

AN INSTITUTIONAL ANALYSIS OF HOW THE CONSTRUCTION INDUSTRY'S COMPLEXITY AFFECTS WASTE: AN ALTERNATIVE RESPONSE TO FUTURE MARKET DEMANDS FOR SUSTAINABILITY

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As a main consumer of resources and an important economic driver, supranational authorities (UN/EU) are expecting the construction industry to address sustainability issues, making the construction process an extremely complex activity. A response to this complexity is often expressed through technologies, strategies, and organisations. However, the effect of waste, defects, and failures affecting both productivity and sustainability has increased due to e.g., tough competition, temporary exchanges, and individual utility maximisation. This has been discussed for many years, where knowledge on the institutional causes for waste is still needed to qualify and target future initiatives stressing the 'Build Back Wiser' theme. We analytically address the waste phenomenon through a lens of institutional theory and a mixed-method inquiry; interviews, literature search and index data linking societal expectations and industry responses. We contribute with understandings on how strategic partnerships can be a response to supranational authorities and future market demands for sustainability.

Keywords: complexity; partnerships; productivity; sustainability; waste

INTRODUCTION

The construction industry is an important part of the global economy, creating growth, jobs, and welfare. However, its activities lead to global warming, pollution, and resource scarcity. The construction industry accounts for 38% of the global CO₂ emissions, of which less than 1% comes from constructing the buildings, almost 10% from material manufacturing, and the remaining 28% from the use phase (UNEP, 2020). The construction and maintenance of buildings and infrastructure represent almost 50% of the global material consumption, and in return generates 40% of solid waste streams, while around 10-15% of building materials are wasted during construction and 54% of demolition materials are landfilled (Eberhardt *et al.*, 2021).

Considering the significant societal impact of the construction industry, an immediate response to ensure a more ambitious sustainable development is needed. Thus, supranational authorities (EU/UN) are expecting the construction industry to address

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different issues, e.g., resource scarcity, CO₂ emissions, and productivity, making the building process a complex activity. The Danish construction industry is trying to handle this complexity through different technologies, strategies, and organisations. Yet, the effect of defects, failures, waste, and rework collectively referred to as 'waste' has increased over the previous two decades. This is reflected in a recent study of waste in the Danish construction industry (de Place Hansen *et al.*, 2021), including a development of a 'waste index', created in 2007 (Nielsen and de Place Hansen, 2007).

Figure 1, highlighting the Danish construction industry waste index during 2004-2019, shows that the amount of waste, in 2004 estimated to make up 10% of the construction activity and costs, still must be taken seriously. This indicates that while the extent of waste has remained practically unchanged, or in some isolated instances even decreased, the overall effect of waste correlates with macroeconomic factors. In 2004, the total construction waste in Denmark was estimated to 10% of the production value EUR 1,6B, which is equal to EUR 3B in 2021 (Erhvervs- og Byggestyrelsen, 2004).

