

Research Article

Multicriteria Fishing Vessel Design Methodology

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Citation: Veenstra F (2017) Multicriteria Fishing Vessel Design Methodology. J Fish Aqua Dev: JFAD- 127. DOI:10.29011/JFAD-127/100027

Received Date: 5 October, 2017; **Accepted Date:** 12 October, 2017; **Published Date:** 20 October, 2017

Dutch Fisheries in Sustainable Transition

Under the umbrella of the Foundation Masterplan Sustainable Fisheries (MDV; 2012-present) the development of a more economically and environmentally sustainable North Sea (flat fish) fishing fleet has been pushed forward and underway. After the successful MDV feasibility studies (2012) and in the meantime support of many stakeholders, an appealing innovative pilot fishing vessel has been launched and awarded as Ship-of-the Year (MDV-1, 2016). Follow-up (on board) research is still going on (Figure 1). As MDV innovation manager/conceptual designer the author introduced (and guarded) a sustainability-integrated design approach. Based on his running PhD research scope, the next step, an all sustainable, scientific vessel design process, has been described in this article: ...towards energy, climate-neutral fishing vessels, in which the nowadays circular economy principles are going to be integrated as much as economically feasible (Figure 2) [1].



Figure 2: Innovative Flatfish Twinrigpulser (MDV-1; 2015-present).



Figure 1: Traditional Dutch Flatfish Fishing Vessel (beamer; 1980's-present).

Problem Statement

sustainable aspects in Dutch fishery eco-designs; from 1990 (Beamer 2000) to present (MDV-1).

The North Sea flatfish fisheries can be characterised by small, family owned enterprises (SME), where the fishermen have a decisive voice in (re)designing and in anticipating on the nowadays sustainable requirements and Corporate Social Responsibilities (CSR) [2]. Their approach is cost-efficient, either by applying technical innovations through a derivative approach (step-by-step; ad-hoc energy-saving and ad-hoc improving working conditions, the safety-integrated Beamer 2000 (re-) design, 1990) and for the first time through a disruptive approach (out-of-the-box; energy-efficient, sustainability-integrated MDV-1 new design, 2015) (Figure 3).



Figure 3: Launching MDV-1, Rotterdam, Jan. 2015.

For fishery SME's the ultimate chosen innovations are mainly based on a realistic return of investments by substantially decreasing the operational costs (investment, fuel) and increasing the earnings (quality fresh fish). However, because of the economic crisis (2008) and aging fishing fleet, the sector was/is urgently looking for innovative new-buildings, future proven with year round positive business models and higher residual/second-hand values at the end-of-lifecycle. Also the SME's must increasingly deal with the societal requirements as well as green North Sea fishery image. Beside skipper-owners are more eager to keep good fishermen on-board, a.o. to substantially reduce the fishermen workload through further automation of the fish processing line. This means that in the (re)designing process the human factor and a greener image have increasingly become more important design criteria (People, Planet, Profit; triple P). Not only for the fishermen but also these design drivers are becoming a scientific challenge to develop innovative (fishing)vessel design methodologies, in which technical as well as societal aspects are integrated. The so-called social/vague (re) design requirements, such as well-being crew, greener image, political trends are often difficult to deal with in (fishing) vessel designs by naval architects, while social scientists are often unfamiliar with the technical (re) design constraints. So far these aspects are either studied by engineers with tailor-made technical solutions (β -approach) or these poor descriptive requirements are separately investigated by social scientists (α -approach). An effective combined β - α (re) design methodology does not exist yet. However, in the Beamer 2000 projects a start has been made and nowadays researchers are developing life-cycle/eco-design methodologies for further integration of potentially conflicting β/α requirements such as LCA assessment and Circular Economy principles. Especially for the complex fishing vessel designs (engineering, fishing techniques, fish processing and catch capacity), the eco-design design experiences are a challenging start-up for more scientific (fishing) vessel design optimization, whereby α - and β design aspects are fully integrated with customization to the evolving circular economy requirements. Such a new methodology can

be validated on the successfully MDV-1 innovation-, design- and building process and expanded with the circular economy principles for (fishing)vessel design and SME's. The MDV multi-criteria approach have successfully been applied to the first sustainable pilot vessel in the Dutch flatfish fisheries (MDV-1, Ship of the Year* 2016 [3]; 80 % energy saving; a prestigious KNVTS shipbuilding Award) (Figure 4).



