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SAFETY OBSERVATIONS IN WIND INDUSTRY

– Mobile application NordSafety

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SAFETY OBSERVATIONS IN WIND INDUSTRY - MOBILE APPLICATION NORDSAFETY

The main aim of this thesis was to support the evolution of safety observation management with a mobile tool deployment in wind farm construction sites. It was already decided that NordSafety is the safety application to be tested. The most relevant features to be tested were the mobile safety observations from sites and also TR-audits conducted straight into electronic form. First test domains were Kooninkallio wind farm construction site, Pori office (service operations) and Helsinki main office (project management). After the initial three-month test period, the use of NordSafety was continued and enlarged into all sites in Finland and other countries in the Nordic area.

In the end of the NordSafety test period in May 2016, the employees and managers were asked to fill in a feedback survey regarding their user experience and improvement suggestions on the mobile reporting tool. Comments and feedback were also received in meetings, interviews and by e-mail. The commissioning of a new safety observation management system was carried out with a low profile and minimum effort in training. Considering the input, the system deployment was rather active and positive, especially amongst company's own personnel. Regarding the foreign employees of the subcontractors, some hinders to reporting were faced due to the overlapping reporting systems and data roaming prices, that cause extra costs to foreigners.

In a shared work place like a construction site, the network of clients and contractors is complicated and in a constant transition due to work phases. It is challenging to share relevant safety information to all involved parties in the project. The system in use should be common to everyone, or at least easy to share, and broad enough to enable centralising of multiple EHSQ-data.

Thesis study presents shortly some other mobile safety tools for a comparison to NordSafety. No major differences were observed between the safety tools regarding their usability, features, customer support or price. Mobile reporting offers many benefits and opportunities as it is progressing rapidly. There is no confusion weather it is more competent to use electronic reporting instead of pen and paper. Companies should go mobile -and beyond.

KEYWORDS:

Occupational health and safety, safety observation, TR-audit, NordSafety, mobile application

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TURVALLISUUSHAVAINNOT TUULIVOIMARAKENTAMISESSA -NORDSAFETY MOBIILIJÄRJESTELMÄN KÄYTTÖÖNOTTO

Opinnäytetyön tarkoituksena oli edesauttaa turvallisuushavaintojen keräämistä, käsittelyä ja hyödyntämistä käyttöönotettavan mobiilijärjestelmän avulla tuulivoimarakennustyömailla. Testausvaiheeseen oli jo aiemmin päätetty valita NordSafety-niminen turvallisuussovellus, jonka tärkeimpinä ominaisuuksina lähdettiin kokeilemaan turvallisuushavaintojen ja TR-mittausten tekemistä sähköisesti suoraan kenttäolosuhteissa. Ensimmäiset testikohteet olivat Kooninkallion tuulivoimalatyömaa, Porin toimisto (huolto) ja Helsingin pääkonttori (projekti). Sovelluksen käyttöä päätettiin jatkaa kolmen kuukauden testijakson jälkeenkin. Lisenssiä laajennettiin ja turvallisuushavaintoja alettiin kerätä kaikilta työmailta, myös muista yrityksen pohjoisen toimialueen maista Suomen lisäksi.

Yrityksen työntekijöiltä, toimihenkilöiltä ja johdolta kerättiin palautetta mobiilijärjestelmän käyttökokemuksista toukokuun lopussa 2016 toteutetulla kyselytutkimuksella. Palautetta ja kehitysehdotuksia saatiin myös palavereissa, haastatteluin ja sähköpostitse. Uuden järjestelmän käyttöönotto tehtiin vähäeleisesti ja minimaalisella koulutuspanoksella. Siihen nähden järjestelmän käyttöönotto oli melko aktiivista ja positiivista, erityisesti oman henkilöstön keskuudessa. Aliurakoitsijoiden (ulkomaalaisten) työntekijöiden osalta ongelmana havaittiin päällekkäiset raportointijärjestelmät ja netin maksullisuus.

Yhteisellä työmaalla urakoitsijaverkostot ovat monimutkaisia ja jatkuvassa muutoksessa työvaiheiden mukaan. Haasteena on saada turvallisuuden kannalta olennainen tieto välittymään avoimesti ja ajantasaisesti kaikille osapuolille. Käytettävän järjestelmän tulisi olla yhteinen tai jaettavissa ja mahdollistaa EHSQ-tiedon keskittämisen.

Työssä on vertailun vuoksi esitelty myös muutamia muita turvallisuussovelluksia, joita on opinnäytetyötä varten testattu ilmaisen kokeilujakson verran. Järjestelmissä ei havaittu keskenään suuria eroja käytettävyyden, tuen tai hinnankaan suhteen. Mobiiliraportointi on tätä päivää ja sen mahdollisuudet kehittyvät nopeasti. Paperiraportointiin nähden sähköisen järjestelmän edut ovat kiistattomat.

ASIASANAT:

Työturvallisuus, turvallisuushavainto, TR-mittaus, NordSafety, mobiilisovellus

CONTENT

LIST OF ABBREVIATIONS (OR) SYMBOLS **7**

1 INTRODUCTION **8**

2 SEVERAL REASONS TO MANAGE SAFETY **10**

2.1 Finnish construction industry aiming at zero accidents 10

2.2 Reporting safety observations raises safety awareness 10

2.3 Finnish law sets the minimum requirements for safety 12

2.4 Safety management system is a frame for continuous safety improvements 13

3 NORDEX ENERGY IN WINDFARM CONSTRUCTION **15**

3.1 High yield wind turbines for all wind regimes 15

3.2 HSE policy sets safety as a priority in Nordex 16

4 SAFETY TOOLS: OBSERVATIONS AND TR-AUDIT **18**

4.1 Safety thinking in a new way 18

4.2 Safety observations and near miss reporting 19

4.3 TR-audit indicates the safety trend in construction sites 20

4.4 TR-audit with NordSafety 22

5 SAFETY OBSERVATION PROCESS IN NORDEX SE **23**

5.1 HSE Web - incident reporting 23

5.2 Case study: Nordex Sweden 25

6 MOBILE APPLICATIONS IN SAFETY REPORTING AND INVESTIGATION **29**

6.1 Mobile applications come with benefits 29

6.2 NordSafety is a Finnish mobile tool for safety 30

6.3 Finnish construction sites are going mobile in safety reporting 31

Fingrid Oyj 31

Oulun Energia Oy 33

6.4 Other available mobile applications 34

Kotopro for documentation in construction sites 34

Insta Audit offers a chemical database 36

Comparison of NordSafety, Kotopro and InstaAudit 37

iAuditor is a global choice 40

7 NORDSAFETY APPLICATION IN NORDEX **41**
7.1 Starting with NordSafety 41
7.2 Test period of three months 42
7.3 System implementation and preliminary training 45
7.4 Feedback survey for the test users 45
7.5 SWOT analysis of paper form versus mobile application 47
7.6 Modification of the NordSafety application after trial period 48
More user rights into the system 48
Observation form 49
Domain structure 50
7.7 Information sharing to personnel via safety bulletin and monthly HSE meeting 51

8 NORDSAFETY SYSTEM EVOLVES ALL ALONG **52**
8.1 New features introduced during summer and autumn 2016 52
Collaborative feature 52
Location services and map view 53
Domain message 53
8.2 NordSafety Windows application allows adding TR-audits retroactively 53

9 HOW TO UTILIZE THE MOBILE TOOL AND THE SAFETY OBSERVATIONS MORE EFFECTIVELY **55**
9.1 Motivating and activating employees is worthwhile 55
9.2 Sorting and grading of safety information flood 57
9.3 Committing employees to NordSafety 59

10 CONCLUSIONS **60**

11 AFTERWORD **61**

REFERENCES **62**

APPENDICES

Appendix 1. User feedback survey conducted in SurveyMonkey after NordSafety trial period 3-6/2016.

FIGURES

Figure 1. Heinrich's theory of accident triangle (Simplified safety, 2016). 11
Figure 2. Heinrich's theory of accident triangle added with basement of leader-ship actions. (Safety Culture World, 2012). 12
Figure 3. TR-audit calculation formula. 22
Figure 4. The management process of safety observations in Nordex organisation. 25
Figure 5. Incidents and safety observations reported in Nordex Sweden during months 1-10/2016. (Brofalk, 2016). 26
Figure 6. Detailed categorization of safety observations in Nordex Sweden during months 1-10/2016. (Brofalk, 2016). 27
Figure 7. Weekly amounts of TR-audits recorded into Kotopro in a bar diagram and the total amount of TR-audits in a line diagram during years 2013-2016. (Marjanen, 2017). 36
Figure 8. QR codes for public safety observations in Nordex sites in the Nordic region (left-old, right-new). 42
Figure 9. NordSafety future vision of safety ecosystems. 52
Figure 10. NordSafety safety feed subscription menu. (Kronlöf, 2017). 58

TABLES

Table 1. Comparison table for the mobile safety tools tested in this study. (Takki, 2017. Lehtomäki, 2017. Marjanen, 2017). 38
Table 2. Number of safety observations collected with NordSafety application during the trial period. 43
Table 3. Number of safety observations collected with paper form during NordSafety trial period. 44
Table 4. Number of NordSafety observations compared to number of all safety observations gathered during period 3-7/2016. 44
Table 5. SWOT of NordSafety or other mobile application for safety observations. 47
Table 6. Visiting activity log of NordSafety portal by ten Nordex users 11/2016. 59

LIST OF ABBREVIATIONS (OR) SYMBOLS

Mobile application	Software designed to run on a mobile device
HSEQ	Health, Safety, Environment, Quality
LTI	Lost Time Incident
MSDS	Material Safety Data Sheet for chemicals
NX	Nordex Energy GmbH
PPE	Personal protective equipment
Safety observation	Turvallisuushavainto, observation related to improvement in occupational health and safety as well as environment. (Source)
Safety walk	Management safety inspection at site
TR-audit	Talon Rakennustyömaan turvallisuusmittari, a measure for a safety audit in construction sites

1 INTRODUCTION

Occupational health and safety should be valued above everything else. No hurry, disregard or financial reason can override the value of employees' health and safety. Majority of work related injuries can be prevented by good planning and assessing risks carefully. The procedure of making safety observations will make people conscious for possible safety hazards in their working environment. Every major hazard has been preceded by several near-misses.

Wind farm construction sites are complicated working environments in many ways: Employees come from different nationalities and have a variety of languages in use. Construction sites are located in remote places. There is a network of client, main contractor, sub-contractors and local suppliers. Wind turbines require heavy lifting and working at heights. Projects are short and work phases even shorter. With this kind of working conditions, it is even more important to have a very effective online reporting system for safety issues.

From Nordex Energy Finnish Branch point of view the main thing to investigate and improve in this study was the process of making and utilizing the safety observations most effectively. It is necessary for the management and employees to gain information about the potentially hazardous places and practices. It is not only collecting and filing of the observations, but also processing, grading and sharing of the main observations into involved parties.

Nordex Energy decided to choose NordSafety tool to be tested in Finnish wind farm construction sites for safety reporting. Later on NordSafety was taken into daily use also in other countries in the Northern region, mainly utilizing the safety observation and TR-audit features. Also other corresponding safety applications have been tested in this study to compare the usability and features they have with NordSafety.