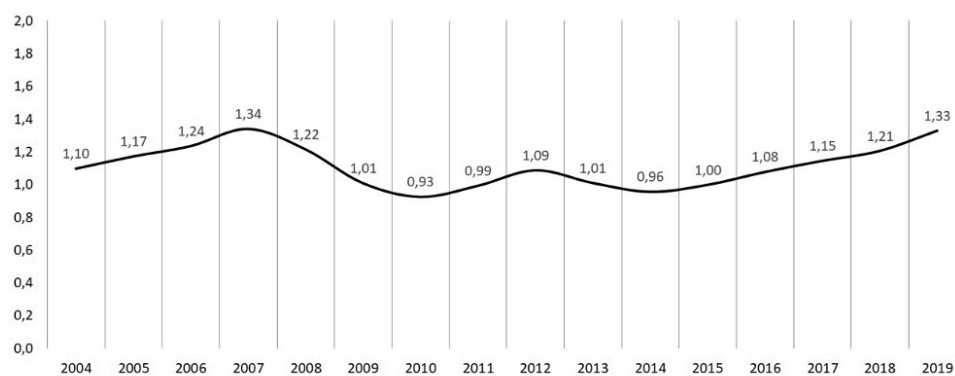


Figure 1: The Danish construction industry waste index during 2004-2019

To assess the waste phenomenon a holistic definition is adopted as: 'any unnecessary deviation with a negative impact on the overall organisational result or project performance' (Love and Smith, 2018). This definition can be divided into two types: 'process waste', e.g., erroneous decisions and actions that produces an incorrect result, and 'product waste', e.g., building defects and excess use of materials. The waste phenomenon causes significant loss of value and impacts, e.g., resource consumption, CO₂ emissions, and productivity, involving direct and indirect costs. Although having been discussed for many years, systematic knowledge on the causes for waste is still needed to qualify future initiatives. The waste phenomenon is being neglected due to its complex nature, which we believe are related to competing institutional settings. Thus, revisiting this complex issue, is a pivotal step towards the 'Build Back Wiser' theme intriguing new knowledge on how the waste phenomenon is related to both productivity and sustainable development in the Danish construction industry.

The objective of the paper is to scrutinize the interplay between institutional pressures and organisational responses in relation to the waste phenomenon. The analysis is made at project, organisational and industry level to understand the consequences of different industry mechanism and dynamics in an institutional perspective. This involves a mixed-method approach using semi-interviews, waste index data, and background literature creating more nuanced insights. The paper proceeds as follows: first, the theoretical perspective is presented, which is based on institutional theory. Then the method is described before moving on to the multi-level analysis. This approach creates an understanding of how competing institutional logics leads to

complexity and an increased amount of waste. Next, the analytical results are discussed and related to the sustainable development of the Danish construction industry. Finally, the conclusions and suggestions for further research are presented.

Due to the Danish construction industry's institutional structures and pluralistic characteristics, the waste phenomenon become equally multifaceted and complex. The pluralistic characteristics originate from a myriad of demands and perceptions (or logics) that coexist and competes based on legitimacy. Pluralism can be difficult to handle, involving multiple societal demands creating, e.g., contradiction between productivity and sustainability requirements. When these different demands and perceptions are incompatible, complexity arises. Analysing institutional complexity involves central institutional theory concepts, e.g., pluralism, complexity, logics, agency, and legitimacy, all of which describes how norms and conventions affects change in social structures. In a general sense, pluralism denotes diversity and societal coexistence, complexity: intricacy and numerosity, logics: modes of reasoning, agency: exertion of power in temporal engagements, and legitimacy: conformance to recognized principles (Greenwood *et al.*, 2011). By perceiving the construction industry as a social system or field, i.e., as a group of actors that abides to different logics in a shared construct, we apply a more systemic approach for understanding how the interrelatedness between different levels, e.g., project, organisation, and industry, defines complexity in relation to analysing the waste phenomenon.

Thus, we argue for an institutional theoretical perspective that addresses systemic complexity, which we find appropriate for analysing the interplay and competition between different ideal institutional logics, i.e., professional, corporate, and market (Goodrick and Reay, 2011), as well as the community logic (Thornton *et al.*, 2012) introduced in the discussion. The professional logic applies when professionals work with other professionals in the same profession and are often supported by pragmatic legitimacy. The corporate logic applies when professionals are employees in a firm, and managers, not professionals, determine the content and organisation of work and the necessary credentials and sanctioning, and are often supported by regulatory legitimacy. The market logic applies on neoliberal understandings (or capitalism) and are often supported by normative legitimacy. Finally, the community logic are the embodiment of local beliefs, norms and rules which are rooted in efforts to ensure the commitment of individuals to a network through means of culture, identity, and values, and are often supported by cultural-cognitive legitimacy (Deepphouse *et al.*, 2017).

