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Intellectual Output 2 (IO2)

BIM models

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A) Identification of the tool to be used in the project.

Results of the first intellectual output have presented these AR/VR tools which might be suitable for use in the remainder of the project:

- CASE 1. 3M Releases Construction Safety Virtual Reality Programs for Hands-on Learning
- CASE 2. How Cat Safety VR Improves Jobsite Training
- CASE 3. SRI International Augmented Reality Solutions for Construction Inspection
- Case 4. Safety Compass - Augmented Reality Workplace Safety
- Case 5. Augmented and Virtual Reality for Safety Training
- Case 6. Virtual Reality in Construction
- Case 7. New construction safety school will use virtual reality to educate workers
- Case 8. YellowJacket
- Case 9. VR Safety Training for Construction companies (LandMarkVR)
- Case 10. A critical review of virtual and augmented reality (VR/AR) applications in construction safety
- Case 11. Fulmax
- Case 12. Role of Visualization Technologies in Safety Planning and Management at Construction Jobsites
- Case 13. A framework for construction safety management and visualization system (SMVS)
- Case 14. OSHA PIXO safety compliance Virtual Reality
- Case 15. Web-based Collaborative Virtual Environments (LIRKIS G-CVE)

The aforementioned cases were all studied to see which one or which ones would be best fitted to the goals of the project, based on the following criteria:

- Is the tool available for use
- Is the tool proprietary or freely available, and if proprietary is it affordable
- What are the hardware requirements (for computing power)
- Is any additional special hardware needed (i.e. special hardware elements, not including Head Mounted Displays (HMD))
- Does the tool have a desktop version in addition to a full virtual environment
- Does the tool have a smartphone version (i.e. for Samsung Gear) in addition to a full virtual environment

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- Does the tool support multiple platforms (supports more HMD's such as HTC Vive, Oculus Rift…)
- Does the tool require additional supporting software, and if yes, is it available to use
- How detailed and realistic can the virtual environment be
- How simple is the tool to install and to use
- Does the tool support multiple users at the same time
- How simple would it be to replicate the research results outside the project partners' institutions
- Is the tool appropriate to teach Health and Safety related topics
- What hazards/scenarios are available in the tool
- Does the tool support the import of user generated BIM models
- Does the tool support creating additional scenarios
- Does the tool have open source, enabling modifications to suit the user's needs

The first eliminatory criteria was the availability of the solution. If the tool is not available for use, then all other characteristics are irrelevant. The second eliminatory criteria would be whether the tool is suitable to teach Health & Safety (H&S) topics. Other criteria serve to differentiate and prioritize remaining tools to determine which would be more appropriate.

Not all criteria carried the same weight, the most important being the ability to create and customize scenarios, the possibility to have multiple users, having open source, being able to support various HMD's and to have mobile and desktop versions. Furthermore, the tool needs to be fairly simple to use and to replicate in outside the project partners' institutions.

After careful consideration of all identified technologies and having these requirements and criteria in mind, the tool "Web-based Collaborative Virtual Environments (LIRKIS G-CVE)" was chosen as the most suitable to use the BIM models and advantages of immersive reality tools for construction safety education. The advantages of the tool are:

- is open source and free to use
- can be customized to user's needs
- supports multiple users
- can be used without installation and without expensive equipment
- supports desktop and mobile version in addition to full virtual environment
- results can be replicated outside the project partners' institutions.

B) Defining the hazards which will be addressed, based on significance and modelability.

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Construction workers face numerous hazards every day, but some are however more frequent and have more serious consequences. Due to the limitations of the final training module, not all hazard scenarios designed to teach safe work practices can be presented to the users in a reasonable amount of time. Therefore, a prioritizing of hazards was needed as an initial step in the BIM model creation and construction hazard scenario building process.

Construction injury statistics are often unreliable due to injury underreporting. Most injuries which do not require immediate assistance of a medical professional and more than a few lost work days are seldom reported. This is due to contractor's cost with regards to government penalties, H&S injury rating, worker compensations, higher insurance premiums and others. Injuries that are always reported are those with serious consequences, which might skew the total injury type statistics. For example, all falls from height are reported, while some less severe accidents which happen quite often, are most likely underreported. Both types of hazards are significant in their own way and both should be included in safety training tools.

