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Understanding the Risks to Artisanal Fishers on Lake Victoria Using Design Methods

John Powell^a, Dennis Nkurunziza^b, Arthur Mugema^c, Nora Kawira^b, and Rebecca C. Sindall^a

^aRoyal National Lifeboat Institution, International Department, Poole, UK; ^bDesign Without Borders, Kampala, Uganda; ^cEnvironmental Management and Economic Development Organization, Mwanza, Tanzania

ABSTRACT

Objectives: The purpose of this study was to document, understand, and communicate the daily activities and associated risks faced by artisanal fishers working on Lake Victoria, Tanzania, in order to identify opportunities for intervention design.

Methods: Established human-centered design techniques were combined with drowning risk analysis to create a process that visually captured and analyzed the risks to fishers in two lakeside communities engaged in long-line fishing (mostly by day) and net fishing at night.

Results: Two visual journey risk maps were developed. One map detailed the long-line fishing process for larger fish like Tilapia and Nile Perch, while the other focused on seine net fishing for dagaa at night. Each journey map covered the “before,” “during,” and “after” stages of fishing activities. For long-line fishers, preparation began early in the morning, including food and equipment collection, launching the boat, and setting long lines at the fishing site. Risk scenarios, such as storms or boat capsizing, were identified, with fishers often relying on makeshift flotation devices. For seine net fishers, the journey began in the afternoon with preparatory tasks at the fishing camp. Night fishing required the deployment of solar lamps to attract fish, followed by net casting. Risk factors like boat collisions, crew fatigue, and engine failure were noted. Both groups identified common risks and discussions around these journey risk maps emphasized the need for holistic safety interventions, including access to accurate weather forecasts, buoyancy devices, and formal safety training. The participatory mapping approach enabled fishers to provide valuable insights into how risks can be mitigated.

Conclusion: Small-scale artisanal fishers working on Lake Victoria face significant drowning risks. The design-led co-creation of visual journey risk maps with fishers and drowning prevention experts allows a deep understanding of livelihood journeys and associated risks. Opportunities for risk mitigation and intervention design are presented visually. Further research combining other design tools with scientific analysis could highlight points where control measures can be most effectively implemented, but this must be documented, and its impact and effectiveness evaluated. Interventions suggested by the process will be co-created and evaluated for effectiveness.

KEYWORDS



Co-creation; drowning prevention; human-centred design; journey mapping; small-scale fishing

Introduction

Fishing is widely acknowledged to be a high-risk profession, with fatalities occurring at rates of 100–500 deaths per 100,000 workers with variation depending on the study location and catch type.^{1–3} Drowning and hypothermia dominate fatalities⁴ with fishers primarily entering the water because of falls overboard¹ or boats sinking or capsizing.² Accepted interventions to reduce fatalities, such as personal flotation devices, exist but there are often barriers to adoption and use.⁵ Furthermore, many of the existing studies focus primarily on high-income and commercial fishing settings, despite over 90% of fisheries and aquaculture workers being based in low- and middle-income countries

in Asia and Africa, and the majority working in small-scale artisanal fishing and aquaculture.⁶

Africa’s largest in-land fishery, Lake Victoria, supports 102,000 fishers and a fleet of 30,600 small vessels within Tanzania.⁷ Whilst the government does not publish official statistics on occupational drowning in fisheries, drowning has been recognized as a significant risk for small-scale fishers with researchers estimating 217 and 502 deaths per 100,000 person-years from community-based studies on the Tanzanian and Ugandan shores of Lake Victoria respectively.^{2,3} Few preventative interventions are in place and there has been limited consideration of the interventions that can address these risks beyond recommendations to

CONTACT John Powell  John_Powell@rnli.org.uk  International Lifesaving Manager, Royal National Lifeboat Institution, West Quay Road, Poole Dorset BH15 1HZ, UK

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adopt existing practices from other (often higher-income) settings.^{8,9}

Much of the work that has been conducted in this area draws on traditional research methods, including literature reviews, focus group discussions, semi-structured interviews, and surveys. This paper proposes that adopting a more design-focused approach to investigating problems of occupational safety in small-scale artisanal fishing can lead to a better understanding of the hazards and the barriers to addressing them, allowing co-designed interventions with a higher chance of being effective.