METHOD

A mixed-method approach is chosen, as it enables an abductive and qualitatively driven research paradigm with complementary strengths. The abductive approach is expressed through an empirical problem (the waste phenomenon), where the analysis and discussion create contexts and patterns across the empirical data through a lens of institutional theory (Dubois and Gadde, 2002). A qualitative coding has been created across the empirical data involving a literature search, index data, and semi-structured interviews. The literature search has been conducted in the Scopus database targeting process and product themes, e.g., defect, waste, risk, rework, failure, and error in the construction industry. The waste index data was generated based on the 'Danish index of construction defects' (Nielsen and de Place Hansen, 2007) and the recreated index

(de Place Hansen *et al.*, 2021), involving data on waste from Danish sources, focusing on macroeconomic statistical data regarding construction costs and activity.

Eleven representatives from the Danish construction industry were interviewed, representing five roles: client, architectural consultant, contractor, researcher, and insurer. The interviews were based on an interview guide addressing different open questions about how e.g., project processes, organisations, company structures and industry environments influences the waste phenomenon as well as more reflective questions on productivity and sustainability. The statements were transcribed and coded according to different 'identify patterns', which was used to qualitatively capturing the different institutional logics, i.e., professional, corporate, and market in the empirical data (Reay and Jones, 2016). Initial results have been coded in Table 1, stressing various solutions and problems mechanisms as well as linking institutional theory and the empirical data to the multi-level analysis of the waste phenomenon.

| Levels and logics | Empirical problem mechanisms | Empirical solution mechanisms |
|--|---|--|
| Project: Influenced by the professional logic and pragmatic legitimacy | Low influence, client changes, and narrow cost focus counteracts performances. Time and economic pressure reduce motivation and poor initial planning affects the entire operational process. | Early involvement practices, operational awareness and focus on buildability through the different construction phases. Better process management, planning, coordination, and stronger professionalization. |
| Organizational: Influenced by the corporate logic and regulatory legitimacy | Difficult to meet societal pressures, high-risk scenario, low earnings, and hidden economical buffers. Lack of leadership, communication, learnings and academization creates organizational misalignments. | Risk and quality management, and better alignment between formal strategies and the operational process. Stronger strategic handling of the uncertainty and variation that defines specific construction processes. |
| Industry: Influenced by the market logic and normative legitimacy | Competitive tendering, re-tendering, deadline pressure and many legal disputes. Lack of stability and continuity. Project-based organizations, fragmentation, and short-term relationships. | A partnership and process-oriented approach focusing on planning and coordination of common workflows and cooperation throughout the value chain creating e.g., repetition effects and a more solution-oriented culture. |

Table 1: Various mechanisms of solutions and problems of the waste phenomenon

In sum, the mixed-method approach creates an opportunity to triangulate the empirical data to better analyse the waste phenomenon in the institutional setting of the Danish construction industry. Yet, generalisations are not universal, but context based and require understandings of how this study differs from other studies (Siggelkow, 2007).

ANALYSIS

Institutional complexity refers to the experience of incompatible prescriptions from different logics that coexist or compete in the same field (or industry). The field perception is utilized in the analysis to dissect and understand institutional complexity in the Danish construction industry across different levels, i.e., project, organisational and industry. Thus, emphasizing an analytical focus on how different institutional logics dominate and influences these different levels creating complexity and waste.

Project Factors and the Professional Logic

A construction project can essentially be seen as a temporary social system involving a set of agreements made between different actors to complete a specific task. In the early project stages a multitude of decisions for the functionality of the finished building are made, which will affect the outcome of the construction project - the physical building. Even at this early stage, the professional logic may be at play involving pragmatic legitimacy (it must be buildable). This often applies to early

involvement practices, where there are interactions between e.g., client, architect, and engineer, and to some extent the contractor. However, a high level of abstraction is present at this stage, as the proposed building is still an abstract idea that is being specified and designed, which does not necessarily create a high influence of the professional logic. As for subsequent project complexity and waste, this is where the first errors are made that will potentially permeate the rest of the construction project.