The theoretical background for this thesis is based on case study method. The aim of the test period and case study was to gather a significant amount of applicable observations, to process them in an effective way and share the results.

Time, place and people involved have a significant role in case studies and that is why the conclusions are specific and cannot be repeated in a same manner. In case studies the qualitative and quantitative methods can be combined and the final report is an entity or a descriptive story.

Elite sampling method was used in this study, because only a few people were directly involved in the test period of NordSafety application. These people were the main source of practical information to this study. The collected data was processed with a triangular approach, where a vast amount of material and information was compressed into a synthesis and the report was created based on that synthesis. The report is following the funnel technique where it goes from general information into more and more detailed specific data.

2 SEVERAL REASONS TO MANAGE SAFETY

2.1 Finnish construction industry aiming at zero accidents

The number of working hours has constantly increased in the Finnish construction sites, whereas the number of accidents has decreased at the same time. Also the number of lethal and severe accidents has decreased. Most often the accidents in construction sites affect employees' hands and fingers (almost 50% of accidents). Head and eyes are also in danger (16% of accidents), even thought that the requirement of wearing eye goggles is in force. Other typical accidents include slipping, tripping and falling. (Rakennusteollisuus, 2016)

Accident frequency rate describes how many accidents happen during million working hours. It does not segregate the severity of accidents, but shows the trend. The general level of accident frequency in Finland during year 2013 was about 64. The leading companies in safety are able to keep the rate under 10. It is possible to aim at zero accidents. "Nolla tapaturmaa" is a campaign raised by the Finnish construction industry targeting to minimize the accident rate into zero level by 2020. This requires a close co-operation and involvement in the whole chain of contractors. Nolla tapaturmaa -forum is a Finnish network for companies who commit themselves to zero accident target. (Rakennusteollisuus, 2016)

2.2 Reporting safety observations raises safety awareness

According to well-known Heinrich's theory from the 1930's, there are approximately three hundred minor incidents preceding a severe accident. Heinrich's theory has been further investigated several times and supplemented with estimates of the number of near-misses and risky behaviours preceding fatal accidents. In the accident triangle (Figure 1.) the ratios of risky behaviour, near misses, recordable injuries, LTI's and fatalities can be visualized. By recording and investigating the reasons leading to near-misses and minor injuries it is possible to influence and avoid the risk of more severe accidents.

Figure 1. Heinrich's theory of accident triangle (Simplified safety, 2016).

In Finland employees have a tendency to report actively about less severe incidents better than their European colleagues. The accident triangle with ratio of 3000 near misses – 300 recordable injuries – 30 lost time incidents – 1 fatality is not actually true in Finland. There are approximately 9000 near-misses or minor injuries reported in Finland against one fatality. (Rakennusteollisuus, 2016)

Safety is based on management and leadership actions. Before entering to the first step of Heinrich's triangle, many actions have been made: introduction / induction / other training, work instructions, communication of policies and targets, risk assessments etc. Leadership actions (Figure 2.) create the basement for safety management and have a huge influence on the success or failure in avoiding work related injuries. Working ability of the employees shall be considered as a priority. Succeeding in safety creates a positive company image.

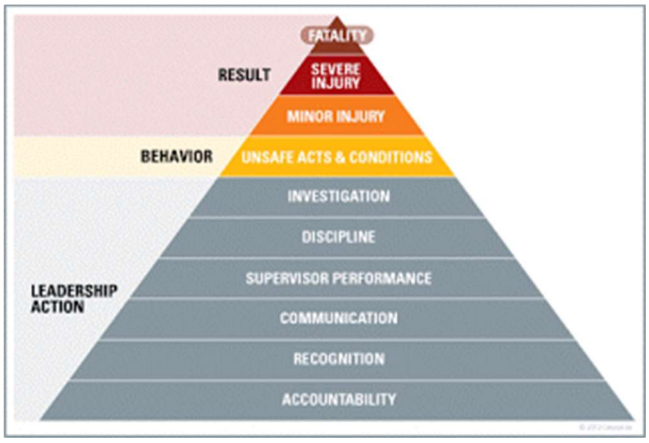

Figure 2. Heinrich's theory of accident triangle added with basement of leadership actions. (Safety Culture World, 2012).

2.3 Finnish law sets the minimum requirements for safety

The objective of the Finnish Occupational Safety and Health Act 738/2002 is to improve the working environment and working conditions to ensure the working ability of employees, to prevent occupational accidents and diseases and eliminate other physical and mental hazards from work. (Työturvallisuuslaki, 2002)

Employers' general duty to exercise care means that the employer is obligated to take care of the safety and health of employees with planned necessary measures. Measures include preventing the creation of hazards and risks, eliminating the hazards or selecting a less harmful alternative, adopting general safety measures and considering the technological developments and other available means (such as mobile apps). Employer should continuously monitor the safety level of the working environment. (Työturvallisuuslaki, 8§, 2002)

Continuous improvements in safety level require cooperation between employers and employees. Employees have the right to submit safety proposals (= safety observations) to the employer and get a response on them. Employer must immediately inform the employer of faults and defects in working conditions and equipment that cause a risk to health and safety. If safe and possible, the em-

ployer shall eliminate the hazard and give a report of the measures taken. Employer shall report back to employee of the measures taken in the matter concerned. (Työturvallisuuslaki, 2002)

Employees have the right to stop an unsafe work phase and leave the workplace if the work causes a serious risk to someone's life or health. The risky situation causing refusal of work must be informed to employer as soon as possible and the employer must eliminate the risk before work can be continued. (Työturvallisuuslaki, 23§, 2002)

In shared working places the employer exercising the main authority shall ensure that all external employers have received necessary information and instructions regarding hazards and risk factors as well as fire control, first aid and evacuation. All employers and employees in a shared work place shall inform the main contractor of the hazards and risk factors caused by their work or otherwise identified. Generally, there needs to be sufficient cooperation and information sharing regarding risks and hazards, safety measures taken and coordination of work phases between all parties. (Työturvallisuuslaki, 50&54§, 2002)

2.4 Safety management system is a frame for continuous safety improvements

The Finnish Standards Association SFS (Suomen Standardisoimisliitto SFS ry) is the national central standardisation organisation controlling and coordinating standardisation work in Finland. SFS is a member of the International Organisation for Standardization ISO. SFS develops, approves and publishes national standards for e.g. quality (ISO 9001), environment (ISO 14001) and safety management (OHSAS 18001). (SFS, 2016)

Management system based on OHSAS 18001 Occupational Health and safety standard helps companies to control risks and continuously improve safety performance. It supports the integration of safety into daily management and planning. There will be also a new standard ISO 45001 for Occupational health and safety management systems available during year 2017. (SFS, 2016)

Nordex Health, Safety and Environmental Management System is accredited to ISO 9001, OHSAS 18001 and ISO 14001. All three standards have similar Plan - Do - Check - Act structure aiming to continuous improvements. They were composed compatible in order to be used concurrently. Standards require the company to have appropriate quality, health, safety and environmental policies as well as clear procedures and protocols to ensure a HSE conscientious organisation.

3 NORDEX ENERGY IN WINDFARM CONSTRUCTION

3.1 High yield wind turbines for all wind regimes

The Nordex Group is one of the world's leading suppliers of high capacity wind turbines. Nordex offers powerful onshore wind turbines, ranging from 1.5 MW to 3 MW, for almost all geographical regions across the globe. Over seven thousand Nordex wind turbines with multiple rotor and tower combinations have been erected in more than forty countries. Nordex offices and subsidiaries are established into twenty countries. Continuous growth is recently granted by a corporate acquisition of Acciona wind power in 2016. By pooling their activities, Nordex and AWP aim to establish a global player to face future market challenges. Nordex stock has been listed in on the Frankfurt stock exchange since 2001. (Nordex, 2016)

Nordex was established 30 years ago in Give, Denmark in year 1985. Nowadays Nordex SE management holding company's headquarters is located in Rostock, Germany. The domicile of the board and administration is in Hamburg. Nordex SE controls and coordinates the activities of the subsidiaries Nordex Energy GmbH, Nordex Energy B.V. and Acciona Windpower. (Nordex, 2016)

The core business of Nordex is to offer development and production of wind turbines, project development and the construction of turn-key wind farms as well as maintenance and service. There are over four thousand employees in total. Production facilities are located in Germany and China. Nordex has profiled itself with the clean wind energy, which does not create any carbon releases and thus helps to tackle against the global warming. (Nordex, 2016)

In the Northern area Nordex Energy GmbH has activities in Finland, Denmark, Norway, Lithuania and Estonia. These countries lie under the same project, service and QHSE management organisation. Nordex Energy Finnish Branch has around 65 employees, one third of them being located at Helsinki office.

3.2 HSE policy sets safety as a priority in Nordex

Based on Finnish law, the employer shall have an occupational safety and health policy. The policy should aim to develop and improve the working conditions. Company's safety objectives are derived from the policy. Objectives must be discussed and agreed with employees or their representative. (Työturvallisuuslaki, 9§, 2002)

Companies often have a combined policy for health, safety and environmental matters. Nordex has embedded health, safety and environment as top priority in company. HSE policy follows Safety First! -principle and states that "No injuries, to Anyone, at Anytime".

- Health and safety of our people is valued above all else
- All injuries can be prevented – we plan for safety
- Management at all levels is accountable for safety and leads by example
- Everyone looks after each other no matter who they work for
- Safe behaviour is recognized, acknowledged and rewarded
- ZERO tolerance for safety breaches
- Everyone has the courage to STOP any unsafe work
- We aim to use resources sustainably, minimize end reuse waste and mitigate negative environmental impacts as effectively as possible

(Nordex HSE policy, 3/2016, signed by Lars Bondo Grogsgaard)

In addition to previous statements, Nordex HSE policy brings up the ideas of

- positive safety culture
- zero occurrence by risk assessment and prevention
- continuous improvements in HSE performance
- HSE as an integral part of all business activities
- HSE standards applied and followed by partners, contractors and suppliers as well
- Legal requirements (national/regional/local) implementation

- Accredited HSE management system OHSAS ISO18001 and ISO14001

HSE policy and targets are implemented by more detailed health and safety procedures such as “Notification and investigation of incidents”. Procedures are amended with several practical work instructions like “Accident and incident investigation” and “Incident classification matrix”. HSE management is verified by a variety of safety records such as work permits, PPE inspection and site safety induction records.

Nordex will apply a HSE plan for each new wind farm construction site. Risk assessment is done generally to the whole construction site plus specifically for each work phase. Every new employee at site will go through a safety induction where he or she is also reminded about how to maintain a good level of personal safety and how to make safety observation in order to improve the general safety level and awareness.

