult or complex situations and in relationships [34].

13. Substance use: It is a brain disease that is manifested by compulsive substance use despite harmful repercussions. People with severe substance use disorder have a strong focus on using certain substances. It can be any form of alcohol or drugs etc [31].

<table>
<thead>
<tr>
<th>Problem domain</th>
<th>During the past TWO (2) WEEKS, how much (or how often) have you been bothered by the following problems?</th>
<th>None</th>
<th>Slight</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.</td>
<td>1. Little interest or pleasure in doing things?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>2. Feeling down, depressed, or hopeless?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>II.</td>
<td>3. Feeling more irritated, grouchy, or angry than usual?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>III.</td>
<td>4. Sleeping less than usual, but still have a lot of energy?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Starting lots more projects than usual or doing more risky things than usual?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>IV.</td>
<td>6. Feeling nervous, anxious, frightened, worried, or on edge?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>7. Feeling panic or being frightened?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>8. Avoiding situations that make you anxious?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>V.</td>
<td>9. Unexplained aches and pains (e.g., head, back, joints, abdomen, legs)?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>10. Feeling that your illnesses are not being taken seriously enough?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>VI.</td>
<td>11. Thoughts of actually hurting yourself?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>VII.</td>
<td>12. Hearing things other people couldn’t hear, such as voices even when no one was around?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>13. Feeling that someone could hear your thoughts, or that you could hear what another person was thinking?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>VIII.</td>
<td>14. Problems with sleep that affected your sleep quality</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Problems with memory (e.g., learning new information) or with location (e.g., finding your way home)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IX.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unpleasant thoughts, urges, or images that repeatedly enter your mind?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Feeling driven to perform certain behaviors or mental acts over and over again?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Feeling detached or distant from yourself, your body, your physical surroundings, or your memories?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XI.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not knowing who you really are or what you want out of life?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XII.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not feeling close to other people or enjoying your relationships with them?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drinking at least 4 drinks of any kind of alcohol in a single day?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XIII.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Smoking any cigarettes, a cigar, or pipe, or using snuff or chewing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
23. Using any of the following medicines ON YOUR OWN, that is, without a doctor’s prescription, in greater amounts or longer than prescribed [e.g., painkillers (like Vicodin), stimulants (like Ritalin or Adderall), sedatives or tranquilizers (like sleeping pills or Valium), or drugs like marijuana, cocaine or crack, club drugs (like ecstasy), hallucinogens (like LSD), heroin, inhalants or solvents (like glue), or methamphetamine (like speed)]?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.1-1: DSM-5 Level 1 Cross Cutting Symptoms Measures, Adults [20]

- **Scoring and Interpretation**

As it is showed in the above table, each item on the measure has been rated on a 5-point scale.
0 = none or not at all;
1 = slight or rare, less than a day or two;
2 = mild or several days;
3 = moderate or more than half the days;
4 = severe or nearly every day).
If a person scores mild (that is 2) or greater on any question within any domain, then that domain will be added in the list for details diagnosis. However, there are 3 domains (i.e. For substance use, suicidal ideation, and psychosis) for which a score of slight (i.e. 1) or greater on any question within the domain means further diagnosis is required [18].

3.1.2 Second research goal- Determination of a patient criticality

The second research goal involves determining a person’s criticality based on the test. Lot of challenges and obstacles were witnessed while working on this research goal, as per the need to succeed with this goal, a customized framework has to be built. When we talk about prioritizing patients, it can be based on innumerous things and everything is not possible to cover in a master thesis report and also at the same time, we need to make sure the whole test should not be too long that patients are not comfortable of taking at the first place. So, the expert and I discussed on several criteria and after doing some research and accumulating with expert’s experience, we came up with three sections that can potentially be considered to evaluate the criticality of the patient. The description of these three sections are as follows:

1. Identifying patient’s suicidal tendencies

The most important among those three components would be patients’ suicidal tendencies. According to WHO, every year around 800 000 people die committing suicide, which is roughly one person every 40 seconds. Apart from that there are many more attempts of suicide which are beyond the numbers that we have for suicide. There is a hint that for each adult who eventually died of suicide, may have tried to attempt suicide more than 20 times. There is no specific time for that as it can happen throughout the lifetime of any individual [21]. Study also shows 90% of people who committed suicide, had suffered from some kind of mental disorders [22]. It has also been noticed that people who lost someone due to suicide, also can go through similar trauma and that lead to suicidal attempts and it’s important that they have someone close to talk to when they have this kind of thoughts [23]. Based on these factors, the expert suggested a few questions and depending on patient’s answer, the critical-
ity of a patient can be decided. Due to the exigency of this section, it is the primary section for evaluating patients’ criticality. Patients from priority 1-4 can be decided from this section. The description of different level of patient’s priority are described in the table 3.1-3. Patient who is already categorized as priority 1 would remain as priority 1 no matter what he/she answers in next sections. Now, next two sections can only elevate the relatively lower priority (priority 2-4) patients based on patient’s results in the following sections 2 and 3.

