ASSESSING THE FEASIBILITY OF IMPLEMENTING 3D-PRINTED PROSTHESES IN CONFLICT ZONES ACROSS THE MIDDLE EAST AND NORTH AFRICA REGION

Maariyah Malik

Research Supervisor: Associate Professor Victoria Arrandale

LAIDLAW SCHOLARS | UNIVERSITY OF TORONTO

Background

Conflict zones in the MENA region have large amputee populations due to military conflict. Amputees are unable to access prosthetic care due to collapsing healthcare systems. With faster production times and less reliance on functional healthcare systems, can 3D-printed prostheses feasibly mitigate this access gap?

Research Questions

1) What capacity do 3D-printed prostheses have to address rising amputee populations in warzones that lack medical infrastructure?

2) What obstacles exist in both physical feasibility and in government policy that prevent the implementation of 3D-printed prostheses in conflict zones?

Methodology

Conflict zone policy analysis: Analyze policy frameworks in conflict zones impacting the use of 3D-printed prostheses.

Case study analysis: Analyze two case studies of implementations of 3D-printed prostheses in conflict zones.

Semi-structured interviews: Conduct six semi-structured interviews with industry experts (biomedical engineers, prosthetists, doctors, and NGO staff).

Concept Indicator Framework

POLICY **Governments, militaries, non-state actors present in conflict zones, how their policies may prevent implementation of 3D-printed prostheses.**	**INDICATOR** References to “dual-use” rules, import restrictions, or aid delivery permits, identifying military checkpoints, gaps in policy surrounding medical imports
ENGINEERING **Production challenges in manufactuing durable, low-cost prosthetics designed for conflict zones.**	**INDICATOR** Production costs of prosthetics and 3D printing, durability and longevity of materials, capability to fit 3D printed prostheses to patients without medical practitioners/facilities
SCALABILITY **Capacity to scale 3D-printed prostheses implementation initiatives across the MENA region.**	**INDICATOR** References to “dual-use” rules, import restrictions, or aid delivery permits, identifying military checkpoints, gaps in policy surrounding medical imports
PRACTICALITY **Physical, environmental, and infrastructural conditions impacting administration of 3D-printed prostheses.**	**INDICATOR** Cost comparisons of 3D printed vs conventional prosthetics, growing R&D in 3D printing markets to enforce scaleability, capacity to produce/fit 3D printed prostheses amidst unstable healthcare systems

YEMEN

SYRIA

PALESTINE

Research Gap

Research regarding conflict zones is limited because institutional collapse has impacted data collection.

Despite conflict zones having large amputee populations, little research exists regarding 3D-printed prosthetics in conflict zones.

This study addresses this gap by:

- **Using qualitative analysis (concept-indicator framework)**
- **Combining existing literature on 3D-printing prostheses, existing gov. policies and NGO reports, and firsthand experiences through interviews**

Results

Policy: **Fragmented authority structures** force NGOs to navigate multiple policies thoughout the aid delivery process. **Attacks by political actors**, such as the Houthis and the IDF, upon aid workers, are used to intimidate NGO presences. **Counterterrorism policies** may also complicate aid delivery.

Scalability: There is **available funding** in the MENA region from the GCC countries. Prostheses must be tailored to the **individual needs** of the amputee and cannot be mass-produced. **Local manufacturing** increases the longevity of the solution.

Engineering: There is **potential to automate** certain processes of prosthetic production and fitting. Concern still exists regarding the risk of **pressure sores, misalignment, and instability**. Making a professional available for **online consultation** may also partially satisfy the need for an on-site expert.

Practicality: **Follow-up** increases the impact of the prosthetic device, but funding, military conflict, and disabilities reduce patient’s accessibility to follow-up appointments. Also, **ethical considerations** are central to global development, including 3D-printed prostheses initiatives.

Key Findings

Conflict zones in the MENA region are governed by fragmented authorities, complicating import policies and aid access. Intimidation attacks and counterterrorism designations may also prevent the implementation of 3D-printed prosthetics.

Sustainable development must be prioritized for a long-lasting, continuous solution for amputees. Sustainable development involves sourcing local materials, investing in local talent, and prioritizing local manufacturing.

Ethical considerations must remain at the forefront of global development and 3D-printed prosthetic initiatives. Consultations to understand patient needs is key, and aid workers must be cognizant of cultural nuances, social norms, and the barriers to accessibility that civilians living in MENA conflict zones experience.

Finding funding for follow-up appointments is crucial to the longevity of 3D-printed prosthetics as a sustainable solution in conflict zones.

Available funding from nations in the MENA region coupled with increased demand for prosthetic care and 3D-printed medical devices suggests potential for 3D-printed prosthetic healthcare initiatives to scale.

There is potential to automate production and fitting processes, but on-site expertise is needed to fit prosthetics onto patient limbs. Additional expertise can be made available if locals are able to consult experts online.

Conclusion

Results suggest that a variety of intersectional factors between policy, engineering, scalability and practicality interact to generate obstacles to the implementation of 3D-printed prostheses. Key obstacles include policy frameworks and engineering risks. Key opportunities include available funding and automation potential. By identifying these obstacles, this study aims to contribute to a wider effort to address these obstacles and thus strengthen the 3D-printed prosthetic initiative in the MENA region, providing accessible support to vulnerable amputee populations.