

“To Him Who Has, More Will Be Given...”

*A Realist Review of the OHSAS18001 Standard of OHS Management*

Madsen, Christian Uhrenholdt; Kirkegaard, Marie Louise; Hasle, Peter; Dyreborg, Johnny

*Published in:*

Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018) - Volume IV

*DOI (link to publication from Publisher):*

[10.1007/978-3-319-96080-7\\_18](https://doi.org/10.1007/978-3-319-96080-7_18)

*Creative Commons License*

Unspecified

*Publication date:*

2018

*Document Version*

Early version, also known as pre-print

[Link to publication from Aalborg University](#)

*Citation for published version (APA):*

Madsen, C. U., Kirkegaard, M. L., Hasle, P., & Dyreborg, J. (2018). “To Him Who Has, More Will Be Given...”: A Realist Review of the OHSAS18001 Standard of OHS Management. In S. Bagnara, T. Alexander, Y. Fujita, R. Tartaglia, & S. Albolino (Eds.), *Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018) - Volume IV: Organizational Design and Management ODAM, Professional Affairs, Forensic* (4 ed., pp. 140-149). Springer. [https://doi.org/10.1007/978-3-319-96080-7\\_18](https://doi.org/10.1007/978-3-319-96080-7_18)

#### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

#### Take down policy

If you believe that this document breaches copyright please contact us at [vbn@aub.aau.dk](mailto:vbn@aub.aau.dk) providing details, and we will remove access to the work immediately and investigate your claim.

## **"To him who has, more will be given..." – A realist review of the OHSAS18001 standard of OHS management**

*Christian Uhrenholdt Madsen<sup>a</sup>, Marie Louise Kirkegaard,<sup>b</sup> Peter Hasle<sup>a</sup>, and Johnny Dyreborg<sup>b</sup>*

<sup>a</sup> Department of Materials and Production, Aalborg University, Denmark

<sup>b</sup> The National Research Center for the Working Environment, Denmark

### **Abstract**

*The OHSAS18001 standard was first published in 1999 by British Standards and is now the most widely adopted management systems for occupational health and safety worldwide. The standard is intended to support companies in attaining a higher health and safety standard. However, there is limited knowledge on how this standard in fact is working in practice and thus can improve health and safety at work.*

*In order to investigate how the OHSAS18001 standard is working in practice, we identified the main mechanisms assumed to be actively involved in the successful implementation and management of the standard, by using a framework inspired by a realist methodology. In line with this methodology, we assessed how the context of the adopting organizations impinges on the identified mechanisms and synthesized the findings into useful knowledge for practitioners and fellow researchers alike.*

*The starting point for the analytical process is the program theories that we identified in the standard and supplementary materials from key stakeholders. Thus we analyze how key stakeholders and policymakers expect the standard or program theory to work when it is implemented in an organizational setting. The three program theories (PT) we identified are: An 'operational' PT, a 'compliance' PT, and an 'institutional' PT.*

*Then we compared these 'assumed' program theories to how the OHSAS18001 actually worked in real-life settings. We identified four so-called context-mechanism-outcome configurations by reviewing available empirical studies and by extracting knowledge from them. These CMO-configurations are: 'Integration', 'learning', 'motivation' and 'translation'. This analytical approach means that our paper provides both i -depth understanding of the assumed program theories behind the OHSAS18001 standard and understanding of the actual mechanisms of certified*

*management systems in occupational health and safety management in various context presented by the included implementation studies.*

## **Introduction**

Organizations increasingly seek to resolve and mitigate occupational health and safety concerns with the use of voluntary and certified occupational health and safety management systems. The OHSAS18001 standard, which was first published in 1999 by British Standards, furthered this tendency, and is by now the most widely adopted management systems for occupational health and safety worldwide. The OHSAS18001 standard is becoming more and more important in the governance of health and safety in companies, and thus it becomes paramount to understand both how these new management systems are intended to work, but also importantly, how they actually 'work' within organizations.

There are already a number of empirical studies on the use of OHSAS18001, generally divided into two streams of research: One stream of research has sought/has tried to measure effects of the OHSAS18001 on organizational performance in general and on organizational safety outcomes in particular [1]–[3]. These studies point to a positive effect of the certification process on organizational safety performance. Lo and colleagues [2] report a decline in compliance failures from US-based manufacturers [2]. Abad et al. not only describe a positive effect of the OHSAS-certification but also demonstrate how this effect increases with the number of certification years, leading them to conclude a learning effect in the Spanish organizations in their study [4]. However, studies of this kind rarely describe the processes and social mechanisms inside the organizations that may lead to safety outcomes in the end.