The client is often subject to entering agreements with the cheapest contractor heavily influenced by the market logic, but only 56% of construction projects meet the agreed budget and only 48% comply within the time frame (Eke *et al.*, 2019). This calls for a greater focus on buildability instead of a narrow cost focus. Moreover, the client's change of materials, designs, plans, or objectives have the greatest negative impacts on costs, quality, and waste (Hwang *et al.*, 2014). These issues are supported by the architects' respondents, stressing that the client is the culprit for waste. This is allegedly due to a lack of understanding for the subsequent production processes, which is dominated by professional logic. Yet, there are different attitudes to early involvement and influence of the professional logic expressed by an architectural respondent: "If you focus on buildability too early, you might miss requirements for what it is you're building. So, if the contractor is involved too early, they will likely be more occupied by how to build, more than what to build". In contrast, one of the contractor respondents argues that: "early involvement is essential for reducing waste and stresses the importance of getting involved in the early project stages".

Lack of motivation caused by changes appears to be a significant cause of waste but can also be accredited to commitment if the actors can't find meaning in their work. This is emphasized by a culture of perpetual time pressure and intense competition of lowest price, where time and economic pressure has a negative effect on behaviour (Josephson and Hammarlund, 1999). This is unveiling an inefficient influence of the market logic, which is normative legitimized or what is considered appropriate on a neoliberal market. The client's primary interests are arguably economical and temporal; the architect's interest - especially when acting as the client's consultant - reflects the client's interest, needs and requirements into a realisable project material; and the contractor's primary interest is in buildability and biggest possible earning, which, naturally, applies to competition between the market logic and the professional logic. This competition is manifested by various inconsistencies across the construction phases leading to complexity and waste. The result is that the production is initiated before the project is ready to handle the execution, with frequent rework, delays, interruptions, and complications leading to both process and product waste.

Organisational Factors and the Corporate Logic

In the field of the construction industry, there are embedded different organisations, where the dominant and major contractor companies are guided by the corporate logic. The corporate logic is based on regulatory legitimacy through formal structures and sanctioning. In an organisational perspective, the contractors' success is based on its ability to create market legitimacy by responding to societal expectations, e.g., digitalisation, sustainability, and productivity. However, efficient handling of institutional pressure is expressed through a high-risk scenario. Thus, handling risks plays a crucial part in the company's performance and especially in relation to a low earnings margin of 3-5% in the Danish construction industry. Contractors seek to respond to institutional expectations and risks through strategies, organisations, and management. Yet, the corporate logic competes with the professional logic, and

within major organisations, where there often is a misalignment between the main organisation and the project organisation. Moreover, contractors often employ hidden economical buffers due to risks, which conflicts with the overall intent of reducing waste, as any protective buffers can be regarded as waste (Ortiz *et al.*, 2018).

This problem is expressed through an ongoing implementation of formal quality management, but errors and defects continue to arise in the construction industry (Jingmond and Ågren, 2015). This indicates that it is difficult to produce building components, systems, and installation processes, adapted to specific dimensions, variations and insecurities that characterizes a construction project. Seemingly, these problems can be accredited to human errors on the operational level, which is influenced by the professional logic, but they can often be related to organisational factors in the form of a lack of leadership and communication on strategic levels (Love and Smith, 2018). This misalignment between the corporate logic and the professional logic was pointed out by a contractor respondent, who emphasized that managerial 'academisation' of the construction industry has impacted the production process in a negative way: "Academics can do a lot of things very well, but there tends to be a lack of practical understanding of what aspects are needed when the operational phases start". Despite a somewhat reluctant stance towards including academia (or business school understandings) into management, the interviewees agree that a more practical understanding plays an important part in reducing waste.