4 SAFETY TOOLS: OBSERVATIONS AND TR-AUDIT

4.1 Safety thinking in a new way

Safety thinking has been changing over the time passed. Safety is not solely a task and responsibility of the HSE department, but also the management has to be involved and lead by example. Safety is the duty of everyone. As Timo Kronlöf, a co-founder of NordSafety, states (Kronlöf, 2005, page1), safety should be a positive and easy part of our personal job description. The field of safety management is in a transition period due to new technological solutions e.g. in communication and wearables. (Kronlöf, 2005)

Mobile devices, which every employee carry with them anyway, enable real-time safety reporting. In the future it might be that the PPE will do the reporting automatically on the employee´s behalf. With the new kind of PPE or “safety tracker” it might be possible to evaluate individual employee´s performance in safety and connect the results into personal bonus. This would surely improve the individual motivation in safety. Safety tracker (cf. sports tracker) might measure the altitude, dust levels, chemical fumes etc. and give automatic warnings –not only to an individual employee, but also the others working near-by. (Kronlöf, 2005)

Safety communication will involve many parties in the future when industries go towards safety ecosystems in shared work places. When several companies and other interested parties (such as neighbours, clients and authorities) are working in a shared work/construction site, an open and quick safety communication will be a challenge. Kronlöf has a vision on location based push notifications sent automatically to all people working close to an accident place or a near-miss. (Kronlöf, 2005)

Emergency warnings given to the citizens by the authorities could also be done via mobile phones, but it is too expensive to realize at the moment. That´s why for example during the Suomi-Slovakia ice hockey game in television 15 May

2016, the whole Finland was warned about a bear moving in Hamina city area. (MTV, 2016)

4.2 Safety observations and near miss reporting

According to Wikipedia a near miss is “an unplanned event that threatens human safety or health, the environment, or the continued normal operation of the business enterprise, wherein the last protective barrier is challenged, but defeated” (Wikipedia, 2016). Safety observation means that someone has noticed the previous happening, or that it might happen in current circumstances, and that he or she notifies other employees about it. Near misses and safety observations can be seen as a zero-cost learning opportunity to avoid accidents.

Employer needs to ensure a safe and healthy working environment for every employee. Management should be engaged and motived to continuously improve the safety level and lead by example. Management in all levels create the safety culture in the company and specific work place. Yet the safe working environment is the responsibility of each individual employee as well. He or she needs to comply the legal requirements as well as working instructions given by the employer. If employee notices some work-related deficiencies or faults, he or she is obligated to inform management and do some preliminary actions. If the hazard is immediate, unsafe work must be stopped. Safety reporting gives valuable information for a better performance in safety. (Kanerva, 2008, pages 6&12)

Safety observation (in Finnish turvallisuushavainto, vaarailmoitus, läheltä piti -ilmoitus etc.) has many synonyms such as good catch, near miss, close call, narrow escape, near hit and a preventive observation. Safety observations can include general notices related to health, safety and environmental issues on site and suggestions how to improve these issues as well as reporting of potential hazards and near misses. Safety observations can be also positive findings of an exemplary actions and behaviour.

The studies based on Heinrich's theory (see more in chapter 2.2) show that the more observations you get, the more likely it is to avoid an accident from happening. Risks are related to probabilities and frequencies and by affecting them it is possible to impact the accident rates (NordSafety, LinkedIn, 11 July 2016)

Everyone working on site shall be guided and encouraged to make safety observations. At Nordex sites there is a certain safety observation form to fill in and return to the mail box in the site office. Site manager's responsibility is to process the observations once a week and give related tool box talks. All the observations will be forwarded to Nordex Finland HSE committee. Actively participating sites will be rewarded. Since April 2016 employees have been encouraged to favor mobile reporting with NordSafety application. Both safety observation methods have the same structure and content.

Safety observation form consist of the following sections:

1. Domain: specification of the site or office
2. Incident reported by
3. Time
4. Type: first aid / near-miss / environmental / property / other
5. Target: people / electricity / PPE / machines / housekeeping /
6. Country
7. Type of location office / site / service point / wind farm / project / other
8. Description (text box)
9. Immediate solution
10. Investigation Actions and photos & status & assignee

4.3 TR-audit indicates the safety trend in construction sites

TR-mittari or TR-audit is generally used to measure the safety level in Finnish construction sites for buildings. TR-audit is a registered method, which fulfills the legal requirements for the weekly maintenance inspections in construction sites.

The method was developed in the beginning of 1990's to observe the housekeeping level and hazards in the construction sites. Abbreviation TR comes from words Talo (house) and Rakentaminen (construction). One inspection in a large construction site includes normally more than a hundred observations. The safety features measured in TR audit are:

- Scaffolding, access and ladders
- Machinery and equipment
- Falling protection
- Working habits
- Electricity and lighting
- Housekeeping
- Dustiness

(Työsuojelu, 2016)

Weekly TR measurements can be done in many ways, depending on the inspector. While using the paper form, the inspector will tick lines for both positive and negative observations and normally add comments related to the incorrect items. Inspector will also nominate a responsible person for the corrective action and set a deadline for the corrective action. It is possible to add pictures and other attachments into TR-audit, but unless they are printed into one PDF document, the handling and reporting of the entirety is complicate.

If the inspector changes, inspector makes the TR-audit in a different way every time or the inspector is not very precise with the reporting, the results of the audit are not comparable with each other. When the inspector marks only lines into a paper form, it is hard to define afterwards what was done well in the construction site and which points needed to be corrected more often. It is also possible to cheat –there is actually no need to leave the office desk in order to fill in the paper form if no pictures are included.

The target level is good to have, but honesty is the only way to improve safety. Some clients or supervisors may require that the result of TR-audit should be 95% or more. This is utopia and can be reached only by closing inspector's eyes.

The TR-level percentage is calculated by dividing the number of correct observations by the sum of the correct and incorrect ones (Figure 3.).

$$TR\ level = \frac{correct\ (number)}{correct + incorrect\ (number)} x\ 100 = \ \%$$

Figure 3. TR-audit calculation formula.

This means that if there are no incorrect observations, the safety level will be 100%. But if there are some incorrect observations, you can raise the level by adding correct observations. So, some sort of manipulation is possible to use to reach the target level.

4.4 TR-audit with NordSafety

To use the NordSafety mobile application for TR-audit, it is necessary to have full access to the app. While using the mobile application, certain benefits can be reached. It is easy and simple to attach pictures related to observed incorrect items. You can appoint someone to make the corrective action by adding his/her email address and there will be an automatic notification send to that person. Note that you have to double click in order to add and activate the responsible person. He/she does not need any username and password to reach the report.

TR-audit statistics will be automatically created in the NordSafety system. If the measurements are done regularly and preferable the same way every time, the trend figures give out important information for safety management.

Adding the TR-audit paper form data to NordSafety retroactively is only possible by using the Windows application. With the normal use, the TR-audit will be dated to present even if it was done earlier. This is intended to make the reporting more credible and up-to-date.

5 SAFETY OBSERVATION PROCESS IN NORDEX SE

5.1 HSE Web - incident reporting

Nordex HSE web contains all corporate health, safety and environment relevant information. It can be reached via company intranet by choosing HSE in the Web Navigator. Incident notification template in HSE Web is used for both safety observations and incident reporting. Notification and investigation of incidents is guided by HSE procedure and work instructions. All safety observations (and incidents) received by paper or electronic form needs to be typed into the HSE Web -system manually. Original report is attached into the new report created in the system. (Lehtinen, 2016)

Observations and incidents are separated by the level of severity, which is valued between 1-4. Safety observations should always have severity level 1, because nothing happened yet. Work accidents (lost time – LTI) and incidents with severity rate 3-4 need to be investigated immediately and documented on G0110P1F02 Investigation of incidents –form or a locally released similar document. Incident notification form must be filled out for first notification of any HSE related incidents and a copy forwarded to a certain distribution list within 24 hours. Investigation reports are uploaded into incident database by local Nordex HSE manager. Form is available in many languages: English, German, French, Chinese, Portuguese, Turkish, Italian and Spanish. (Nordex HSE Web, 2016)

Notification of incidents –form consist of the following sections:

- Type of incident (e.g. Accident LTI, Environmental incident, Damage to property)
- Date and time
- Place (country and location)
- Description of what happened

- Quality non-conformity?
- Corrective and preventive actions
- Signature and contact information
- Distribution list

The user rights for the incident reporting in HSE Web system are only within very few people in the organisation. Also the sharing of the information and lessons learned is quite scarce, considering that the HSE manager is the only person in Finland in the mailing list of all incidents and observations. (Lehtinen, 2016)

Collecting the safety observations from wind farms is a significant part of improving the safety culture and avoiding incidents and accidents. Making and processing the observations shall be made as easy and simple as possible. Also the investigation and action procedure of the observations, as well as pointing responsibilities, shall be clear and univocal.

Safety management process in Nordex is presented in the process chart below (Figure 4.) in a work flow level. Main actors in this safety observation management process are the safety observer, NordSafety administrator (or safety observation administrator in general) and the Nordex HSE department. Nordex HSE means both the Finnish HSE organisation and the global HSE organisation in the headquarters.

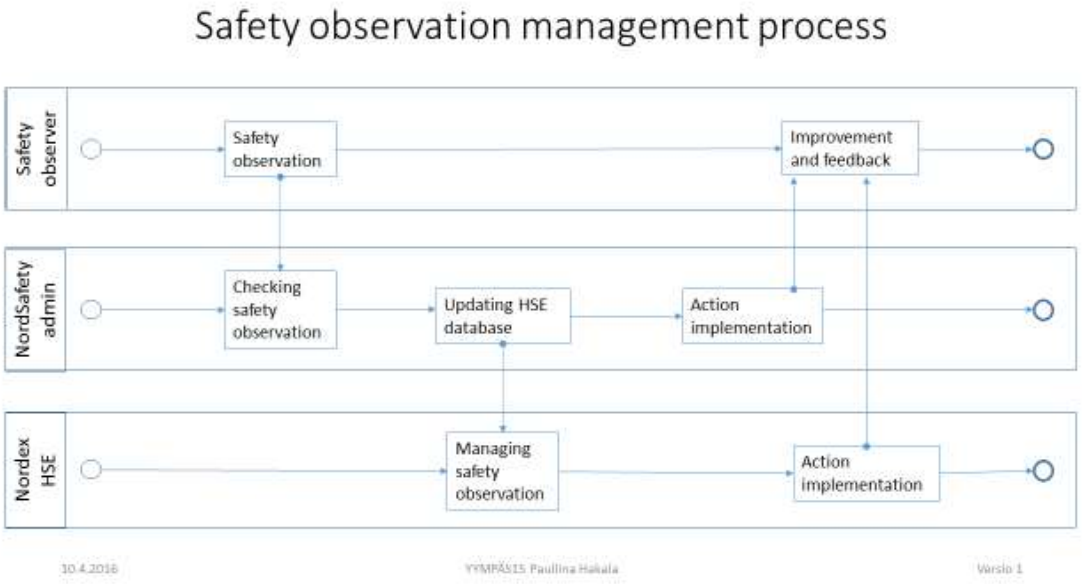

Figure 4. The management process of safety observations in Nordex organisation.

The person who is checking the safety observations depends on the location. In the offices, it is the HSE representative or the office assistant, at construction sites it is the site assistant or the site manager. When the safety observations are checked first on the spot before delivering to the “higher level”, the first actions can be made immediately at site, if the case is urgent.