User journey maps and visual storytelling are tools often used in the initial discovery phase of human-centered design (HCD) methodologies. Giacomini¹⁰ explains HCD as employing methods that engage, communicate with, empathize with, and inspire participants, leading to a deeper understanding of their needs, wants, and experiences, often surpassing their own awareness. This approach is generally highly visual and allows researchers to uncover insights and adapt in real time, leading to broader and more relevant findings. For instance, IDEO's work on HCD emphasizes how iterative prototyping and direct user involvement can reveal deeper insights into user needs and behaviors that traditional methods might overlook.¹¹ This dynamic process ensures that the research remains aligned with actual user experiences, ultimately producing more user-centered outcomes.

Although user journey maps and visual storytelling give valuable insights into the users' interactions and emotions, they do not often specifically highlight risks that may be apparent to technical injury prevention experts. The authors propose that by co-creating visual user journeys with fishers and drowning prevention experts, a richer story can be developed and potential areas for risk mitigations identified. Focusing on fishers' journeys, this paper intends to share some of the outputs and author observations from a study conducted using a combination of methods to gain insight into the risks that artisanal fishers face on Lake Victoria.

Methods

Research for this study was conducted in two fishing villages on the Tanzanian shores of Lake

Victoria, in the Musoma district. Both are situated on the mainland and have a single landing site. The smaller of the two villages has a population of approximately 5100, whilst the larger village has a population of approximately 5800, which increases dramatically during the fishing season as it hosts several camps of migratory fishers. Fishers from the smaller village primarily use long-lines and paddled or sailed open vessels to catch Tilapia and Nile Perch, during daylight hours, whilst fishers from the larger village primarily use nets and open vessels with outboard engines to catch *dagaa* (*Rastrineobola argentea*), a small sardine-like fish, at night.

In each of the two communities, eight fishers were identified to participate in a journey mapping workshop. The workshops were facilitated by a team of designers, drowning prevention experts and community engagement partners who make up the authorship of this paper. The drafted journey maps were shared with boat owners and camp managers for additional input on the activities and hazards identified. During the data collection phase, interviews were conducted with a range of fishing stakeholders, including village leaders, fishers' family members, fish processors, boat builders and those working in the wider fishing industry. These interviews helped to inform the probing questions that were asked by facilitators in the journey mapping workshop, but the findings from these interviews are not considered further in this paper.

The data collection took place in September 2022, with design and research teams spending two weeks in the two fishing villages participating in the study. This study was granted ethical approval by the Tanzania Commission for Science and Technology (COSTECH) (research permit number: 2012-348-NA-2021-155).

Research tools

The data collection phase employed numerous research and design tools including context immersion, key informant interviews, observations of boats leaving and returning to the landing sites, object analysis of tools and equipment used by fishers, and focus group discussions. However,

this paper focuses on the use of co-created journey risk mapping, which was conducted in two workshops with fishers. The authors used a combination of journey mapping, visual storytelling, scenario analysis, and risk assessment to accurately record a typical journey for the two target groups of fishers. Combining these techniques allowed a rich picture to be generated that gave the participants and study team a complete picture of the fishers' journey with risk and response scenarios overlaid.

Figure 1 demonstrates the risk journey maps, which combine design techniques including journey mapping, visual storytelling, and scenario analysis, with the applied science of risk assessments.

Journey mapping

Journey mapping is traditionally used by designers to analyze a user's experience with a product, service, or system over time. This technique involves creating a detailed, often visual representation of the user's interactions, emotions, and touchpoints across various stages of their journey.¹² The process undertaken by the authors included group discussion and roleplay. This was then integrated in real time into a coherent illustration that outlined the fishers' experience from start to finish of a fishing trip. Fishers could see and amend the journey as a group to ensure its accuracy. Figure 2 displays fishers creating and discussing

their visual journey during a co-creation session. (Credit: J. Powell, Royal National Lifeboat Institution).

Visual story telling

Where details around a specific event were needed, the participants were prompted to talk through an event which gave more information from the user perspective. This was particularly useful when describing hazardous events due to an increase in wind or waves and the effect that this had on the fishing boat and its crew. The information was again captured in a visual format.

Scenario analysis

For elements that needed further analysis from an ergonomic and object interaction perspective, scenario analysis was undertaken. For example, how fishers move around the boat during fishing operations can help shed light on boat stability and risk of falling overboard. By drawing a full-size plan layout of a typical fishing boat on the floor and allowing the fishers to move around as they would in a real situation, certain perspectives and risks became apparent that might not normally be highlighted. Figure 3 shows fishers undertaking scenario analysis of "on boat" movements. (Credit: J. Powell, Royal National Lifeboat Institution).