2. Patients’ previous encounter with psychiatric care

Second section is about patients’ previous encounters with psychiatric care and whether patient is taking any medication or took any medication in the past. Based on that, patient’s critical level would level up from last section. Priority 4 can become Priority 2 & 3. However, priority 3 can reach up to priority 2 and priority 2 will remain unchanged. This section is more suitable for people who have come from different countries, and their previous records are not accessible by Swedish healthcare, according to the expert.

3. Patient’s quality of life

Third section has been materialized from patient’s Quality of life (QoL). QoL is a person's awareness of his position in life in regard to the people, culture and system surrounding him. Study shows that there is a correlation between patient’s mental health with his/her activity of daily routine [24] and sometime a chronic disease (i.e. high blood pressure, diabetes etc.) can lead to some kind of mental disorders [24]. Keeping all these factors in check and with expert’s help, a customized scoring system for the quality of life questionnaire has been created and is illustrated in table 3.1-2. This section will also play a vital role to elevate, patient’s priority level from previous section (i.e. patients’ previous encounter with psychiatric care). Priority 4 can become Priority 2 & 3, priority 3 can only reach up to priority 2 and priority 2 can be altered to priority 1. The reliability of this scale and previous sections depend on expert’s extensive experience at psychiatric care as he has done it quite intuitively.

The diagram of this whole process how patients’ criticality has been evaluated, will be as follows in the Figure 3.1-1. However, before that I would like to introduce to the questionnaire of QoL and its scoring sys-
tems. The QoL questions are also motivated from ‘36-Item Short Form Survey Instrument by Rand’ [17].

- QoL questionnaires

<table>
<thead>
<tr>
<th>Questions</th>
<th>Answer options &amp; respective score card</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) In general, would you say your health is?</td>
<td>Excellent 0</td>
</tr>
<tr>
<td></td>
<td>Very Good 1</td>
</tr>
<tr>
<td></td>
<td>Good 2</td>
</tr>
<tr>
<td></td>
<td>Decent 3</td>
</tr>
<tr>
<td></td>
<td>Poor 4</td>
</tr>
<tr>
<td>2) Do you feel as healthy as everyone around you?</td>
<td>Yes 0</td>
</tr>
<tr>
<td></td>
<td>No 3</td>
</tr>
<tr>
<td></td>
<td>Not Sure 1</td>
</tr>
<tr>
<td>3) To what extent your physical health or emotional problems hindered your normal social activities in the past 4 weeks?</td>
<td>Not at all 0</td>
</tr>
<tr>
<td></td>
<td>Slightly 1</td>
</tr>
<tr>
<td></td>
<td>Moderately 2</td>
</tr>
<tr>
<td></td>
<td>Extremely 3</td>
</tr>
<tr>
<td>4) How much of the time has your physical health or emotional problems interfered with your normal social activities in the past 4 weeks?</td>
<td>None of the time 0</td>
</tr>
<tr>
<td></td>
<td>Some of the time 1</td>
</tr>
<tr>
<td></td>
<td>Most of the time 2</td>
</tr>
<tr>
<td></td>
<td>All of the time 3</td>
</tr>
<tr>
<td>5) Do you have any pain that has affected your daily indoor and outdoor activities?</td>
<td>Not at all 0</td>
</tr>
<tr>
<td></td>
<td>Slightly 1</td>
</tr>
<tr>
<td></td>
<td>Moderately 2</td>
</tr>
<tr>
<td></td>
<td>Extremely 3</td>
</tr>
<tr>
<td>6) Does your health now limit you in moderate activities, such as walking several blocks, stairs, carrying groceries?</td>
<td>No, Limited at all 0</td>
</tr>
<tr>
<td></td>
<td>Yes, Limited a little 1</td>
</tr>
<tr>
<td></td>
<td>Yes, Limited a lot 3</td>
</tr>
<tr>
<td>7) Does your health now limit you in basic activities, such as bathing or dressing, bending, kneeling?</td>
<td>No, Limited at all 0</td>
</tr>
<tr>
<td></td>
<td>Yes, Limited a lot 3</td>
</tr>
</tbody>
</table>
8) Did you feel tired during last few weeks?

<table>
<thead>
<tr>
<th></th>
<th>little</th>
<th>Yes, Limited a lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>None of the time</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Some of the time</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Most of the time</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>All of the time</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.1-2: Customized QoL Questionnaire

**Please note that scoring point is considered as nominal value so arithmetic operations, such as addition, can be done on this scale.**

- Descriptions of different level of priorities

According to the expert, different priority levels can be defined as follows. Point to be noted that, these definitions may differ from place to place in association with the degree to the criticality.