Injury statistics for severe injuries are reliable as they are reported to the authorities. Most frequent severe injuries are from falls, struck-by accidents, electrocutions and caught in-between accidents, also called fatal four by the US Occupational Safety and Health Administration. Lower severity injuries are not often reported to the authorities, but there is however a way to quantify and rank the them using tacit knowledge contained in either H&S experts' personal experience or in the contractor's private databases.

To structure the presentation of those more significant hazards, it was necessary to group them by type of construction workers who were exposed to the hazards, while the hazards to which all workers can be exposed to were grouped by injury type.

Unfortunately, out of all the identified hazards listed below, some could not utilize immersive reality tools to train workers in safe work practices. Those are hazards which result in professional illnesses, such as physical strain, weather effects, exposure to harmful substances and others. Most appropriate hazards to model in virtual settings are those which have visual and auditory feedback.
Significant hazards which were identified in this step of IO2 are:

- Reinforcement works

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    - Tripping and/or foot caught in the slab rebar
    - Cutting and impaling body parts on the protruding bars
    - Power tool accidents (angle grinder)
    - Scratches, cuts, burns and other injuries when preparing or welding the bars for placement
- Formwork works
    - Table saw injuries
    - Hand tools injuries (hits, cuts)
    - Formwork elements overturning and falling on the worker
    - Accidents when dismantling formwork elements
- Concrete works
    - Fall from the working platform when pouring concrete
    - Struck by the concrete pump hose
    - Fall and trip hazards on the placed rebar
- Masonry works
    - Shotcreting accidents
    - Hand tools injuries (hits, cuts, eye injuries)
- Falls on the same level
    - Tripping hazard
    - Slipping hazard
    - Falls while carrying objects
- Falls from height
    - Falls from roof and during high altitude assembly works
    - Falls from mobile scaffolds
    - Falls from fixed building scaffolds
    - Falls through the scaffold
    - Falls from unprotected building edges
    - Falls through openings in the building structure
    - Falls from ladders
- Falls of objects from height
    - Fall of objects from scaffolds
    - Fall of tools and materials during high altitude works
    - Fall of objects carried by a crane
    - Fall of objects from unprotected building edges
    - Fall of objects through openings in the structure
- Accidents during transit
    - Head and other body part injuries while walking through the construction site
    - Struck by working machinery or equipment
    - Injury from the carried object
    - Hit by traffic
- Other
    - Electrocution hazards

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- Power tools hazards
- Caught in-between hazards
- Flying particles injuring worker's eyes
- Trench cave-ins
- Fall into a trench
- Fall of objects and machines into the trench

The list above contains some of the most common and most significant construction hazards. There are of course many more construction hazards but following the Pareto efficiency principle these were chosen as an initial sample to provide the greatest benefit until a comprehensive training program in immersive reality can be designed, created and applied for construction safety training.

Unfortunately, the list above will have to be shortened even further due to the fact that some hazards cannot yet be represented in the virtual environment and that some hazards are too difficult to model and effort is better placed on those hazards which are simpler to model and can be transferred to intended audiences in the shortest amounts of time.

C) Injury statistics and safe work practices.

This section introduces injury statistics and results from Health and Safety reports of a construction contractor in Croatia with the intent to validate the choice of most significant construction hazards.

In the USA, the governing H&S administrative body is the Occupational Safety and Health Administration (OSHA). OSHA regularly publishes workplace accidents statistics for all workplace injuries, out of which the construction industry always has a disproportionately large percentage. These statistics also include the information on the type of accidents, making it possible to quickly see which hazards accidents are most common. Amongst those accidents with severe consequences, four types stand out by being responsible for more than half of all worker deaths in the construction industry. Those accidents and their percentages are as follows [1]:

- Falls – 338 (33.5%)
- Struck by Object – 112 (11.1%)
- Electrocutions – 86 (8.5%)
- Caught-in/between – 55 (5.5%)

An equivalent institution in the European Union would be the European Agency for Safety and Health at Work (EU OSHA). Unfortunately, due to

the EU being comprised of countries with similar but still different legislation and H&S practices, as well as injury classifications, compiling accidents is not a straightforward job and the EU OSHA serves a different purpose than its US counterpart. Injury statistics in the EU can therefore be gathered either from Eurostat or from each member country individually. Eurostat does aggregate individual member country accident statistics but does not differentiate injury types based on the hazards which cause them, but rather by injured body part and the type of injury.

