YRKESHÖGSKOLAN
NOVIA

Competence Development in a Test Organization

Emil Sandin

Master Thesis

Industrial Management and Engineering

Vasa 2024

DEGREE THESIS

Author: Emil Sandin
Degree Programme and place of study: Industrial Management and Engineering
Supervisor(s): Roger Nylund

Title: Competence Development in a Test Organization

Date: 30.5.2024 Number of pages: 34 Appendices: 0

Abstract

This thesis was made for Mirka Ltd and focused on the test organization within the Power Tools R&D organization. The aim of this thesis was to study competence development needs in a test organization within a larger R&D organization.

The study was done with the survey method, with a separate survey for the members of the test organization and another for people representing other functions in the R&D organization. The study had respondents evaluate several skills organized into competency categories. In addition to the evaluation of skills, the respondents were also asked to consider the overall competency level in the test organization, as well as the ideal role for the organization.

The study showed that while overall competency level in the test organization was considered good, more competence was needed in some areas, especially in embedded software and battery technology. The opinions on the role of the test organization were divided.

The conclusion of the thesis was that competence in the test organization should be developed especially in battery technology and embedded software testing. A strategy and vision for the test organization where the role is clearly stated would be beneficial for the test organization.

Language: English
Key Words: Competence Development, Learning, Product Verification

EXAMENSARBETE

Författare: Emil Sandin
Utbildning och ort: Industrial Management and Engineering
Handledare: Roger Nylund

Titel: Competence Development in a Test Organization

Datum 30.5.2024 Sidantal: 34 Bilagor 0

Abstrakt

Detta examensarbete gjordes för Mirka Ltd och fokuserade på testorganisationen inom Power Tools FoU-organisation. Syftet med denna avhandling var att studera kompetensutvecklingsbehov i en testorganisation inom en större FoU-organisation.

Studien genomfördes med enkäter, med en separat enkät för medlemmarna i testorganisationen och en annan för representanter för andra funktioner i FoU-organisationen. Respondenterna fick utvärdera flera färdigheter organiserade i kompetenskategorier. Förutom utvärderingen av färdigheter ombads respondenterna också att utvärdera den övergripande kompetensnivån i testorganisationen samt den svara på en fråga om testorganisationens roll.

Studien visade att även om den övergripande kompetensnivån i testorganisationen ansågs vara god, behövs mer kompetens inom vissa områden, särskilt inom inbäddad programvara och batteriteknologi. Åsikterna om testorganisationens roll var delade.

Slutsatsen av avhandlingen var att kompetensen i testorganisationen bör utvecklas särskilt inom batteriteknologi och testning av inbäddad programvara. En strategi och vision för testorganisationen där rollen tydligt anges skulle vara fördelaktigt för testorganisationen.

Språk: Engelska
Nyckelord: kompetensutveckling, lärande, produktverifiering

OPINNÄYTETYÖ

Tekijä: Emil Sandin
Koulutus ja paikkakunta: Industrial Management and Engineering
Ohjaaja(t): Roger Nylund

Nimike: Competence development in a test organization

Päivämäärä 30.5.2024 Sivumäärä 34 Liitteet 0

Tiivistelmä

Tämä opinnäytetyö tehtiin Mirka Ltd:lle ja se keskittyi Power Tools T&K-organisaation testiorganisaatioon. Tämän opinnäytetyön tavoitteena oli tutkia testiorganisaation osaamisen kehittämistarpeita suuremman T&K-organisaation sisällä.

Tutkimus toteutettiin kyselyillä, joissa oli erillinen kysely testiorganisaation jäsenille ja toinen kysely T&K-organisaation muiden toimintojen edustajille. Vastaajat arvioivat useita taitoja, jotka oli järjestetty osaamiskategorioihin. Taitojen arvioinnin lisäksi vastaajia pyydettiin myös arvioimaan testiorganisaation yleistä osaamistasoa sekä vastaamaan kysymykseen testiorganisaation roolista.

Tutkimus osoitti, että vaikka testiorganisaation yleinen osaamistaso katsottiin hyväksi, tarvitaan lisää osaamista joillakin alueilla, erityisesti sulautetun ohjelmiston ja akkuteknologian osalta. Mielipiteet testiorganisaation roolista olivat jakautuneita.

Opinnäytetyön johtopäätöksenä oli, että testiorganisaation osaamista tulisi kehittää erityisesti akkuteknologiassa ja sulautettujen ohjelmistojen testauksessa. Strategia ja visio testiorganisaatiolle, jossa rooli määritellään selkeästi, olisivat hyödyllisiä testiorganisaatiolle.

Kieli: Englanti
Avainsanat: osaamisen kehittäminen, oppiminen, testaus

Table of Contents

1 Introduction

This Master´s Thesis was written for Mirka Ltd Power Tools Research and Development department, more specifically the test department. The purpose of this thesis is to study the competence and skills in the test team to identify areas where competence development is needed. The competence is evaluated both internally in the test organization, and externally by the rest of the organization.

1.1 Background

The Mirka Power Tools department develops power tools for surface finishing, such as sanders and polishers. The tools are mainly electrical, both battery and mains powered, but the product portfolio also contains a small part of pneumatic and manual tools.

The test team has grown from one person in 2013 to a team of around 10 people in 2024, and has test laboratories in two different locations, Jeppo and Jakobstad. At the same time, the Power Tools department has grown from around 10 people to over 60 people.

The test team performs tests for all other parts of the development organization. The biggest part of testing is for new product development. The second biggest part is tests for the product lifecycle department, that handles product improvements, cost reduction projects and component changes to the product. Quality assurance tests and inspections on parts and products are the third biggest category. Lastly, some test resources also go to preliminary compliance testing and failure analyses for the After Sales team.

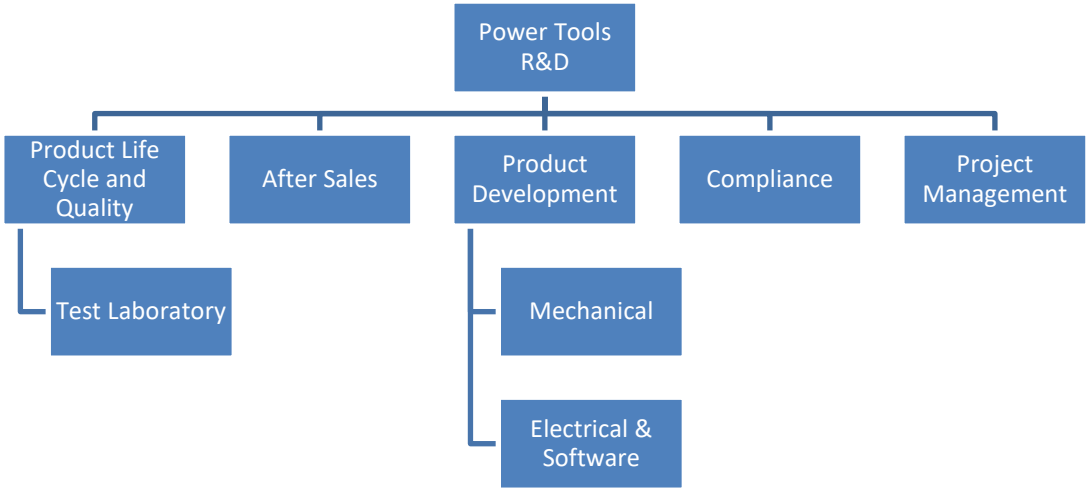


Figure 1 General overview of the Power Tools R&D organization as of 2024.

1.2 Problem Area

With a rapid development pace and many new products in development, the demand for testing is also high. There are many kinds of tests performed during the development of a new product. The tester needs to understand the product itself, the test equipment, the measured units, and measurement data. The tester also needs analytical and statistical skills to analyse and report the results in a clear manner.

