

Health, safety and environment (HSE) in the bachelor education of construction engineers in Norway

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Abstract

The construction industry is more exposed to serious accidents than other sectors in Norway, and needs to improve its performance on health, safety and environment (HSE). Newly educated engineers quickly enter into management positions with responsibility for HSE, so our educational institutions ought to prepare their students for this kind of responsibility. One should therefore expect HSE to be part of the official educational strategy when educating construction engineers.

This paper 1) examines how aspects of HSE are included in the learning outcomes of the bachelor education of construction engineers in Norway, and 2) assess the emphasis on HSE topics in these learning outcomes. The investigation is limited to the HSE requirements under the provision of the Working Environment Act. Descriptions of learning outcomes were collected from five educational institutions in Norway, and the documents were subjected to content analysis.

We found that the inclusion and emphasis on HSE in learning outcomes vary among the different educational institutions in Norway. The paper argues that not all educational programmes in construction engineering have HSE high on their official educational agenda. Furthermore, based on our analysis of learning outcomes, we suggest that the educational programmes consider adopting a more holistic approach to HSE. The paper provides a starting-point for further research on how the engineering educations can contribute to improve HSE performance in the construction industry.

Keywords: Health, safety and environment (HSE), learning outcomes, engineering education, bachelor education, construction industry.

1. Introduction

In the Norwegian model of labour relations, employees expect personal development, codetermination and participation at company level, and to be protected against harmful accidents and other health consequences of their work (Løken and Stokke, 2009). The authorities and the social partners of trade unions and employers' associations all have high aspirations for HSE (Karlsen, 2010). The Norwegian Working Environment Act give all employees in management positions responsibility for health, safety and environment (HSE) within their own jurisdiction (aml., 2005§ 2-3 (3)). HSE are advertised as central values of many of the larger Norwegian companies, especially in the petroleum industry, and are used quite actively in reputation management (Falkenberg, 2006). Roberts et al. (2012) even suggest that companies that include HSE work on their top priority list will obtain a competitive advantage. Trade unions, on the other hand, regard HSE work as vital to improve working conditions for employees (Løken and Stokke, 2009). Thus, the actors in the labour market may have different motives, but they all seem to set high goals for HSE and depend largely on managers at different levels to achieve them.

During the post WW2 period in Norway, engineers dominated management positions in industrial and technical enterprises in both the private and the public sector (Nygaard, 2014a). Even though their dominant management position in the last decades has been somewhat reduced (Nygaard, 2014b), engineers still hold a vital position amongst managers (Ravn, 2015). A study from 2002 found that 27,2 percent of leaders in Norway have a technical background (Vie, 2012).

Judged by the absolute number of fatalities, the construction industry is currently the most dangerous industry in Norway, according to the Labour Inspection Authority (Arbeidstilsynet, 2017). The lack of safety measures, short deadlines, great work pressure and a significant number of foreign employees are some of the specific risk factors in the construction industry identified in earlier studies (Andersen et al., 2009, Ødegård et al., 2007, Bråten et al., 2012). According to these, there are discrepancies in the way HSE regulations are implemented by different enterprises, suggesting that there is a lack of common understanding of HSE in the industry. A status report from 2009 on HSE work in Norwegian enterprises discloses insufficiencies in HSE competence among managers and that that only 42 % of employers report to have procedures to execute required HSE training for their managers (Andersen et al., 2009, p. 52).

These earlier studies indicate that HSE training on the workplace is not enough to ensure the HSE performance in the industry. However, to our knowledge, no studies have been conducted on how HSE is included in formal education programmes that are designed to prepare students for working life in the construction industry. In a 2008 evaluation of the education of engineers in Norway, employers were asked what competences they need but find to be lacking when hiring newly educated engineers (NOKUT, 2008, 45). Competence on HSE was among the elements mentioned, however, this finding was not subject to further investigation. That is why this paper will take a first step to examine how aspects of HSE are included in the education of construction engineers. We will do this by 1) examining how HSE is included in the learning outcomes of the bachelor education, and 2) assess the emphasis on HSE topics in these learning outcomes.

2. Research methods

Our analysis is based on learning outcomes collected from the five educational institutions in Norway with the highest admission numbers of bachelor students in engineering in 2014 (Norwegian Centre for Research Data, NSD, 2015). The following educational institutions are included: 1) Høgskolen i Bergen (HiB)¹, 2) Høgskolen i Sør-Trøndelag (HiST)², 3) Høgskolen i Oslo og Akershus (HiOA), 4) Høgskolen i Østfold (HiØ), and 5) Universitetet i Agder (UiA).