In Croatia, the governing body for H&S also does not publish statistics on specifically construction H&S, but rather on workplace accidents in all industries. It therefore cannot be easily discerned how many, for example, fall accidents occurred in the construction industry, out of the total number of such accidents.

Luckily, construction contractors keep their own injury statistics which contain not just severe injuries which are always reported to the authorities but also those minor injuries which cause a day or two of lost work time. From these data, we were able to discern which of the hazards should be focused on in the project. Information on accident occurrence used in this report is available in Annex I.

Identifying the most significant hazards is just the first step in safety education. To educate workers, it is not enough to simply show them the hazards to which they might be exposed to, but also to educate them on how to avoid hazard scenarios, how to resolve hazards, to report hazardous situations and to raise their awareness of the importance of H&S. Safe work practices were taken into consideration when designing potential scenarios. Best safety practices, upon which the hazard scenarios are based can be found in Annex II of this report.

D) Defining hazard scenarios which will be addressed by the tool

Section B mentioned that some hazards cannot be represented in virtual environment and that some are more feasible to model than others. This section will present some possible scenarios which could be modelled in BIM and imported in virtual environment while a subsequent section will prioritize the hazard scenarios.

Hazard scenarios presented in the remainder of this section are intended to present the dangers of hazards presented in section B and to teach safe work practices.

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1	Tripping on slab rebar
Hazard type	Tripping hazard
Severity	Low to medium
Scenarios where hazard is present on the construction site	Workers when walking over placed rebar for concrete slabs can often trip and have their leg stuck.
Scenario for immersive reality	Worker is told to walk over the slab with placed rebar before the concrete is poured. After a few meters, the worker's leg gets caught between steel bars and he falls. To be able to safely cross, the worker needs to identify that there are wooden boards next to his starting point and he needs to place them over the rebar to be able to safely cross. Hints will be available to the worker in form of a pop-up text if he needs help getting through the scenario.
Outcome	Workers are equipped to identify potential tripping hazard and to eliminate the hazard by creating walking platforms over the rebar

2	Angle grinder accidents
Hazard type	Struck by
Severity	High
Scenarios where hazard is present on the construction site	A worker is cutting rebar with an angle grinder. The blade is not well attached to the machine, so it breaks and hits the worker at a high speed.
Scenario for immersive reality	Worker is told to pick up a tool and to cut the rebar. At the tool bench he has the angle grinder, safety glasses and a wrench at his disposal. Above the bench he has a warning that workers must inspect all tools for safety reasons before using them. If he simply takes the tool and starts cutting, the blade breaks and hits the worker. The worker can then see that there are safety glasses available and he puts them on. However, the glasses are not sufficient to prevent the injury. He must realize that he needs to inspect the tool and tighten the blade before using the tool. Hints will be available to the worker in form of a pop-up text if he needs help getting through the scenario.
Outcome	The workers are taught to check all power tools for safety before using them. Also, the workers are reminded that they need to wear safety glasses.
3	Table saw accidents

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Hazard type	Cuts and amputations
Severity	Medium
Scenarios where hazard is present on the construction site	Worker is cutting wooden elements on the table saw and cuts his fingers if all safety measures are not in place and he does not use special tools for handling objects which are being cut.
Scenario for immersive reality	Worker is told to cut a small wooden board. Firstly, the protection around the saw is missing, and if the worker starts working without all protective equipment an accident occurs. The worker must recognize that the protection is missing and install it. After installing saw protection, the worker is again injured if he uses his hands to push the material to the saw. He must then realize that there are additional tools at his disposal which are designed to safely push the material to the saw.
Outcome	The worker is taught to check whether all required safety equipment is installed properly. Additionally, the worker is taught never to use his own hands when pushing a small piece of wood close to the saw.