As a diverse range of tests are performed in multiple locations, it has become even more important to document and evaluate competency in the test team so that it is possible to ensure that people with the right competency are located in the laboratory where the competence is needed.

While competence gaps in the test organization are known, at least in new areas of testing, the competence gaps have not been studied and documented. This makes it hard to assure that competence development resources are be used in the right area and for the right people. By identifying individual and organizational competence gaps, it will be easier to systematically develop the competence in the test organization in a systematic way.

1.3 Purpose of the thesis

The purpose of this thesis is to document the competency in the test team both from an internal and external point of view. In the internal view, members of the test team evaluate their own competence and skills they would need to improve to do a better job. In the external view, opinions from the rest of the Power tools-organization are collected, to identify skills in the test team that they see as important or in need of improvement for the test organization to be able to deliver the desired information.

By studying and comparing both the internal and external view of the test team competency, the goal is to identify areas where improvements could be made, such as training, to better align the test team competency with the needs. If areas are identified where there is a big difference between the internal and external opinion on a competency, it might be due to a different opinion on what the role of the test team should be in the organization, and thus there might be a need for clarification on goal and strategy for the test team.

The ultimate goal is that this thesis can be used as a starting point for a long-term vison and strategy for the test team, where the members of the test team feel confident in their competency for their job, and the rest of the organization are confident in that the test team can deliver the desired results.

1.4 Delimitations

The thesis is focused on the test team and their competence, specifically skills and competencies needed in daily work. General competencies such as reading, and mathematics are not considered as such but are instead part of more specific test-related competencies. A detailed training plan is not within the scope for this thesis, instead the focus is on identifying gaps in skills and competence where improvements should be made.

Different kinds of safety and company-wide training is also outside of the scope for this thesis, as that is handled through HR department. Getting additional competencies through

recruitment is also not a focus area for this thesis, although some areas where this could be used might be identified in the surveys.

The surveys used for data collection in this thesis does not measure the competence in the test organization. Instead, they gather the internal and external opinions on the competence in the organization, as well as the views of the respondents on the role of the test organization.

1.5 Outline of the thesis

The theoretical background will focus on what learning, competency and skills are. How competency can be evaluated with competency matrixes are also described, and which kinds of skills that are important in a test organization. The methodology chapter will describe the survey that will be used to gather data for analysis, and what kind of data analysis that will be performed on the data.

The results chapter will present the results of the survey. The discussion chapter will discuss the results from the survey, what conclusions can be drawn from the results and what was left unanswered.

The ending conclusion chapter will conclude the thesis and discuss how the results can be applied, and what aspects that could be further examined.

2 Theoretical background

2.1 Learning and competence development

In this section, the definition of what learning is will be discussed both at a general level and more specifically at an organizational level. Different types of learning will also be discussed, with a focus on types relevant for the workplace.

2.1.1 What is learning

Learning can be defined as a more or less permanent change in behaviour potential as a result from experience. There are two important components to this definition of learning: The first one is that learning does not automatically lead to a change of behaviour, but only creates the potential for the change to occur. To translate learning to behaviour, there is also a need for sufficient motivation to make the change. The second component of the definition is that the change is not always permanent. New experiences may cause previously learned behaviours to no longer be exhibited. Forgetting earlier experiences is also a thing that makes learning something that is not always permanent. It is also worth noting that not all changes in behaviour are a result of learning. Hunger, fear and maturation are examples of other things that can affect behaviour. (Klein, 2019)

Sarder makes the point that much of the learning in organizations consists of formal learning with a specific and immediate goal in mind. An example of this might be to train someone to do a new task. Sarder categorizes this type of learning as training. Another type of formal learning is education, which Sarder describes as long term as opposed to the focus on immediate needs in training. Education gives the learner a foundation for further learning and helps with understanding different concepts.

Sarder then notes that learning is not limited to this type of formal learning but is instead something that we do all the time as we read, discuss, and experience things. This is called informal learning and is something that is valued in learning organizations.

2.1.2 Different types of learning

According to Sarder, there are five primary learning methods: Classroom (physical or virtual), coaching, mentoring, on-the-job training, and self-study (reading, e-learning etc.) For a learning method to be effective in a specific situation, the method chosen should be the best fit for the situation. This means that the content should be relevant, the method should be suitable for the subject being taught, and reflection, practice and application of the subject should be included. (Sarder, 2016)

For competence development in the power tools test team, on-the-job-training and self-study are the most common methods used for learning today, and sometimes classroom training might also be used. Coaching and mentoring are not used in any formal way today.

2.2 Learning organizations

According to Senge in The Fifth Discipline, there are five disciplines that are essential for a learning organization (Senge, 2006):

1. Personal Mastery - the discipline of personal growth and development, which involves mastering new skills, expanding one's capabilities, and continuously learning.

2. Mental Models - the discipline of examining and challenging our assumptions and mental models to better understand how they shape our perceptions, decisions, and actions.

3. Shared Vision - the discipline of creating a shared sense of purpose and direction that aligns individuals and groups toward a common goal.

4. Team Learning - the discipline of fostering collective learning and collaboration among team members to achieve shared goals.

5. Systems Thinking - the discipline of understanding and managing the complex, interdependent relationships and feedback loops that exist within organizations and between organizations and their environment.

While neither the test organization nor the whole power tools organization has been designed as learning organizations, most of the points seem relevant to the test organization. Personal mastery is important for the individual tester, to continually reflect on their own work and strive to improve their work and knowledge.

Mental models are important to be aware of, as it might lead to mistakes or errors in test results if erroneous assumptions are made on how something should be. The focus might be on the wrong part for example, as the other part involved in the test “has never had any problems.”

A shared vision would also be important in a test organization. A basic level of this would be the level of the output, are the organization happy with a thumbs up/down result, or do we want a detailed report? A more detailed level of vision might be a what the test organization should look like in the future.

Team learning is essential in a test organization where new tests are continually designed, and new equipment is taken into use. By utilizing team learning, the test organization can share the knowledge and quickly introduce new people to the new processes and methods.

Systems thinking is important in a test organization, both in a highly practical level, where parts that are tested can be seen as parts of a bigger system or product. It is also important to have an organizational system thinking, where different markets and customer use and misuse can be considered when designing tests. It is also important to be aware of the optics of different problems, i.e. how a relatively small problem might in practice be very important, as it annoys customers and lowers the brand quality in the customers eyes.

2.3 Competence and skill

In the literature, “competence” and “skill” are sometimes used interchangeably, and sometimes referring to different things, so a definition of these words is needed to ensure a clear understanding of the meaning of these words when used in this thesis.

A short and simple definition of competency can be found in Mahesh Kuruba’s book about role competency matrixes. He offers the definition that “competency is the ability to do a job properly.” (Kuruba, 2019). He describes competency as a “combination of knowledge, skill ability and personal characteristics.”

Skills and competences are related, but different from each other. Skills are specific abilities and expertise that can be learned and improved over time. Skills can be divided into hard skills and soft skills. Hard skills include technical skills such as data analysis and programming, and they can be learned and enhanced through training and education. Soft skills are more behavioural, and examples of these are teamwork and problem solving. (Fournier-Bonilla, 2024)

2.4 Generalists vs. specialists

In "Range: Why Generalists Triumph in a Specialized World," (Epstein, 2019) author David Epstein discusses the advantages of being a generalist versus a specialist. Epstein argues that in many fields, especially those that are complex and rapidly changing, generalists tend to outperform specialists. One disadvantage he mentions regarding specialists, is that they often are so deeply focused on the area of their own expertise, that they can become blind to things outside of their own expertise that can also affect their work.