A second stream of research has tried to uncover the internal organizational dynamics related to the implementation and utilization of OHSAS18001 (cf. [5]–[10]). This research mainly utilizes case studies based on qualitative methods to uncover the social interactions and structurations related to the organizational adoption of the standard. These types of studies are often specific and bound to the particularities of the cases without providing much details and prescriptions for future implementations in other contexts. The integration of these two streams of research is so far not developed, and knowledge about the organizational mechanisms related to positive OHS outcomes is therefore lacking. We intend to fill this research gap by reviewing the existing studies on OHSAS18001 in order to integrate knowledge that is rich on contextual details, but still provides valuable insights into the generalizable mechanisms and processes for future implementations.

To achieve this goal, we have conducted a review inspired by a realist approach [11] of the use of OHSAS18001 and the social mechanisms it activates within organizations. In this way, we have utilized both qualitative and quantitative studies in our synthesis. We have researched the use of the OHSAS18001 across a range of different albeit comparable organizational and regulatory contexts in different industries and countries across OECD-member states. Thereby, we have developed suggestions for the 'demi-regular' [12] mechanisms and causal potentials inherent in the OHSAS18001, and how they interact in various contexts.

## Methodology

In contrast to other review-methodologies, the realist approach compares and analyzes the CMO-configurations (context-mechanism-outcome (cf. [13]) that appear in empirical studies of both quantitative and qualitative studies, and thereby provide a deeper insight into the interplay between actual mechanisms and contexts related to the successful implementation of OHSAS18001. Our review followed the realist review procedure [11] by identifying the intended program-theories of policy makers and standard publishers [11] first, and then by gradually refining the theories through our iterative review and through the comparison of available and relevant empirical data. In other words, we compare how the voluntary and certified OHSMs are 'supposed to operate' (i.e. the program theories) [11] and how they actually operate (i.e. the CMO-configurations) when put under researchers' magnifying glasses. By doing so, our review adds valuable knowledge to the discussion on how and when OHSAS18001 works or fails to work. In the first step, we investigate how the OHSAS18001 is supposed to work by unpacking policymakers and stakeholders assumptions about how the OHSAS18001 would 'operate' – the so-called 'rough' program theories [12], [14]. We selected a number of key documents, which included the OHSAS 18001 standard (OHSAS18001:2007)<sup>1</sup> and the accompanying 'Guidelines for implementation' (OHSAS18002:2008)<sup>2</sup>. As suggested by Wong and colleagues [11], we also consulted public communication and promotional material from the original publishers, British Standard, which we found on their website<sup>3</sup>. Finally, as an illustrative example of materials from more distant

---

<sup>1</sup> From DS Håndbog 127:2010, Dansk Standard)

<sup>2</sup> From DS Håndbog 127:2010, Dansk Standard)

<sup>3</sup> <https://www.bsigroup.com/>

stakeholders, we used material from the Danish government's public sources (i.e. legal documents, debates from parliament and public statements from the ministry of occupation) about the reasons for incentivizing the use of the standard among Danish companies from 2005 and onwards. Together these key documents provided us with a somewhat clear overview of the expectations about the outcomes of the implementation of OHSAS18001 from a range of stakeholders that promotes OHSAS18001 as a way of securing safe and healthy workplaces. These key documents were then used to identify possible rough program theories. We scanned all these sources for descriptions of intended outcomes (i.e. what organizations gain from certification). Then we searched for described resources in the text that would lead to said outcome (continuous improvement demands, demands about documentation etc.). Finally, we described the mechanisms that would have to be in place for this resource-outcome constellation to 'work', and that is known from other empirical areas within mainstream organizational and management literature (e.g. legitimacy)

In step two, we identified the CMO-configurations [14]. First, we designed an exhaustive list of concepts, terms and synonyms that would help us to find the most relevant studies. We included studies that covered the three following aspects:

- 1) An actual example of a OHSAS18001 ('management system' terms)
- 2) The 'processual elements of a OHSAS18001' ('processual terms'), and
- 3) Sources that had descriptions of OHS concepts and issues ('OHS terms').