Figure 4: Delivery MDV-1, Urk, June 2016.

The MDV-1 is already 2 years successfully fishing in the North Sea and follow-up design discussions and further (PhD)research are taken place anticipating the near-future required "ultimate sustainable fishing vessels" [4].

Triple P Vessel Design Methodologies

single-, dual-, multi-design criteria customized to a circular economy approach (made to be --> made again). Regarding the dual-criteria (re) design aspects, a more or less β - α approach has already been dealt with in the 80's- 90's. In close-collaboration with the fishing sector the Beamer 2000 projects were started and conducted by RIVO technical researchers (Frans Veenstra, 1988-2002) and TU Delft (Safety Sciences; John Stoop, 1988- 1992). In first instance the focus was on safety and preventing occupational accidents, later by RIVO also expanded with fish quality and environmental design aspects (Beamer-and Trawler 2000 concepts; Frans Veenstra, 1990-2000) (Figure 5).



Figure 5: Frans Veenstra.

A spin-off of the beamer 2000 projects was the first scientific safety integrated (re)design methodology for existing beamers with a technical solution matrix. This development has been successfully analysed and scientifically described in the PhD study, “Safety and the design process (Kindunos; John Stoop, 1990)”. For the first time personal safety aspects were integrated in beamer ship designs, from a retrospective accident analysis up to prospective use with operational and technical (partial) solutions. At the time many partial solutions were accepted by the fishermen and it gave also a boost to the safety- and quality awareness in the Dutch fishing sector.

Where in the Beamer 2000 projects (1988-1998) the result was a conceptual redesign, in the Masterplan Sustainable Fisheries (MDV, 2010-2018) the result has been a revolutionary new design and the building of the first sustainable pilot vessel, the MDV-1 IMMANUEL [5]. The MDV design drivers are the multi-criteria aspects. These include the requirements for a good North Seaworthy working platform (safety and working conditions; People), sustainability (Planet) and operational excellence (future proven business models; Profit). One may say that for the MDV-1 pilot vessel the multi-criteria approach worked very well in practice, without hardly any scientific design support with the exception of a directional LCA approach (lifecycle assessment, TNO) and length/replacement analysis (MARIN). Because of his conceptual designer background (BvS, RIVO, Beamer-, Trawler 2000 and his MDV innovation role, Frans Veenstra introduced and guarded the multi-criteria MDV-1 design approach (Triple P) resulting in the MDV fishing vessel innovative design- and building process with in advance explicitly mentioned design targets (80 % energy saving, proven sustainable, positive business models). During the process the (interim) results were regularly communicated with the sector, students and fishery stakeholders (ministries, NGO) (Figure 6).

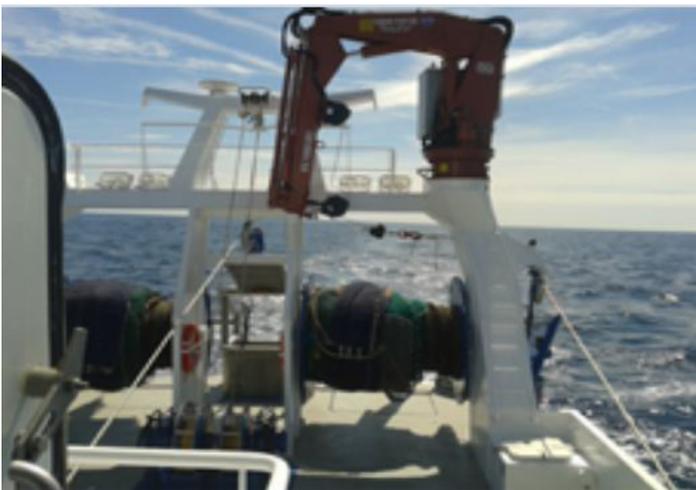


Figure 6: Twin rigging MDV-1 in practice 2016.

In a sector with predominantly small enterprises, the MDV approach required good knowledge of the North Sea flatfish fisheries and an intensive collaboration with fishermen and fresh fish supply chain actors. This was guaranteed by the MDV multidisciplinary team under the umbrella of the Foundation Masterplan Sustainable Fisheries (MDV; 2010-present) with many eco-friendly innovations, these have been described in detail in various newspapers and (inter)national maritime journals [6].