Epstein suggests that the best approach often involves a mix of generalism and specialization. He argues that people should be willing to explore widely, especially early in their careers, to build a broad foundation before specializing. This allows them to remain flexible and innovative. (Epstein, 2019)

As testing of power tools involves both mechanical, electrical and software components of the machine, as well as external factors such as environmental conditions, as well as other interfacing products such as abrasives and dust extractors, it can clearly be argued that while specialization can be beneficial in some areas of the test work, at least some generalism is needed to be able to understand the whole system and everything that can affect the test and its results.

2.5 Measuring competence

According to (Kuruba, 2019), it is very hard to determine success if the objectives are not clearly defined, and this also applies to competency. By measuring competency gaps, the company can proactively address these gaps through coaching and training.

Kuruba lists four areas where a company can benefit from competency measurement:

- **Workforce planning**, by being able to better allocate people to the right kind of work so that available competencies are utilized.
- **Recruitment management**, by knowing which competencies are needed in the role and therefore being able to choose the right person for a job.
- **Career development**, by enabling employees to compare their own competencies to those specified for a role and identify suitable positions.
- **Training Development,** by being able to arrange the kind of training needed to help the organization fulfil its goals.

Workforce planning is an important aspect, as planning who does what is part of the daily work. The tester assigned to a test must have enough competence to be able to deliver reliable results. It is also important for training development to know where competence gaps exist, so that suitable training can be arranged.

Kuruba advocates for quite well-defined roles and competencies, which might work well in a bigger organization, or when hiring for specific roles in a project. However, in a smaller

team that have diverse tasks, it might not work as well. The competence evaluation in this thesis will be on a more general level than Kuruba advocates and focus more on the respondents' opinions on the competencies.

2.6 Competencies in a testing organization

The skills and competencies in a test organization can be divided into four categories (Black, 2009):

- General professionalism
- Technology
- Application domain
- Testing

General professionalism means basic skills that are needed for the job, such as reading, writing and mathematics. It is important that a test engineer can read data sheets, specifications and other documentation and understand the details. In the same way, it is important to be able to write well to be able to communicate and discuss the results with other parties. Math is not as important as reading and writing for test engineers, but still important as test results often are reported as different numbers, and a bad understanding of them makes it harder to spot errors or other problems with the data. Language skills are also important, as a test engineer regularly needs to be able to communicate in English, Swedish and Finnish.

Technology competencies are an understanding of how the products are designed and built, and how they work. For power tools testers, this includes material knowledge, electronics, mechanics, and often general physics.

Application domain competencies mean an understanding of how the product is used. In this case, this means an understanding of surface finishing in different industries and a general knowledge of how power tools in general and sanders in particular are used.

Testing competence is the last category of skill, but not the least important. This category includes knowledge of how testing is performed and how the results are understood correctly.

To complete a test assignment successfully a tester needs to be able to read and understand the test request and relevant documentation (general professionalism). After that, the tester needs to understand how the device that is to be tested are meant to be used and what an end-user might expect from it (application domain). The tester then has to translate the real-world use to a test that can be performed, where the aspects of interest can be tested and evaluated, and the correct data gathered (technology and testing). Lastly, the tester has to document the results in a test report, in a clear and concise way so that others can understand what has been done and what the results were.

All in all, to successfully perform a test a tester has to have the right competencies in all four categories. General professionalism should generally already be on a sufficient level when a person starts as a tester, as it is something that their previous education and work experience should cover. Technology knowledge is also quite general, so it is possible to find and hire people with enough competence in this category. But as it is a very broad category, it can be assumed that there are areas where testers need competence development in this category sometimes.

Application domain knowledge, or knowledge about how different power tools work and are used, as well as testing knowledge, are areas where prior knowledge cannot always be found in new candidates, as it is quite specific. Therefore, knowledge in these areas is probably most likely to need development for people in a test organization, especially people who are new to the field. Application domain knowledge should be relatively easy to gain after some work experience within the power tools organization, as the expertise to learn from is readily available.

2.7 The test organization role

The competence requirements in a test organization are also dependent on the role of the test organization as part of the whole organization.

There are several different organizational models that can be applied. The main difference between the different models is the level of independence of the test organization from the rest of the organization. Black mentions several possible organizational models, each with a varying degree of independence for the test organization. (Black, 2009)

The testers can be directly involved as part of the core development team. This can work well, but there is a risk that development gets the focus and test lacks the needed resources, as the project might have to prioritize where to use available resources. There might also be situations with conflict of interest, as the developers try to finish a product while the testers try to find as many problems as possible with the product. (Black, 2009)

Another possible model is where the test organization is separate from the development organization, but instead works as a project resource within the development projects. This gives a higher degree of independence, but the testers are still highly involved in the projects, which can be both good and bad, depending on the project. (Black, 2009)

A third model is where the test organization is truly independent and is not as directly involved in the projects as in the earlier mentioned models. The upside is that there is no direct conflict of interest, so finding problems with products is not as likely to be frowned upon as in the other models. (Black, 2009)

2.8 Application of theory in thesis work

The survey has been designed with the basis in the theoretical framework, with skills and competencies being evaluated in a form of competence matrix. Skills have been grouped into bigger competence areas. The focus has been on skills in the testing and technology categories.

The role of the test organization has been included as a question in the surveys to see how different parts of the organization think about the ideal role for the test organization. The theory has been used when designing the question.

Theory about learning organizations and generalists vs. specialist are used in the discussion part of the thesis to discuss the results from the surveys.

3 Methodology

3.1 Method selections

The method chosen for this thesis is surveys done both internally in the test team and externally in the rest of the Power Tools R & D organization in the form of questionnaires. The surveys consist of an evaluation of relevant skills, and questions regarding improvement areas, things that are on a good level and a question about the ideal role for the test organization. The surveys consist of multiple choice-questions and free answers in text-form.

The internal test organizations survey is answered by all persons in the test organization, while the external survey is answered by a group of people representing all other departments in the Power Tools organization and consists of around 25% of the total number of people.

3.2 Survey Methodology

According to Blomkvist and Hallin in Method for Engineering Students, “survey methodology is suitable when you want to do a quantitative study, when you are interested in finding a general answer to the question formulation hypothesis or model you have formulated, or when you are interested in gaining an overview of all the examples that shed light on a phenomenon.” (Blomkvist & Hallin, 2015, p. 88). Based on this explanation, the survey method is suitable for this thesis, where a quantitative study of the competence is a goal and where the aim is to gain an overview of the opinions on competence in the test organization.

Two things are important when designing a questionnaire: The formulation of questions and the answering alternatives, and the overall design of the questionnaire. The questions should be relevant, easy to understand, not contain negations and not be value laden. The questionnaire should have the questions organized in a clear way, possibly in different

sections, and brief descriptions should be included where needed. The total number of questions in the questionnaire should not be too large. (Blomkvist & Hallin, 2015)

3.3 Selecting and Grouping of Skills

When considering skills and competencies to evaluate for a test team, the list of possible skills and competencies can become very long, if skills are defined too narrowly. Then again, if the skills are defined too broadly, they become hard to evaluate, as each skill or competency contains so many variations, that someone can be an expert in some parts and a complete beginner in others.

In the survey the choice was made to create several general competency categories, in which I listed 3-5 more specific skills for evaluation. Listings of skills by NC State University for hardware test engineers (NC State University (1), u.d.) and mechanical test engineers (NC State University (2), u.d.) were used as a starting point and skills were then picked based on the current types of tests performed in our laboratories and expected needs for future projects. After internal review of the selected skills, some of them were redefined to better cover skills deemed important.

3.3.1 Mechanical skills

Materials: Properties of different materials, such as plastics and metals, and how they are affected by different physical properties such as temperature, vibrations, abrasion etc.

Robotics and automation: How well robots and automation are utilized in testing

Functional testing: How to translate practical usage into standardized test that can be repeated and compared. For example, vibration testing, dust removal)

Reliability testing: How well testing of component and product reliability is planned, performed and reported (for example motors and bearings)

3.3.2 Electronic skills

Circuit analysis: Understanding of how circuits work and how to analyse faults.

