COUNTERFEIT MATERIALS IN THE NORWEGIAN AEC-INDUSTRY

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ABSTRACT

The literature states that counterfeit materials can have major implications in particular concerning competition between suppliers, between contractors as well as general challenges regarding cost, time, quality and safety. Counterfeited materials are defined as unauthorized materials which special characteristics are protected as intellectual property rights, patents and copyrights. This paper seeks to answer the following questions:

1. What does counterfeit materials mean in the context of the Norwegian AEC-Industry?
2. Does counterfeit materials exist in the Norwegian AEC-Industry?
3. What are the potential consequences of counterfeit materials?
4. Which methods are suitable to detect and mitigate counterfeited materials?

This is a qualitative research study. The methodology consists of a review of literature and the research is carried out using explorative interviews with the purpose to gather experiences and examples of specific cases. This approach is chosen to encourage discussion with interviewees and thereby collect information that would otherwise go under the radar by more structured forms of interviews and surveys. Counterfeiting is a well-known problem, but there are limited literature addressing this phenomenon in the construction industry. This is a pilot study and the limitations include a limited number of interviewees. The nature of the counterfeit phenomenon limits the study in regards of accessibility, amount of previous research and literature addressing this phenomenon. By illuminating the scope of the problem possible consequences and evaluating the current strategies for dealing with the problem, this study could lead to an increased awareness within the industry. The study works as a basis for further research within the field.

Keywords Counterfeit materials; Supply Chain Management; Safety and Quality; Anti-Counterfeiting Strategy

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INTRODUCTION

The aim of a construction project is to create unique products that create value for the participators. For the contractors and suppliers this value is typically economic profit. To maximise profit and win tendering competitions, construction companies generally aim to lower their costs. Cost reduction can be achieved by globalizing supply chains, which usually means by buying construction products from the lowest cost source (Wang and Wang, 2010). Construction projects are, however, characterised by variety of constraining factors such as project complexity, limited time horizon and profit opportunities. Such factors render the industry vulnerable to counterfeited products entering the supply chain. Another important factor is the quality of the construction project. Quality can be defined as meeting the legal, aesthetic and functional requirements of a project (Arditi and Gunaydin, 1997).

For more than three decades, researchers have investigated the possibility of counterfeit products circulating in various industries. Consequently, literature on counterfeit products exists from a broad range of sectors, including such as the pharmaceutical, electrical and the fashion industry (Grossman and Shapiro, 1988); (Stevenson and Busby, 2015). The construction industry, on the other hand, has had far less research carried out on counterfeiting than other industries. The International Chamber of Commerce estimates that roughly 7-8% of world trade every year is counterfeited goods, equalling approx. US$600 billion (CIB, 2016). The effect of counterfeit trade surpasses, however, simple losses/increases in sale revenues. Counterfeiters are unfair competitors in that they do not have the same expenses as genuine producers (Berman, 2008). In the context of the construction industry, counterfeit materials will influence tendering competitions between contractors, suppliers and producers alike. It also leads to increased quality assurance activities such as controls, inspections and documentation in all parts of the supply chain (UNICRI, 2011).

The first step in this explorative study of the counterfeit phenomena was to look what counterfeiting could mean in the context of the construction sector. The second research question explores the existence of counterfeit materials. The study aims to expand the awareness surrounding this phenomenon. The third research question aims to identify potential consequences and the final research question examines strategies, methods and other anti-counterfeiting activities. In sum, this paper addresses the following research questions:

1. What does counterfeit materials mean in the context of the Norwegian AEC-Industry?
2. Does counterfeit materials exist in the Norwegian AEC-Industry?
3. What are the potential consequences of counterfeit materials?
4. Which methods are suitable to detect and mitigate counterfeited materials?

METHODOLOGY

The research carried out in this pilot study explored the phenomena of counterfeiting materials in the Norwegian Construction Industry. The study consist of a qualitative

approach according to the prescriptions of Yin (Yin, 2013). The aim is to gain an understanding of the existence of and the reasons for the phenomena. The ambition is that this insight will work as a fundament for further research, with the aim to quantify the magnitude of the problem. The presented results stem from a literature review and from ten semi-structured interviews.