5.2 Case study: Nordex Sweden

Nordex Swedish branch has promoted reporting observations since early 2013. They implemented safety observations reporting first to get a picture of the risk situation and to encourage people to start looking at their work environment. Today the Swedish branch has reached a level with more than 150 observations reported during the quarters Q1- Q3 2016. Everyone in Nordex Sweden has a personal target of making at least six observations per year. With a personnel of 50 employees, it means that three observations per person were made by end of September 2016. That is only half of the target of six observations per person each year -way to go until end of 2016. (Brofalk, 2016)

It has been clearly seen that the observations also improve the safety level. The issues reported in the safety observations are always followed up and solved if possible. In Nordex Sweden the information about all observations reported during the past month are shared in a monthly newsletter to all local employees. Employees report observations to local HSE manager also by e-mail and text messages. Most observations are good ones and they help to improve safety, even if there still are a few that seems more like complaints. The most relevant information to be included in the observation is the observation itself, suggestion for improvement and what has been done so far to correct the issue. The last point is included in order to activate everyone to start think themselves and to feel that they also have a responsibility to improve the work environment. (Brofalk, 2016)

When the local safety manager reports the received safety observations into the Nordex system (HSE Web), the observation becomes either unsafe condition, unsafe behaviour or a near-miss depending what it is about. All near-misses are counted as observations, even if there might be a few that are incidents. The below figure (Figure 5.) shows that there have been approximately 170 observations between months 1-10/2016 of which there were seven first aid cases and one lost time incident. In Figure 6. the observations are divided into 43 subcategories. The most common observations are related to technical defects, falling items, weather conditions and physical stress. (Brofalk, 2016)

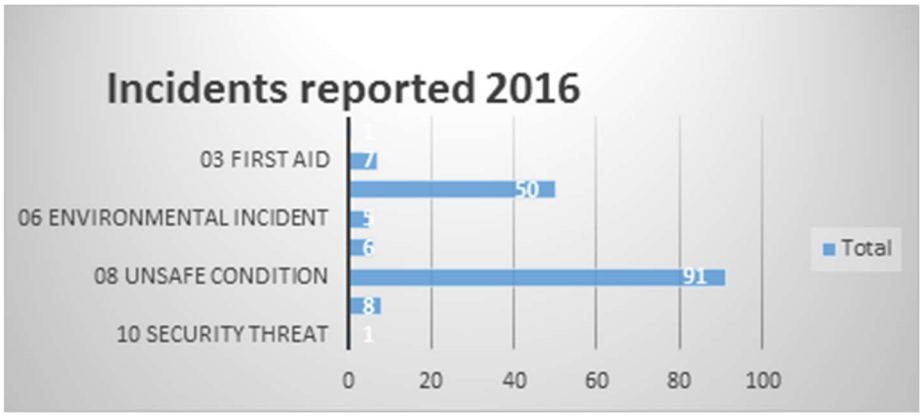

Figure 5. Incidents and safety observations reported in Nordex Sweden during months 1-10/2016. (Brofalk, 2016).

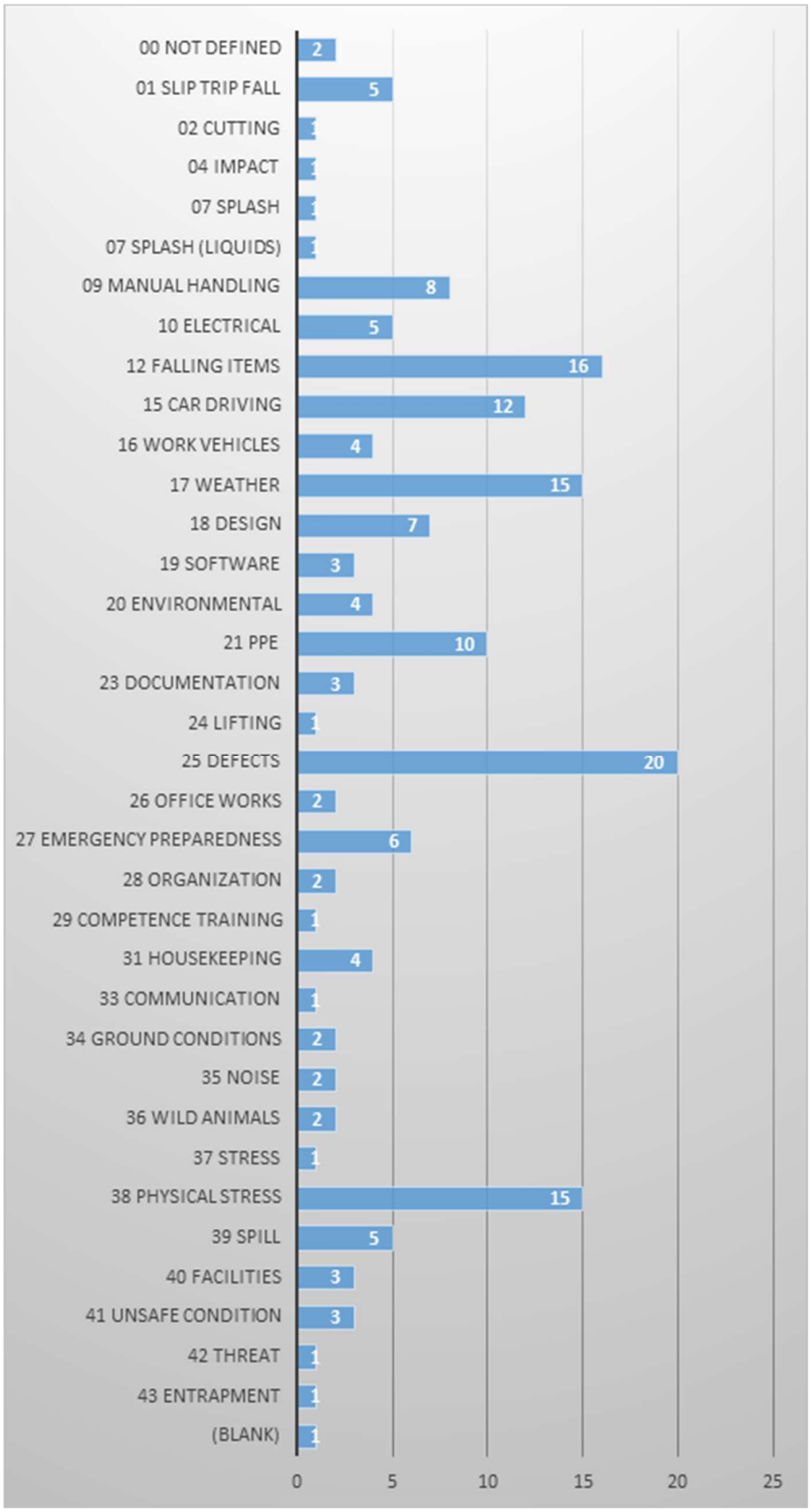

Figure 6. Detailed categorization of safety observations in Nordex Sweden during months 1-10/2016. (Brofalk, 2016).

Nordex technicians in Sweden have requested a better tool for safety reporting and due to that need, it has been decided that they will test the common Swedish system ENIA during year 2017. With ENIA one can report safety observations with a smartphone app and the management will receive the information in electronic form without delay. (Brofalk, 2016)

Katarina Brofalk states that it is definitely necessary to have a system in Nordex where every employee can report incidents into an incident management system where tasks, investigations and action plans can also be managed. Today, it causes a lot of extra work when people write incident reports, which she has to translate and re-write into Nordex HSE web. The system should be web based and possible to reach with computer and smartphone without logging into Nordex intranet and VPN client. (Brofalk, 2016)

Nordex Sweden is a separate unit from Nordex Nordic area. The Nordex brances surrounding Sweden (Norway, Denmark, Finland) are all involved in NordSafety reporting at the moment. Considering a wide scale scope of safety management in Nordex, it would seem beneficial to have the same safety reporting system used in all regions. According to Nordex HSEQ manager Nordic area Anna Lehtonen, there will be a completely new corporate safety system in the future, which will possibly swipe away the temporarily used NordSafety -and ENIA.

6 MOBILE APPLICATIONS IN SAFETY REPORTING AND INVESTIGATION

6.1 Mobile applications come with benefits

Mobile application, which is most commonly referred to as an app, is a type of application software designed to run on a mobile device e.g. a smartphone or tablet computer. Mobile applications offer users with similar services to those accessed on personal computers. Apps are generally small, individual software units and they have a limited function. Use of apps has been popularized by Apple Inc. and its App Store, which sells a variation of thousands of applications. (Techopedia, 2016)

Each app provides a specific functionality such as a game, tools (flash light, calculator), social media (Instagram, Pinterest) or entertainment (Netflix, Veikkaus). Apps allow you to personally choose and pick which elements you wish to have in the phone or tablet. There might be parallel PC-based applications and mobile apps, but the new apps are most often developed directly for the mobile environment. Apps can use location based features, where Pokemon Go -game and Geocaching are good examples. (Techopedia, 2016)

Almost every employee is nowadays equipped with a mobile phone offered by the employer. It is always with us and readily available with features such as camera, voice recorder, positioning and variable applications. Using a mobile app saves a lot of information and time compared to old fashioned pen and paper method.

The difference between working with a web browser and mobile application is that for example in construction site conditions you may not be in the internet coverage area either geographically or due to circumstances (working in the basement or a turbine). Still you can use the application and it will update all information online when the internet connection is available. Inspection records are backed up to the cloud and they are available in real-time.

6.2 NordSafety is a Finnish mobile tool for safety

NordSafety is a software platform and a mobile application produced to help in managing company's EHSQ requirements with smart devices. It is a tool to collect and share HSEQ information within an organisation or a larger project. The most suitable business sectors for using NordSafety are construction, civil engineering, manufacturing and services. NordSafety promises to improve the productivity of HSEQ by over 60%: based on user experience, going mobile with NordSafety saves 60% of time compared to paper and Excel. Graphs and figures will be automatically generated and updated while new data is entered into the system. (NordSafety, 2016)

NordSafety can be used for general safety management (TR audit, safety observations, incident investigation etc.) and it helps to increase the reporting volume by the public reporting feature. Visitors and subcontractors don't need to login when the public link is offered by NFC-tags, QR-codes or redirects from company homepage. NordSafety has put effort on engaging employees in safety. There are also quality features available, such as Lean 5S auditing for working environment. All the needed auditing templates can be found in NordSafety's mobile 5S application with predefined KPI's. Forms can be also edited to custom needs. (NordSafety, 2016)

NordSafety is looking towards launching a new feature "collaborative sites" for improved work and communication in shared sites. This means that different contractors can share their safety data in the application during the project they share. A whole network of companies will be up to date with latest auditing results, safety observations and incident reports. The site owner can control what is shared and who are involved. (NordSafety, LinkedIn, 11 July 2016)

The following reasons can be stated to promote NordSafety or some other mobile application for HSEQ reporting:

- Productivity improvements: Companies have managed to save up to 60% of time per audit because all the work will be done during the audit and reports with figures are generated automatically.
- Lower accident frequency: By engaging the whole personnel to safety reporting, all risks will be detected and there's less interruptions in production and less accidents.
- Company image: Responsibly acting companies reach advantage while competing on new customers and projects as well as job seekers and investors.
- Saving money in insurance premiums and accident related costs. Projects keep their schedule if there's no interruptions.
- NordSafety can be connected to company's other IT-systems in use such as ERP or analytic tools.
  (NordSafety, 2016)

NordSafety application was chosen by Nordex Energy GmbH to be tested and taken into use in the Finnish branch during spring 2016. Read more in paragraph 7. NordSafety application in Nordex.