To a contractor, waste is not just temporal and economical, but also physical, i.e., construction materials. And to reduce waste, different perspectives on waste must be considered when designing an effective project-organisation, as these perspectives are not only determined by the professional logic but are also heavily affected by the company's formal business models and strategies involving the corporate logic. Yet, an ongoing academisation of the construction industry is taking place, as claimed by a contractor respondent: "I think there's a tendency to the early project phases getting academicized. Often, a practical understanding is missing". The contractor elaborates through describing how it used to be a tradition that you started your career in the production, then progressed to engineer, and then you could become an architect or part of senior management in a contractor organisation. Yet, formal organisations are dominated by the corporate logic (or business school understandings) leading to misalignments and thereby waste between the formal organisation and the production.

Industry Factors and the Market Logic

When different types of construction organisations are enclosed by the same field, a common set of structures and norms is defined and enforced by a dominant market logic, e.g., conjectures, tender forms, and cooperation models. The market logic is apparent in the way that different organisations respond to societal expectations, where waste is about financial means, more than a consideration of sustainability. The market logic is characterized by neoliberalism (or free market forces) involving competitive tendering, which is a cause for waste. This is evident by an architect respondent: "the way these projects are put out to tender and the competition it creates, causes a magnitude of issues and consequent waste, defects and errors, that are very apparent in construction". This is a general issue with many interfaces, including time pressure: "Add time pressure to competitive tendering, then you are sometimes forced to send a project out to tender before it is buildable, so you can meet the deadline". Thus, the market logic competes with other logics, e.g., the corporate

and professional logic, which emphasizes a constellation of several logics that affects the construction processes throughout the different phases and activities.

One solution mechanism to accommodate this issue of competitive tendering and time pressure, is initiatives aimed at increasing cooperation throughout the value chain, as indicated by Fernandes *et al.*, (2018), who argue that partnerships or strategic alliances can make construction more efficient and less resource demanding through repetition effects and stronger relationships. These approaches can potentially foster more cooperation, trust, and solution-oriented culture, than what is traditionally associated with the construction industry. This would in turn reduce the extent of e.g., errors, defects, and legal disputes. However, this approach necessitates effective interactions and adjustments between the various logics rather than competition and dominance of only one logic stressing a more pluralistic response to institutional expectations and demands (Fredslund, 2021). Thus, a productive and quality conscious construction industry prerequisites a more partnership and process-oriented approach focusing on planning and coordination of common workflows, resulting in a higher construction quality (Sacks *et al.*, 2017). Reduction of general waste are achieved by continuous notification, assessment and indication of work processes focusing on stability, continuity, and evaluations. This approach means increased focus on involving all parties in the early project processes or the adoption of a partnership organisation creating cooperation, knowledge sharing and communication across the value chain.

Such approaches are significant for e.g., minimizing erroneous deliverances and unfit products on the construction site, as well as reducing waste in the construction processes (Alves *et al.*, 2020). Despite this premise, few organisations in the Danish construction industry assess their quality costs, understood as internal costs, e.g., errors and rework and external costs, e.g., negative reputation before and after a product or service has been delivered (Love and Li, 2000). This problem may help to explain why the waste percentage has been constant in recent decades. In sum, a reproduction and focus on the market logic fails to reduce waste in the Danish construction industry.

FINDINGS

The findings of the multi-level analysis indicated that the Danish construction industry is characterized by complex business processes and project-based organisations that fosters uncertainty, risk, and inadequate quality, despite its societal significance. The level of complexity is high in the Danish construction industry due to inefficient competition between logics, e.g., professional, corporate and market, which leads to both process and product waste. A partnership organisation is highlighted across the literature and respondents as a significant solution mechanism among other potential initiatives. The assumption is that a partnership approach creates effective interactions and adjustments between the different logics involving a more pluralistic response to different institutional pressures, demands and expectations. This approach is stated through new forms of strategic partnerships in the Danish construction industry, focusing on interactions and adjustments between logics, rather than an ineffective competition and dominance of one logic obviously increasing waste and negative externalities. As such, the strategic partnership approach has created fewer disputes, stronger productivity, repetition effects, long-term cooperation, and less waste.