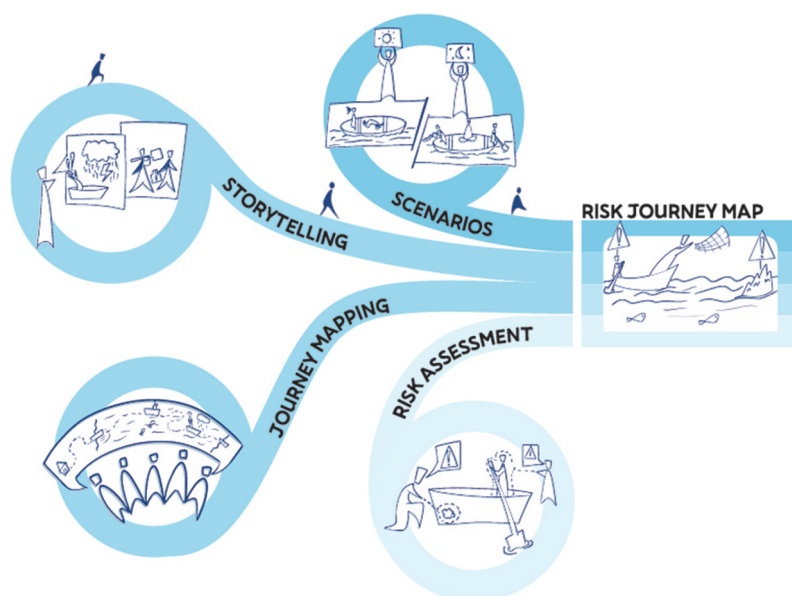


Figure 1. Risk journey maps combine design techniques including journey mapping, visual storytelling, and scenario analysis, with the applied science of risk assessments.



Figure 2. Fishers creating and discussing their visual journey during a co-creation session. Credit: J. Powell, Royal National Lifeboat Institution.



Figure 3. Fishers undertaking scenario analysis of ‘on boat’ movements Credit: J. Powell, Royal National Lifeboat Institution

Risk assessment

Risk assessments are a structured approach to pinpointing, analyzing, and evaluating potential risks that might adversely affect an individual or system. This process includes evaluating the probability and impact of negative events and taking steps to reduce or control these risks.¹³ During the workshop, fishers and drowning prevention experts were able to agree on areas and times of risk and record this graphically as part of the illustrative output.

Results

Two journey maps were developed for small-scale artisanal fishers in villages on the Tanzanian shore of Lake Victoria, due to the differences in fishing operations and therefore risk: one journey map was developed for long-line fishing for larger fish (Tilapia and Nile Perch) during daylight hours, and the other for net fishing for *dagaa* at night. Each journey map started with the activities that the fishers participate in before they set out to fish, and proceeded through the activities undertaken while they are on the water, to finish with activities that they carry out after they return to shore. These three sections of “before”, “during” and “after” helped to structure the journey map as it was created by the fishers. For activities “before” and “after” fishing, the location of the activities helped to provide additional structure, while activities in the lake were structured more by the order of fishing operations undertaken. [Figure 4\(a\)](#)

