Is Your Organisation Ready For Managing "Back-End" Projects?

Professor Giorgio Locatelli PhD
School of Civil Engineering
University of Leeds
g.locatelli@leeds.ac.uk

PLEASE CITE AS "Locatelli, G. 2021. Is Your Organization Ready for Managing 'Back-End' Projects?. DOI:10.1109/EMR.2021.3098064. pp.175-181. In IEEE ENGINEERING MANAGEMENT REVIEW. - ISSN:0360-8581 vol. 49 (3)"

ABSTRACT

The vast majority of projects deals with their "front-end", i.e. the planning and delivery of new assets, goods and services, including building infrastructure, developing new drugs, and coding software. However, more and more projects need to deal with their "back-ends", such as decommissioning infrastructure, withdrawing dangerous drugs from the market and eliminating malign software. While the "front-end" of projects, and organizations involved in projects, have been empirically investigated for millennia (and academically for decades), the "back-ends" of projects is a novel field with extremely limited practical and academic knowledge. The management of "back-end" projects are peculiar since it lacks traditional project motivations (e.g. usually there is not cash flow at the end of a "back-end" project), the stakeholders are different (e.g. drug addicts and not patients), and the organizations involved might have very different agendas (e.g. criminal organizations). This paper discusses the relevance and peculiarities of "back-end" projects, providing key insights to manage them.

Keywords: Project Management; Decision making; Decommissioning; Back-end; Infrastructure

1 Introduction: A new kind of projects

What old nuclear reactors, the opioids, and land mines have in common? We want to get rid of them, and we need projects to do so. A new type of project: back-end projects.

There are thousands of years of experience in traditional "front-end" projects, like building new infrastructure or developing a new product. The Giza pyramid complex was built around 2600-2500 BC; the Great Wall construction started in the 7th century BC and the Colosseum in Rome 70-80 AD. What all these marvellous and complex projects have in common from a management perspective? Surely a complex supply chain, workforce organization, leadership, financing mechanism etc. but also little or no considerations regarding the end of their lifecycle. Indeed nobody thought about dismantling a pyramid! Of the seven wonders of the world, three have been lost due to natural disasters such as earthquakes (Mausoleum at Halicarnassus, Colossus of Rhodes, Lighthouse of Alexandria) or destroyed (e.g. in wars or by the simple passing of time), and of the one that still exists (Great Pyramid of Giza), there are no plans for dismantling. The issue of dealing with infrastructure decommissioning is far more recent, reasonably a few decades old.

Today, the world faces the issue of dismantling major infrastructure that are reaching their end of life, such as nuclear power plants, dams, oil & gas refineries, and platforms. Still, as we will see later, this is one of the biggest markets in the world today and will grow rapidly over the next decades. For example, we don't know how many nuclear reactors we will build in the future across the world. What we know for certain is that 51 nuclear reactors are under construction now, 444 are operating, and 193 in permanent shutdown [1]. Less than 20 nuclear reactors have been decommissioned, but more than 600 nuclear reactors still need to be decommissioned. Nuclear decommissioning alone is a business of trillion of dollars with the enormous investment needed in new technologies, e.g. robots, to replace humans to safely and effectively handle and dispose of radioactive waste.

Remarkably, the issue of dealing with end of life projects is not just an engineering problem. Let's take medicine. The development of a new drug follows a quite standard, regulated process. Every year about 40-50 new drugs are approved in the USA alone [2]. So, developing a drug is a fairly standard (yet expensive) project. However, what's about "taking a drug off the market"? Bayer firstly sold heroin in 1895 as a "non-addictive morphine substitute," over-the-counter drug. Among the other things, heroin was sold as was cough suppressant. The development and marketing of heroin was a very successful project for Bayer. Unfortunately, today's well-known downsides quickly emerged, and in 1924, the USA banned its importation, manufacture, or sale. Other countries quickly followed the USA ban, and a new massive project started: to withdraw this drug from the market. Eliminate the production, distribution and consumption of heroin is an ongoing, unsuccessful project. Heroin is not an exception, and other illegal or misused drugs need to see their "end of life ". The opioid crisis in the USA killed 42,000 people in 2016 alone [3] and has a social cost of about *"$504 billion, with 15% of the total from nonfatal and 85% from fatal overdoses. This represents ~2.8% of the 2015 US gross domestic product"* [4].