In advocating the need for partnerships and organisational harmonisation across the Danish construction industry in general, we argue that there is a misalignment between how waste is perceived and created at different levels, e.g., project, organisational, and industry stressing an inefficient competition between logics. This misalignment significantly adds to the institutional complexity that permeates the construction industry, and consequently maintains the level of waste. The metrics for the first Danish index of construction defects (Nielsen and de Place Hansen, 2007) did not take macroeconomic factors into account, whereas the new Danish waste index (de Place Hansen *et al.*, 2021) reflects the overall level of waste in the Danish construction industry relative to surrounding factors, e.g., development of construction activity and costs. More activity and higher costs equal a larger waste impact affecting productivity and the sustainable development of the Danish construction industry.

It is based on these issues that we will introduce the community logic, which is legitimized by conforming to meanings that supports the overall sustainable development of the society. In a sustainability perspective, the community logic is currently supported by different supranational ambitions, e.g., the UN 2030 Agenda for Sustainable Development and the EU Taxonomy on Sustainable Activities, involving a transformation to the circular economy. The circular economy is interesting since waste does not exist in an ideal form and actors work together in more aligned and long-term relationships, creating different product or service loops. Thus, the community logic is based on the constitution of a community through shared values and ideologies involving a more 'cooperative capitalism' (Thornton *et al.*, 2012) or solidarity-based economy with a greater regard for both sustainability and circularity.

In a historical perspective, economic needs have preceded environmental needs, as the former legitimized itself before the latter. Sustainability did not receive attention before the issue of climate change was legitimized relatively recently as an all-encompassing concern. In the Danish construction industry, public tendering is governed by EU legislation, which we argue is reproducing the market logic intended to govern fair market competition. However, it contributes to loser/winner benefits, contractual cooperation, conflicts, and waste affecting motivation, cost, reputation, and the environment. This is an example of how different sustainability aspects, i.e., economy, social and environment are affected through waste and a reproduction of the market logic. Hence, sustainability ought to be recognized as a new core premise in the institutional field of the Danish construction industry, involving a stronger influence of the community logic adjusting the 'taken-for-grantedness' of the current market logic. We therefore argue that relevant attributes of the community logic must be involved in the constellation of logics affecting the overall structures and practices of the Danish construction industry. In this pursuit, we advocate for a more pluralistic response to the waste phenomenon addressing an ambitious sustainable development.

CONCLUSION

The institutional perspective has helped to better understand the ineffective and self-replicating practice that perpetually produces waste through institutional complexity in the Danish construction industry. Apparently, waste did have an increasing effect over the past two decades, understood by an ineffective competition between different logics, e.g., professional, corporate and market. The Danish construction industry should potentially focus on a strategic partnership approach, involving a pluralistic

constellation and interactions of different logics, to reduce disputes, misalignment, and waste. The partnership approach not only entails a reduction of waste, but at the same time creates an opportunity to involve other empirical solution mechanisms, e.g., early involvement, process management and organisational alignment. At the same time, this creates a better opportunity to respond to supranational ambitions (EU/UN), which is highly influenced by the community logic e.g., the EU Taxonomy on Sustainable Activities or the 17 UN SDG 'Partnerships for the Goals'. Thus, a future pluralistic constellation of logics must seek relevant influence from the community logic stressing a more solidarity-based economy with a greater regard for both sustainability and circularity. As such, the paper contributes with a more holistic and institutional understanding on how the waste phenomenon can be related to relevant empirical problems and solutions in the Danish construction industry including the overall sustainability challenge. This approach stresses the 'Build Back Wiser' theme creating new knowledge about how to handle historical and well-known issues in the Danish construction industry by addressing relevant problems of the future. Further and more empirical research into radical change of the waste phenomenon is of course necessary, and particularly how waste can accurately be converted into CO₂ values.

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