4	Formwork collapsing on a worker
Hazard type	Object falling on a worker
Severity	Medium
Scenarios where hazard is present on the construction site	Workers often do not follow the correct procedure of dismantling formwork. When removing the formwork for beams and slabs, some elements of the formwork might fall down and injure the worker.
Scenario for immersive reality	Worker is told to start removing the formwork for a ceiling slab. If the worker starts removing the elements in the incorrect order, the entire section of the formwork collapses and injures the worker. The worker must assess which formwork post shore can be dismantled so that the remainder does not fall. If the worker starts dissembling in the correct order, there still exists the chance of a localized collapse. The worker starts the scenario with a hammer but must realize that he needs other tools to dismantle the formwork from a safe distance.
Outcome	Workers are taught a correct order how to dismantle slab formwork and are taught that they must use specialized tools, not hammers, to remove the elements from a safe distance.

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5	Wall and column formwork overturning and falling on a worker
Hazard type	Object falling on a worker
Severity	All
Scenarios where hazard is present on the construction site	Formwork elements are rarely completely disassembled completely, because they are reused throughout the construction process. They are often stored vertically and can easily overturn and fall on a worker. Additionally, when placing the formwork, workers must make sure that the formwork is secured in place and will not fall because of the wind or when pouring the concrete.
Scenario for immersive reality	Worker is walking through the site, and sees formwork fall on him. The worker must take care not to get to close or else he will be injured. However, if he merely avoids the area, the formwork will not fall until a computer-controlled worker passes behind him and he instead is injured. The scenario repeats until the worker realizes that he needs to section of the hazardous area and to report the issue to his supervisor.
Outcome	The outcome of the scenario is that the worker is taught to observe the situation on the construction site around him and to fix and/or report issues to his superiors.

6	Hazards when concreting with a pump
Hazard type	Struck by object / Fall
Severity	Medium to high
Scenarios where hazard is present on the construction site	When pouring concrete, the hose can hit the worker because of the high pressure at which the concrete is pumped through. The worker can fall, and if the worker is standing near an unprotected ledge, he may even fall from height
Scenario for immersive reality	Worker is holding the hose through which concrete will be pumped. When the concrete starts flowing, the hose hits the worker and he falls. The worker must stand away from the edge and the hose must be held by two workers at the beginning of the process.
Outcome	Workers are taught to be mindful of their surroundings and potential hazards, as well as enlisting help from their peers for tasks which may require more people to be safely carried out.

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7	Objects flying in the worker's eyes
Hazard type	Struck by
Severity	Low to medium
Scenarios where hazard is present on the construction site	Workers are often exposed to small particles such as sawdust and metal debris when cutting materials, as well as dust, flying particles and rubble.
Scenario for immersive reality	Worker is told to finish placing masonry brick for a wall. The last brick, however, must be shortened to fit in the wall. The worker has a hammer and safety glasses in his toolbelt. If the worker only picks up the hammer and starts breaking the brick, a piece of rubble will hit him in the eye. The worker needs to put on safety glasses before starting.
Outcome	The worker is taught to always put on safety glasses when performing work which might result in objects flying towards his eyes.

8	Tripping when walking through the construction site
Hazard type	Trip hazard
Severity	Low
Scenarios where hazard is present on the construction site	Work area on the construction site is often cluttered with debris, construction materials, tools and electrical cables. Workers are often injured when tripping over objects left on the ground
Scenario for immersive reality	Worker is given a box to carry through a path on the construction site which is visibly cluttered with many objects on the floor. The box significantly limits his field of view, particularly of the floor. After a few meters of walking, the worker will trip and fall. The worker needs to check the area where he will walk and remove obstacles.
Outcome	The worker is taught to always check the movement path and to be aware of his surroundings and also not to leave his own workplace cluttered because he endangers other workers.

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9	Fall from height when working on roof structures
Hazard type	Fall hazard
Severity	High
Scenarios where hazard is present on the construction site	Workers often perform work at height, such as roofing and assembling frame structures, during which they are exposed to fall hazards.
Scenario for immersive reality	Worker needs to walk across a structure being assembled. When he reaches a certain point, he falls down. The worker is equipped with a safety harness, but he must connect it to the anchor point. If he connects only one line, then the worker will fall once he gets to the second anchor point. The worker needs to connect both lines to the anchor to be safe from falling.
Outcome	Worker is made aware of the dangers of fall hazards and the importance of properly using lifelines.