Astonishing, 78 countries are contaminated with land mines, and 15,000–20,000 people are killed every year while countless more are maimed. According to the United Nations, *"Their prices vary between US $ 3 and US $ 75 per unit whilst the cost of clearance estimated by the United Nations, including support and logistic costs, is between US $ 300 and US $ 1,000 per mine."* [5]. With several millions of mines buried, the budget for demining projects is in the region of billions, and existing technical solutions fall shorts.

Examples of "back-end projects" can continue across businesses, countries and sectors. Back-end projects are relevant from the social and economic perspective (it is a multi-trillion market already) and will be increasingly relevant in the future. Unfortunately, there is a huge gap in research and knowledge about this topic. The author of this paper dedicated the last seven years to research this topic in the energy sector. This paper summarises the key lessons learned and provides relevant suggestions usable by decision-makers and practitioners in their organizations across sectors.

2 Problem setting

I am a Professor of Project Business Strategy in a leading UK university. In one lecture, I asked my students, "What's the biggest project in the UK?" They come up with different answers ranging from the development of a new high-speed railway (called High-Speed Railway 2) to a new subway in London (the Crossrail project) or even the construction of 2 new nuclear reactors (called Hinckley Point C). All these answers are wrong. The decommissioning of the Sellafield nuclear site is the biggest project in the UK and probably in Europe.

Sellafield estimates reach almost £100bn alone (around $140bn) [6], and its decommissioning is expected to last more than 120 years. This figure is comparable with only a few other cases, one being the US Hanford site cleanup effort, which is estimated to exceed $100bn (more than €71bn) and keeps increasing [7], [8]. Sellafield hosts six nuclear reactors in permanent shutdown, nuclear fuel storage ponds and waste silos, nuclear fuel fabrication and reprocessing plants, a nuclear lab and a fleet of nuclear waste storage facilities. According to gov.uk [6], *"Its oldest facilities were built in great haste during the early years of the Cold War with no plans for how they would be decommissioned. Record-keeping in the early days was poor by modern standards, meaning much work has had to be carried out to confirm the nature and state of the material kept in these facilities. There is no blueprint for decommissioning Sellafield's oldest facilities. Staff and contractors had to come up with ground-breaking engineering projects in order to decommission these one-of-a-kind facilities. And these highly complex projects have to be done on small parcels of land, often just feet away from buildings containing highly hazardous material, with all of the safety constraints this presents."*. This testifies how Sellafield is the single most complex and expensive megaproject in Europe, not just as a back-end but also as absolute terms. Yet, very few people heard about this, and even fewer companies are in the supply chain. Let me be clear here: of this £100 billion, only a minority are for "nuclear activities" since the budget is spread over a plethora of costs, including the development and deployment of new robots, virtual reality and artificial intelligence projects. A considerable amount of money is also spent on "Immaterial items" like safety, security, monitoring, communication, and information management.

Among other back-end projects, nuclear-decommissioning megaprojects (Sellafield being one of them) are probably the most studied ones. They include nuclear reactors and several other infrastructure such as laboratories, fuel fabrication facilities, waste processing plants etc. Despite the experience in building 637 reactors, several of the 51 reactors under construction are late and/or over budget, demonstrating the intrinsic difficulties in planning and delivering projects in the nuclear industry [9]. In the UK, nuclear decommissioning is an extremely critical field. Indeed, according to the UK government, the budget for nuclear-decommissioning megaprojects is higher than any other sector (e.g. transportation, renewable energy). The UK government states [6] *"The 2019 forecast is that future cleanup [of Britain's historic nuclear sites] across the UK will cost around £124 billion spread across the next 120 years or so* […] *In recognition of this uncertainty, the NDA publishes a range of estimates that could potentially be realistic. Based on the best data now available, different assumptions could produce figures somewhere between £99 billion and £232 billion."*. It is worth notice how the uncertainty alone is equivalent to the annual GDP of a country as big as Hungary. A good review of "back-end projects" in the energy sector is presented in [10]. More in general "back-end projects" cover all kinds of human activities, and the reader can look for information in various sectors.