The learning outcomes represent what competence the educational institutions consider essential that their students master before graduation. They are, thus, relevant indicators of whether and how aspects of HSE are included as part of the official educational strategy of the institutions studied. In this desk study, we have examined both the overall learning outcomes of the different bachelor programmes, and the learning outcomes given in all the different subjects included in these programmes. Although the overall learning outcomes are usually decided on a higher level of the institution, the process of formulating the learning outcomes of specific subjects is usually delegated to the teachers in charge of the subject at hand (Sørskår, 2015). There can evidently be some discrepancies between the written learning outcomes and the actual teaching in a specific subject. However, it is unlikely that what are regarded as important aspects of teachings are not mentioned in these documents. Thus, we regard the absence of HSE aspects in the learning outcomes as an indicator that these aspects are not regarded as sufficiently important to be part of the overall educational strategy, and that the eventual focus on HSE is left for the individual teacher to decide.

Our investigation is limited to the bachelor education of construction engineers and to the HSE requirements under the provision of the Working Environment Act. Thus, we exclude HSE requirements concerning the outer environment, consumers and the wider public, and concentrate on the health, safety and working environment of employees in the construction industry.

The collected learning outcomes were subjected to a content analysis to identify indicators of the HSE focus in the bachelor education programmes. This method allows the combined use of qualitative and quantitative approaches to the data, and we do not risk the data being influenced by the data collection itself (Weber, 2011). The analysis focus especially on the use of the term HSE, in what way the term is mentioned and in which context. Risk, regulations and project management are other terms commonly found within the field of HSE, and are included in the analysis to detect other possible indications of HSE in the education programmes. We have also documented the number of credit points and whether the subject at hand is required or optional. The scope (credit points) and status (required or elected subject) can indicate the general emphasis of HSE topics in the overall bachelor education.

¹ Høgskolen i Bergen (HiB) merged with two other institutions from January 1st 2017 to form the new Høgskulen på Vestlandet, and ceased to exist as an autonomous institution from this date.

² Høgskolen i Sør-Trøndelag (HiST) merged with NTNU from January 1st 2016, and ceased to exist as an autonomous institution from this date.

3. Theoretical background

The Norwegian model of labour relations is based on a tripartite cooperation at the national level between the state and the social partners. For the model to function it is, however, crucial that the cooperation between trade unions and employers is also practiced at company level, including cooperation on health and safety activities (Løken and Stokke, 2009). Several studies show that competent managers, employees and staff representatives are all crucial for effective local work on HSE (Andersen et al., 2009, Bråten et al., 2012, Ødegård et al., 2007, Karlsen, 2010).

We have already established the fact that the construction industry is a risky business. The construction engineers, however, are not the ones getting killed or injured. Such consequences are mainly left to the construction workers. Accidents occurring are often blamed on the victims themselves and causes of human error (Perrow, 1999, Swuste et al., 2012). We will nevertheless argue with Swuste et al. (2012, p. 1335) “that (safe) behavior cannot be isolated from its (i.e. the organization’s) structure, processes, or culture”. These factors are highly influenced by engineers, as they often hold managing positions in the industry. Additionally, studies have found that in the construction industry the design phase is highly important to safety. However, the potential for promoting safety in this phase is hampered by architects and engineers having limited knowledge on safety issues (ibid.). In their study of the construction industry in Norway, Bråten et al. (2012) concluded that the attitude towards HSE amongst project and construction managers are vital to HSE performance. Similar results are found in the construction industry in the United States (Abudayyeh et al., 2006) and Singapore (Teo et al., 2005). Thus, the knowledge of HSE among construction engineers seems a relevant focus to make this risky business safer.

Engineering is often regarded as one of the classic professions (Brante, 2013). Most scholars seem to agree that profession is a term that applies to certain occupations held by people with specialized training based on higher education, and that they have a particular obligation to work for the common good (Abbot, 1988, Macdonald, 1995, Brante, 2011, Saks, 2012). This would suggest that the education of engineers should include ethical components as well as technical training. Such ethical components could include HSE issues. When education of engineers was established in Norway, however, it was heavily influenced by German traditions with its strict technology and natural science approach (Nygaard, 2014a). This tradition might prevent ethical and other non-technical components from finding its way into the education programmes.