6.3 Finnish construction sites are going mobile in safety reporting

Fingrid Oyj

Fingrid is a nation-wide electricity company in Finland, taking care of the high voltage grid, which transmits electricity from power plants to distribution network companies and industries. They also take care of the cross-border connections and promote the functioning of the electricity market. For a company, which is responsible for maintaining and developing the Finnish power system, safety is a serious business. (NordSafety - Fingrid, 2016)

Field works are organised with several contractors, who need to be engaged and integrated into Fingrid's EHSQ management practises. Aim of their occupational safety management program is to reach zero accident level. Having many active

sites simultaneously, Fingrid Oyj needed new tools to monitor and report safety performance. It was time to transfer from manual paperwork to online reporting. Since year 2014 Fingrid has been piloting with NordSafety application in order to improve their safety level. Fingrid and NordSafety agreed on a period of 36 months of co-operative application development and unlimited use. NordSafety is nowadays used in every location of Fingrid projects by 500 users. (NordSafety - Fingrid, 2016)

The main advantage of using (NordSafety) application is that even if the construction site is in the middle of nowhere, employees can complete their reporting in situ and forward important information quickly online. Managers are able to check the situation at sites online and real-time. Fingrid Oyj is mainly using the following NordSafety features: daily site diaries, safety reporting (including accident investigation and safety observations management), tracking of working hours and tool-box-talks. (NordSafety - Fingrid, 2016)

Fingrid Oyj has been partnering with NordSafety from the very beginning. They have co-operated to progress towards a mobile HSEQ platform, which is at the same time a mobile application and a comprehensive reporting system. For Fingrid NordSafety soon appeared as a solution to multiple needs. Users experienced the application simple and easy to use, with training and support organised according to needs. Fingrid has been active to improve the usability and tools selection of NordSafety system and take the most out of it. (NordSafety - Fingrid, 2016)

Fingrid recommends all their subcontractors to use the same tool as well. Safety observations can be done in NordSafety without login. Making a safety observation is worthwhile - it can save someone’s life. The whole incident investigation process can be reported and recorded into NordSafety. Near miss reporting (number of safety observations) increased dramatically in Fingrid Oyj with the help of NordSafety tool. During year 2016 they have received three times more observations compared to year 2015. (NordSafety - Fingrid, 2016)

Oulun Energia Oy

Working conditions in the energy sector are rather demanding, considering for example the storms. Safety responsible Reino Nygard from Oulu Energia Urakointi Oy says that their employees have to work in a climate conditions where no one would keep their dogs out. PPE is an important safety measure, but several other measures have to be used as well to reach high safety level. In Oulu Energia Urakointi Oy the last lost time accident happened in November 2012. (Okko, 2016)

There were 28 accidents causing 225 lost working days in Oulu Energia corporation during year 2010. LTA figure was 53 accidents per million working hours and the situation was alarming. Company's new CEO Juhani Järvelä set the safety improvements as a high priority management target in the company. Employees were involved in defining company values and setting targets to safety management. Safety mission underlined top management involvement, leading by example, anticipation, open communication and strict targeting. (Okko, 2016)

Oulu Energia employees are encouraged to make safety observations while working, on their way to work and during the leisure time. When people get used to making safety observations, they make them automatically everywhere and will be prepared to react on unsafe conditions. Employee´s free time safety has improved significantly as well. During year 2011 there were 41 lost time accidents happening and during year 2015 there were seven. (Okko, 2016)

Mobile technology has made safety reporting in the field quick and simple. Reports and pictures are immediately available for everyone in the system. Pictures can be added easily in situ. The most recent emphasis in Oulu Energia´s safety reporting are the positive observations. This campaign has showed that many things are well done in the company and improvements happen. (Okko, 2016)

Oulu Energia is using a mobile tool offered by WellWorks Oy. They have several software in use from the same provider. Database package is custom made to Oulu Energia's needs. Mobile application is based on the EHSQ software, which

includes the reporting tool of safety observations and incidents. Application enables a simple and quick way of reporting and filing safety observations with photos in worksites out of office. WellWorks tool can be used with Android and Windows operating systems at the moment. (Räisänen, 2017)

6.4 Other available mobile applications

There are several mobile applications for safety purposes available. One can choose between international companies and local small businesses. Here only one international option (IAuditor) and some Finnish mobile applications are shortly introduced. Kotopro and InstaAudit were chosen randomly for a closer inspection in this study. Kotopro and InstaAudit were both tested during a trial period. In addition, there are safety databases and mobile applications such as 3T HSEQ Online, Congrid Oy, AtlantisRatkaisut, Arrow Shop floor management, Novi, Wellworks and Synergi Life. Some of them offer special features compared to others, such as working ability monitoring, legislation follow-up or a chemical database.

Kotopro for documentation in construction sites

Kotopro is a tool for safety monitoring and documentation in the field conditions. Kotopro is a responsive web based application for safety reporting, which is comparable with NordSafety system. Kotopro offers a free trial period of seven days in their web pages. After the free trial, the price depends on the features that are chosen (min. 35 eur/month). Kotopro uses the web browser, so no uploads or updates are necessary. Nevertheless, it requires the internet connection for any data input at site. The product promise is to reduce the time used for reporting and documentation into a half. All the pictures, drawings and notes remain filed in the same place. The application generates reports automatically. (Kotopro, 2016)

To start with Kotopro, one will receive a password by e-mail. It is possible to sign in straight away with a smart phone, tablet or laptop. Company logo and company information can be added to the app to incorporate into your documents. It is possible to create customized folders, forms, records and diaries or to use the existing ones in the system. User rights can be shared for viewing or also editing capabilities to folders and documents with competent participants of a project. (Kotopro, 2016)

Kotopro makes information available immediately to all participants. Real time reporting and documentation can be shared by the management and customer. Everyone reports into same system and have the information available. It also cuts down the time used for logging in information. It creates reports, diaries and records automatically. (Kotopro, 2016)

Kotopro system is in use in several construction companies such as NCC Rakennus Oy and it is utilized also for educational purposes in apprenticeship training documentation. Kotopro passed the mile stone of 100 000 electronic documents in 21 June 2016. By the same date there were 12 000 TR-audit measurements made into Kotopro. The number of TR-audits and other electronic documentation in Kotopro has been in a steady rise since early 2013 (Figure 7.). The total number of Kotopro users lies close to 10 000 employees. (Kotopro, 2016)

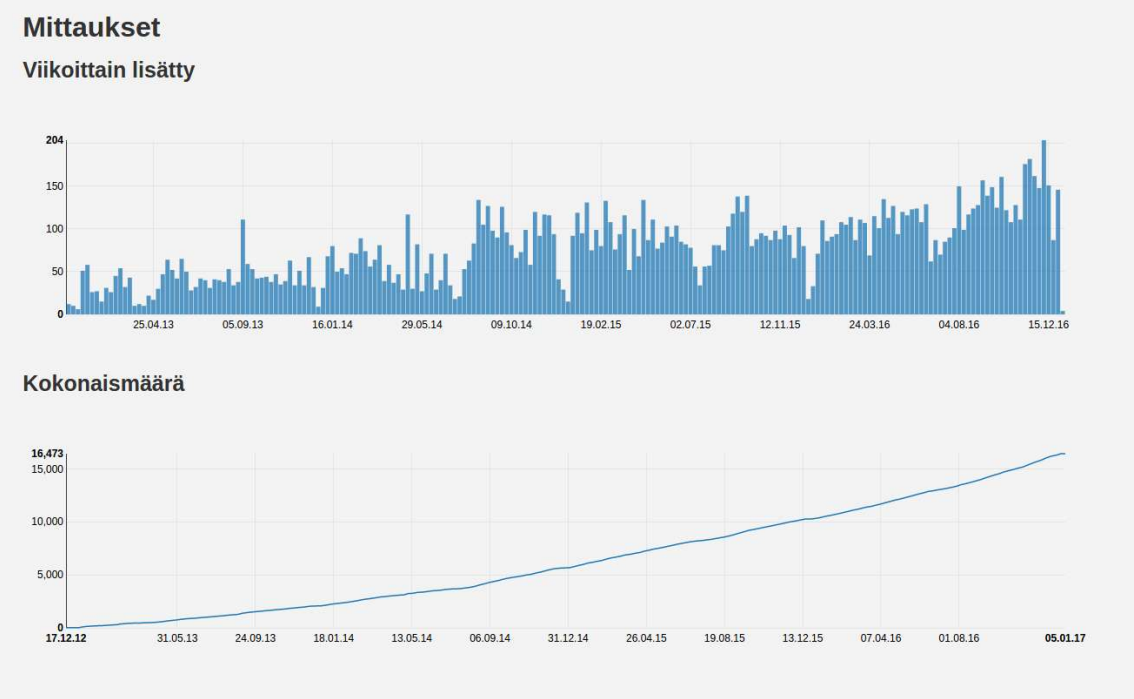

Figure 7. Weekly amounts of TR-audits recorded into Kotopro in a bar diagram and the total amount of TR-audits in a line diagram during years 2013-2016. (Marjanen, 2017).

Insta Audit offers a chemical database

InstaAudit is one of LIS Group Oy's products. InstaAudit EHSQ management system is created to utilize the mobile devices in safety reporting. They advertise their system as easy to use and adaptable to variable requirements. Users can create their own inspection forms in the application without any extra cost. Public safety observation link is easy to create and it is automatically shortened. The QR code is also automatically generated by the system. When the QR code is created by InstaAudit, it will not expire and it will not be recycled forward (as it may happen with an external QR code generator service). (Lehtomäki, 2016)

One special feature, which not all the competitors have, is the chemical database. Database contains approximately 2000 chemicals, for example the chemicals that Wurth is selling. The material safety data sheets are available in Finnish, but they can be obtained in other languages as well by agreement. Chemicals

MSDS's that are missing from the database can be added by the service provider or the user itself. The advantages of the chemical database are:

- MSDS's are always up to date
- You may conduct chemical's risk assessment with the system
- Chemicals quick guide contains the most essential information from MSDS's
- Sticker printout contains the symbols and statements
- Possibility to follow yearly usage and storage amounts
- Chemicals MSDS archive helps in fulfilling the legal requirements (Lehtomäki, 2016)

InstaAudit has a specific module for safety and environmental risk assessment that complies to requirements of Ministry of social affairs and health. By using that tool companies will fulfil the legal requirements. It is also possible to make enterprise level risk management assessments. From the environmental point of view, companies can record information of energy use and waste amounts and get automatic CO2 calculation figures based on the energy consumption. (Lehtomäki, 2017)

Comparison of NordSafety, Kotopro and InstaAudit

The features and costs of using different safety applications or databases is not so easy to compare. While asking for the prices and advantages, the service providers avoid the direct answer by pleading to customer-based modifications. In Table 1. some basic information about NordSafety, InstaAudit and Kotopro is gathered for a comparison. As the technical improvements happen all the time, the facts might have changed already. LinkedIn and blogs are good tools to follow the recent evolution of a certain application.