3 Problem-solving: four priorities to approach back-end projects

To approach problem-solving is useful to summarise the characteristics of back-end projects in infrastructure, but similar considerations are true for other sectors as well [11]:

- They range from simple projects (e.g. removing an oil Pumpjack) to major national multi-billion projects (Sellafield cleanup)
- The government and government bodies often play a key role (e.g. financing, regulating)
- They involve several stakeholders, including technology provides, local communities, regulators, owners
- They are morally troublesome also from an intergenerational perspective since a generation might enjoy the benefit (electricity production) while the next has to pay the decommissioning cost
- Traditional "economic benefits of new build" do not materialize, since no revenue-generating-assets created, and therefore no or little cash in-flow at the end
- Traditional "social benefits of new build" do not materialize since no "landmark outputs" are created and, when the decommissioning project is over, job positions are often lost.

Back-end projects are a new class of projects with extreme complexity and unprecedented challenges. In the following section, I identify four key classes of stakeholders involved in back-ends projects (mostly energy infrastructure), and for each class, I suggest a priority to focus their attention.

3.1 For managers and executives: establishing the right management culture

Managers, executives and project leaders can play a major role in back-end projects, as they did in Rocky Flat. Rocky Flats was a military nuclear weapons facility that produced plutonium and enriched uranium from 1953 and stopped operations in 1989. The US Department of Energy (DOE) owned it, it was managed by a series of weapons contractors, and during its decommissioning, its waste was shipped to other states in the US [12], [13].

When Rocky Flats was shut down in 1989, due to the significant radioactivity on-site, the US DOE estimated it would have taken 70 years and $ 36 billion to decommission it. However, its decommissioning was completed safely by a joint venture in less than ten years and $ 3.5 billion. In Rocky Flats back-end project, at least three different leadership roles supported the transformational change necessary for the completion of the decommissioning activities, i.e. the idea champion, the sponsor, and the orchestrator [12]. Rocky Flats adopted the "abundance approach". Key factors in the success of Rocky Flats were (1) the incentive-based type of contract (where the contingent fee wouldn't be paid until the job was complete), (2) the government commitment to risk sharing and to work towards timely furnish equipment and services, and (3) the alignment of objectives between stakeholders. Additionally, Rocky Flats, measuring performance both top-down and bottom-up, was a driver for success. Conversely, within the Sellafield, there has been an attempt to measure performance bottom-up, but the initiative was halted by the management [14]. The importance of early and timely engagement of stakeholders (also emphasized from the beginning of the accelerated decommissioning project of Rocky Flats) proved to be a key factor for its success. So, in Rocky Flats, a "change of culture" was needed to promote accelerated decommissioning, whereas in other sites undergoing decommissioning, the idea of "*100 years to decommissioning it? I will be dead by then! And I have no rush to put myself out of job*" remains.

3.2 For project managers and planners: benchmarking for decision making

OECD/NEA [15] provides the potential cost savings identified by the UK Nuclear Decommissioning Authority (NDA) from the application of cost benchmarking techniques. According to the stage when benchmarking is applied, the savings are:

- Conceptual stage – 70%
- Partly conceptual, partly underway – 30%
- In progress 20%

Being the NDA in charge of cleaning up the UK's earliest nuclear sites safely, securely and cost-effectively, they have first-hand experience and data. These data should be analyzed following a benchmarking process, and *"the NDA was able to gain sufficient confidence to make a significant reduction in the nuclear provision for projects across the NDA's estate"* [15].

Benchmarking involves *"comparing actual or planned practices [...] to identify best practices, generate ideas for improvement*" [16] and offers significant potential to improve the performance of project selection, planning and delivery. In the 1990s, Büyüközkan & Maire [17] stated that benchmarking was one of the most efficient and effective management tools to help an enterprise to improve its performance and that it was a cyclical, "*never-ending and learning*" process. However, when Longbottom [18] investigated benchmarking, he realized that benchmarking was not so well-established as common practice as suggested by the literature.

For instance, within the construction industry, benchmarking interests have risen because by finding examples of superior performance, firms can adjust their policies and practices to improve their performance [19]. Nevertheless, the benchmarking analyses performed by these authors cannot be directly applied to "back-end", mainly due to the unfeasibility of collecting dozens of projects, the alleged "uniqueness" of projects and the intense effort required to establish and incorporate a project performance measurement system [20], as well as the difficulty of obtaining data, the insufficient resources and overall internal resistance [21]. Indeed, even if benchmarking can be generally summarized into three main phases, i.e., (1) plan (develop a project proposal), (2) perform (recruit and work with participants, collect and compare data) and (3) improve (improve the organization) [22], or described through the 13 common steps by [23], benchmarking still needs to be adapted case-by-case to the specific project under scrutiny.