The Norwegian Working Environment Act commits all enterprises to ensure safe physical, organisational and psychosocial working conditions, and “a basis for a health-promoting and meaningful work situation” (Løken and Stokke, 2009, p. 15). This includes monitoring all aspects that influence the working environment (aml., 2005, § 4-1 (1)). Thus, a strict technology approach to HSE work will not suffice to fulfil the requirements of the law.

During the last two decades, there has been a growing interest in the influence of organisational culture on safety performance. Scholars agree that efforts to reduce accidents need to have a wider perspective than a purely technological one; both organisational and human factors need to be addressed as well (see f.ex. Antonsen, 2009, Perrow, 1999, Reason, 1997). A substantial part of the work on HSE and safety culture in Norway has been conducted in the field of the petroleum industry (see f.ex. Haukelid,

2008, Høivik et al., 2009a, Høivik et al., 2009b), however, the work done on this subject in the construction industry in Norway seems somewhat deficient (Bråten et al., 2012).

Swuste et al. (2012) have reviewed available literature on construction safety. They suggest two different approaches to improve safety in construction. The first is to establish a strict safety science route including “targeted interventions directed at clients, designers, top managers at construction companies” (ibid., p. 1341). Koch (2013) found that – when focusing on construction – projects rather than enterprises frame the constitution of safety cultures. Høivik et al. (2009b) found similar results in the petroleum industry. Wu et al. (2016) also identified a strong interaction between safety leadership and safety culture. Thus, it would seem that managers in general and project managers in particular are important to HSE performance. These findings could indicate possible ways to implement a strict safety science route in the construction industry and the education of construction engineers.

The second approach suggested by Swuste et al. (2012) is “frappez toujours”, or to be persistent. An example of an initiative following this second approach is the Charter for a construction industry free of injury (our translation)³. The charter was established in 2014 and includes trade unions, employers’ associations and some of the largest enterprises in the industry; thereby aligning well with the Norwegian model of labour relations. Among the participants, are also the Norwegian University of Science and Technology (NTNU), committed to the following goal: “NTNU will contribute to a construction industry free of injury. Health, environment and safety are included as a common thread in our teaching. NTNU will educate students with good attitudes towards HSE” (Charter, p. 6, our translation). The establishment of the charter suggests that the industry is aware of its HSE challenges, that educational institutions are recognized as part of the solution, and that good HSE work is recognized as not solely a matter of technical knowledge, but also a matter of attitude. A persistent HSE focus in education could therefore contribute to safety and improved HSE performance in the industry.

4. Findings

In the following, we present how different aspects of HSE are included and emphasized in the learning outcomes of the studied bachelor education programmes. We start with the general learning outcomes of the bachelor education on construction engineers before we turn to the required, specialized and elective subjects of the different educational programmes.

4.1 Overall learning outcomes of the bachelor degrees

When studying the overall learning outcomes, we found that most have some general description of learning outcomes that could indicate some focus on HSE. HiB, HiST and HiOA have simply copied the national guidelines from the Norwegian Association of Higher Education Institutions (UHR) when it comes to learning outcomes in construction engineering. Attachment 2 to these guidelines states that knowledge of HSE is required in the engineering professions (UHR, 2011, p. 49). Still, we find no explicit mentioning of HSE in neither in the stated learning outcomes of these institutions nor in the national guidelines themselves. They do, however, make a general reference to the candidate’s ability

³ For more information on the charter, go to <http://www.statsbygg.no/files/samfunnsanvar/sha/SHATiltaksplanOkt2015.pdf>

to put his/her work into an ethical perspective, and having knowledge of the societal role of the engineering profession and consequences of the development and use of technology.

Both HiØ and UiA have made adjustments in their overall learning outcomes compared to the national guidelines. HiØ states that the bachelor candidates should be able to “ensure health, environment and safety in all life phases of the product” (our translation), giving the learning outcomes an explicit focus on HSE. UiA emphasizes its bachelors’ “ability to apply current regulations for construction measures” (our translation). As the public regulations concerning the industry clearly emphasize HSE, we assume that this is an indication of HSE being included in the education at UiA. To find out whether these overall learning outcomes are reflected in the different subjects that constitute the bachelor degree, we nevertheless need to look into the specific subjects taught.