The studies were hereafter carefully read by the reviewers and classified into the 'active mechanisms' (e.g. translation) involved in the study, contextual elements that affected the outcome of the mechanism (e.g. how the existing organizational OHS approach becomes the blueprint for implementation), and finally into outcomes (e.g. OHSAS18001 is implemented in a formalistic and compliance focused manner).

## **Findings**

### **The program theories**

We identified three program theories [14] on the basis of the key documents mentioned above. Each program theory has its own expected positive outcome for organizations (See table 1). First, we identified an "operational' program theory (PT1) that emphasizes operational gains to the safety

management system of the organization. In PT1, the standard is expected to provide the organizations with systematic tools such as PDCA<sup>4</sup>-procedures, continuous improvement or the possibility to integrate the OHSAS18001 with other key management systems within the organizations. When the tools are used as stipulated in the standard, the assumption is that these tools will increase the maturity level of the OHS management system, ensure a systematic and lasting approach, and increase the focus on OHS issues within the organization. A second program theory (PT2) was identified that emphasizes 'compliance' as the most important outcome. PT2 emphasizes the resources in the standard that help the organization to streamline and comply with increasingly complex and diverging regulatory frameworks, which in particular was salient for organizations operating in multiple countries. Finally, an 'institutional' program theory (PT3) was identified. PT3 assumes that the institutional legitimacy public image is improved, and that the company thereby gains the advantages and resources that accompany these institutional advantages such as better stakeholder relations. These outcomes are achieved by using proper documentation systems and mandatory stakeholder communication – both mandatory within the OHSAS18001 standard.

Table 1: Program theories of OHSAS18001

	Resources within standard	Mechanism	Outcome
<b>'Operational' program theory (PT1)</b>	<ul style="list-style-type: none"> <li>- PDCA approach</li> <li>- Compatible with other CMS (e.g. ISO9001 or ISO14001)</li> <li>- Demands of continuous improvement</li> <li>- Demands of management and employee participation</li> </ul>	<ul style="list-style-type: none"> <li>- Systematization</li> <li>- Specialization</li> <li>- Continuous improvement processes</li> <li>- Maturing management system</li> </ul>	<ul style="list-style-type: none"> <li>- Improved OHS performance</li> <li>- Preventive and proactive approach (e.g. registration of near-misses)</li> <li>- Increased awareness and commitment from management and employees</li> <li>- Lower accidents and health risks within organization</li> </ul>
<b>'Compliance' program theory (PT2)</b>	<ul style="list-style-type: none"> <li>- Structured approach to compliance</li> <li>- Demands about formulation and running update of official organizational OHS-policy</li> </ul>	<ul style="list-style-type: none"> <li>- Formalization</li> <li>- Meta-regulation</li> </ul>	<ul style="list-style-type: none"> <li>- Always ensured compliance with all legal requirements across geographical and regulative boundaries</li> </ul>

<sup>4</sup> Plan-do-check-act

<b>'Institutional' program theory (PT3)</b>	<ul style="list-style-type: none"> <li>- Demands for documentation</li> <li>- Demands about stakeholder communication</li> <li>- Certificate 'to show'</li> </ul>	<ul style="list-style-type: none"> <li>- 'License to operate'</li> <li>- Legitimacy through adoption of institutionalized practice</li> <li>-</li> </ul>	<ul style="list-style-type: none"> <li>- Better reputation</li> <li>- Reputational gains and advantages</li> <li>- Improved relations with key stakeholders</li> </ul>
---	---	--	--

### The CMO-configurations in OHSAS18001 implementations and management

The included OHSAS18001 studies showed four different CMO configurations. They are described in Table 2, and in further detail below. Each CMO-configuration is described in terms of what resources in the OHSAS18001 are activated, the active social mechanisms, the contextual elements, the outcomes, if they relate to the assumed program theories described above.