The interviews comprised a predetermined sequence of semi-structured questions (Interview-Guide), with options for follow-up questions. The sample consis of personal with management responsibilities, quality assurance, procurers and researchers with responsibilities regarding legislation, verification and control of materials entering the Norwegian market. Dialogue with the interviewees was encouraged. Questions were designed to explore the phenomena with the research questions in mind. The questions were all qualitative of nature (i.e. no questions involving numerical information or other quantitative approaches). Seven of the interviews were conducted face-to-face and three were carried out over the telephone. All interviews were audiotaped and transcribed. Resumes were sent to the interviewees for acceptance before the process of data analyses.

The aim of the literature review was to create a context for the research. Reviewing existing research and literature created a basis for the theoretical framework and to relate previous findings, theories and ideas to the problem (Blumberg et al., 2011).

The research theme of counterfeited materials came with some challenges. The first was the lack of knowledge on the subject in the industry. Furthermore, due to either a lack of knowledge or problems concerning communication, acquiring interviewees proved to be a challenge. The challenge of acquiring interviewees could be a result of counterfeiting being a sensitive subject. Another challenge was the scarcity of literature.

Regarding the sampling size, the population of personal with such professional roles, compared to the industry as a total, is quite small. Ten interviews were therefore considered as a necessarily convenient sample size. The approach of using a diversity of professionals from a small population made it difficult to determine whether each of the interviewees fulfilled the selection criteria. The solution was to contact each person to talk loosely about the subject, and then make a mutual evaluation of the candidate's further relevance for the study.

THEORETICAL FRAMEWORK

Increased globalization challenges the traditional supply-chain in construction projects. Import of products from emerging markets tosses an extended stress on producers, suppliers and contractors concerning quality assurance. The seller has to know about the local legislations in the market they want to trade their products in. The customers need to verify that the products they buy meet their requirements.

All flows of materials in the construction projects are typically categorized as forming part of a supply chain. A supply chain can be categorised according to three main axis; First, the flow of materials to the construction site, second, the temporary nature of the supply chain i.e. it is unique for each project, third, that the supply chain is designed to produce a specific product for one specific customer (Vrijhoef and Koskela, 2000).

Counterfeiting is generally understood to mean the "act of producing or selling a product containing an intentional and calculated reproduction of a genuine trademark"

(Launer and McCarthy, 1996). Grossman and Shapiro (1988) divide counterfeits into two categories, deceptive and non-deceptive. Deceptive counterfeits are products believed by the customers to be authentic and/ or according to the requirements requested. The non-deceptive are those products which customers know are counterfeits due to factors such as price, quality and lack of documentation.

The Construction Industry Institute uses the following categorizing of counterfeit materials (CII, 2010):

Class A – Goods produced by means of patent piracy; high-end goods that are as close as possible to real merchandise.

Class B – Goods that look nearly identical to genuine product, but that possesses sub-standard internal components and may cause catastrophic failures.

Class C – Obvious junk, poor quality goods that are easy to spot.

Being of an explorative nature, this paper does not limit its scope to parts of such categorisations. Rather, it defines counterfeit materials as materials that do not meet the specifications. This could be quality deviation, lack or insufficient documentation, unauthorized or not authentically certificates or reproduction of genuine trademarks. Thereby encompassing all occurrences within the Norwegian construction industry.