The key question was (and still is) the economic/ecological survival of the current sea fishing industry and to design future proven, sustainable fishing vessels with a good residual value at the end-of-lifecycle. For the existing, aging fleet the residual value is next to nothing because of the specifically Dutch flatfish fishing method in the North Sea and specific national fishing vessel classification rules (ILenT) (Figure 7). From a social scientist’s point of view one is also interested in how these triple P requirements are adapted in fishery systems, according to which model and to what level is it transparent/acceptable for the fishermen/SME and for the environmental stakeholders. Are these systems resilient and can/will fishermen/SME adapt to it and if so, can its current level of resilience (human behaviour) be explained. Are these levels likely to change in the near future, anticipating new legislation (IMO, EU, NL and regional) and pressure from environmental groups and is the circular economy approach the new design methodology for ultimate sustainable (Fishing) vessels, where MDV is aiming at (transition North Sea fleet 2015-2020) [7].

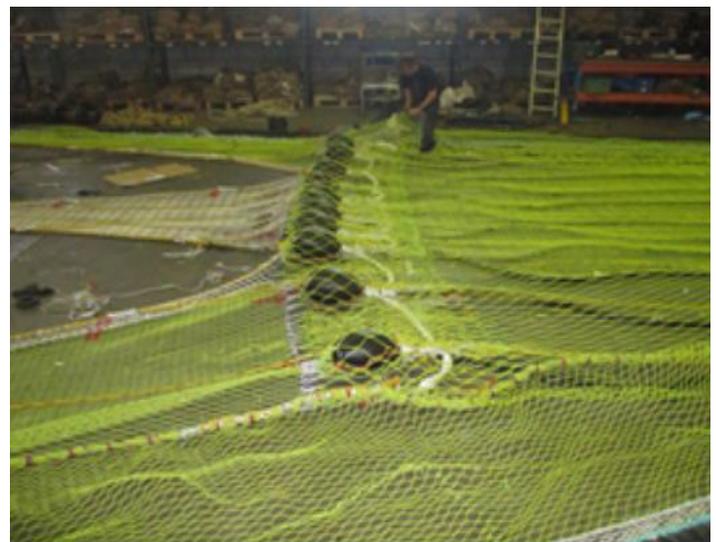


Figure 7: Twin rig pulse rigging, electrical stimulating flatfish.

Research Aim

Towards a scientific vessel design methodology based on the MDV-1 fishing vessel sustainability integrated design approach and pilot fishing vessel in practice (Figure 8).



Figure 8: AC-DC diesel-electric installations MDV-1.

The PhD research aim is the development of a more scientific, sustainability integrated design methodology for (fishing) vessels. Based on the beamer (re) design experiences (Beamer 2000, MDV-1;1990-present) and the current/evolving eco-design approaches. In particular, with reference to the Kindunos-process (safety/working conditions in re-designs), the Resilience approach (fishery innovations and human behaviour) and the end-of-life recycling process (retaining and residual values). So far there doesn't exist yet a fully β - α integrated design approach. The existing vessel design approaches are either technologically driven or socially driven and circular economy principles are still missing. With the intended methodical design optimization process, technical (β) as well as social (α , crew acceptance), all requirements are integrated: "Sustainability in the vessel design process (triple P Plus)". A triple P approach has more or less been applied in the design process and launching of the first innovative Dutch pilot fishing vessel, the MDV-1 IMMANUEL. However, because of the MDV financial constraints and time restrictions, the design drivers were mainly focussed on substantial energy saving, proven sustainability and new business models. A Life-Cycle Approach (LCA) has been considered but it has only been directionally applied in the MDV process (80 % emission reduction over 30 years) as well as the MARIN length/replacement analysis. At that time the MDV team was not yet familiar with the circular economy principles (prolonged life, retaining value, reducing waste). These additional eco-friendly design drivers will be further integrated in the new fishing vessel triple-Plus design process (people, planet, profit & circular economy). The MDV-1 follow-up fishing vessel (S) must become the "Ultimate sustainable fishing vessel for the North Sea and Wadden Sea" and with the first step to a more "Generic vessel design process", where-in a lot sustainability is integrated. For the fishery sector the methodology must be business driven with excellent fishermen perspective, green image and proven Corporate Social Responsibility [8].

Kindunos (Safety) Methodology in Fishery Proven Beamer 2000 Concepts (Dual Criteria Approach: Safety (Re-Design))

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