<table>
<thead>
<tr>
<th>Priority Level</th>
<th>What does it mean?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priority 1 or P1</td>
<td>The patients who are in need of an acute (at best in one day) psychiatric evaluation because of the high scores in risk assessment measures such as suicidal tendencies. These patients probably need an acute consultation by a psychiatry specialist after the initial assessment in the primary care.</td>
</tr>
<tr>
<td>Priority 2 or P2</td>
<td>The patients who need of a rapid psychiatric evaluation due to higher scores in the screening measures. This means probably more severe mental problems and/or lower levels of functioning. These patients probably need a telephone consultation with a psychiatry specialist after the initial assessment in the primary care.</td>
</tr>
<tr>
<td>Priority 3 or P2</td>
<td>The patients who need a psychiatric evaluation due to positive screening in the self-assessment. These patients might probably get better with a treatment</td>
</tr>
</tbody>
</table>
intervention in the primary care without contacting the psychiatry clinic.

| Priority 4 or P4 | The patients who need a psychiatric evaluation due to positive screening indicating some degree of distress in the self-assessments. These patients might or might not need a treatment intervention in primary care. |

Table 3.1-3: Description of different priority level

- **3 Steps Patients priority process**

  First step is to evaluate the patient’s suicidal tendency as it is the most important step for evaluation. Thus, it is considered to be the primary evaluation criteria. Patient’s priority from 1 to 4 can be obtained after completion of this step. If patient’s priority is evaluated as 1, it remains the same irrespective patient’s responses to next two sections. Following two sections are ‘patient’s previous encounter with psychiatric care’ and ‘patient’s quality of life’. These two sections help to elevate patent’s severity that is evaluated as 2 to 4. The final result is determined after completion of all three steps. For more details description of these 3 steps, please refer the section 3.1.2.

  Following figure 3.1-1 is the depiction of three steps process of how a patient’s priority has been determined.
### Patients' Priority Determination: 3 Steps Process

<table>
<thead>
<tr>
<th>Step 1: Patients' Suicidal Tendency related questions and answer options</th>
<th>Different Answer combinations</th>
<th>Patients’ criticality level (P1 to 4) evaluation Stage 1</th>
</tr>
</thead>
</table>
| Question 1: Have you ever tried to commit suicide?  
  a) Yes  
  b) No | P1 | P1 |
| Question 2: Have you considered committing suicide recently?  
  a) Yes  
  b) No | P2 | P2 |
| Question 3: Do you have people (family, friends) you can reach to when you are not feeling OK?  
  a) Yes  
  b) No | P3 | P3 |
| Question 4: Is there anyone in your family who has died by suicide?  
  a) Yes  
  b) No | P4 | P4 |

<table>
<thead>
<tr>
<th>Step 2: Patients background with psychiatric care questions and answer options</th>
<th>Different Answer combinations (P1 And P2 from Suicidal section remains the same, this section elevates P2 and P4 to P2 and P3)</th>
<th>Patients’ criticality level (1 to 4) evaluation: Stage 2</th>
</tr>
</thead>
</table>
| Question 1: Have you contacted Psychiatric care anytime in the past?  
  a) Yes  
  b) No | P1 | P1 |
| Question 2: Are you taking any medication right now?  
  a) Yes  
  b) No | P2 | P2 |
| Question 3: Have you taken any medication in the past?  
  a) Yes  
  b) No | P3 | P3 |
| Question 4: Have you been diagnosed with any physical chronic disease (i.e. High blood pressure, diabetes etc)?  
  a) Yes  
  b) No | P4 | P4 |

<table>
<thead>
<tr>
<th>Step 3: Patients' Quality of Life (QoL) answer options</th>
<th>Score management for QoL with previous priority (P1 from stage 1 &amp; 2 remains the same, this section elevates P2, P3 and P4 to P1, P2, and P2/P3)</th>
<th>Patients’ criticality level (1 to 4) evaluation: Stage 3 or Final</th>
</tr>
</thead>
</table>
| Question 5: Assessing the patient's QoL  
  a) Good  
  b) Fair  
  c) Poor  
  d) Very poor | P1 | P1 |
| Question 6: Assessing the patient's QoL  
  a) Good  
  b) Fair  
  c) Poor  
  d) Very poor | P2 | P2 |
| Question 7: Assessing the patient's QoL  
  a) Good  
  b) Fair  
  c) Poor  
  d) Very poor | P3 | P3 |
| Question 8: Assessing the patient's QoL  
  a) Good  
  b) Fair  
  c) Poor  
  d) Very poor | P4 | P4 |

In this section there are 8 questions and each are considered equally important. And all possible answers for each question got a corresponding value (nominal number). So a patient can score in between 6-26. If a patient’s critical point is 26 which means his/her quality of life is worst.