EMC: What different EMC measurements are, how they are measured and things that can affect the results.

Embedded software: How embedded software works and how to test it

Battery technology: How batteries and chargers work, how they are evaluated and what risks that are involved with them.

3.3.3 Measurement and Data Collection skills

Sensors and measurement tools: Use of different sensors and measurement tools to get measurement data from tests.

Accuracy & precision in data logging: To collect the correct data in a good way, and with a suitable sampling speed, so that the data can be used for the intended purpose.

Geometric measurements: Use of CMM-measurements, 3D-scanning and manual measurement tools.

Data acquisition systems: Knowledge of different software to log data: Test Framework, Diagnostics, etc.

3.3.4 Test Planning and Reporting Skills

Data analysis and presentation: How to analyse and present the results in a clear way to others.

Test design: How to design tests so that the results provide the needed data

Test planning: How to create test plans that provides good test coverage for the product.

3.4 Surveys

Two surveys were made, that covers the same skills and competencies and other questions, but were the framing is adjusted so that in the internal survey the test team members evaluate their own personal skills, while the external survey asks the participants to evaluate the skills for the whole test team as one unit. The skills could be rated on a scale of four steps.

In addition to the rating of skills and the open questions about skills to improve, a few questions were added to inquire about the respondents' view of the test team in the bigger organization. How the respondents look at the role of the test team might affect what skills they think are more or less important.

3.4.1 Internal survey competence evaluation

The respondents in the test team were asked to rate their own skills as described in 3.1 according to the following scale, with the same explanations of the different options available to them:

Underused *- My competence is underused - Knows more than is needed for the job.*

Good *- Enough competence in the subject - Can perform tasks within this subject well and with confidence.*

Fair *- More competence would be beneficial - Can perform tasks related to this subject, but unsure or lacking competence in some cases.*

Low *- Not enough competence in the subject - Cannot perform tasks in this subject without help or guidance. Is not always able to understand and analyse the results.*

3.4.2 External survey competence evaluation

In the external survey the respondents were asked to evaluate the competence level in the Power Tools test department for each skill describe in 3.1 from their own point of view, according to the following scale with the same explanations available to them:

Good *- The test team competence is on a good level, the test performance and results are on a good level, and there are enough team members with the needed competence.*

Fair *- The competence is on a good level, but there are not enough people with the competence.*

Low *- Improving the competence in this subject in the test team would be beneficial.*

N/A *- This competence is not relevant.*

3.4.3 Open questions

In addition to the assessment part, the survey also included some questions with free-form answers. These questions focus both on improvement areas and on things that work well.

Internal survey open questions:

- What skills/competences do you feel would benefit you most to develop to handle tasks in your daily work?
- Are there other competences (not mentioned above) that you think you personally would benefit from developing?
- What competences/skills do you think are on a good level in the test organization as a whole and work well?

External survey open questions:

- What skills/competences above do you feel would be the most important to improve in the test team from your point of view?

- Are there other competences (not mentioned above) that you think the test team would need to improve?

- What competences/skills do you think are on a good level in the test organization and work well?

3.4.4 Ideal role of the test laboratory

Both surveys ended with a multiple-choice question where the respondents had to choose an ideal role for the test laboratory out of four options. The available options were as follows:

- Works as a helping hand to the developers and assist with testing and measurements.

- Works as a sparring partner that is actively taking part in the development work of new products by planning and performing tests.

- Works as an independent part of the organization that tests and approves new products in development.

- Work with external test institutes to plan and perform tests needed for the certification of the product.

The options available to the respondents in this question were chosen so that they represent a wide spectrum, from basic assistance to the developers to a very formal internal verification function.

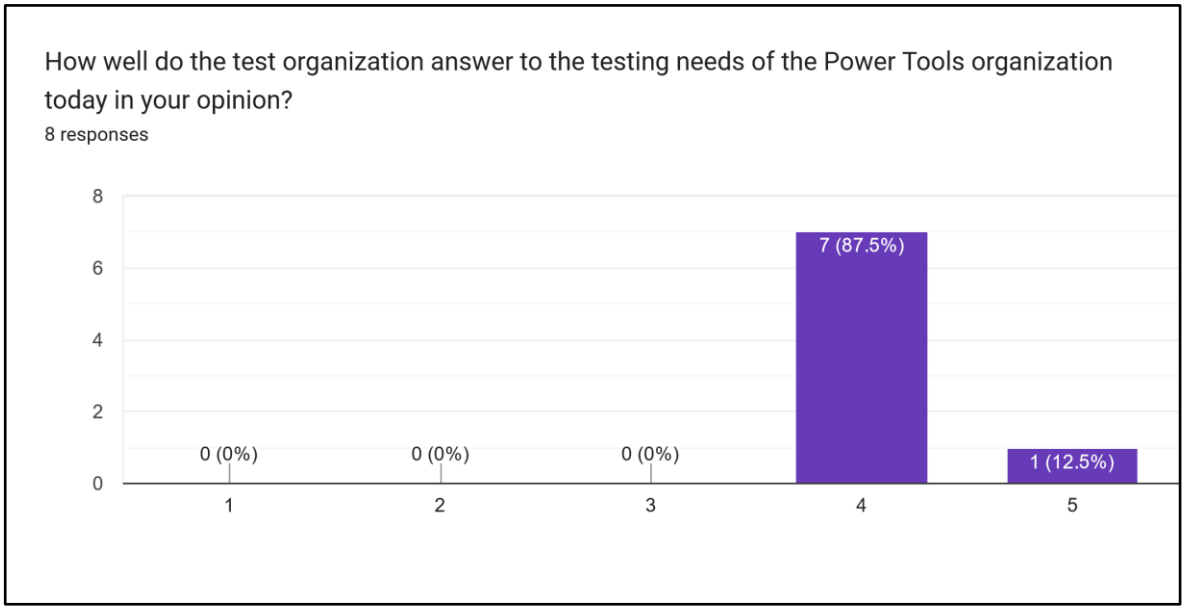
4 Results

4.1 Test Organization

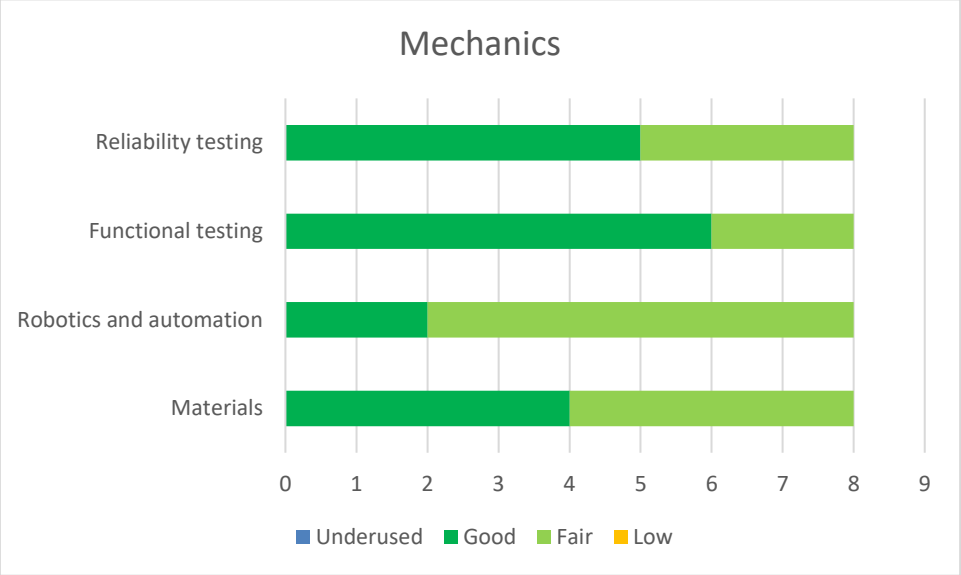
All eight members in the test organization were asked to answer the survey which they also did, so the eight answers represent the whole test team. The supervisor for the test team was not included as he is the writer of this thesis.