10	Fall of objects from height
Hazard type	Struck by
Severity	High
Scenarios where hazard is present on the construction site	Work areas often overlap on the construction site, with one group of workers working above the other group. Objects may fall from height and injure workers below.
Scenario for immersive reality	Worker starts on the ground level and is told to go up to his work area. When he starts working a tool falls out from his hand and injures a worker working below. To ensure that the tool does not fall, worker needs to attach it to his hand. Additionally, the worker needs to place signs on the ground level that there is a danger of objects falling from height. The scenario repeats until the worker takes all precautions against the hazard.
Outcome	Worker is taught safe work practices which keep his fellow workers from harm.

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11	Falling from a mobile scaffold
Hazard type	Fall hazard
Severity	Medium to high
Scenarios where hazard is present on the construction site	All work at height must be done from a scaffold and not from ladders. The workers often do not secure the scaffold because they are in a hurry to complete their tasks. If the scaffold is not fixed, worker may fall when performing his activities.
Scenario for immersive reality	Worker is told to climb the scaffold and to carry out works. In the first part of the scenario, the wheels of the scaffold are not fixed and when the worker starts working, the scaffold moves and the worker falls. The worker must first make sure that the scaffold's wheels are locked in place. In the second part of the scenario, after locking the wheels, when the worker starts working, the scaffold overturns on its side. The worker must then check to see whether the scaffold is horizontally fixed in place. To do that the worker must place horizontal stabilizations, making the scaffold as safe as possible
Outcome	The worker is taught of the dangers when using mobile scaffolds and how they must be properly secured.

12	Fall from ladders
Hazard type	Fall hazard
Severity	Low to medium
Scenarios where hazard is present on the construction site	Workers often use ladders for purposes for which they are not intended, such as carrying objects and performing work. Additionally, ladders are often not placed and secured according to safe work practices.
Scenario for immersive reality	Worker is told to ascend to an upper floor, while carrying his tool. The worker first needs to make sure that the ladder is placed at the required angle and that it is properly secured against slipping. If not, the ladder will slip and he will fall. Additionally, if the worker starts climbing the ladder with the tool in his hand, he will also fall down because he mustn't be carrying anything in his hands while climbing the ladder.
Outcome	The worker is taught how to safely use the ladder.

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13	Fall of object from a crane
Hazard type	Struck by
Severity	High
Scenarios where hazard is present on the construction site	Almost all heavy materials and equipment are transported by cranes. While there is low probability of the cargo falling from a crane, the potential severity is very high.
Scenario for immersive reality	Worker is walking through the site and at a certain point, cargo from the crane falls in front of him.
Outcome	The worker is made aware that the danger is also possible from above and that he should also be aware of what is happening above him

14	Worker struck by construction machinery
Hazard type	Struck by
Severity	High
Scenarios where hazard is present on the construction site	Workers often need to move through area where heavy machinery is present. The machinery has many blind spots because of which the operator cannot see all workers in the vicinity.
Scenario for immersive reality	Worker is told through a path which takes him close to a working excavator. When he gets near the excavator, he gets hit and injured. The scenario repeats until the worker signals the operator that he needs to pass and until the operator signals the worker that it is safe to pass.
Outcome	The worker is taught of the dangers of heavy machinery and how to behave in their vicinity.

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15	Collision with a vehicle
Hazard type	Struck by
Severity	Medium to high
Scenarios where hazard is present on the construction site	Some construction work requires that works which are carried out next to traffic. In that case, the workers need to be visible to the drivers.
Scenario for immersive reality	Worker is required to do some work outside the borders of the construction site, next to a road with vehicle traffic. When he first steps outside to the road, he gets hit by a car. The worker must first make sure that he is wearing a reflective vest. After that he must place appropriate traffic signs which signal that there are construction works ahead.
Outcome	The worker is taught to make himself and his work area visible to nearby drivers.