Good examples of research using benchmarking for dealing with back-end projects, besides the aforementioned [15], are those from Invernizzi and her team. Invernizzi et al. [24] provide an overview of benchmarking and how it can be tailored for back-end projects in the nuclear sector. It shows that benchmarking can be done both qualitatively and quantitatively. Invernizzi et al. [25], [26] apply the methodology identifying the project characteristics associated with the project performance. These characteristics can be used to better plan and deliver back-end projects. The benchmarking methods used in the case of nuclear decommissioning can be applied to virtually all beck-end projects.

3.3 For engineers and scientists: develop technologies that can overcome the innovation valley of death

A considerable cost of back-end projects (particularly in energy infrastructure) is related to labour. Differently from construction projects, human resources need to be properly trained to deal with the hazardous environment with high uncertainties. For example, let's think again about the nuclear sector's case: there is no radioactivity during the construction of nuclear reactors since the loading of the radioactive fuel is done once the construction has been finalized and several safety checks completed. However, during the decommissioning phase, there is a considerable radioactive material to deal with, including the spent fuel, concrete and equipment. People working in radioactive areas need to take precautions that lead to higher cost and lower productivity. Productivity might be lower because considerable time and cost are required to properly dress the operator before he/she gets into the environment and deal with contaminated clothes after.

The idea of using robots instead of people has been around for a long time, at least from the Chernobyl accident. Unfortunately, in robotics, the transition between research produced in universities and research institutions and its industrial application & commercialization is always challenging, and costs are often prohibitive. This challenge is exacerbated by the peculiar characteristics of back-end sectors like nuclear or oil & gas, being highly regulated [27], which hinder the timely adoption and deployment of innovations. Nevertheless, the back-end seems to still be remarkably overlooked by practitioners researchers who focus on how to overcome the "valley of death" in new product or technology development, i.e. the "*the point where a business, often a technology-based business, has a working prototype for a product or service that has not yet been developed enough to earn money through commercial sale*s (p.8)" [27]. The "valley of death" affects innovations ranging from generic technologies (e.g. a new pump) and robotics and is a well-known challenge for the transformation of innovation into marketable products.

Although all these difficult robots will be part of the "back-end" future, the market's size is so huge that it will inevitably attract investments and developments in this field, as it happens in the automotive, food industry etc. Companies in developing robots (or automation) should pay more attention to this field, while a company that might use robots should try to expand their professional network to liaise with vendors. Policy makers should foster this exchange; a good example is the UK scheme described by gov.uk in the reference [28].

3.4 For policy makers: foster modularisation as an enabler of circular economy

Policies fostering the development of sustainable infrastructure leveraging the principles of the circular economy are essential for infrastructure. Traditional stick-built infrastructure has a lifecycle predetermined by the lifetime of its modules and components. Modular infrastructure might be reconfigurable and extend/adapt their lifecycle decoupling the infrastructure's life from their modules. The circular economy would be a cornerstone of this novel strategy to manage sustainable modular infrastructure from a wider perspective [29].

Policies aimed to promote modularisation could improve disassembly, maintainability, upgradability, reusability, and recyclability. The inclusion of components with similar characteristics (e.g. same likelihood of reuse or recycling) in the same module facilitates the achievement of the circular economy goals. Furthermore, modularisation could reduce construction and demolition waste and improve the deconstruction process. Modularisation could also reduce the lifecycle energy requirement and material consumption, becoming a key enabler for sustainable energy policies.

In the case of a modular product, there are several modularisation methods, and each method is related in a different way to the circular economy. A precondition to achieving the expected advantages of modularisation in a "circular economy" perspective is assessing the lifecycle options of components/modules in the early design stages. Furthermore, several methods that evaluate the impact of modularisation in a "circular economy" perspective have been developed already at an academic level, less at an industrial level and almost unexisting at the policy level.

4 Conclusions: the way forward

We don't know how many infrastructure we will build, but we know that we need to deal with existing ones' back-end. Back-end projects are challenges that organizations face now and will, even more, deal with in the future. Unfortunately, academics, managers and decision-makers are ill-prepared to deal with this new class of projects. This article looked at the details of energy infrastructure (a key area for back-end projects). It is worth now to conclude with some general recommendations to prepare organizations for this inevitable challenge (and market).