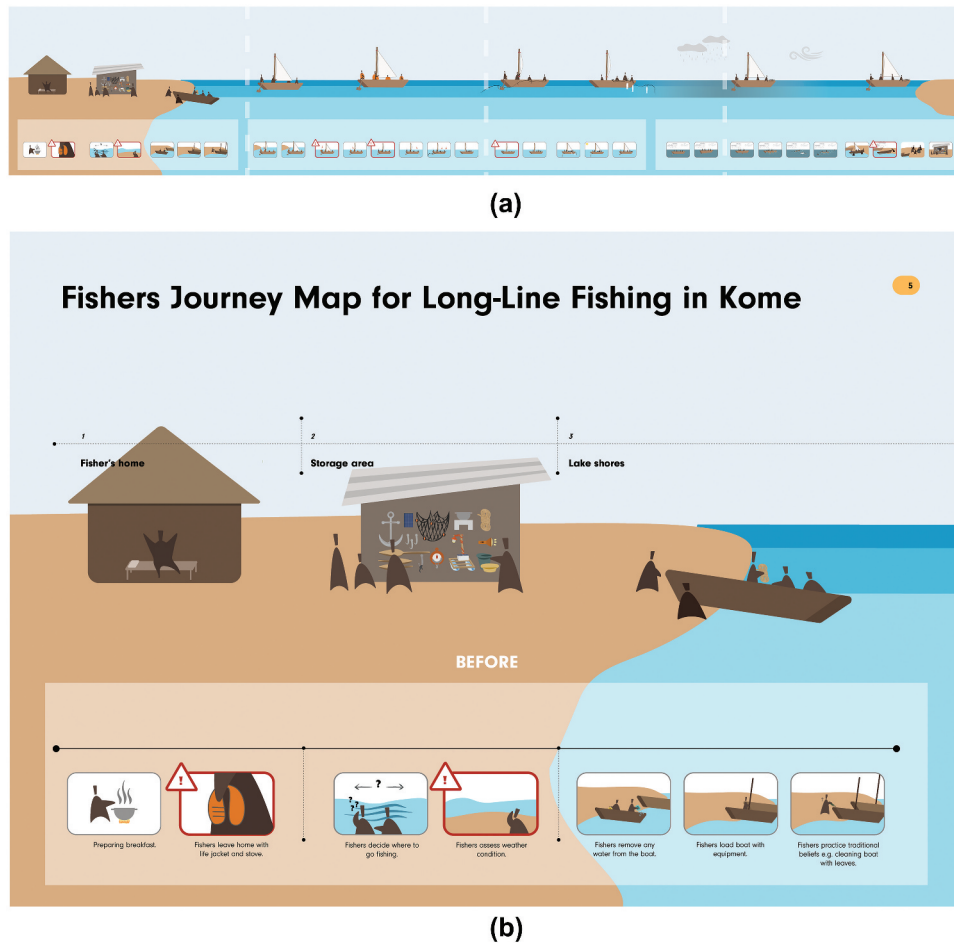


Figure 4. (a) Overview of the whole journey map for long-line fishers. (b) Section of journey map with detail for long-line fishers.

provides an overview of the whole journey map for long-line fishers, and [Figure 4\(b\)](#) shows a section of a journey map with detail for long-line fishers.

For long-line fishing, most fishers are permanent residents in the village so their journey map starts at home early in the morning with the preparation of food and collecting personal equipment that will be used during the fishing trip. Fishing equipment that is jointly owned by the crew, or that belongs to the boat owner, is then collected from local storage and the crew makes a decision about whether and where to fish based on the observed weather conditions. At the lake shore, the boat is prepared for launching, including bailing out water, loading equipment onboard, and undertaking traditional practices intended to protect the boat.

Fishers tend to wear lifejackets as they push off from the landing site and set the mast and sails.

On arriving at the chosen fishing site, the helmsman (known locally as the *shofa*) slows the boat, the sail is taken down, and the anchor is dropped. At this point, the fishers take off their lifejackets, and proceed to bait and set the long lines. As they wait for fish, they converse, sleep and eat. They can then spend up to two hours hauling in catch before setting sail back to the landing site. On returning to the landing site, fishers weigh the catch with the boat owner to agree payment for the day's catch before they return equipment to the local storage area.

A stormy weather scenario was introduced to the fishers, which added additional content to the journey map, including that the most common response is to take down the sail and mast, drop the anchor, and wait out the storm if possible. If strong winds catch the sail, it can cause the boat to capsize. In this scenario, fishers will hold onto

debris, the boat hull, or jerry-cans (used as buoys on the long-lines) to stay afloat. It is only in circumstances where fishers have encountered adverse weather conditions that boat owners will inspect boats for damage once they return to shore. Figure 5(a) provides an overview of the whole journey map for seine net fishers. And Figure 5(b) shows a section of a journey map with detail for seine net fishers.

For *dagaa* fishers, fishing takes place at night, and many of the fishers are migratory, moving between landing sites as required by their employer. As such, the journey map for seine net fishing starts with an afternoon meal at the fishing camp, before fishers collect their personal belongings and go to the landing site, where they agree on whether and where to fish in conjunction with the camp manager, based on the observed weather conditions. Fishers are not responsible for preparing and loading the boats

for launching, with each camp employing one or more *boda bodas*, youth who are responsible for retrieving the boat from its mooring point in the lake and loading necessary equipment onboard. The fishers can travel for several hours using outboard engines to fishing grounds where they will drop anchor and attach solar lamps to jerry-cans and set them on the lake to attract the fish to the surface. Once the lamps have been deployed, the fishers will rest for a couple of hours, often sleeping or talking amongst themselves. There is rarely a designated look-out at this point, and the only lights are those on the water, which are often up to 100 m away from the boat itself.