The Counterfeit Intelligence Bureau (CIB, 2016) states that counterfeiting is one of the fastest growing economic crimes worldwide. There is a great amount of cases of counterfeits worldwide spanning all sorts of industries. At one point the US Air Force, for instance, found counterfeit microprocessors in their F-15 fighter Jets. This could affect safety, operational readiness and costs (Journal of the IEST, 2010). A study published in 2014 did a search in three relevant databases (Counterfeit Intelligence Bureau, Federal Bureau of Investigation and Nexis). They found a number of 1,283 reports on counterfeiting (Stevenson and Busby, 2015). The reports ranged from pharmaceuticals, automotive parts and electronics to children´s toys. There are also examples of counterfeit products having fatal consequences; in 1989, a Convair 580 airplane crashed in the ocean on their way from Oslo to Hamburg, with 55 casualties resulting. The Aviation Accident Reports concluded counterfeited fasteners in the airplane tale caused the accident (HSL, 1989)

The construction industry is characterised by diversity. Construction projects range from commercial housing to large skyscrapers, from petroleum installations to bridges and other infrastructures. This implies that the industry face a diversity of potential counterfeit products. Previous research, such as Minchin et al. (2013), have identified cases of counterfeiting within the construction industry involving cranes, drywall, fly ash and pipes to mention some.

The potential impacts of counterfeiting are considerable. Construction projects are sensitive to changes in cost- and time schedules. Cunterfeiting can also potentially affect quality and safety. For many, a loss in reputation could be more devastating than a loss of profit. Recent example of economic consequences; a Wisconsin-based Architectural Firm was found guilty in repacking materials and falsify documentation in order to hide their use of noncompliant construction materials. The firm entered a guilty plea and paid $3 million in fees (USDJ, 2016).

There are a variety of gaps where counterfeit materials can be introduced into the supply chain of a construction project. Cheta (2008) identifies 5 common gaps where counterfeits potentially could enter the supply chain. Such gaps could be inadequate processes for approving suppliers or procurement being performed by third party contracts without adequate oversight from user. The contract itself could serve as a gap when liability and requirement to verify the authenticity of products are not emphasized or specified. Another gap is actors in the supply chain that does not apply adequate processes for verifying the authenticity of products. Such processes could be lack of inspections or verification of documentation on receiving materials.

Naderpajouh et al. (2014) has proposed a catalogue of risk mitigation strategies as a reference point for the construction industry. This catalogue consists of 19 different strategies ranging education of personnel to developing databases. The American National Standards Institute identifies four main topics in the fight against counterfeiting (ANSI, 2010). The first was collaboration and public-private partnerships. To share experiences, best practices and the use of common standards were all mentioned. The next point is education. Customers and consumers must understand the true impact of counterfeited products; as well as to learn how to avoid purchasing them. The third point was enforcement. This means that cases of counterfeited materials should be reported and then the authorities commit to follow up. It also means implementing proper security assurance programs, continually testing critical components, certification and other assessment activities. The fourth point is developing proper standards; Standards play a critical role in spreading best practices and assuring safety and quality.

FINDINGS

A consensus of the interviewees is that counterfeit materials are construction products that do not fulfil their requirements. Furthermore, the interviewees believe in a distinction between those who intentionally deliver products that do not meet the requirements and those who are not aware that the products do not meet the requirements. Some of the interviewees highlight the very broad aspect of the term counterfeit materials or the use of "fake" materials. This can be a product with right quality, but with deficient or lacking documentation. The term can as well be understood as a problem regarding quality and products that mislead the customers. The interviewee´s believed that the range of products that potentially could be counterfeit is broad. Among the product groups, most frequently mentioned were precast concrete elements, steel-reinforcements and other steel products such as fasteners. Products related to building facades such as glass, windows, fastening systems and others were equally mentioned. Table 1 shows the three major types of counterfeits identified from analysing the findings:

Table 1: Categorizing and characterizing counterfeit materials

Types of deviation	Explanation
Specification (Intentional/ unintentional)	Does not fulfil specifications according to contract, legislations, standard etc.