Table 1. Comparison table for the mobile safety tools tested in this study. (Takki, 2017. Lehtomäki, 2017. Marjanen, 2017).

Feature	NordSafety (Takki, 2017)	InstaAudit (Lehtomäki, 2017)	Kotopro (Marjanen, 2017).
Platform	Web, iOS, Android, Windows	Web, iOS, Android, Windows	Web application
Language (mobile application)	Finnish/English. More languages during 2017.	English. More languages Q2/2017.	Finnish. User interface will be updated early 2017 to allow language selection.
Public observation without login	yes	yes	No. It is possible to authorize employees or e.g. client representative to view/modify certain docs.
Modification	By service provider or by the users depending on the level of licence.	By the users, very flexible, even the organisational structure can be modified and the collected data remains.	Yes. User can modify form templates or create new ones with Kotopro editor.
Price	19-39€/user/month, levels	25€/user/month, less if 50-200 users	35-60€/user/month for management and supervisors,

	starter/pro/enterprise		workers for free to view/modify certain docs.
Special features	Collaborative feature for information exchange in shared workplaces. Domain message. Photo stream. Notification selection. Map view.	Chemical database, advanced statistical module, possibility to create templates, tailored dashboards, automatic link shortening and QR-code generation.	Form text fields can be filled in by dictating.* Added pictures will be saved into network without loading the device memory.
Support**	+++	+++	++
User reference	Fingrid, YIT, Eltel, Empower, Voimatel, Olvi	Skanska, Rudus, Metso, VR Track, Savon voima	NCC Rakennus Oy, Haahtela Oy, Lujatalo Oy, Vestoppi Oy
Activity figures	100 000 observations/year, 5500 TR-audits/year	350 000 observations/year, 2000 TR-audits/year, 25 000 electronic documents/year	6100 TR-audits/year, 90 000 electronic documents/year

* This feature is connected to iOS and Android operating systems, not Kotopro.

** Based on thesis worker experience.

iAuditor is a global choice

iAuditor is an audit and checklist application for safety and quality inspections. It is offered by SafetyCulture Pty Ltd and used in 180 countries. iAuditor is advertised to be the world's most powerful inspection checklist application used 50 000 times a day in over 80 countries. One can test the application for free for a period of 30 days. For individual users it is free all the time for basic inspection and auditing. (SafetyCulture, 2016)

iAuditor allows to create and modify mobile forms and checklists by dragging and dropping from a selection of iAuditor fields. Inspection reports can be completed by using phone camera for pictures. Findings can be highlighted with arrows, diagrams and drawings. Digital signatures authorize the inspections and also other involved parties can sign off instantly. Reports are ready to be shared and they can be exported in many formats. (SafetyCulture, 2016)

One interesting feature in iAuditor is the access to a Public Library of templates created by industry leaders. Global companies in all industries are using iAuditor: Hilton for hotel management, Volvo for automotive industries and Qantas for aviation pre-flight checks. As a reference in American construction industry, SafetyCulture iAuditor is used by Level 10 Construction, which has been performing 2.5 million man hours with no loss-time injury. (SafetyCulture, 2016)

7 NORDSAFETY APPLICATION IN NORDEX

7.1 Starting with NordSafety

There was a starting meeting in Nordex Helsinki office with the NordSafety representatives in 8th of March 2016. All the agreed features were activated into user account in the next day and the trial period started. The performance indicators were added into the system one week after. Originally there were five user rights into NordSafety for Nordex.

NordSafety portal can be found in https://portal.nordsafety.com/domains and the link to application for e.g. reporting safety observations is https://app.nordsafety.com The basic guidance for use can be found in https://www.nordsafety.com/support. From the NordSafety home page you find a link to their blog, which presents all the recent updates and new features into the application.

The electronic public safety observation forms can be delivered to sites with for example QR code, e-mail link etc. QR code allows an easy access to NordSafety system with mobile phones. QR code for general access to Nordex safety observations, where no username or password are needed, is presented in picture below (Figure 8.). There were two versions of the QR code: the expired QR code in the left side leads to old observation form, whereas the QR code on the right side leads to the current observation form, which was modified after the trial period.

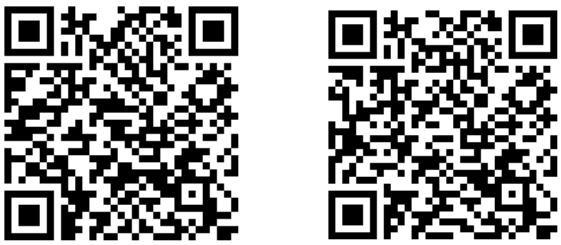

Figure 8. QR codes for public safety observations in Nordex sites in the Nordic region (left-old, right-new).

The service used as an example by NordSafety for making QR-codes was “QR Code Generator from the ZXing Project” http://zxing.appspot.com/generator/. While choosing the application for uploading the QR code reader into a mobile phone, it is recommended to have a reader, which will open the link with phone’s browser and not in the reader. The browser features of the QR code reader applications may sometimes be insufficient.

Original links obtained from NordSafety can be rather long and thus difficult to use. Links can be shortened with for example the following services:
- https://bitly.com/ (use of link can be traced)
- https://goo.gl/ (Service offered by Google, use of link can be traced)
This is the original link to Nordex public safety observation: https://portal.nordsafety.com/publicforms/fhzawg779pd28cry and the shortened version is http://tinyurl.com/safetyobservation.

7.2 Test period of three months

The test period of NordSafety was started in March 2016. A team of five users were appointed as the administrators of the system, having full access to all features of the system: Anna Lehtinen (HSEQ manage), Julia Rekinen (HSE assistant), Pauliina Hakala (site assistant), Telmo Marques (site manager) and Matti Palosaari (field operations manager). This was because the licence allowed us five users. Others were able to make the public observations. The length of the

test period was three months, until June. There were four domains created into NordSafety system: Kooninkallio (wind farm construction site), Pori service, project management/Helsinki and a test site for fake observations. Later on also Tyrinselkä and Kantti (wind farm construction sites) were added.

The first corrective action to Nordex's NordSafety mobile application was to change the language from Finnish to English. This fault was noticed by a Portuguese site manager in April. He was the only site manager who was able to test the TR-audit feature with full user rights in site conditions. One reason was the shortage in user licences. Other reason is that many site managers work as externals (entrepreneur) and thus gain no rights to Nordex systems.

During the trial period there were 29 real safety observations made into NordSafety system as shown in table below (Table 2.): March 2, April 13, May 14. In addition, there were many fake observations to test the system features and functionality. Kooninkallio was the most active construction site, but it was ongoing already in March whereas Kantti project started in May.

Table 2. Number of safety observations collected with NordSafety application during the trial period.

SITE/MONTH	MARCH	APRIL	MAY
KOON	2	3	4
PORI			5
TYRI		5	1
KANTTI			4
HELSINKI		5	
ALL	2	13	14

Also the safety observation paper form was in use at the same time. The amount of safety observations collected with paper forms remained bigger than the number of mobile observations on March and April, but overtook already during May (Table 3). One reason for the continued use of the paper form for safety observations is that the subcontractors have a separate safety observation system, which they insist their own employees to use. Nordex will normally receive those observations as scanned and delivered by e-mail.

Table 3. Number of safety observations collected with paper form during Nord-Safety trial period.

SITE/MONTH	MARCH	APRIL	MAY
KOON	3		
PORI		2	
TYRI		7	2
KANTTI		1	9
HELSINKI		5	
Sum	3	18	11

The gathered safety observation amounts between April and early August are presented in Table 4. More windfarm sites were involved in reporting after June, leading to an even distribution of NordSafety observations made across Finland in July. Yet the number of safety observations made with a paper form remained notable. A comparative analysis is hard to make in a constantly changing project field. During summer 2016, new projects were started in Limakko and Kivivaara. Projects have various clients and contractors, with variable own systems. Also new service points were established and new employees hired.

Table 4. Number of NordSafety observations compared to number of all safety observations gathered during period 3-7/2016.

2016	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	TOTAL
KOON	2	3	4	1	1		11
MYLLY					1		1
HONKA					1		1
PORI			5	2	3	2	12
TYRI		5	1	1	2		9
KANTTI			4	4	4		12
HELSINKI		5			2		7
KIVI					2		2
Nord-Safety	2	13	14	8	16	2	55
All (inc. paper forms)	15	30	47	19	42	2	183

7.3 System implementation and preliminary training

A short training or induction was given in the three separate domains: Pori office for the service department, Helsinki office for the project management and Kooninkallio wind farm for the site personnel. It appeared to be quite challenging to get new observations from the employees at site. For the office personnel in Helsinki this seemed to be a more interesting tool to play with. Printed QR codes or more detailed adds with the QR code were placed in several places in the main offices and site offices. In addition to noticeboards, they were placed visible in coffee rooms, doors and even toilets.

Some of the mobile safety tool providers offer to organise the first trainings during the system implementation. For example, EHSQ Online states that the main advantage in comparison to the other systems is the support and training they offer (3T, 2016). Training package includes for example online multimedia presentations and workshops. If the resources in HSE department are scarce, it might be worth considering to get a good start for the mobile system by utilizing an external company for induction.

7.4 Feedback survey for the test users

In the end of the test period all the employees who had tested the system where asked to give feedback via a short survey conducted in SurveyMonkey. The survey had three sections: general about safety observations, NordSafety observations and NordSafety TR-audit. In a short period, we received eleven replies from a group of fifteen test users. Afterwards there were two replies more from the safety managers in Sweden and Germany. Generally, the feedback was positive and encouraged to continue with NordSafety application.

The full feedback survey regarding safety obseverations and TR measurements in NordSafety test period are presented in Appendix 1. To summarise the results of the feedback survey, the following conclusions can be made:

- Safety observations are an effective tool to improve safety level in wind farms. They raise the level of awareness.
- Employees report their safety observations almost always when they notice or experience something significant.
- It is seen important to get feedback and/or rewarding regarding observations made. Without feedback and/or rewarding, the tendency to make observations will decrease.
- Some of the survey respondents had used the NordSafety App or a portal, some used the public link with QR code. They replied that it was easy to find a way to reach NordSafety, but still they faced some difficulties during the first trial in the system.
- Answers were spread between which way of making NordSafety observations was seen the preferable way. Yet only one person was voting for the paper form instead of the mobile system.
- There were conflicting opinions of which way the information about the safety observations reach the correct persons and gets fixed faster: the paper form at site or the mobile system in the internet.
- Regarding the feedback related to TR-audit measurements in NordSafety, there were only three persons who had tested it and given feedback on that feature. Due to small range, no general conclusions can be made.

Several good points were brought up during discussions with the test users. Most of them are mentioned in their context in this study. Just to mention some: It would be useful to have a product video available e.g. in YouTube to show users how the application looks like and how to get started. Safety reporting system should be linked into Facebook or some other social media that is commonly used by young people to get them activated.