After a couple of hours, a seine net is cast near to the first of the lamps. Hauling the net onboard requires four of the crew to pull the catch onboard from one side of the boat while the fifth crew member stands on the opposite side of the boat

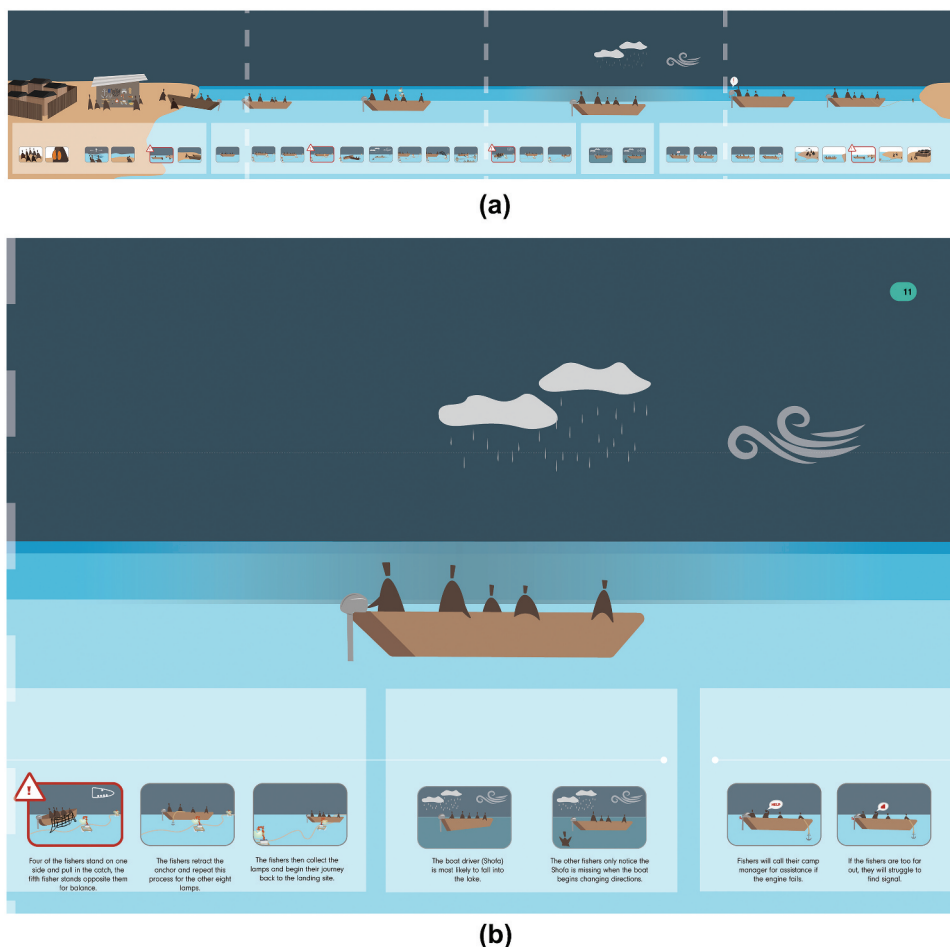


Figure 5. (a) Overview of the whole journey map for seine net fishers. (b) Section of journey map with detail for seine net fishers.

to act as a counterbalance. Most boats will carry 8–10 solar lamps and so this process is repeated with the other lamps before the lamps are collected and the fishers start the return journey to the landing site. By this point, fishers are usually tired, and it is not uncommon for fishers to fall asleep on the return journey. On arrival at the landing site early in the morning, the catch is auctioned and sold to the highest bidder. The crew will take the boat to the location along the landing site where the buyer is based, and the buyer's land-crew will unload the boat before the fishers return to their mooring point. It is then the responsibility of the *boda boda* to unload equipment and moor the boat. Meanwhile, the fishers return to their camp to rest or socialize.