Now we will use this scorecard to determine patient’s final/actual criticality level. We have divided the total score in 3 sections.

- Critical [C1]: 0-12
- Critical [C2]: 13-18
- Critical [C3]: 19-26

* In other combinations, existing Patients severity becomes the final severity.
3.2 Alignment with Gregor and Jones’ DSR framework

This section discusses about how the framework that was designed in the previous section 3.1, aligned with the Gregor and Jones DSR framework.

3.2.1 Purpose and Scope:
The purpose and scope of a design theory should be engaging and also contributes a new knowledge to the relevant research community. Earlier in the methodology section, I have mentioned that this DSR research knowledge comes under ‘Improvement’ as it’s adding a new knowledge of how to prioritize patients in an exciting way. The prototype has designed to be interactive so the individual who takes the test, is motivated enough to complete the test. At the same time, it limits the display of sensitive personal information, for example test results, only to the healthcare personnel.

3.2.2 Constructs
The proposed artefact comprises 4 sections. Among these four sections, one section (i.e. screening test) is a stand-alone segment which determines which areas a person needs, could be diagnosed if he/she has any kind of symptom that raises a flag for any mental disorder. Other 3 sections are coupled together to evaluate patient’s criticality.

3.2.3 Knowledge of Form and Function
As explained earlier, this DSR delivers a knowledge that clearly defines its root cause and respective solutions to that. The DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure, Adult has been used to reach the first research goal and was taken from the American Psychiatric Society which is a reliable source and it has been implemented as per the
guidelines [20]. The second research goal is the new knowledge, deduced from various aspects of a patient’s life and it has been materialized with the help of an expert having in depth knowledge and experiences in this area.

3.2.4 Abstraction and Generalization
The whole framework has been totally abstracted out and it is totally language independent. However, the artefact in the system can also adapt based on new requirements and can be extended as per requirements.

3.2.5 Evaluation and Validation Propositions:
Evaluation and validation will be two-fold as mentioned earlier. First part was evaluating the authenticity of the data which are used to build the framework and that has been evaluated by the expert before design and implementation. And second part will be overall review after the prototyping is complete.

3.2.6 Justificatory Knowledge:
The knowledge has been thoroughly verified by the guidelines provided by American Psychiatric Society [18] and the specialist in this area.

3.2.7 Expository Instantiation
Instantiation of the artefact has been with the help of a web-based system. Thorough system development and walk through of the system have been covered in the next section 3.3, that is System Development.
3.3 System Development

This section demonstrates how the ‘Expository Instantiation’ from the section 3.2.7 was implemented.

3.3.1 Web Based Technology

The screening tool has been developed in HTML, CSS, Java Script with jQuery framework and PHP-MySQL. Front end has been designed with HTML, CSS, Bootstrap and front-end validation has been taken care by jQuery. Back end has been developed with PHP and MySQL database and backend validation has been taken care by mostly object-oriented PHP.

The key motive behind selecting a web application is its platform independence and there won’t be any need of setting up or installing the application to the respective local machines. It will also be compatible with tablets and smart phones.

3.3.2 Prototyping of the artefact

After conceptualizing the DSR knowledge, I started prototyping the system regarding Gregor and Jones’s framework for instantiation of the artefact [18].

3.3.3 A walk-through of the system

This section displays the complete user manual of the system step by step. It also demonstrates the different access rights between a healthcare personnel / clinician and an individual / patient who visited the primary care.

- Register and login into the system

This is the register page of the artefact and as displayed, there are two ways an account can be created, one is for healthcare personnel and another for a common individual who has visited to a primary healthcare to get the check-up done. Note in this prototype anyone is capable of creating both types of accounts. This is because a lot of testing required before implementing to the real time situation.
After creating the respective account user can login with email and password. Just to explain the system with clarity, I have created two below accounts.

Jane Doe: HealthCare Personnel
John Doe: Common Individual

Figure 3.3-2: Register Page

Figure 3.3-1: Login Page
A common individual’s home page- About Test.

After successfully login, a common person is redirected to ‘About the test’ page. This page is the home page for a common user where he gets to know more about test in case of any curiosity.

Figure 3.3-3: About Test

Begin Test

Begin section starts with the questionnaires of patient’s previous encounter with psychiatric care followed by screening test, suicidal tendencies and patient’s quality of life.