4.1.1 Overall competency level

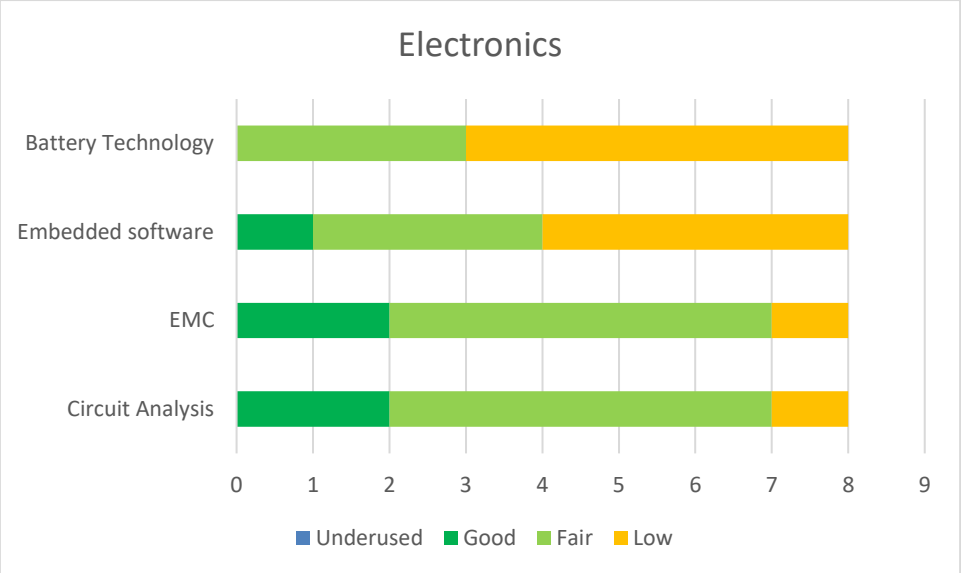
Everyone in the test team gave the overall capability of the test organization to answer to the testing needs of the whole Power Tools organization a high score, with most choosing 4 out of 5 and one choosing 5.



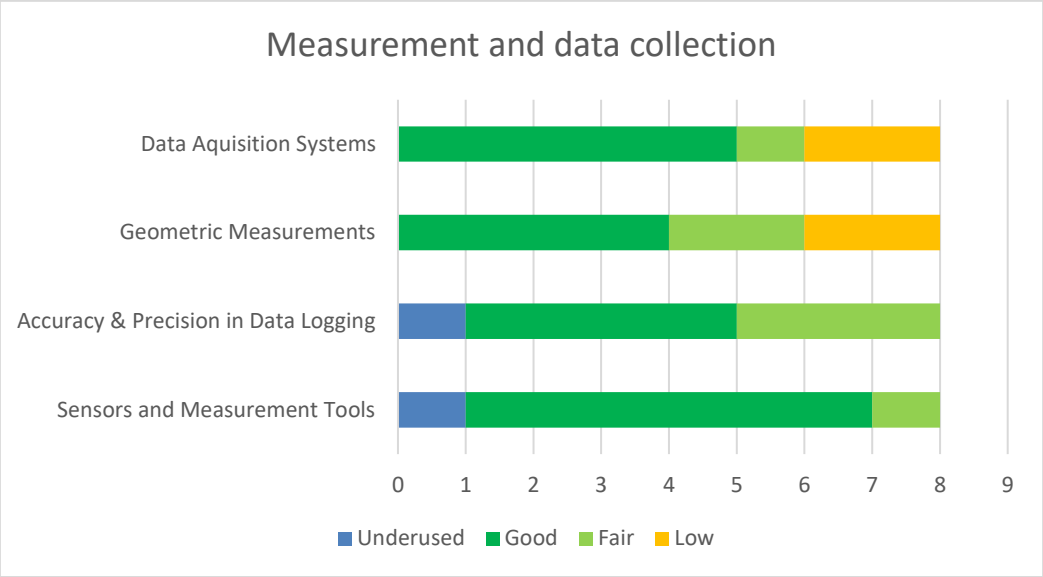
4.1.2 Competence evaluation



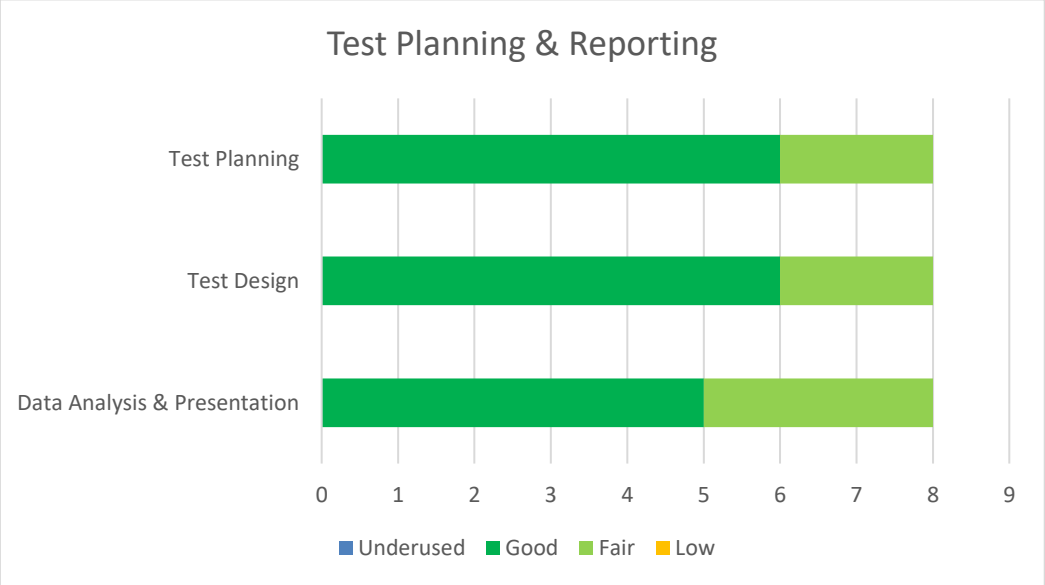
Within the mechanical competencies the testers all evaluate their skills as good or fair. Different people have rated different skills as good or fair, which is logical as different persons have been focused on different types of tests.



It is in the electronics competency where the testers generally have ranked their skills the lowest. Battery technology is an area where no one has ranked their own competency as good. Embedded software is also an area where half of the testers ranked their own competency as low.



In the measurement and data collection competency there are skills that have been ranked as underused by one tester. These skills were the only two skills where someone selected underused.



Test planning and reporting is at least on a fair level for everyone in the team according to the self-evaluation. These are skills that everyone uses in their daily work, so it is not surprising.

4.1.3 Improvement areas

In the question about what skills/competences they feel would benefit them most to develop to handle tasks in their daily work, the following answers were given:

Embedded software
Electronics
What to prioritize if there's a lot in queue.
Test design, data acquisition systems & data analysis & presentation.
More competence in small electronics. For example, how components on a Deros PCB works together
Robotics & Automation
Electronics testing, 3D Scanning, 3D Drawing,
A good way of working/tool for handling and presenting larger amounts of data. Excel is good, but sometimes gets too slow with large data sets.

There was also a question about other skills not mentioned otherwise in the survey that the tester would like to improve. Two answers were given to that question:

Speed Controller testing, electronic components and Software. These things evolve fast and it's possible to forget about these tasks if not regularly working with them.
Programming/scripting to easier automate some testing and data collection.