Table 2: CMO configurations of OHSAS18001

Type of CMO?	Resource(s)	Mechanism(s)	Context(s)	Outcome(s)	Related Program Theory	Source(s)
Integration	Plan-Do-Check-Act  Compatibility with other CMS	Integration	Existence of similar organizational -, production- or management systems	Improved OHS performance	Operational	[2], [5], [8], [17]
Learning	Continuous improvement	Organizational learning	Existing structures and culture for learning (e.g. other continuous improvement frameworks, such as TQM, LEAN etc.)	Continuous improvement of OHS efforts (e.g. learning from accidents)	Operational	[9], [10]
Motivation	Certificate  Obligatory management involvement in OHS efforts  Continuous Improvement	Commitment	Motivation for certification process	Successful implementation	Institutional  Operational  Compliance	[4]–[6], [8], [18]
Translation	Internal audits	Translation and adaptation	Existing OHS approach	OHSAS18001 is tailored to already existing approaches  OHS management becomes 'auditable'	Institutional  Operational	[5]–[8]

Multiple included studies indicate that organizations that have compatible systems already in place have an easier time implementing and managing the OHSAS18001 standard as well [2], [5], [8],

[17]. Together they describe a CMO-configuration which we have dubbed 'integration'. In short, this means that the main organizing principles in the standard work best, if the implementing organizations have a context characterized by similar principles already in place. Lo and colleagues [2] found a clear effect of certification in their study of large American manufacturing companies. Furthermore, they show that organizations characterized by 'tightly coupled' production systems have even bigger safety advantages from certification. This is supported by a Danish research project [5], [8], [10] which demonstrates that organizations used to operate with systematic and formalized routines more easily implement and operate certification schemes. Finally, two studies show that organizations that already operate OHSAS18001's 'next-of-kin' management systems (ISO14001 and ISO9001) also experience greater safety and processual advantages [9], [17]. Overall, the studies indicate that previous experience with implementing standards provides an important mechanism and context in order to explain the operational effects of the OHSAS18001 certification.

The CMO-configuration 'learning' likewise shows that existing structures and resources determine whether implementation of OHSAS18001 leads to effective organizational learning and continuous improvement processes. Two of the included studies support this mechanism [9], [10]. The standard has a clear learning component in its 'continuous improvement' demands and processes. It is also this mechanism that can be seen as the logical driver behind the maturity model envisioned in PT1 – the operational program theory. Abad and colleagues (2013) found that the effects increase with the number of years with a certification program (OHSAS18001). This indicates that a learning process takes place after the implementation of OHSAS18001. However, as both Granerud & Rocha [10] and Silva et al. [9] show, implementation of the OHSAS18001 standard is by no means a guarantee for a higher-level OHS learning effect.

Finally, five of the included studies show that the organizational motivation for seeking certification is a rather important factor in the operational success of the intervention. In this CMO-configuration, the motivation is the primary contextual element that defines successful implementation and the commitment to the OHSAS18001 in larger parts of the organization. Motivation is the active mechanism. The resources that is supplied from the certification process is both the potential of improvement frameworks to deal with OHS issues [4], [18] as well as the promise of social legitimacy that comes with having a certification [5], [6], [8]. We know from Bevilaqua and colleagues' study (2016) that the motivational factors for implementing the management system are quite important in determining the success of an OHSAS18001



certification in terms of actually improving OHS factors at the organizational level. These motivational factors can take the form of desires to comply with rules and regulation, with displaying social responsibility, and with improving important OHS issues within the organizations [18]. The same overall mechanism is identified in the studies by Rocha & Granerud [6], Kristensen [8], and Hohnen & Hasle [5]. To a various degree, they demonstrate that many of the case organizations see the certificate as a social and institutional necessity, and as something an organization like them should have. This external legitimacy-seeking behavior in many cases turns into the main driver of commitment, which the internal actors interested in the implementation of OHSAS 18001 subsequently use to their advantage in order to further the implementation process.

A fourth CMO-configuration centers on 'translation'. The translation configuration shows how the certification is carried into organizations by carriers who interpret and translate the certification process to fit a new context. To varying degrees in the four included studies [5]–[8], the configuration describes how the new policy is tailored to fit the internal context of the organization and the known processes, and furthermore how the translated standard becomes a part of internal positioning and hierarchical processes and is made a part of the political processes and discussions in the organizations. The translation mechanism thus explains how the systems and organizational hierarchies which the carriers are embedded in influence the implementation of the OHSAS18001 certification, and thus partly relates to the other CMO-configurations described above.