Figure 3.3-4: Begin Test
Submit and resubmit the test

After completing all 4 sections, user can submit the test and gets only a notification that it has been submitted successfully. However, if the user tries to resubmit, the system does not allow user to do so. However, this situation can also be handled if there is any mistake committed by the user at the first attempt and the test needs to be taken again. Healthcare personnel can help user with that by completing/cancelling existing test session.

Figure 3.3-5: Submit Page

Figure 3.3-6: Resubmit Notification
Healthcare personnel can view the user’s current and previous records along with the standards for different set of priority which are hidden for the common individual. The result may be unpleasant and it’s better if the person does not see as it can have an adverse effect on the person, according to the expert. The priority and the relevant areas of mental disorders that to be diagnosed further, are visible only healthcare personnel under the user records page. Also, they can complete a someone’s test, so the test can be taken again if required. Please find below all the screenshots what a clinician can only see.

1. **User Records section in the home page:** Healthcare personnel or clinician can see the all the current and previous records of users along with the definition of different priority level.

![Figure 3.3-7: Healthcare Personnel or Clinicians Home Page](image-url)
2. About Different Priority Page: In this page, clinician can see the descriptions of different level of priorities.

![Figure 3.3-8: Explanation about Different Level of Priority](image)

3. Current user records: In this page, clinician can see the current test results of all the people whose treatments are still in progress. If the treatment is complete for someone, clinician can mark it as ‘Complete’ and the record is transferred to the ‘Previous Record’ section.

![Figure 3.3-9: Current Users’ Records](image)
4. Previous users’ records: In this page, clinician can see the previous test results of all the people whose treatments were completed earlier. Clinician can mark any case as ‘Active’ and transfer the record to ‘Current Record’ section if the treatment needs to be resumed.

Figure 3.3-10: Previous Users’ Records
• Other security measurements of the system

As per the security constraints of the system, I would like to mention that user’s password is being hashed and then stored into the database. And SQL injection has taken care of while accessing the database through PHP. This has been done to display how to avoid security breaches related to this area. SQL injection can be used to destroy the database of any application if it’s not taken care of [28]. Please find below screenshots for the same.

![Figure 3.3-11: Avoiding SQL Injections with the help of ‘bind_param’](image1)

![Figure 3.3-12: Hashed Password for Database](image2)
4. Results

As per research goals of this DSR, there are two research questions, declared in the beginning of the section.

First goal is about the possibility of creating an artefact that can determine the number mental disorders, patients’ may be suffering with the help of a widespread psychometric tool. As stated earlier the framework has been successfully implemented and evaluated which can refer to DSR knowledge and artefact has been developed successfully and reviewed the same by the expert as well.

Second goal is about the possibility of creating an artefact that can determine a patient’s criticality with the help of expert’s domain knowledge and it has been done based on several customized sections. As stated earlier the framework for prioritizing patients has been successfully implemented and evaluated by the expert. It has also been incorporated into an artefact as a part of prototyping and the expert validated that as an appropriate implementation.

First goal was relatively straight forward as there is a straight forward guideline that we needed to follow. There was no hassle while materializing the framework as the concept was already available there at the site of American Psychiatric Society [20], it was mentioned that we could use it just by using the appropriate references and there was no need of getting an approval.

However, the challenge came from the second goal where expert knowledge has been incorporated to conceptualize and later materialize the whole system. This area of science is not tangible enough to be hundred percent certain about everything at a first go or second, so it took a lot of efforts along with trial and error various technique to tailor the final framework that comprises on 3 sections. Suicidal tendency and previous encounters with psychiatric care have been designed at the beginning of this project. But, somehow the QOL section was hard to conceptualize
after several attempts. We tried to use rand 36-Item [17] and it did not work out as it has its own numbering scale which deals with ordinal values. Though we were not successful to implement Rands’ 36-ITEM [17], it definitely helped us to finalize our own set of question for quality of life section with its own scoring system and that deals with numerical value. We wanted to use numerical scoring system for this section not just to identify the patient’s current quality of life, but also to incorporate them in the main evaluation of patient’s critical section in a logical way. So, after doing so, we successfully created the framework for determining patients’ priority finder. However, this is based on the knowledges and experiences from the expert I worked with. We have taken his perception into consideration and tried to make it more abstract and general. However, another expert may differ with the ideas and share a different opinion about it.

4.2 Test results

Below are the three examples of all the test cases that were used for evaluating the system. It would be easy to display how the reliability of the system has been confirmed. All the tests have been done by the experts.

Please refer to the section 3.1 for detailed questions and corresponding answer options.