4.2 Learning outcomes of required subjects

Although, as suspected, the learning outcomes of the individual subjects are generally more specific than what we found in the overall learning outcomes, it is not always clear what the students are intended to learn about HSE when examining these documents.

At HiB, the bachelor students of construction engineering are all required to learn about project work. Perhaps HSE are included when learning about projects, but it is hard to say based on the learning outcomes that do not mention HSE. When learning about material science, the students are required to gain knowledge of health and environmental risks. The students must also learn some ground rules of working life that perhaps could include HSE. Nevertheless, it seems clear that aspects of HSE are not regarded as important topics in most required subjects taught at HiB.

The situation seems quite similar at HiST. Some of the required subjects have an environmental focus, however they do not seem to include the working environment. In the subject of Road building and geomatics, the students are required to learn relevant laws and regulations that could include HSE. When it comes to the students’ work in model labs, the students are required to learn about HSE. We assume that the emphasis here is on physical health and safety. Even though the students at HiST are required to learn how to conduct their work in model labs in a safe way, we still cannot conclude that HSE are strongly emphasized in the required subjects in general.

Moving on to HiOA, this institution seems to have a more explicit focus on HSE in the required subjects compared to HiB and HiST. Even though, the inclusion of HSE is unclear in some subjects, the opposite is the case when it comes to the subject called The building process. The learning outcomes of this subject suggest a strong emphasis and persistent focus on HSE. Turning to HiØ, the findings are similar. The subject of Construction project management has an explicit focus on HSE, even though not quite as strong and consistent as HiOA. On the other hand, HiØ also teaches the students basic HSE in the subject of Physics/chemistry.

When studying the learning outcomes at UiA, the traces of HSE almost disappear. When analysing the learning outcomes it seems clear that UiA does not regard HSE as an important part of their educational strategy. Even though project work is included in the introduction course, there is no mention of HSE.

Based on the learning outcomes of the required subjects of the five educational institutions studied, the emphasis on HSE varies. Most of the institutions claim to teach the students project management. However, only two of them (HiOA and HiØ) connects project management explicitly to HSE. Additionally, only HiST and HiØ explicitly state that students learn how to work safely with chemical substances in labs. However, this picture can change as we look into the subjects taught at different directions of specialization in the bachelor programmes.

4.3 Learning outcomes of specialization subjects

While HiØ only distinguishes between required and elective subjects, all the other institutions make their students specialize in a specific field. According to the field the students choose, they are required to attend certain subjects.

Specialization in structural engineering is offered at all the studied institutions (except HiØ). However, none of the subjects included in these specializations mention HSE in their learning outcomes. HiST, HiOA and UiA all offer specialization in Technical planning. The learning outcomes of subjects offered in this specialization all include some understanding of rules and regulations relevant for the industry. This could imply some sort of HSE elements, and some even specifically mention safety, environment and risk. The same applies to the subjects offered at HiB as part of the specialization called Project and construction management.

The only specialization subject we found that explicitly mentions HSE is the subject of Construction engineering offered at HiST. It is interesting to note that in this subject one of the learning outcomes is “understanding and commitment to HSE”. For the first time in our data, we see signs of an educational institution stating a very specific goal to influence the attitudes of the students towards HSE.

When looking at the learning outcomes of the specialization subjects, the overall picture, thus, remains the same: Most of the subjects taught have unclear stated goals regarding HSE.

4.4 Learning outcomes of elective subjects

The students’ opportunities to choose elective subjects differ among the studied institutions. While students at HiST and HiOA only choose one elected subject (10 credit points), both HiB and HiØ let students choose 3 subjects, and at UiA students choose 4. HiB offers 14 elective subjects, but some of them are required subjects in specializations that are also offered as elective subjects. The other institutions offer between 6 and 8 elective subjects to their students.

The learning outcomes of elective subjects generally do not explicitly mention HSE. However, they do mention some aspects in which HSE could be relevant, such as knowledge of relevant regulations, coordination in construction projects and project management. Some elective subjects still mention HSE more explicitly, such as the elective subject of Controlled practice at HiB where knowledge on health, environment and safety is one of the stated learning outcomes. HiST offers a similar subject where the working environment is mentioned in the course description.