16	Electrocution due to faulty wires or tools
Hazard type	Electrocution
Severity	All
Scenarios where hazard is present on the construction site	Faulty wires and tools may be found on the construction site, which pose electrocution hazards to the workers.
Scenario for immersive reality	The worker is tasked to complete a task with a visibly damaged power tool. When the worker starts the tool, he is electrocuted. He has the equipment to repair the tool next to it. However, if he attempts to repair the tool himself, he will again be electrocuted. The correct ending to the scenario is to report the damaged tool to his supervisor and to ask for a properly working one.
Outcome	The worker is taught to not use faulty tools and not to attempt to repair it himself, but rather to inform his supervisor.

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17	Trench cave in
Hazard type	Struck by
Severity	Medium to high
Scenarios where hazard is present on the construction site	Some construction work is carried out in the trenches, where the worker is exposed to cave-in hazard as well as to something falling in the trench from outside
Scenario for immersive reality	The worker descends into the trench and begins his work. Shortly after, the walls of the trench collapse on him. The worker needs to see if the trench is deep enough to require shoring and if it is, report to his supervisor that the trench is unsafe for work.
Outcome	The worker is taught the dangers of working in trenches and to report unsafe working conditions.

18	Fall from an unprotected edge
Hazard type	Fall hazard
Severity	Medium to high
Scenarios where hazard is present on the construction site	Construction work often occurs near edges of the building or near openings in floor slabs (elevator and installation shafts, near the edges of the building, in stariways,…). Those areas are particularly hazardous to work in, since worker can fall of an edge or through and opening if it the potential hazard is not addressed.
Scenario for immersive reality	a) The worker is tasked to complete a task near the edge of the building slab, which includes walking near the edge. When he is close to the edge, he trips and falls from the edge. Second time the worker is prompted to secure the edge himself, but also falls if he is not wearing fall protection safety gear. The correct way to pass the scenario is to notify the supervisor of the dangerous situation, to put on the safety harness and only then to place the protective fence on the building edge. b) The scenario is similar to a), only with an elevator shaft instead of an unprotected edge.
Outcome	The worker is taught that he needs to be careful when working near unprotected edges and that such areas need to be protected or that he needs to wear fall protection safety gear and also that he needs to report such unsafe areas to his supervisor.

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E) Construction hazard scenarios identified for modeling

During the virtual meeting held on 4th September 2020 the project partners have identified which hazard scenarios will be modeled and gamified in the remainder of the project. Those scenarios are:

- Fall from an unprotected edge;
- Trench cave in;
- Fall of objects from height;
- Electrocution due to faulty wires or tools;
- Worker struck by construction machinery.

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Annex I) Accident statistics

Accident statistics vary from construction industry to construction industry due to numerous factors such as safety culture, societal awareness, legislative requirements and construction traditions and technologies. It was previously mentioned that the four most common fatal hazards in the USA are falls, struck by object, electrocutions and caught-in/between. The most significant difference between the EU and USA safety factors are differences in the prevailing construction technologies. USA has more prefabricated, steel and wood structures, compared to masonry structures in the EU. This means that workers in the EU are slightly less exposed to working at height than their counterparts in the USA.

Health & Safety Executive (HSE), a UK government agency for responsible for health & safety issues, published their annual report with construction accident statistics for 2020. In the report they state that out of 30 fatal injuries top five causes were [2]:

- Fall from a height – 47%
- Trapped by something collapsing/overturning – 16%
- Struck by moving vehicle – 12%
- Struck by moving, including flying/falling object – 10%
- Contact with electricity or electrical discharge – 4%

These numbers are similar to numbers for the period from 2014 to 2018 and as can be seen, the most common fatal accidents are no different than in the USA.

It important to note that the industry partner in the project has also stressed the importance of these hazard types, and it is also their personal experience that these hazards are the most common at the construction sites.

Injury statistics in this section confirm that the hazard scenarios chosen for further study indeed pose the most significant health and safety risks for construction workers.

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Annex II) Safe work practices

After identifying which hazard scenarios will be adressed, it is necessary to define safe working practices for those situations on the construction sites. Construction workers and other intended users need to be taught how to correctly carry out activities, so that they do not endanger themselves or others any more than it is unavoidable, in other words, to minimise the H&S risks as much as possible.

There are numerous sources of safe work practices available including, but not limited to: H&S guidelines, manuals, national reccomendations, H&S books, safety reports, accident data, safety training videos, research papers, interactive games and others. For the purpose of this project, such sources were studied, as well as best pracites from our project partner Kamgrad which is a construction company with their own H&S educational materials.