7.5 SWOT analysis of paper form versus mobile application

There are several strengths and opportunities that mobile safety applications can offer. Of course, there are some weaknesses as well compared to paper forms and other solutions. In below table (Table 5.) the pros and cons of a mobile safety application discovered in this study were collected into a SWOT analysis.

Table 5. SWOT of NordSafety or other mobile application for safety observations.

Strengths	Weaknesses
+ A new mobile way of working + Reduced paperwork + Available in the pocket all the time + Real-time reporting + Sharing is easy and quick + Not reliant on internet connection + Location GIS, GPS + No archiving needed + Open / closed status + Automatic reminders + Appointing responsibilities	- Mobile phone and internet access / connection needed - Application needs uploading - Training for use at the first time - Mobile phone (battery) can die in cold circumstances - Not possible to make public observations offline
Opportunities	**Threats**
• To focus reporting in one application / software • Spoken comments can be recorded; no need to write in difficult circumstances • Supervisors and managers can spend more time in the field	○ No-one will process the observations if the responsibilities are not clear ○ Employees' opposition for changes, negative attitude ○ Too many complicated systems in use at the same time

• Information is stored in cloud to meet the legal requirements and reporting needs of different stakeholders	○ Information flood

7.6 Modification of the NordSafety application after trial period

After the trial period, Nordex decided to continue the use of NordSafety application from June 2016 onwards. All sites in Finland and other countries of the Nordic region were included in the reporting as well. That is why the domain structure had to be modified and enlarged. Domain structure is important feature regarding the reporting. It can be modified by the service provider only.

More user rights into the system

In the new licence of one year, there are ten users with full rights to NordSafety application instead of five. During this transition, a few site managers were added into NordSafety users and they were enabled to make mobile TR-audits. It was also possible to appoint responsibilities to site managers for a certain construction site. That way they received notifications of the safety observations made in their own project site and were able to influence and follow up the process. Unfortunately, the project situations are quite mutable and the site managers change sites. NordSafety administrator shall update the users and their responsibilities in NordSafety regularly. Roughly half of the site managers are external i.e. not directly employed by Nordex. This makes the situation more complicated as the external site managers will not gain full rights to NordSafety -and cannot thus take responsibilities in the system or make electronic TR-measurements.

Observation form

The safety observation form needed major changes after the trial period. During the trial period a ready-made template offered by NordSafety was used as such. While involving with the system, it was time to integrate the NordSafety form with Nordex form to better comply with HSE Web incident reporting form and database, where all observations still need to be entered. Name of the form was changed from Observation to Safety observation in order to separate them from each other.

Incident classification is valued in Nordex system as 1-4 according to a severity matrix. The matrix consider harm to people as well as harm to assets and environment. For the safety observation a same kind of classification needed to be used. Also a help icon was added later on, because people tend to evaluate the severity of observations too high (they should remain in level 1).

1 = No effect
2 = Moderate
3 = Major
4 = Extreme (Fatal)

After the form modification it was test used by a small team and observed that the form needs an open field for description of the observation to be typed in. The modified and completed new form was released 30.6.2016 with a new QR code and link (see paragraph 7.1.).

One possible change to be considered into the Nordex NordSafety safety observation form is the allowance and even encouragement of the positive observations. It is a trend to recognise also the good performance in the safety field. Sharing a positive safety observation is a lesson learnt and the good habit can be useful and easy to adopt in other locations too.

Documents that are printed out from NordSafety system in pdf-format are big in size, approximately 2 MB even without any pictures. This makes information sharing difficult as mailboxes get full easily. It is also possible to refer to a certain safety observation by attaching the link, but employees without login cannot enter the system in order to see the observation.

Domain structure

The reporting in NordSafety is based on domain structure. The domains where extended from Finland to cover also Denmark, Estonia, Lithuania and Norway. These domains divide into Project management and Service. Construction sites remain under project management until they have been handed over to service department. In Finland there is additionally office -domain. Test site, which is intended for testing purposes and fake observations only, remain under the main domain.

Data roaming

One thing that hinders foreign employees' from making mobile safety observations came into awareness in a quite late phase. The data roaming prices may be a significant obstacle to foreign employees using their private mobile phones in Finland. They may have to buy a pre-paid internet access card and don't afford to use it for safety observations. This is mainly problematic to subcontractors and their subcontractors working in a blue-collar level. Management level employees tent to have a company phone.

One possible solution is to utilize the mobile phones at site, which are in use for signing in and out of work in Tuntinetti system. The phone is available there, so it could be used for making safety observations in NordSafety application as well. NordSafety application was installed into Karvia-Kantti windfarm's Tuntinetti -phone landing page. Unfortunately, in order to use the application, one needs to log in with a username and password that only a few people have. A tab with a

link to NordSafety public observation should be kept open for easy access of everyone.

Tuntinetti -phone is very important at sites because of the legal requirement to follow up employee's presence and working time at construction sites. It is a threat, that while trying to make a safety observation with that phone, people will mix up the tabs and the elementary mission of working hours tracking is lost.

NordSafety mobile application can be used also offline. This allows employees who have the username and password to the system to make observations and TR-audits in circumstances were the internet connection is not available. Unfortunately, the public observation feature cannot be used offline.

7.7 Information sharing to personnel via safety bulletin and monthly HSE meeting

The first weekly safety bulletin in Nordex Energy GmbH Finnish branch was launched for week 40/2016. The head of project management in Nordic and Sweden is delivering the bulletin to employees by e-mail. HSE weekly review presents the amounts of safety observations gathered from different locations, pointing out the most serious near misses and possible incidents. Near misses and incidents are explained in more detail for the lessons learned. Nordex aims to send out a weekly safety review for Nordic region to all employees every week.

Safety issues are communicated to employees also in the Monday morning -calls and monthly HSE meeting, where the site personnel attend with remote access. At the construction sites there are morning meetings every day for the coordination of works. It is possible to use these meetings to promote safety issues, bring forth safety observations and organise tool-box-talks based on the latest HSEQ findings.

8 NORDSAFETY SYSTEM EVOLVES ALL ALONG

8.1 New features introduced during summer and autumn 2016

Collaborative feature

Wind farm construction sites can be seen as special situations of organising work: One employer exercises the main authority at the work place and several other employers operate there simultaneously and successively in a way that the work may affect other employees' safety and health. The employers of a shared work place shall each for their part and in cooperation and by information sharing ensure that their activities do not endanger any employees' safety and health. (Työturvallisuuslaki, 49§, 2002)

Figure 9. NordSafety future vision of safety ecosystems.

Safety management is complicated in shared workplaces –and construction sites are normally shared by many employers. Several companies have started using NordSafety collaborative feature with their stakeholders. NordSafety user may

invite others to join his project and share safety information in real-time. NordSafety vision (Figure 9.) is to create broad safety ecosystems with synergy benefits. (Kronlöf, 2016)

Location services and map view

With the NordSafety location service you can pin coordinates to e.g. audits, observations and incidents. Data can be located based on the pre-defined domain coordinates, the use of GPS positioning or you can manually type in more detailed coordinates. Map view helps to visualize the collected HSEQ data and possibly locate some high-risk areas. This feature helps to see how inspections have been conducted in a larger construction site area. (Löfberg, 2016)

Task management can be also followed in a map with colour based status indicators. In a bigger construction site, it is wise to handle and close out tasks in a certain area in one go. Task map gives out a holistic view and helps managers to focus on the most critical tasks. (NordSafety, 2016)

Domain message

Domain message is a communication tool between the users in NordSafety. With that tool one can send a message to all other NordSafety users (with full user rights) under a specific company. The message will show up in the web application under “domain messages”. With that tool its easy and quick to inform other NordSafety administrators in the company about recent changes in the system.

8.2 NordSafety Windows application allows adding TR-audits retroactively

NordSafety Windows applications can be used for the same purposes as the web application: reporting accidents and safety observations, filing documents, writing hot work permits and site diaries and making TR-audits. Windows application can

be obtained from Windows app store and it is free. It is meant for tablet and desktop computers. The same username and password will be requested as for other NordSafety use.

With this application it's possible to make TR-audits afterwards for a certain date. It means that we are able to add missing information into NordSafety when it is collected with other means e.g. with paper form. By adding all TR-audit results into NordSafety (partly retroactively) it is possible to obtain reliable figures and graphs and see trends in different construction sites. While making the TR-audit in the Windows application, the sum of positive and negative findings is not visible. The audit result (percentage) will be visible only after the measurement has been finalized and submitted. This is supposed to keep the results more objective.

9 HOW TO UTILIZE THE MOBILE TOOL AND THE SAFETY OBSERVATIONS MORE EFFECTIVELY

9.1 Motivating and activating employees is worthwhile

While motivating people to do something, it is the same discipline for the humans and animals: positive feedback will most likely amplify the desired behaviour. People who have a safety-orientated mind will make frequent observations in their working environment. Young employees, people with low education level and careless employees will need to be pushed and encouraged to make safety observations.

In Nordex it's been a habit for some time to reward employees for making safety observations. This is done by a monthly lottery in each construction site, office and service point. Unfortunately, the tax authorities in Finland are interested in the rewards that the employer gives out. The rewards assimilate to presents and their value should be kept minor. The limit value for what is considered as minor is somewhere around 100 euros. Employees would prefer to be able to decide what they need and like to get, but the employer cannot give any gift vouchers without paying the taxes. Tax manager Ann-Mari Kemell from Central chamber of commerce says that freedom to choose the gift means that the value of the gift is comparable to salary (Eronen, Taloussanomat, 2015). However, Nordex has decided to continue rewarding some of the safety observations.

NordSafety has made a study resulting to "10 ways to engage staff when implementing an HSE solution". When implementing a new system, the aim is to have it widely adopted and actively used in the organisation in order to reach the desired improvements and results. That target is impossible without proper training and motivation of the personnel. Staff should feel engaged and excited instead of feeling that they are obligated to adopt something new, which will require them to learn and do more. These are the ten initiatives that NordSafety recommends:

1. Make personal safety paramount
- Make employees aware of the safety fundamentals
2. Develop an EHSQ ecosystem
- Create a culture where individuals manage safety collectively with a group mentality
3. Outline the company vision
- Make staff confident that safety is a value that really matters to your organisation.
4. Keep communicating
- Explain what is going to happen, how it will effect and why it is done. Communication should reach all levels and parties involved.
5. Lead by example
- Management shall create a positive and collaborative culture over the tool
6. Explain the personal benefits
- Clarify safety benefits as well as ease of work and savings in time
7. Optimise your mobile investment
- Provide comprehensive training, promote all features, ensure problem-free use. Give access to necessary mobile devices.
8. Be inclusive
- Make an activation program to ensure all workers and co-companies are involved and motivated to run a pilot
9. Give the workforce a voice
- Collect thoughts, opinions and suggestions from all user levels and utilize them. Request regular feedback about the app's usability.
10. Make it easy to engage
- Keep instructions, usage and desired goals as and simple as possible.