HiST also offers two elective subjects especially relevant for students who want to work in the petroleum industry. Here the focus on HSE is noteworthy in the learning outcomes, and safety concerns

are strongly emphasized. It is striking how the HSE focus seem to increase the closer the students get to the petroleum industry and away from the traditional construction industry.

5. Discussion

This paper 1) examines how the elements of HSE are included in the learning outcomes of bachelor education of construction engineers in Norway, and 2) assess the emphasis on HSE in these learning outcomes. We will now discuss the implications of our findings to these questions and suggest some possible improvements that should be subject to further research.

5.1 How aspects of HSE are included in learning outcomes

Swuste et al. (2012) suggest two options to improve HSE performance in the construction industry: 1) the strict safety science route, and 2) the “frappez toujours” (or persistence) route. Although Swuste et al. suggest these routes as possibilities for the actors in the construction industry, we argue that they are also relevant for the (bachelor) education of construction engineers. This distinction, thus, seems relevant when turning to our first research question.

The strict safety science route would seem to suggest that HSE should be taught either as a specific subject in the education of engineers, or at least HSE should be specifically highlighted in the teachings. As we show in this paper, none of the studied bachelor programmes uses the approach of HSE as a subject in its own right. When learning outcomes mention HSE, it is done as part of a wider subject, thus, knowledge on HSE is mainly just one out of a number of different learning outcomes and not the main focal point. Nevertheless, both HiOA and HiØ offer required subjects with a strong emphasis of HSE that could be part of a strict safety science route in the education of construction engineers. The same goes for the specialized subject of Construction engineering and some of the elective subjects at HiST.

Turning to the “frappez toujours” route, this route would suggest that HSE should be integrated in almost every subject taught, as the persistent common thread described by NTNU in the Charter for a construction industry free of injury. However, this description does not seem to fit our findings. For HSE to be an integrated, common thread through the bachelor education, we would expect the mentioning of HSE in the learning outcomes of a far greater number of subjects that constitute a bachelor degree. We only found explicit HSE focus in a few. We must therefore conclude that none of the bachelor education programmes of construction engineers we have studied follow the “frappez toujours” route suggested routes by Swuste et al. (2012).

Which elements of HSE are highlighted in the bachelor education programmes, are also important. It will not be sufficient to teach future engineers the pure technical side of HSE (although important in itself). All factors in the working environment interact with each other and are important for HSE. This resonates well with the findings of Swuste et al. (2012), notably when considering that all phases in the construction process are important to HSE, and that the behaviour of employees largely depends upon a variety of factors such as management, organisational structure, culture, conflicting goals, and design decisions. Thus, construction engineers need a holistic understanding of HSE. Our findings, however, suggest that, overall, the technical aspects of HSE are emphasized significantly stronger than other

aspects of HSE. Thus the legacy of the German engineering profession, as noted by Nygaard (2014a), still seem to manifest itself in the way aspects of HSE are included in the learning outcomes.

5.2 The emphasis of HSE in learning outcomes

We find that the emphasis of HSE in the learning outcomes of the bachelor programmes vary among the institutions. Only HiØ mentions HSE in the overall learning outcomes. Both HiØ and HiOA have 20 credit points of required subjects where HSE are strongly emphasised in learning outcomes, however, this is still a small part of the 180 credit points included in a bachelor degree.

When the students specialize, they will find the strongest HSE emphasis at HiST. At HiST, the specialization in construction engineering requires 20 credit points in Construction engineering and engineering geology where the learning outcomes include developing an understanding of and commitment to HSE. HiB, HiOA and UiA all mention safety and risks in some of their specialized subjects, but it is not clear if they refer to HSE risks or whether it is the safety of employees, consumers or the public which is addressed. When looking at elective subjects, only HiB and HiST offer subjects with explicit learning outcomes on HSE. HiB offers one such elective subject, while HiST offers three. However, two of these electives offered at HiST are directly related to the petroleum industry rather than to the construction industry.

Even though we find traces of HSE in the learning outcomes of all the bachelor programmes studied, the emphasis, when looking at the number of credit points and the content of required subjects, suggest that aspects of HSE are not main topics in the educational programmes. However, some educational institutions seem to emphasize HSE more strongly than others.