With regards to resources available online, the European Network Education and Training in Occupational Safety and Health (ENETOSH) has compiled a list of construction Health & Safety training materials and manuals which are available at:
https://www.enetosh.net/webcom/show_article.php/_c-178/_nr-4/i.html.

Examples best suited for the project were extracted from the ENETOSH's list and they include:

BYGGESIKKERHED (Construction Safety) (Denmark) [3]
BYGGESIKKERHED.DK is a multimedia website dealing with construction safety. The website is available in four languages: Danish, English, Polish and German. It contains 15 different areas, each of them covering one profession at the construction site: bricklayer, scaffold builder, glazier, floor fitter, construction builder, mason paviour, building builder, electrician, painter, demolition worker, roofer, carpenter, plumber, asphalt worker and safety representative.
For every profession, a video clip puts a focus on the special safety requirements. In addition, a collection of facts is available, as well as "Tasks", a kind of quiz to show what the user has learned so far.
This example can be found in detail in our GOOD PRACTICE area
Website

Håndbogen (Denmark) [4]
This manual is a work of reference for the working environment in the building and construction industry. The manual provides guidelines on good working environment practice and on how the rules of the Working Environment Act can be followed within enterprises and on building sites.
The manual has been published by Branchearbejdsmiljørådet for Bygge & Anlæg, with specialist assistance from Working Environment Authority experts in the field of building and construction.
Website

Construction safety and accident prevention video (Portugal) [5]

A video by the University of Porto, Faculty of Engineering, featuring Alfredo Soeiro about accident prevention in construction industry and at construction sites, especially in temporary structures.

Video

Prevention Videos – Construction Hazards (USA) [6]

The videos by Occupational Safety & Health Administration OSHA of the United States Department of Labor below show how quickly workers can be injured or killed on the job and are intended to assist those in the industry to identify, reduce, and eliminate construction-related hazards.

Video-Website

OSHA Fall Prevention Campaign (USA) [7]

This website by Occupational Safety & Health Administration OSHA of the United States Department of Labor is part of OSHA's nationwide outreach campaign to raise awareness among workers and employers about the hazards of falls from ladders, scaffolds and roofs. The educational resources page gives workers and employers information about falls and how to prevent them. There are also training tools for employers to use and posters to display at their worksites. Many of the new resources target vulnerable workers with limited English proficiency.

Campaign website

Young Workers Safety Topics Videos (USA) [8]

A selection of videos by Occupational Safety & Health Administration OSHA of the United States Department of Labor about work-related dangers and risks in construction and landscaping. The construction safety videos are available in English and Spanish, the landscaping safety videos are available as images and text in addition.

Video website

Construction risks: an apprentice's view (UK) [9]

A video produced by the British Safety Council shows a young construction apprentice working on a new block of flats who talks about workplace risks and how learning new skills includes doing the job safely.

Video

elcosh - Electronic Library of Construction Occupational Safety and Health (USA) [10]

The Electronic Library of Construction Occupational Safety and Health (eLCOSH.org) was developed to provide accurate, user-friendly information about safety and health for construction workers, employers, researchers and others interested in construction safety and health from a wide range of sources worldwide.

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The library offers presentations, images, videos and documents dealing with condtruction safety and accident prevention in the construction sector.
Website

The Construction Safety Training System (CSTS) (Canada) [11]
The Construction Safety Training System (CSTS) is a CD-ROM-based course developed by the Alberta Construction Safety Association (ACSA) that uses interactive multimedia including full-motion video and sound. CSTS training is a requirement on most job sites in Alberta and a growing number of jobsites in BC. Participants receive instruction on various health and safety topics and are then tested for 100% mastery. Training is completed in about 5 hours, after which a CSTS certificate is issued.
Website

The Construction Safety Toolkit (Canada) [12]
This toolkit, as well available as an interactive internet "web-flip" version, is part of the Construction Safety Training System (CSTS), a CD-ROM-based course developed by the Alberta Construction Safety Association (ACSA).
Website

Co-funded by the Erasmus+ Programme of the European Union

Annex III) References

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