4.1.4 Positive notes

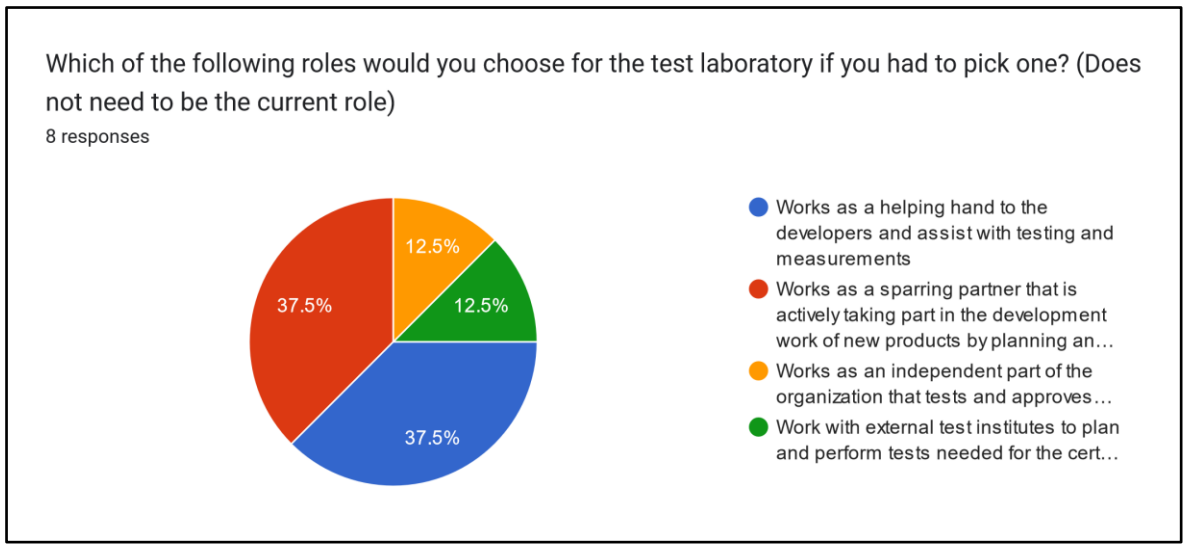
A question about what works well and is on a good level was also included in the survey, as a counterpart to the questions about improvement areas. These were the responses:

Fault analysis and teamwork
Keeping afloat with a large test queue
Mechanical testing, test setup, test planning,
Mechanics are on a good level.
Most, but mechanical and practical testing perhaps a bit better than electronics and software.

Test planning
Test planning and creating different setups to perform specific tests.
The base system is on a good level and have good answers to most requests of different tests but more specialization on specific equipment can always be sharpened.

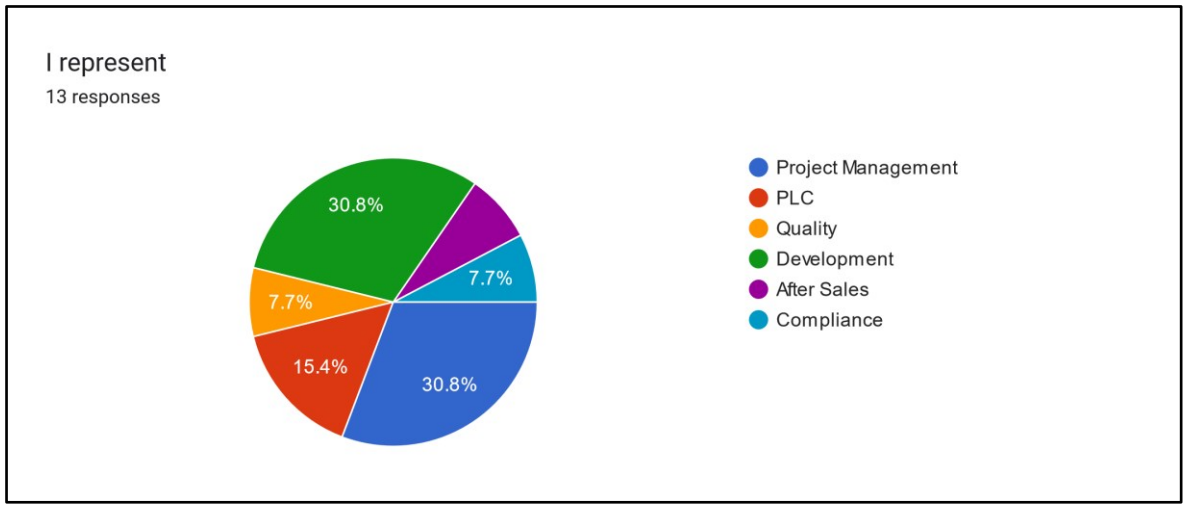
4.1.5 Role of the test organization

The last question was about the ideal role for the test organization according to the respondent. The responses were quite varied, with all options represented in the answers.