The fishers highlighted multiple higher risk scenarios and how (or if) they manage that risk. Collisions between boats are a risk when fishers are waiting between deploying solar lanterns and casting nets and this can result in boats sinking. In this scenario, fishers in the water will hold onto debris or any floating equipment that they have access to. On the return journey to the landing site, when fishers are tired, there is a risk of the helmsman (*shofa*) falling overboard if they fall asleep. Due to their position at the rear of the boat, and the fact that other crew members may also be asleep, it may only become apparent that there has been a fall overboard once the boat starts to veer off course. In this scenario, the crew will attempt to locate and rescue the helmsman but acknowledged that this is difficult. In a scenario of engine failure, fishers will call the camp manager for assistance on a mobile phone if they have access to a phone signal. If they do not have access to a phone signal, they will aim to attract the attention of other boats by using lights to signal for help or waving items of clothing and shouting.

Risk mapping

Based on the visual journey maps, the fishers were able to identify the times when they felt that their work involved high levels of risk or when they took calculated risks to make their work easier or more comfortable to carry out. Within each crew, fishers collaborate to make numerous small risk

management decisions throughout their workday, including when observing the weather to decide whether to fish, making choices about when to put on or take off lifejackets, and determining when a boat requires maintenance, but few of these decisions are associated with formal risk management strategies and are instead based on experience and informal knowledge transfer between fishers.

For long-line fishers, many of these risks arise before they launched the boat, with fishers recognizing that not all crew members had access to personal flotation devices to take with them, and that the observed weather from the shore did not always provide a good indication of whether the weather would be safe for fishing later in the day or further out on the lake. Those fishers that did have access to lifejackets stated that they would normally take them off once they reached their fishing grounds as it became hot and uncomfortable to wear them while they were working. Furthermore, they regarded the risk of falling overboard to be greater when sailing than when at anchor. It was also noted that when the wind direction or strength was unfavorable for sailing and the crew resorted to paddling, lifejackets would be removed as they were hot and uncomfortable to wear. Finally, the fishers highlighted that boat owners only inspected boats that had been exposed to adverse weather conditions on a trip, which meant that while storm damage was likely to be spotted, more general wear and tear on the boat was less likely to be identified and addressed.

For seine net fishing, some of the risks that fishers identified were associated with the need for fishing to take place at night, and ideally on darker nights with little or no moonlight. In particular, the risk of collisions between boats without lights when all crew members were sleeping between deploying lamps and casting nets was highlighted. Similarly, there was seen to be additional risk for the helmsman of falling asleep due to fatigue on the return journey as it was likely to result in them falling overboard without other crew members noticing. Other risks were linked to the type of fishing operations undertaken, with crew members noting the increased risk of falls overboard during the process of hauling in the catch, and risks associated with the role of the

boda boda in swimming out to the boat's mooring point to prepare it for launch.

There were some similarities between the risks identified by the two groups of fishers. Both groups identified that observing the weather from the shore was often a poor predictor of the weather they would encounter during a fishing trip which limited their ability to make informed decisions about whether to fish in poor weather conditions. Once on the lake, there were few communication options as all fishers relied on a mobile phone as their primary method of communication, and this would only function when they were in range of onshore mobile phone towers. Navigation was highlighted as a challenge, with both groups of fishers relying on observable landmarks to navigate in the lake with no support from navigational aids such as a compass or GPS locator. In addition, fishers were unlikely to share information on where they were going to fish on a particular day as they did not want others to know their fishing grounds if they had a successful trip and a large catch. This combined with navigational and communications barriers so that it was often difficult to locate a boat if they did not return to the landing site when expected. Finally, fishers in both groups emphasized that some fishers would be in an unfit state to work during parts of the fishing trip. Some fishers mentioned that they were fatigued following a night of work or from sustained periods of paddling, while others mentioned that fishers may be intoxicated from taking alcohol or drugs to "prepare" themselves for the dangers of their profession.

Discussion

The live visual illustration of the fishers' journey acted as a starting point for discussions around risk and safety. The participants were able to closely examine the journey and annotate it with questions, ideas, and suggestions. By using a storytelling approach, the fishers were centered as experts on both the fishing journey and the risks. This interactive and collaborative approach helped engage all the participants, regardless of level of education or literacy, making sure that the user story evolved into a dynamic and valuable

resource not only for understanding the risks associated with fishing but also to allow the fishers to demonstrate how they thought that risks could be addressed.