5.3 Suggested improvements

One way of including HSE in the bachelor education programmes of construction engineers would be to explicitly include HSE in the teachings of project management. For many engineers, the position as project manager is the first kind of management position achieved after graduating. The project manager faces many challenges – technical, organisational and cultural – thus, providing an opportunity to include a more holistic understanding of HSE. Technical challenges to the project manager include factors like type and method of construction and safety procedures (Teo et al., 2005). Main organizational challenges in the construction industry include the organic structure that characterize the companies (Swuste et al., 2012) and the complexity of most construction sites, including diverse activities and the presence of (many) subcontractors (Teo et al., 2005). A cultural challenge facing the project manager is safety culture, represented by safety behaviour and attitudes. The safety commitment of managers is important to enhance safety culture (Teo et al., 2005, Bråten et al., 2012, Høivik et al., 2009b). A more holistic approach to HSE, including technical, organisational and cultural elements interacting, corresponds well with the combined focus on the physical, organisational and psychosocial working environment, as prescribed by the Working Environment Act. Such an approach to the teachings of project management, would also seem to correspond well with the strict science route suggested by Swuste et al. (2012), though it should be subject to further research.

Another approach would be to further develop the “frappez toujours” route. One way of pursuing this route in the bachelor education would be to include HSE in the overall learning outcomes of the

bachelor programmes, and at the same time include elements of HSE as a common thread throughout many, if not all, of the different subjects taught. This would signal a strong commitment from the educational institutions to the goal of improved HSE performance in the construction industry. One starting point could be to look at how the common thread of HSE is implemented at NTNU because of their commitment in the Charter for a construction industry free of injury. Perhaps this can provide learning possibilities for other educational institutions on how to implement a persistent HSE focus.

We would argue that the suggested routes of strict science and “*frappez toujours*” are not necessarily mutually excluding, but can be combined in different ways. To find the best route for formal education to contribute to a safer construction industry, we nevertheless need to include the perspectives of clients, contractors, earlier students, the social partners, and the public authorities in the industry. As even more master graduates gain management positions than bachelor graduates, we will also need to look more closely at the master level of education.

6. Conclusions

In this paper we have examined how aspects of HSE are included in the learning outcomes of bachelor education of construction engineers in Norway. We have found that only one of the educational programmes studied explicitly includes HSE in its overall learning outcomes. Aspect of HSE are, nevertheless, included in the learning outcomes of the bachelor programmes, mainly as one of many elements of technical subjects. Thus, safety and the physical working environment are represented in the learning outcomes, while other factors are almost absent. According to what is presented in their learning outcomes, only HiOA and HiØ seem to leave newly educated construction engineers with more than only bits and pieces of what we would argue needs to be a more holistic understanding of HSE work.

We have also assessed the emphasis on HSE in the learning outcomes, and our findings vary. While HiOA and HiØ have some required subjects with a strong and explicit focus on HSE, the other institutions appear to leave their focus on HSE to specialized and elective subjects, if indeed aspects of HSE are at all mentioned in their learning outcomes. However, it seems clear that HSE can neither be regarded as a “common thread” in the education programmes (i.e. the “*frappez toujours*” route), nor as an explicit scientific focus (i.e. the strict safety science route). Thus, we conclude that, when looking at the learning outcomes, most of the studied educational programmes do not seem to follow any of the suggested routes by Swuste et al. (2012). Again, the possible exceptions are HiOA and HiØ who through their strong HSE focus when it comes to project management, may attempt to follow a strict science route.

Formal higher education could play a vital role when it comes to making the construction industry safer. Based on our findings, we have suggested some possible improvements to the educational bachelor programmes of construction engineers. We argue that the role of the engineers as project managers represent an opportunity to strengthen the knowledge and understanding of HSE among bachelor graduates. It is also possible to pursue the “*frappez toujours*” route by improving the integration of HSE in the general teachings of different subjects. The education programmes of construction engineers should adopt a holistic approach to their teachings of HSE which include technical, organisational and cultural elements and their influence on each other and on HSE behaviour

in the construction industry. Only such a holistic approach will prepare students for HSE responsibility in accordance with the intentions of the Working Environment Act.

This paper provides a starting-point for further research on how the engineering educations can contribute to improve HSE performance in the construction industry by mapping how aspects of HSE are included in current learning outcomes. Further work should investigate if the formulated learning outcomes reflects what is actually taught in bachelor study programmes. It should also investigate study programmes at master's level. An important part of further work should be to examine how to enable construction engineers to meet future practical HSE challenges.

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