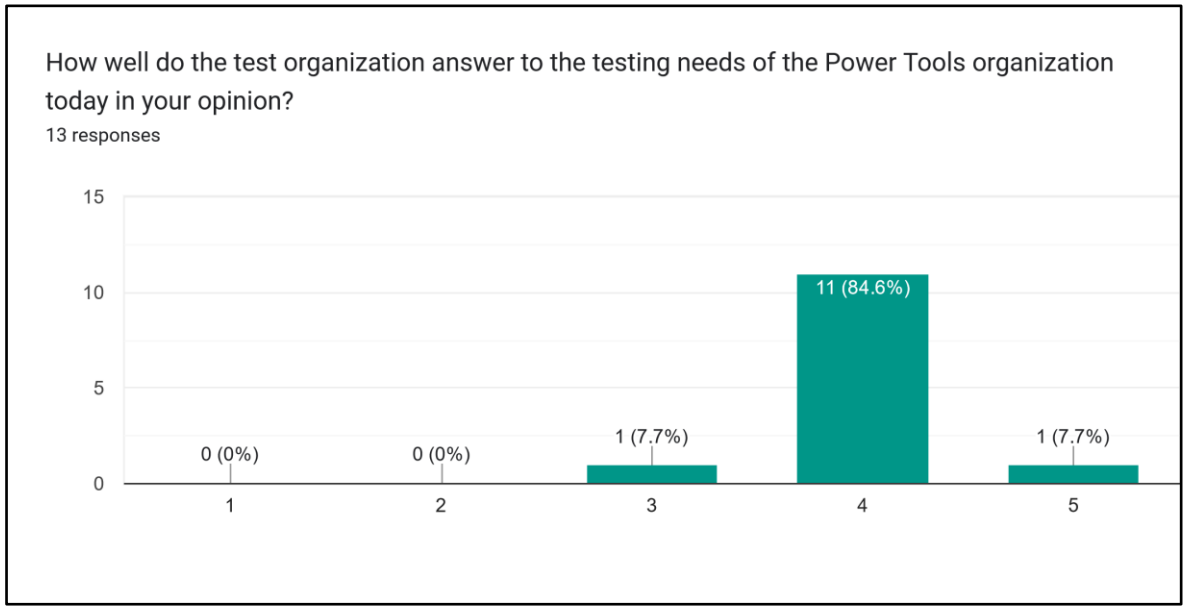


4.2 External organization

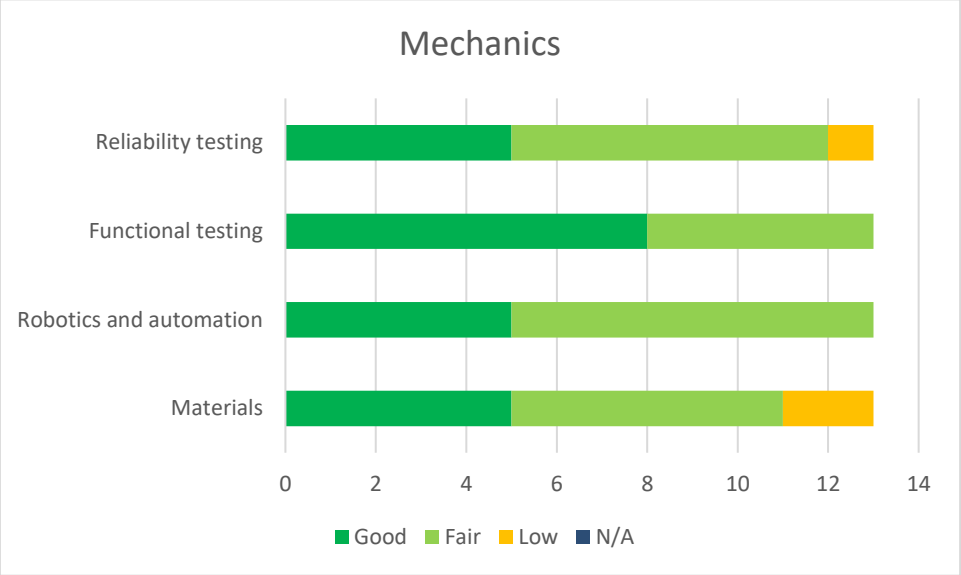
The survey of the external organisation consisted of people from different parts of the organization. People chosen were managers for the different functions, all project managers and then some additional people to cover all parts of the organization. 13 people in total participated in the survey.



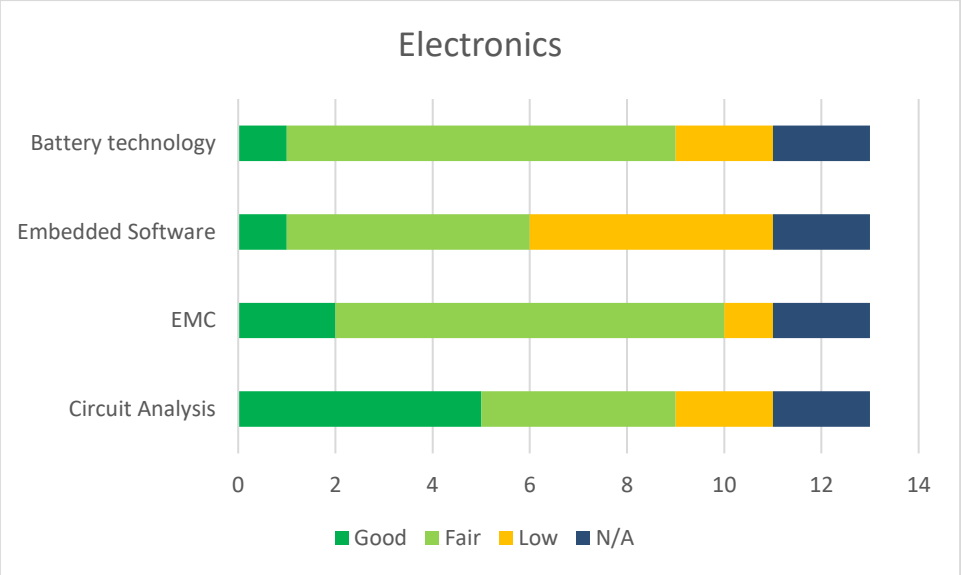
4.2.1 Overall competency level



4.2.2 Competence evaluation

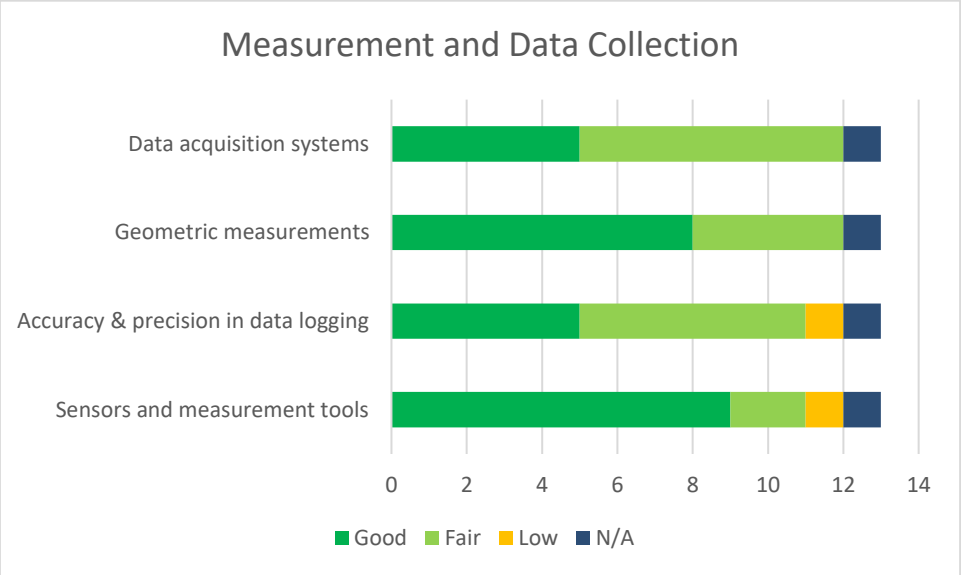


The mechanics competency level is mostly good or fair, with a few responses that indicate a need for better materials knowledge and reliability testing.

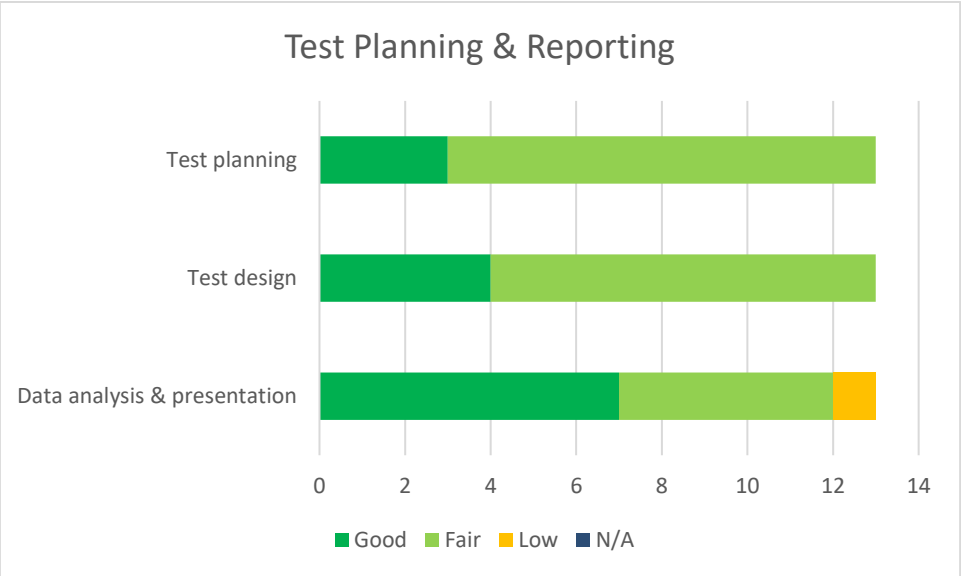


In the electronics category, there were a few N/A responses. It is somewhat doubtful that the respondents really think that these skills are not relevant. It is more likely that they have chosen this option to indicate that they are not able to evaluate theses skills. The

number of respondents giving the evaluation “good” is generally quite low in this competency.



In Measurements and Data Collection the results are also mostly good or fair. All N/A responses are from the same respondent, again indicating that the respondent was not able to evaluate these skills than that the skills were irrelevant.



The Test Planning and Reporting competency has only one “low” response, on the Data analysis & presentation skills, that otherwise has got a high evaluation with many respondents ranking it as “good”. Test planning and test design skills both have quite many “fair” rankings, indicating some room for improvement.

4.2.3 Improvement areas

What skills/competences above do you feel would be the most important to improve in the test team from your point of view?