Documentation and certification	Does not have the required documentation. Not necessary a problem with product performance or quality
Quality	The product quality does not correspond with project specifications, product legislations or product standards

The majority of the interviewees had experienced counterfeited materials. One of the responders stated, *"I have not experienced manufacturers who deliberately tried to deceive us or selling us fake products. In the cases experienced we have not had enough expertise to check that foreign manufacturers follow Norwegian requirements or have proper knowledge of them."*

Concerning the question of what the interviewees *think about the state of the industry today regarding counterfeit materials*, the answers varied. The majority pointed at an increase of awareness regarding documentation of construction products, but the awareness regarding intentionally deceiving products seemed to be lacking. Table 2 shows cases of counterfeits the interviewees had experienced:

Table 2: Counterfeited products

Products	Explanation
Assorted steel products	Deviation in quality, wrong treatment, thickness, galvanization
Anchor bolts	Lack of compliance between certificate and test result
Fixing bolts	Deviation in quality
EPS-Foam Insulation	Wrong values according to specifications
Precast concrete	Wrong steel quality in the reinforcement Lack of control systems in the production
Insulation boards	Lack of certification/ documentation
Faucets and pipes	Lack of certification/ documentation
Building modules	Lack of certification/ documentation
Prefabricated Bathroom Modules	Lack of certification/ documentation
Facade cladding systems	Lack of certification/ documentation

Regarding the existence of counterfeited materials, the interviewees were also questioned about the potential reasons. One interviewee stated that the tough competition could be an incentive for some producers to take shortcuts. Among different reasons, two reasons stood out; one of them was profit; *"There is a financial reason. Inferior products cost less to produce. You also have producers producing a full-fledged product, but it costs too much to verify it. Then some might falsify documentation."* The other reason was lack of competence, such as competence on Norwegian legislations.

The consequence that nearly every interviewee mentioned was the potential of structural failure and the structures' resistance over time. Lower quality might increase the construction owner's expenses during the course of the structures lifetime. *"The consequence is largely on the customer side, precisely because it is only in the future that you see if the quality of the product is right in regards of what you actually paid for."*

On the contractor side, consequences like delays, cost overruns, safety and loss of reputations were all mentioned. There was a consensus among the interviewees that

projects were indeed vulnerable. Tight time- and financial budgets, lack of competence regarding procurement were mentioned as reasons. To the question regarding which consequences counterfeiting *should* have, one interviewee answered; *"You must distinguish between conscious and unconscious. If you deliberately tried to deceive anyone there should be major consequences. If the reason is negligence, such as when a buyer has chosen to only look at the price, there should also be some consequences."*

The interviewees described a variety of methods for discovering and mitigate the risk of counterfeited materials. The contractors empathized on developing competence on procurement; *"The general procurer who buys everything in a project is on its way out. The reason why we think that is because one procurer will not be able to have the necessary overview of the specifications of all the products needed"*

Many addressed increased awareness, better communication, and exchange of experience. Some mentioned the advantage of developing a database with approved suppliers. A quality manager mentioned use of risk analyses: *"What I think is the most important measure is the risk analysis, where one takes a multidisciplinary review of what can go wrong and how to control this."*

There was a broad consensus among the interviewees that the regulations surrounding construction products today was (in some way) not good enough. The reasons were different; some want more oversight from the authorities. Others pointed out that the rules were unclear or cumbersome. The industry is much based on self-regulation and that could be problematic in relations to counterfeiting.

Table 3 shows different methods mentioned as potentially effective to combat counterfeit materials.

Table 3: Strategies

Types	Explanation
Use of tools; Databases, archives	Databases showing legitimate suppliers and producers
Competence	Train and educate personnel both in the procuring process and controlling process Know what questions to ask Know the requirements and legislation
Inspections	Inspect the supplier/ producer Inspection on deliveries
Partnering	Partnership and commitment between contractors and suppliers
Risk analyses	Plan and analyse which deliveries are critical and should be inspected/ tested
Reporting	"Whistle blowing" Report to government or other institutions
Demand documentation	Product documentation needs to be controlled and verified
Supervision	Third party control Active supervision from government

DISCUSSION

The findings show that the industry has a very divergent perceptive on counterfeiting, and counterfeited materials. For some, this was a completely new concept. No cases of imitations, product violating intellectual property or trademarks were discovered. It is interesting that few of the interviews regarded imitations as a category of counterfeit. From other industries, producers producing imitations of genuine products are a large part of the problem. The reason could be many; the construction industry has not been exposed to these kinds of cases and thereby the lack of awareness. Another reason could be the types of personnel interviewed with their personal competence and awareness.