<table>
<thead>
<tr>
<th>Test Case No</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tester</td>
<td>Expert</td>
</tr>
<tr>
<td>Test Description</td>
<td>Determining whether conditions to be fulfilled with desired input values</td>
</tr>
<tr>
<td></td>
<td>1. Patient to be prioritized as P1</td>
</tr>
<tr>
<td></td>
<td>2. Screening positive for below domains: Depression, Anger and Anxiety</td>
</tr>
<tr>
<td>Input Selection</td>
<td>4 questions relat-</td>
</tr>
<tr>
<td></td>
<td>• Q1: No</td>
</tr>
</tbody>
</table>
| ed to Previous encounter with psychiatric | • Q2: No  
• Q3: No  
• Q4: No |
| Input Selection 2: 23 questions related to screening of possible problem domains | • Q1: 1  
• Q2: 2  
• Q3:  
• ..  
• ...  
• Q23: 0 |
| Input Selection 3: 4 questions for any suicidal tendencies | • Q1: No  
• Q2: Yes  
• Q3: No  
• Q4: No |
| Input Selection 4: 8 questions related to patient’s quality of life | • Q1: Poor  
• Q2: Not sure  
• Q3: Moderately  
• Q4: Most of the time  
• Q5: Not at all  
• Q6: Limited a little  
• Q7: Limited a lot  
• Q8: Some of the time |

| Expected Output 1: Patient Priority No | 1 |
| Expected Output 2 Screening is positive for below domains | Depression  
Anger  
Anxiety |
| Actual Output 1 | 1 |
| Actual Output 2 | Depression  
Anger  
Anxiety |
| Pass/Fail | Pass |
| Comments | Conditions have been met as actual results are equal to expected results. |
| Any Defects Found | No |

Table 4.2-1: Test Case 1
<table>
<thead>
<tr>
<th>Test Case No</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tester</td>
<td>Expert</td>
</tr>
<tr>
<td>Test Description</td>
<td>Determining whether conditions to be fulfilled with desired input values</td>
</tr>
<tr>
<td></td>
<td>3. Patient to be prioritized as P2</td>
</tr>
<tr>
<td></td>
<td>4. Screening positive for below domains: Mania and Personality Functioning</td>
</tr>
<tr>
<td>Input Selection 1: 4 questions related to Previous encounter with psychiatric</td>
<td>• Q1: No</td>
</tr>
<tr>
<td></td>
<td>• Q2: No</td>
</tr>
<tr>
<td></td>
<td>• Q3: No</td>
</tr>
<tr>
<td></td>
<td>• Q4: No</td>
</tr>
<tr>
<td>Input Selection 2: 23 questions related to screening of possible problem domains</td>
<td>• Q1: 1</td>
</tr>
<tr>
<td></td>
<td>• Q2: 1</td>
</tr>
<tr>
<td></td>
<td>• Q3: 1</td>
</tr>
<tr>
<td></td>
<td>• Q4: 0</td>
</tr>
<tr>
<td></td>
<td>• Q5: 2</td>
</tr>
<tr>
<td></td>
<td>• Q6: 1</td>
</tr>
<tr>
<td></td>
<td>• Q7: 1</td>
</tr>
<tr>
<td></td>
<td>• Q8: 2</td>
</tr>
<tr>
<td></td>
<td>• Q9: 0</td>
</tr>
<tr>
<td></td>
<td>• Q10: 0</td>
</tr>
<tr>
<td></td>
<td>• Q11: 0</td>
</tr>
<tr>
<td></td>
<td>• Q12: 0</td>
</tr>
<tr>
<td></td>
<td>• Q13: 0</td>
</tr>
<tr>
<td></td>
<td>• Q14: 0</td>
</tr>
<tr>
<td></td>
<td>• Q15: 0</td>
</tr>
<tr>
<td></td>
<td>• Q16: 0</td>
</tr>
<tr>
<td></td>
<td>• Q17: 0</td>
</tr>
<tr>
<td></td>
<td>• Q18: 0</td>
</tr>
<tr>
<td></td>
<td>• Q19: 2</td>
</tr>
<tr>
<td></td>
<td>• Q20: 0</td>
</tr>
<tr>
<td></td>
<td>• Q21: 0</td>
</tr>
<tr>
<td></td>
<td>• Q22: 0</td>
</tr>
<tr>
<td></td>
<td>• Q23: 0</td>
</tr>
<tr>
<td>Input Selection 3: 4 questions for any suicidal tendencies</td>
<td>• Q1: No</td>
</tr>
<tr>
<td></td>
<td>• Q2: No</td>
</tr>
</tbody>
</table>
Input Selection 4: 8 questions related to patient’s quality of life

- Q3: No
- Q4: No

Expected Output 1: Patient Priority No 2

Expected Output 2 Screening is positive for below domains

- Mania
- Personality Functioning

Actual Output 1 2

Actual Output 2 Mania Personality Functioning

Pass/Fail Pass

Comments Conditions have been met as actual results are equal to expected results.