## **Discussion**

The CMO-configurations each shows, how the existing contexts in terms of existing structures ('integration'), capabilities ('learning') or incentives ('motivation') influence how the resources and mechanisms inherent to the intervention end up shaping OSH efforts. This is not surprising. Researchers within organization studies and operations research have long pointed to the fact that organizations are best suited to absorb what is recognizable from neighboring fields [19], [20]. Furthermore, it is posited that advantages often, although not always (cf.[21]), are building on top of existing capabilities in a cumulative process, not replacing them in a trade-off [22]. These findings bring us to the title of our paper, which we borrowed from The New Testament "...for to him who has, more will be given..." (Matthew 13: 11-12).

However, the fact that organizations build on already existing knowledge, systems and structures can also potentially have somewhat unintended consequences for the implementation of the standardization, as is also pointed out by some of our included studies. First of all, the fact that the

certification is integrated into already existing procedures also means that organizations are prone to detect and assess risks and health issues that fit into the existing data and systems within the organizations. The occupational health and safety becomes 'auditable' as pointed out by Hohnen and Hasle [5]. This means that so-called 'wild' OHS issues such as psychosocial factors tend to be somewhat overlooked in the OHSAS processes in these companies. The same result is also shown in one of the municipal cases described by Jespersen and colleagues [7]. However, we do not know the extent of this, because none of the included studies that measure effects on OHS [2], [4], [17], actually take psychosocial issues into specific consideration. And furthermore while it is clear that organizational motivational factors for implementation are important for successful implementation, there is also a danger that this can lead to symbolic and decoupled adaptations within the organizations, meaning that the system is only implemented to satisfy external stakeholders (e.g. regulators, customers, partners). In [6], there is one case example of this. We tentatively suggest that organizations that implement the system because of external pressure, but then recognize key features and practices in the OHSAS18001 certification from their already implemented systems will have a higher likelihood of avoiding symbolic adaptation. This is also hinted at in two included sources [5], [8]

Together, the four CMO-configurations explain specific paths to success in the OHSAS18001 certification process. What our findings tentatively point out, is that the OHSAS18001 certification will not work as a 'silver bullet' or panacea for every organization with OHS issues, if there is not any existing capabilities, structures or routines to build on. Furthermore, the organizational motivation seems to play a role in determining positive outcomes, as well as if there is a will to implement, and whether the organizations in question see the certification as something positive for the organization. Finally, multiple sources describe how the certification process is driven by actors and their interpretations of the policy implications which again helps determining the final implemented system of certified OHS management.

## References:

- [1] M. Pagell, R. Klassen, D. Johnston, A. Shevchenko, and S. Sharma, "Are safety and operational