- Look at potential projects that your organization can be involved in. Ask yourself, what are the reasons for doing those projects, what are the costs and the benefits. Identify the business cases and a detailed list of potential risks involved.
- Investigate the potential role of your organization in back-end projects. For instance, if your organization is building wind farms, assess the option to develop capabilities for dismantling wind farms too.
- Learn from other sectors. The nuclear sector is probably the sector with more experience, and several lessons have been learned over the last two decades. Many of these lessons learned can be applied to other sectors, the energy infrastructure *in primis.*
- Acknowledge and reflect on these decommissioning projects' peculiar nature: there are no "red-ribbons" to cut, and job positions are often lost. The value proposition for internal and external stakeholders needs to be carefully defined before starting the project. Approaching a back-end project with the same mindset as a front-end project won't work.
- External stakeholders (local population, government etc.) are key. The development of a drug inside a laboratory has clearly defined stockholders: the company developing the drug and specific agency (e.g. Food and Drug Administration) with clear pre-established procedures. Conversely, withdrawing a drug involves dealing with criminal organizations, addicted patients etc. Similarly, building a power plant has clear stakeholders and the

number of jobs created. Conversely, dismantling a power plant might imply losing thousands of job positions. Failing to recognize these aspects can lead to very negative project outcomes.

Biosketches

Professor Giorgio Locatelli received the bachelor's and master's degree in mechanical engineering and the Ph.D. degree “Cum Laude” in management in 2011 all from Politecnico di Milano. He is the Chair in Project Business strategy at the University of Leeds. His research focuses on the management of complex projects and programmes, particularly in the context of energy infrastructure. He attracted founds in the excess of £1,000,000 and published more than 100 peer reviewed papers.

References

[1] IAEA, “PRIS - Home,” 2020. [Online]. Available: https://pris.iaea.org/PRIS/home.aspx. [Accessed: 09-Jul-2020]

[2] A. Mullard, "2018 FDA drug approvals," *Nature reviews. Drug discovery*, vol. 18, no. 2. NLM (Medline), pp. 85–89, 01-Feb-2019.

[3] HHS.gov, “About the Epidemic,” 2019. [Online]. Available: https://www.hhs.gov/opioids/about-the-epidemic/index.html. [Accessed: 03-Jan-2020]

[4] S. A. Ryan, "Calculating the real costs of the opioid crisis," *Pediatrics*, vol. 141, no. 4. American Academy of Pediatrics, 01-Apr-2018.

[5] L. Doswald-Beck, P. Herby, and J. Dorais-Slakmon, "Basic Facts: the human cost of landmines - International Committee of the Red Cross," 1995. [Online]. Available: https://www.icrc.org/en/doc/resources/documents/misc/57jmcy.htm. [Accessed: 01-Jan-2020]

[6] GOV.UK, "Nuclear Provision: the cost of cleaning up Britain's historic nuclear sites," 2020. [Online]. Available: https://www.gov.uk/government/publications/nuclear-provision-explaining-the-cost-of-cleaning-up-britains-nuclear-legacy/nuclear-provision-explaining-the-cost-of-cleaning-up-britains-nuclear-legacy. [Accessed: 09-Jul-2020]

[7] A. Cary, "$107.7 billion needed to finish Hanford cleanup," *Tri-City Herald official web site*, 2017. .

[8] R. Vartabedian, "The price tag for cleaning up nuclear waste at Hanford site just went up another $4.5 billion," *Los Angeles Times*, 2017. .

[9] G. Locatelli, "Why are Megaprojects, Including Nuclear Power Plants, Delivered Overbudget and Late? Reasons and Remedies," Feb. 2018 [Online]. Available: http://arxiv.org/abs/1802.07312. [Accessed: 06-Apr-2018]

[10] D. C. Invernizzi, G. Locatelli, A. Velenturf, P. E. Love, P. Purnell, and N. J. Brookes, "Developing policies for the end-of-life of energy infrastructure: Coming to terms with the challenges of decommissioning," *Energy Policy*, vol. 144, 2020, doi:

10.1016/j.enpol.2020.111677.