As a result of this approach, a wide range of factors were linked to increased drowning risk, and fishers emphasized that there was a need to address more than one risk factor to reduce occupational risk and prevent drowning deaths. Key intervention points included: access to timely and accurate weather forecasts, access to affordable and high-quality buoyancy, and more formal training on safe fishing skills including navigation, communications, and rescue and self-rescue. These interventions align with the risk factors highlighted by Whitworth et al.² which showed 69% of fisher drowning deaths occurred when a boat sank or capsized in bad weather, and only 3% were wearing a life jacket at the time. Combining these interventions provides a more holistic approach to safety and one that is likely to be supported by fishers as they have been central in determining what is required.

By comparison, other studies around the lake have tended to result in a focus on a single intervention, though there is not often agreement on which intervention. For example, Whitworth et al.² recommended tighter enforcement of boat maintenance and safe boating practices, Oporia et al.^{9,14} have started to develop an intervention to improve life jacket use, Rasolofoson et al.⁸ similarly called for interventions to address non-use of life jackets and navigation equipment, and Guy et al.¹⁵ recommended alignment with World Health Organization (WHO) drowning prevention interventions, with a focus on delivering better emergency response services. It is not clear at this stage whether any of these interventions have been successfully applied to reduce occupational drowning risk for artisanal fishers.

Based on the recommendations from the fishers, multiple interventions will be taken forward to prototyping and piloting including (1) using manually or automatically updated weather boards to provide fishers with accurate and timely weather information from the Tanzania Meteorological Authority, (2) importing and selling buoyancy devices that meet international standards using payment options that work for fishers,

(3) health and safety training for fishing crews, (4) emergency response training, and (5) “safe fishing plans” that support involvement of individuals across the fishing value chain in drowning prevention and occupational safety promotion through practical and policy approaches. It is hoped that a future study will document which of these interventions (if any) are deemed effective at addressing fishers’ drowning risk.

Co-creating journey risk maps to develop injury prevention interventions is not without its shortcomings. Bazzo et al.¹⁶ compare the distinct differences of design methods to traditional health research methods and show that design approaches can be seen as having a lack of detailed analysis and academic rigor. Like traditional research methods, the findings will be impacted by who participates – in this case, the findings around when individuals feel that they are at risk will be subjective to those who are involved in the process. Whilst this is mitigated by having a group of participants who are selected to represent the breadth of experiences within the target population, this may result in mainstream views being captured to a greater extent than extreme positive or negative views. A focus on these deviations from the norm, particularly positive, can be a valuable source of information on how risks can be reduced, and it is recommended that questions relating to deviant behaviors are included in the journey risk mapping workshop. In this case, participants were asked about what attributes they associated with the “best” and “worst” fishers ahead of the risk mapping process, so that facilitators could probe on how these two extremes may behave at key points along the fishers’ journey.

From a methodological perspective, and according to Bazzo et al.,¹⁶ tension exists between traditional health research and design led approaches. HCD methods, with their focus on iteration, ambiguity, and rapid prototyping, contrast with the hypothesis-driven, evidence-based approach common in public health. This could lead to uneasiness in some research teams with outputs being undervalued in comparison to more traditional approaches. These concerns could be mitigated

by providing detailed methodologies, combining scientific and design-led approaches, and providing rigorous evaluation of designed interventions.

Conclusion

This study underscores the significant risks faced by small-scale artisanal fishers around Lake Victoria. Traditional research methods have provided valuable insights to the scope of this problem, but the more design-focused approach adopted in this study places fishers at the heart of understanding risks and co-creating potential mitigation strategies and interventions, with input from drowning prevention experts. The co-creation of visual journey risk maps, as explored in this paper is one tool to achieve this.

Further research combining visual storytelling, scenario analysis, analytical risk assessments, and journey mapping, combined with additional design tools like user emotion exploration could highlight points where control measures can be most effectively implemented. Tools to support this integrated “risk-based journey mapping” should be created and documented to enable repeated use of the methodology. Additionally, the evaluation of interventions designed in this way, such as those detailed in the discussion section, should be documented to demonstrate the effectiveness and impact of the approach. Aside from further research, next steps to improve the safety of these workers, includes continued co-development and implementation of highlighted interventions, advocating for policy change linked to findings and sharing knowledge with other injury prevention organizations.

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