- effectiveness contradictory requirements: The roles of routines and relational coordination," *J. Oper. Manag.*, vol. 36, pp. 1–14, May 2015. <http://dx.doi.org/10.1016/j.jom.2015.02.002>
- [2] C. K. Y. Lo, M. Pagell, D. Fan, F. Wiengarten, and A. C. L. Yeung, "OHSAS 18001 certification and operating performance: The role of complexity and coupling," *J. Oper. Manag.*, vol. 32, no. 5, pp. 268–280, Jul. 2014. <http://dx.doi.org/10.1016/j.jom.2014.04.004>
  - [3] B. Fernández-Muñiz, J. M. Montes-Peón, and C. J. Vázquez-Ordás, "Occupational risk management under the OHSAS 18001 standard: analysis of perceptions and attitudes of certified firms," *J. Clean. Prod.*, vol. 24, pp. 36–47, Mar. 2012. <http://dx.doi.org/10.1016/j.jclepro.2011.11.008>
  - [4] J. Abad, E. Lafuente, and J. Vilajosana, "An assessment of the OHSAS 18001 certification process: Objective drivers and consequences on safety performance and labour productivity," *Saf. Sci.*, vol. 60, pp. 47–56, Dec. 2013. <http://dx.doi.org/10.1016/j.ssci.2013.06.011>
  - [5] P. Hohnen and P. Hasle, "Making work environment auditable—A 'critical case' study of certified occupational health and safety management systems in Denmark," *Saf. Sci.*, vol. 49, no. 7, pp. 1022–1029, 2011. <http://dx.doi.org/10.1016/j.ssci.2010.12.005>
  - [6] R. S. Rocha and L. Granerud, "The search for legitimacy and organizational change: The agency of subordinated actors," *Scand. J. Manag.*, vol. 27, no. 3, pp. 261–272, Sep. 2011.
  - [7] A. H. Jespersen, P. Hohnen, and P. Hasle, "Internal audits of psychosocial risks at workplaces with certified OHS management systems," *Saf. Sci.*, vol. 84, pp. 201–209, 2016. <https://doi.org/10.1016/j.ssci.2015.12.013>
  - [8] P. H. Kristensen, "Managing OHS: A route to a new negotiating order in high-performance work organizations?," *Saf. Sci.*, vol. 49, no. 7, pp. 964–973, Aug. 2011. <https://doi.org/10.1016/j.ssci.2011.02.001>
  - [9] S. A. Silva, H. Carvalho, M. J. Oliveira, T. Fialho, C. G. Soares, and C. Jacinto, "Organizational practices for learning with work accidents throughout their information cycle," *Saf. Sci.*, vol. 99, no. A, SI, pp. 102–114, Nov. 2017. <https://doi.org/10.1016/j.ssci.2016.12.016>
  - [10] R. L. Granerud and R. S. Rocha, "Organisational learning and continuous improvement of health and safety in certified manufacturers," *Saf. Sci.*, vol. 49, no. 7, pp. 1030–1039, Aug. 2011. <https://dx.doi.org/10.1016/j.ssci.2011.01.009>
  - [11] G. Wong, T. Greenhalgh, G. Westhorp, J. Buckingham, and R. Pawson, "RAMESES publication standards: realist syntheses," *BMC Med.*, vol. 11, no. 1, p. 21, 2013. <https://dx.doi.org/10.1186/1741-7015-11-21>
  - [12] R. Pawson, *Evidence-Based Policy: A Realist Perspective*. SAGE Publications, 2006.
  - [13] S. M. Dalkin, J. Greenhalgh, D. Jones, B. Cunningham, and M. Lhussier, "What's in a mechanism? Development of a key concept in realist evaluation," *Implement. Sci.*, vol. 10, no. 1, p. 49, 2015. <https://dx.doi.org/10.1186/s13012-015-0237-x>
  - [14] G. Wong, G. Westhorp, R. Pawson, and T. Greenhalgh, *Realist Synthesis. RAMESES Training Materials*, no. July 2013. 2013.
  - [15] DS, *Arbejdsmiljøledelsessystemer*, 2nd ed. Dansk Standard, 2010.
  - [16] BSI, "BS OHSAS 18001 Features and Benefit." BSI Group, 2017.
  - [17] F. Wiengarten, P. Humphreys, G. Onofrei, and B. Fynes, "The adoption of multiple certification

standards: perceived performance implications of quality, environmental and health & safety certifications," *Prod. Plan. Control*, vol. 28, no. 2, pp. 131–141, Jan. 2017.  
<http://dx.doi.org/10.1080/09537287.2016.1239847>

- [18] M. Bevilacqua, F. E. Ciarapica, and I. De Sanctis, "How to successfully implement OHSAS 18001: The Italian case," *J. LOSS Prev. Process Ind.*, vol. 44, pp. 31–43, Nov. 2016.  
<http://dx.doi.org/10.1016/j.jlp.2016.08.004>
- [19] W. M. Cohen and D. A. Levinthal, "Absorptive Capacity: A New Perspective on Learning and Innovation," *Adm. Sci. Q.*, vol. 35, no. 1, pp. 128–152, 1990. <http://dx.doi.org/10.2307/2393553>
- [20] S. A. Zahra and G. George, "Absorptive Capacity: A Review, Reconceptualization, and Extension," *Acad. Manag. Rev.*, vol. 27, no. 2, pp. 185–203, Apr. 2002.  
<http://dx.doi.org/10.5465/AMR.2002.6587995>
- [21] R. G. Schroeder, R. Shah, and D. Xiaosong Peng, "The cumulative capability 'sand cone' model revisited: a new perspective for manufacturing strategy," *Int. J. Prod. Res.*, vol. 49, no. 16, pp. 4879–4901, Aug. 2011. <https://doi.org/10.1080/00207543.2010.509116>
- [22] K. Ferdows and A. De Meyer, "Lasting improvements in manufacturing performance: In search of a new theory," *J. Oper. Manag.*, vol. 9, no. 2, pp. 168–184, 1990. [https://doi.org/10.1016/0272-6963\(90\)90094-T](https://doi.org/10.1016/0272-6963(90)90094-T)