[11] D. C. Invernizzi, G. Locatelli, and N. J. Brookes, "Managing social challenges in the nuclear decommissioning industry: A responsible approach towards better performance," *Int. J. Proj. Manag.*, vol. 35, no. 7, pp. 1350–1364, 2017, doi: 10.1016/j.ijproman.2016.12.002.

[12] K. Cameron and M. Lavine, *Making the Impossible Possible: Leading Extraordinary Performance, The Rocky Flats Story*. Berrett-Koehler, 2006.

[13] DOE, "Rocky Flats Closure Legacy report - Office of Legacy Management," *Office of Legacy Management official website*. 2013.

[14] D. C. Invernizzi, G. Locatelli, N. J. Brookes, and M. Grey, "Similar but different: A top-down benchmarking approach to investigate nuclear decommissioning projects," in *International Conference on Nuclear Engineering, Proceedings, ICONE*, 2017, vol. 7, doi: 10.1115/ICONE25-66155.

[15] OECD/NEA, "Cost Benchmarking for Nuclear Power Plant Decommissioning," 2019 [Online]. Available: http://www.oecd-nea.org/rwm/pubs/2019/7460-cost-benchmark-decom.pdf

[16] PMBOK, *A Guide to the Project Management Body of Knowledge - Fifth Edition*. 2013.

[17] G. Büyüközkan and J.-L. Maire, "Benchmarking process formalization and a case study," *Benchmarking An Int. J.*, vol. 5, no. 2, pp. 101–125, 1998.

[18] D. Longbottom, "Benchmarking in the UK: an empirical study of practitioners and academics," *Benchmarking An Int. J.*, vol. 7, no. 2, pp. 98–117, 2000.

[19] M. S. El-Mashaleh, R. E. Minchin, and W. J. O'Brien, "Management of construction firm performance using benchmarking," *J. Manag. Eng.*, vol. 23, no. 1, pp. 10–17, 2007,

doi: 10.1061/(ASCE)0742-597X(2007)23:1(10).

[20] D. Costa, C. Formoso, M. Kagioglou, L. Alarcón, and C. Caldas, "Benchmarking initiatives in the construction industry: lessons learned and improvement opportunities.," *J. Manag. Eng.*, vol. 22, no. 4, pp. 158–168, 2006.

[21] N. Garnett and S. Pickrell, "Benchmarking for construction: theory and practice," *Constr. Manag. Econ.*, vol. 18, no. 1, pp. 55–63, 2000, doi: 10.1080/014461900370951.

[22] T. Stapenhurst, *The Benchmarking Book: a how to guide to best practice for managers and practitioner*. 2009.

[23] G. Anand and R. Kodali, "Benchmarking the benchmarking models," *Benchmarking An Int. J.*, vol. 15, no. 3, pp. 257–291, 2008.

[24] D. C. Invernizzi, G. Locatelli, and N. J. Brookes, "A methodology based on benchmarking to learn across megaprojects: The case of nuclear decommissioning," *Int. J. Manag. Proj. Bus.*, vol. 11, no. 1, pp. 104–121, 2018, doi: 10.1108/IJMPB-05-2017-0054.

[25] D. C. Invernizzi, G. Locatelli, and N. J. Brookes, "How benchmarking can support the selection, planning and delivery of nuclear decommissioning projects," *Prog. Nucl. Energy*, vol. 99, pp. 155–164, Aug. 2017, doi: 10.1016/j.pnucene.2017.05.002.

[26] D. C. Invernizzi, G. Locatelli, and N. J. Brookes, "An exploration of the relationship between nuclear decommissioning projects characteristics and cost performance," *Prog. Nucl. Energy*, vol. 110, pp. 129–141, 2019, doi: 10.1016/j.pnucene.2018.09.011.

[27] House of Commons, *Bridging the valley of death: improving the commercialization of research*, no. March. 2013.

[28] N.-I. UK, "Robots compete in nuclear decommissioning challenge - GOV.UK," 2018.

[Online]. Available: https://www.gov.uk/government/news/robots-compete-in-nuclear-decommissioning-challenge. [Accessed: 31-Dec-2019]

[29] B. Mignacca, G. Locatelli, and A. Velenturf, "Modularisation as enabler of circular economy in energy infrastructure," *Energy Policy*, vol. 139, p. 111371, 2020.