Any Defects Found No

Table 4.2-2: Test Case 2

Test Case No 3

Tester Expert

Test Description Determining whether conditions to be fulfilled with desired input values

5. Patient to be prioritized as P1
6. Screening positive for below domains:
   Psychosis and Substance Use

Input Selection1: 4 questions related to Previous encounter with psy-

- Q1: Yes
- Q2: No
| Input Selection 2: 23 questions related to screening of possible problem domains | • Q1: 1  
• Q2: 1  
• Q3: 1  
• Q4: 0  
• Q5: 0  
• Q6: 0  
• Q7: 0  
• Q8: 0  
• Q9: 0  
• Q10: 1  
• Q11: 0  
• Q12: 2  
• Q13: 1  
• Q14: 0  
• Q15: 0  
• Q16: 0  
• Q17: 0  
• Q18: 0  
• Q19: 0  
• Q20: 0  
• Q21: 0  
• Q22: 1  
• Q23: 0 |
|-----------------|-----------------|
| Input Selection 3: 4 questions for any suicidal tendencies | • Q1: No  
• Q2: No  
• Q3: Yes  
• Q4: No |
| Input Selection 4: 8 questions related to patient’s quality of life | • Q1: Very Good  
• Q2: Not Sure  
• Q3: Not at all  
• Q4: None of the time  
• Q5: Not at all  
• Q6: Limited a little  
• Q7: No, Limited at all  
• Q8: None of the time |
<p>| Expected Output 1: Patient Priority | 3 |</p>
<table>
<thead>
<tr>
<th>Expected Output 2</th>
<th>Psychosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening is positive for below domains</td>
<td>Substance Use</td>
</tr>
<tr>
<td>Actual Output 1</td>
<td>3</td>
</tr>
<tr>
<td>Actual Output 2</td>
<td>Psychosis Substance Use</td>
</tr>
<tr>
<td>Pass/Fail</td>
<td>Pass</td>
</tr>
<tr>
<td>Comments</td>
<td>Conditions have been met as actual results are equal to expected results.</td>
</tr>
<tr>
<td>Any Defects Found</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 4.2-3: Test Case 3

These test results will be discussed in the section 5.1 in ‘Evaluation and Discussion’ chapter.
5. Evaluation and Discussion

It is certainly obligatory to test and verify an information system in DSR whether it works the way it should after having implemented. There are several ways to conduct an evaluation. First it is important to verify reliability of the system whether the implementation of the system is faultless [19].

First part of the evaluation is related to the data collection process that has been conducted in several ways. To address the first research goal, the data was collected from a widespread psychometric tool which has been backed up by American Psychiatric Society [20] and it was decided during my meeting with the expert and he verified the same as well. For second research goal, the data has been collected from the expert himself. Based on his extensive knowledge in the field of psychiatric, he shared the knowledge with me and helped me to create the framework for prioritizing patients. This process has been supervised by the expert thoroughly and also after completing the full framework, I have got it reviewed from the expert and he gave a go ahead for developing the prototype.

Second part of the evaluation is related to the overall review of the artefact. First level evaluation of the artefact has been conducted rigorously starting from the development phase. His inputs had been invaluable since the time I started designing the system. From which area should be visible to what kind of user, from what access respective user will get to any such tiny detail, were discussed and verified during the development phase of the system.

After completion of the prototype, I asked him to run some tests on the system and to do that efficiently, we created around 18 test cases to assess the system. The test cases were designed to confirm system’s reliability. He ran all the test cases to verify whether the system is getting accurate result based on user test inputs and all the testcases passed successfully.
5.1 Discussion of test results

Please find below explanation of 3 test results that are mentioned in the section 4.1 Test Results in ‘Results’ section. I will explain them one by one and describe how they have been evaluated.

1. Evaluation for Test Case 1:

   First test case was performed in order to determine the validity of the framework for priority 1. It is to check whether priority 1 condition of a patient is getting evaluated properly. In this test, tester also answered positively for ‘Depression’, ‘Anger’ and ‘Anxiety’ to validate the digital form of screening test. The all expected test results matched with the actual test results and tester considered this test case as ‘Passed’ successfully.

2. Evaluation for Test Case 2:

   Second test case was performed in order to determine the validity of the framework for priority 2. It is to check whether priority 2 condition of a patient is getting evaluated properly. In this test, tester also answered positively for ‘Mania and ‘Personality Functioning’ to validate the digital form of screening test. The all expected test results matched with the actual test results and tester considered this test case as ‘Passed’ successfully.