All of the interviewees had in some way experienced counterfeited materials. New types of products such as building modules seem to be vulnerable. The development of prefabricated modules has increased in recent years but it seems that the product standards have not had the same kind of development. This means that neither the producers nor the customers know what documentation that is required. The same can be said about new products, and new types of products entering the market. There are reasons to believe that in the majority of the cases, the involved parts have not deliberately tried to deceive the customer. It is a matter of lack of knowledge, on both customer and supplier side.

None of the interviewees reported having encountered serious consequences to any of the cases of counterfeit materials. Since the intentions in most cases were not perceived to be deliberately deceptive, the consequences are typically rework or resupplies. This implicates economic consequences. For the contractor, rework can be critical whether the project succeed or not. In cases where materials lack documentation, the customer typically grants special permission to continue using the product. This occurs in cases were the product is not critical for quality, safety or durability. The amounts of evidence needed to convict a contractor or supplier for knowingly have used or delivered counterfeited materials are extensive, making the clients hesitate to use legal measures.

In cases such as those with precast concrete elements, fixing bolts and anchor bolts, the client demanded testing for verifying the quality. As a consequence, they started to control every delivery on that specific project. The probability of counterfeited materials affecting structural integrity is fairly low, because structural integrity is a well-regulated part of a construction project. Counterfeited materials will still affect the overall quality because the clients do not get what has been paid for. This resulting in increased cost regarding management, operation and maintenance of the building.

Reducing the risk of being victim of counterfeited materials requires companies to implement an effective anti-counterfeiting strategy. Step one is to increase the awareness; you have to know the problem before you can solve or prevent it. The next step that both literature and the interviewee's points out is to develop competence. For example, a contractor should be using specialized procurers, cost should be avoided as the only factor in procuring and the industry will have mutual gain on increasing the focus regarding documentation of construction products. The procurer should have adequate knowledge about the products they procure such as related specification and legislations.

As the literature states, several gaps exist where counterfeit materials can enter the supply chain. In combination with a lack of awareness, a lack of anti-counterfeit strategies, and a constant time- and cost pressure, this renders the industry vulnerable.

CONCLUSION

The purpose of the present study has been to examine the phenomena of counterfeit in context of the Norwegian construction industry. There were relevant findings to all of the initial research questions. The research found that the industry categorizes counterfeited materials as a problem regarding lack of documentation and delivering of products with wrong specifications according to the requirement. Counterfeited materials as imitations of genuine materials was not regarded a problem by the interviewees, even although this is considered a major problem in other industries.

As for the existence, counterfeited materials should be considered an existing problem in the industry. The magnitude of the problem is unknown. The difficulty in judging whether the documentation or the product itself is fabricated or genuine poses a major obstacle for the industry.

A variety of consequences stem from the use of counterfeited materials. Increased quality assurance, inspections, testing and other activities are consequences. Rework or resupply is common for contractors and the suppliers. The client consequently gets a product with quality that differs from what expected. The sum of it is much unnecessary stress on the supply chain and an increase in overall cost in the industry. Counterfeit materials may cause waiting, rework and increased need for control of the supply chain; all of those activities could be categorized as "necessary waste" (Koskela, 2000).

According to the research, the most effective way to discover and mitigate the risk of counterfeited materials entering the supply chain is to increase awareness. With awareness comes development of competence, attitude and ethics regarding the phenomena. Companies should take counterfeit materials seriously and implement an anti-counterfeiting strategy to mitigate the risk of counterfeit products in their supply chain. The anti-counterfeiting strategy should be implemented with the aim of minimizing waste and securing built in quality.