Materials and EMC
Test planning
Test planning
Automatic software testing to get a good set of base tests for each product family that all the different product families should pass. Automated tests so that the tests always are consistent and can be further developed and added to when a new problem arises so that the same fault does not happen again.
Embedded software and Electronics knowledge
Rapporter kan emellanåt vara inkomplett
Electronics (important area with more and more focus)
Embedded software
Embedded softwre
Understand the tests and critically evaluate if the test result is logical.
software skills & electronics
Reliability and functional testing in mechanics.
Planning and preparing for tests in testplan

Are there other competences (not mentioned above) that you think the test team would need to improve??

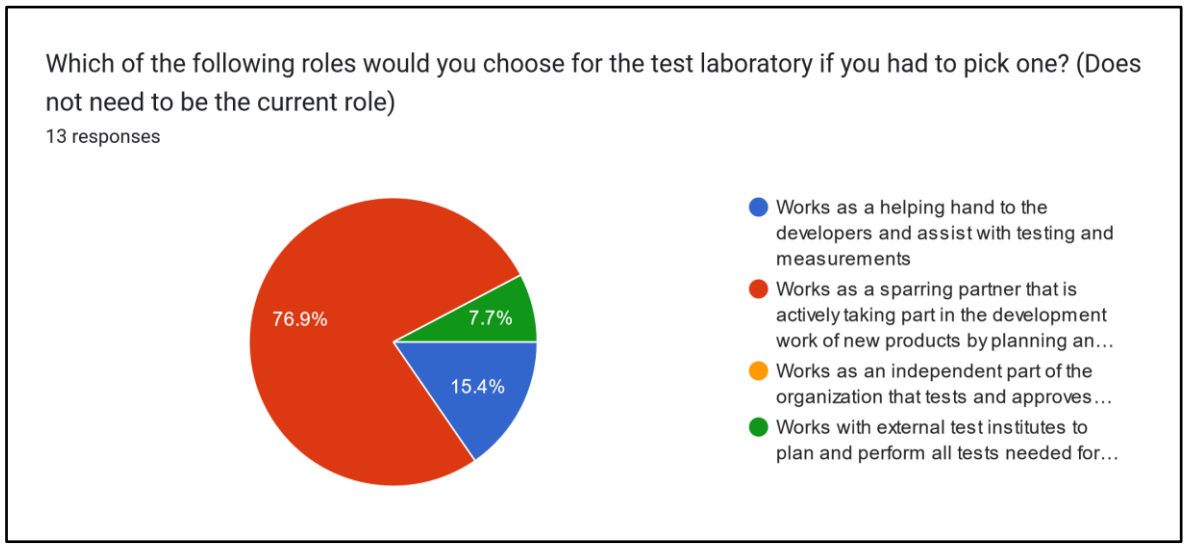
Test structuring and documentation of functionality tests for embedded software so that it is clear what has actually been tested and when and on which version
To better visualize test data and collect and understand what testdata is important. of course this also is the test bookers responsibility to explain.
Nothing in particular

Critical thinking (ability to critically evaluate results, identify patterns and draw meaningful conclusions) and communication (collaborate with stakeholders before test, report findings, preparing technical documentation/data and presenting results to stakeholders)
Priority lane for tests to understand the failures out on the market
engineering test equipment

4.2.4 Positive notes

Mechanical testing
Communication
Test reports
Basic overall functionality tests but the more in depth tests and test automation is a bit lacking. Other areas than embedded software i can not write about since i don't have any experience with that
Mechanical testing.
3d skanning /CMM funkar bra
Functional testing and hands on ability
Data analysis & presentation
Materials tests
General understanding of power tools and mechanical skills.
Functional testing, analyses of failure, test accuracy, creativity...
I think everything is on a good level.
Too many to list, generally highly skilled and competent personel

4.2.5 Role of the test organization



4.3 Internal vs external results

The view on the general competence in the test laboratory is very similar between the two groups, rated at a good level. Looking at the mechanical skills, the internal survey shows a bit higher result, with the external indicating some need for more materials knowledge and better reliability testing.

In the electronics competency, the internal survey clearly shows that many testers feel that they would need more knowledge in battery technology and embedded testing, while most of the respondents in the external survey think that the skills are at a good level. A reason for this might be that the testing in these areas is still quite limited, which means that the testers with enough competence in the areas can cover the testing needs and thereby keeping the external respondents satisfied with the results.

In the question about the role of the test organisation a clear majority of the respondents in the external survey chose the “sparring partner”-alternative, while in the internal survey the responses were more varied, with all options represented in the answers. This might

indicate that a shared vision about the test organization is missing and is something that could be improved.

5 Discussion

The results of the survey show that both the testers themselves as well as rest organization generally sees the competence level of the test organization as being on a good level. When looking at the individual competence levels, the testers seem to lean more towards being generalists than specialists in a narrow area. An exception to this can be found in the electronic competencies, where many ranked some of the skills as “low”. This is understandable, as electronics is an advanced subject, and not everyone in the test team have a background in electronics.

Battery technology has the lowest level of competency of all skills evaluated. As this is one of the newer focus areas in the organization, standardized tests and procedures does not yet exist, which means that the level of competence required to do testing in this area is higher. It is therefore not surprising that many of the testers ranked their competency level as low.

Based on the surveys, competence in electronics, especially in battery technology and embedded software is something that should be improved.

The role and vision of the test organization is something that could be improved, as it would give the organization a good framework for future development.

6 Conclusions

The results of this thesis show that the competency level in the test organization generally is on a high level. New areas for testing such as battery technology and embedded software testing needs more focus to build the competence as the test demand in these areas increases.

In the test team there were varied opinions on ideal role for the test organization. Having a clear strategy that is communicated both in internally in the test organization as well as to the rest of the Power Tools organization would probably be beneficial, as a common understanding of the role could help align the whole team in the right direction. This would improve the shared vision, one of the five main identifiers for a learning organization.

The testers in the test team are more generalists than specialists right now. While this has worked well with a smaller team, as the team grows and the demand on the results rises, more specialist roles might be needed at least in some areas, who are able to design tests that meets the requirements and who can also analyse and report the results on a more detailed level.

To continue building on the work in this thesis, a more detailed competence evaluation matrix could be made, where the competence requirements are more detailed, and roles are also more defined. This might be a good way forward when the test organization grows, and the people in the organization specializes more in their own different areas of expertise.

My own personal goal with this thesis to better understand the competence gaps in the test organization and how the role of the test organization is seen has been accomplished, and the result of this thesis will help with further developing the test organization.

7 References

Black, R. (2009). *Managing the Testing Process.* Indianapolis: Wiley.

Blomkvist, P., & Hallin, A. (2015). *Method for engineering students.* Lund: Studentlitteratur.

Epstein, D. (2019). *Range: Why Generalists Triumph in a Specialized World.* New York: Riverhead Books.

Fournier-Bonilla, S. (2024, April 17). *What's The Difference Between Skills And Competencies?* Retrieved from Nexford University: https://www.nexford.edu/insights/whats-the-difference-between-skills-and-competencies

Klein, S. B. (2019). *Learning: Principles and applications.* Mississippi State University, USA: SAGE Publications Inc.

Kuruba, M. (2019). *Role Competency Matrix: A Step-By-Step Guide to an Objective Competency Management System.* Singapore: Springer Singapore.

NC State University (1). (n.d.). *Hardware Test Engineer*. Retrieved May 30, 2024, from NC State University: https://online-distance.ncsu.edu/career/hardware-test-engineer/

NC State University (2). (n.d.). *Mechanical Testing Engineer*. Retrieved May 30, 2024, from NC State University: https://online-distance.ncsu.edu/career/mechanical-testing-engineer/

Sarder, R. (2016). *Building an Innovative Learning Organization.* Wiley.

Senge, P. (2006). *The Fifth Discipline: The art and practice of the learning organization.* Random House Books.