(NordSafety. 10 ways to engage staff. 2016)

It is highlighted by NordSafety that when somebody takes the time to give out information that they feel is really important, please reply to them. Investigate the safety observation and reply back the findings. People often complain that it is not worth reporting any deficiencies because no-one will react and the issue will

be faced the same next time. Two-way safety communication would be the key to make people continue safety reporting. (NordSafety, 2016)

The most effective way of getting NordSafety into use in the construction sites would be a personal training during the site safety induction that the employees go through anyway. During that guidance, the employee could scan the QR code or otherwise save the link into his/her personal phone and make one test observation into NordSafety system. That way the problems would be solved right away and it would be easy for the employee to make the real observation later on.

9.2 Sorting and grading of safety information flood

The latest release to NordSafety for 2017 is the sorting of safety information flow. Users can choose the information, which they need to be informed by e-mail and thus get only the significant safety feed. Notifications can be selected from NordSafety profile menu under the user icon as presented in below picture (Figure 10.). User can also follow the status changes in the investigation process of observations and accidents. This might be a helpful feature for the managers who don’t have the time to visit the NordSafety database frequently. (Kronlöf, 2017)

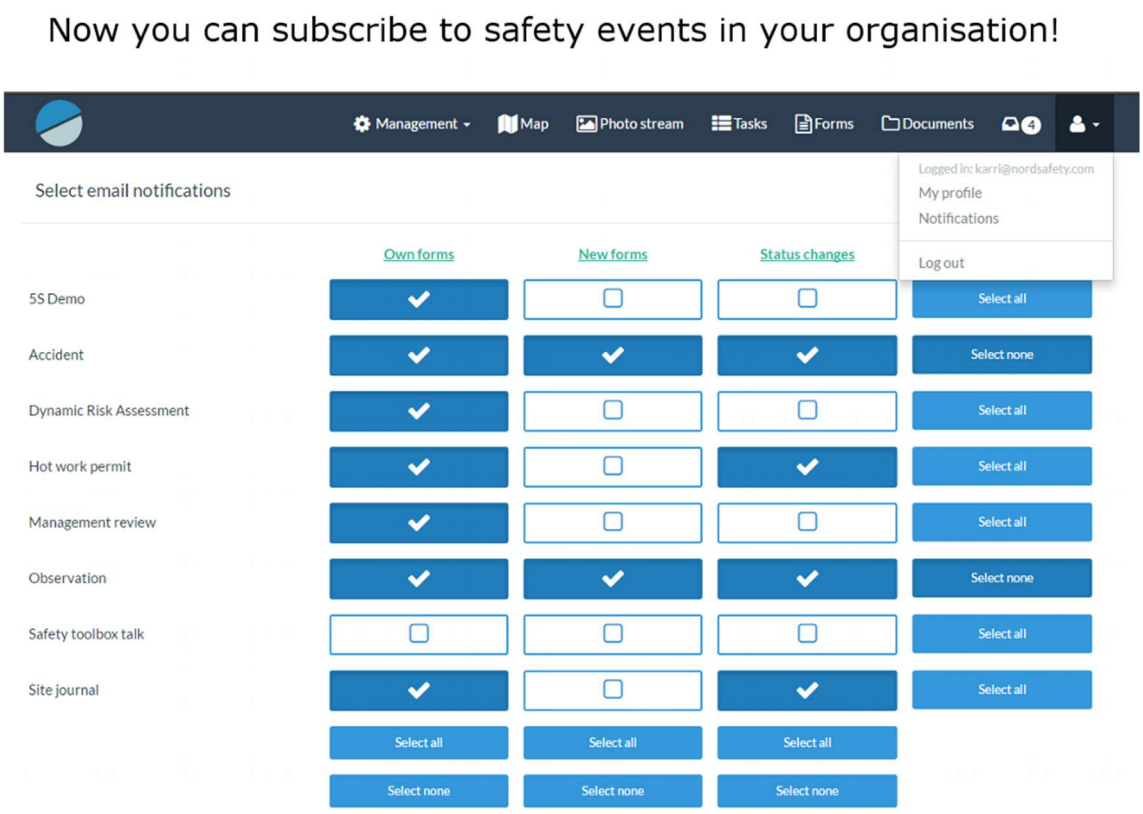

Figure 10. NordSafety safety feed subscription menu. (Kronlöf, 2017).

In a seminar presentation about HSEQ Online -net portal in Safety fair 2016 in Tampere, there was a question from the audience about automatic formation of a tool-box-talk or a safety bulletin regarding a safety observation received in the application (3T, 2016). This feature does not exist in HSEQ Online and probably not in the other applications either. Yet in the same event, the representative of NordSafety Timo Kronlöf showed a study that approximately 20% of the e-mail recipients will open a safety bulletin in the email or its' attachment (Kronlöf, 2016). This kind of information sharing is not effective anymore, because we cannot receive too much information. There should be a way to receive sorted information based on personal interests and location (GPS positioning). It might be some kind of safety feed (social media), which is very short and informative and there's a chance to comment and share. (Kronlöf, 2016)

9.3 Committing employees to NordSafety

In the beginning of November 2016, when NordSafety had been in use in Nordex for seven months, the activity of the ten NordSafety portal users was checked. As seen in below table (Table 6.), the use of NordSafety portal has been a tool for HSE department, whereas the involvement and commitment of the management level has not been too good. In fact, some of the users received the admin rights later on, so in reality they might have visited the NordSafety portal only once. This kind of activity does not serve the preliminary purpose of sharing information effectively.

Table 6. Visiting activity log of NordSafety portal by ten Nordex users 11/2016.

Time of last visit or action	**How many people**	**Position in the organisation**
6-7 months ago	2	top management, service management
3 months ago	1	site manager
1 month ago	3	top management, project management, site manager
1-9 days ago	4	site manager, HSEQ manager, HSE assistant, thesis worker

The responsibility of the deployment of NordSafety system in Nordex organisation was not clearly appointed to anyone. The work was done by the HSEQ organisation with the support of thesis worker, who worked in the project organisation. Personnel in HSEQ organisation changed during the introduction period of NordSafety. The NordSafety trial period and the months that followed could have been better planned and more focused to get the best possible start for the system intake. Nothing is lost though; adopting something new takes a while.

10 CONCLUSIONS

There are several safety tools to choose between for safety observations and other HSE reporting purposes. Differences between prices and features are quite minor and the systems can be modified to meet the company's requirements and needs in many cases. It is recommendable to consider these two things while choosing a database and mobile application for safety reporting:

- To have as many features combined into one system as possible, because most of the EHSQ data is linked into each other. e.g. Nordex daily site diaries, chemical database and site induction follow-up to be done with NordSafety too.
- To have a system that can be used by all the parties in a shared work place or even in a safety ecosystem. Safety information shall be easily and fairly available for all the project parties.

A system which is not actively used, no matter how advanced it is, will not be worth paying for. Introduction of the system shall be made in a way that employees see the actual benefits of using it and engage themselves into companywide and project wide safety reporting in a positive manner. Management leads by example, as stated in the HSE policies commonly.

In a near future it will be possible to combine more and more information into one system. The interfaces between information models, project banks, planning and scheduling software tools and mobile applications will gradually disappear. One databank can be utilized by several software for different purposes. It will lead the reporting towards a holistic digital production and QHSE management system. (Jokka 1, 2016)

11 AFTERWORD

Nordex Energy GmbH Finnish branch reached the milestone of 100 days without any LTI accidents in 19 August 2016. This was celebrated with a free pizza lunch for all employees. No one can say if that positive result had anything to do with the promotion of safety observations and the NordSafety –tool, but it is possible.

During the thesis period there was a lethal accident in a wind turbine outside of Finland within another employer. This kind of information is normally shared between colleagues and companies for the lessons learned in order to avoid similar accidents. Related to that lethal accident, some technicians were discussing about that misery. One commented that the management is always slipping from the safety requirements and asking employees to work in the gray zone to save time and money. The other replied that: “It is us who work in the turbine, not the management. We make the safety!” This attitude was great to hear, because in the end it is the individual who makes the act for safety – hopefully with a strong support from the top management.

A famous statement from Oren Harari has been circulating in the social media lately: “The electric light did not come from the continuous improvement of candles” (Shore, 2016). Managers and engineers should be open-minded and able to think out of the box and figure out something entirely new. Mobile safety applications are referred to as the future solution for safety reporting. Actually mobile applications are today’s solution -future is something else and the new outbreak will approach the markets very soon. A company can choose to be a trailblazer in safety management or then willingly stay in rear and skip some of the steps that the pioneers have done, as the evolution in safety management is very rapid.

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User feedback survey conducted in SurveyMonkey after NordSafety trial period 3-6/2016

1. Safety observations are an effective tool to improve safety level in wind farms:
- Fully disagree 1
- Disagree 1
- Agree 4
- Fully agree 7
- Safety observations surely improve the safety level but especially one's awareness on safety issues and actions taken after something has happened are important.
- The more we now the better we can prepare
- Good tool!

2. I always report my safety observations
- Yes 10
- No 1
- Comment 2
- always when it is necessary
- I report when I remember or when these are discussed generally e.g. in the coffee breaks or in the hall in random chats. The more often somebody reminds about these safety observations, then I most likely remember to report them.

3. It is important to get feedback and/or rewarding regarding the observations made
- Fully disagree 0
- Disagree 1
- Agree 3
- Fully agree 9

- Without feedback people don't learn.
- Without any feedback, the tendency to make new observations will decrease
- Rewards are not necessary, but feedback is always welcome.

4. It was easy to find and upload NordSafety App
- Yes 9
- No 1
- Comment 3
- I have only link for portal. Do you have an app for NordSafety?
- Could be easier. Also more communication material could be provided.
- I didn't upload the app, I used the QR code. It was easy to use the code.

5. While making a safety observation I prefer

- The paper form 1
- NordSafety App (QR code scan) 5
- NordSafety App (link to public observation) 2
- NordSafety App (login) 4
- Report my observations in meetings 0
- Other, what? 1
    - Any web based system that could be used without logging into NX system and VPN client.

6. While making my first safety observation in NordSafety App

- Everything went well 7
- I faced some difficulties 6
- The display was not working correctly, there was one line (graphic error or so) jumping along when scrolling down on the "questionnaire". This made choosing options (site name etc.) a bit difficult, as I could not see all options. Might be phone related too (iPhone 4S).
- downloading of pictures could be much easier
- I had to change wind farm and it deleted everything so I had to start all over.
- The formatting of the file (PDF) which is generated can be improved.
- adding the pictures needs to be a little simple
- QR code at site did not work. The package itself was quite intuitive, but with hindsight I think I filled the wrong descriptions into the wrong areas. My main concern is that the whole point of safety observations is to achieve the quick action loop at site, so routing them via a web app to a central team (as described by Country manager) may not be too effective and means the HSE team become a bottleneck between the work team and the site management.

7. My positive findings regarding mobile TR audit

- Mobility 2
- Adding pictures 2
- Reporting 2
- Assigning tasks and responsibilities 1
- Language (English) 0
- Other 0

8. Negative findings regarding TR-audit

- The reports are not informative if the audit is not done the same way every time.
- The points of the TR didn't link with the pictures

9. Anything else you wish to comment?

- Good survey
- ☺
- In conclusion this NordSafety system is much better than paperform. Because its faster and easier to use. Also very important thing is that it reaches its destination faster than paperform. I made safety notifcation one day and next day it was solved!