This paper proves of the existence of phenomenon in the industry. The magnitude of the problem is unknown; a quantitative research regarding the magnitude should consequently be carried out. There is equally a need for research regarding anti-counterfeiting strategies. Developing a framework for effective methods and implementation of anti-counterfeiting activities in the supply chain management would be essential to prevent further cases of counterfeited materials within the industry. The sample size of ten in-dept. interviews was considered suitable to initially explore the phenomena. This study should be used as an introduction to more formal and extensive research in the future. Regarding consequences, unknown chemical composition possesses a threat to health and safety; this should be addressed in further research.

REFERENCES

ANSI 2010. Best Practices in the Fight against Global Counterfeiting. http://publicaa.ansi.org/: American National Standards Insititute.

Arditi, D. & Gunaydin, H. M. 1997. Total quality management in the construction process. *International Journal of Project Management,* 15**,** 235-243.

Berman, B. 2008. Strategies to detect and reduce counterfeiting activity. *Business Horizons,* 51**,** 191-199.

Blumberg, B., Cooper, D. R. & Schindler, P. S. 2011. *Business research methods,* London, McGraw-Hill Higher Education.

Cheta, A. 2008. Counterfeit and rogue industrial parts and materials, and their impact on safety and reliability. *American Society of Mechanical Engineers, Pressure Vessels and Piping Division* Chicago, Illinois, USA: ASME.

CIB. 2016. *Counterfeit Intelligence Bureau* [Online]. https://icc-ccs.org/icc/cib: International Chamber of Commerce. [Accessed 2016].

CII 2010. Product Integrity Concerns in Low-Cost Sourcing Countries: Counterfeiting within the Construction Industry. *In:* THOMAS, J. (ed.). Construction Industry Institute: The University of Texas.

Grossman, G. M. & Shapiro, C. 1988. Counterfeit-Product Trade. *The American Economic Review,* 78**,** 59.

HSL 1989. Rapport om luftfartsulykke i Skagerrak, 8. september 1989. *In:* TRANSPORT, S. H. F. (ed.). http://www.aibn.no/: Havarikommisjonen for sivil luftfart (HSL).

Journal Of The IEST 2010. Mitigating the Risk of Counterfeit Parts. *Journal of the IEST,* 53**,** 5.

Koskela, L. 2000. *An exploration towards a production theory and its application to construction*, VTT Technical Research Centre of Finland.

Launer, E. E. & Mccarthy, J. T. 1996. Mccarthy's Desk Encyclopedia Of Intellectual Property. JSTOR.

Minchin, R. J., Cui, S., Walters, R., Issa, R. & Pan, J. 2013. Sino-American Opinions and Perceptions of Counterfeiting in the Construction Supply Chain. *Journal of Construction Engineering and Management,* 139**,** 1-8.

Naderpajouh, N., Hastak, M., Gokhale, S., Bayraktar, M. E., Iyer, A. & Arif, F. 2014. Counterfeiting risk governance in the capital projects supply chain. *Journal of Construction Engineering and Management,* 141.

Stevenson, M. & Busby, J. 2015. An exploratory analysis of counterfeiting strategies. *International Journal of Operations & Production Management,* 35**,** 110.

UNICRI 2011. Counterfeiting: A slobal spread, A global threat *In:* INSTITUTE, U. N. I. C. A. J. R. (ed.). United Nations Interregional Crime and Justice Research Institute: United Nations Interregional Crime and Justice Research Institute.

USDJ 2016. Wisconsin Architectural Firm Plead Guilty *In:* DIVISION, C. (ed.) *Wisconsin Architectural Firm to Plead Guilty and Pay $3 Million to Resolve Criminal and Civil Claims.* The United States Department of Justice.

Vrijhoef, R. & Koskela, L. 2000. The four roles of supply chain management in construction. *European journal of purchasing & supply management,* 6**,** 169-178.

Wang, F. & Wang, S. Applying Logistics to Construction Material Purchasing and Supplier Evaluation. System Science, Engineering Design and Manufacturing Informatization (ICSEM), 12-14 Nov. 2010 2010. 90-92.

Yin, R. K. 2013. *Case study research: Design and methods*, Sage publications.