3. Evaluation for Test Case 3:

   Third test case was performed in order to determine the validity of the framework for priority 3. It is to check whether priority 3 condition of a patient is getting evaluated properly. In this test, tester also answered positively for ‘Psychosis’ and ‘Substance Use’ to validate the digital form
of screening test. The all expected test results matched with the actual test results and tester considered this test case as ‘Passed’ successfully.

All 18 test cases showed satisfactory outcome. The expert confirmed all the rules were appropriately incorporated into the prototype. Thus, the instantiation of the DSR knowledge into an artefact is successfully accomplished.
6. Conclusion and Future Advancements

This chapter briefly discusses about the research questions and summarizes the answers and also mentions the limitation thereafter. In the end, it also deliberates the future research scope for this paper.

6.1 Conclusion

This research paper proposed that it would be possible to create an information system to prioritize patients with mental disorders. With the help of an expert and a design science framework, it has managed to deliver the respective goals. The results and respective evaluations of the prototype model also affirmed the same.

First research question was as follows:

1. How is it possible to digitalize a widespread psychometric scale as a screening tool to determine the possible problem domains of mentally ill patients?

It was fairly straightforward as I have only digitalized the pen-paper version of DSM-5 Level 1 Cross Cutting Measure, Adult and there was no change made to the scaling system. And this measure will be equally applicable for any adult personnel around the globe. Based on the test results and the evaluation from the expert, it can be confirmed that this research goal has been achieved.
Second research question was as follows:

2. How is it possible to use a domain expert’s knowledge and experiences along with information systems competences, to create a tool to prioritize mentally ill patients?

The second research goal was not as straightforward as the first one. First, it took several days to conceptualize the idea. Then, the concept was transformed into a prototype eventually. It took long time and a few trials to finalize lastly. Quite a lot of efforts were made to complete this goal. According to the outcome of the expert’s evaluation process, it is affirmative that this research goal has also been accomplished.

6.1.1 Limitations

The limitation of the system is that there is no way to identify the genuineness of the people who are taking the test. It cannot be confirmed whether they are authentic about the answers. So we need to take this for consideration that everyone takes test honestly.

The framework of prioritizing patients was totally based on the expert’s knowledge and experience. As the expert has extensively worked in Sweden and sometime in Turkey, this scale would be more suitable for citizen of Sweden. In case of adapting it to different countries, there may be some reviews required from other experts from respective countries.

6.2 Future Advancements

The future scope of this system is wide ranged. Multiple functionality can be integrated with the system. After discussing with the expert, it was found that there are many directions where the future exploration can take place.
• It can be integrated with BankID login and be used as extension of 1177.se site in Sweden. BankID takes care of user’s authentication so it will be highly secured and there won’t be no need for a separate login system.

• Currently, patient’s test session can resonate between two different statuses. It can be changed to more status types to adhere the complex real-life situations. For example: cancelled, on hold, withdrawn can be added.

• There can be an addition of notification system. If a patient takes the test, and based on the priority, all healthcare personnel gets a notification with brief but relevant information. For example, a high priority alert can be generated and sent to all responsible healthcare personnel for a priority 1 test result.

• This system can be integrated with the patient’s existing records, so the previous records of the patients can be accessed at any point of time. It is better to have all the information in one place, rather than having multiple systems to take care of that.

• This system can be extended to adapt more advanced diagnostic tests based on the result from the current screening tests. According to the expert, the eventual goal is to make one central system to capture all the test related information of a patient. It is to customize appropriate treatments for every patient more efficiently on time.

• The framework is platform independent. That means it is not restricted to any programming language or platform. If it is required, a new system can be designed at ease with the help of the DSR knowledge, developed as a part of this research paper.
7. Glossary

**American Psychiatric Society:**
“The American Psychiatric Association is an organization of psychiatrists working together to ensure humane care and effective treatment for all persons with mental illness, including substance use disorders. It is the voice and conscience of modern psychiatry. Its vision is a society that has available, accessible quality psychiatric diagnosis and treatment [29].”

**DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure, Adult:**
The DSM-5 Level 1 Cross-Cutting Symptom Measure, Adult is used to identify mental health domains that are essential to use while performing different psychiatric diagnoses for adults. It is intended to help clinicians recognize problem domain areas of a patient. However, it should only be used as a screening tool not as a diagnosis tool [20].

**Quality of life:**
According to WHO, ‘Quality of Life’ is a person's awareness of his position in life in regard to the people, culture and system surrounding him. It is a broad concept that can affect in various way to person's mental and physical health. [30].

**RAND 36-Item:**
RAND Health is a research division that belongs to RAND Corporation that helps decision making through research and analysis. Their goal is to enhance people’s health along with healthcare system around the world. 36-Item is a set of generic scale for measuring people’s quality of life. The scale is known to be coherent and easily applicable [17].
8. References


