Project description

Project title: Collaborative project: Incubation sites: Self-replicating, open production spaces as innovation incubators in Tunisia
Subproject: Coordination, management and implementation of the project

Acronym: PISWI

Project leader: Mr. Dr.-Ing. Tobias Redlich
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I Objectives

Overall objective of the project

The project proposes the development, implementation and dissemination of OpenLabs as spaces for experiential technological learning, hardware product development and innovation using Open Source Appropriate Technology (OSAT), thereby contributing to the development of an open manufacturing infrastructure in Tunisia. In addition, business models for specific use cases will be developed in the context.

To achieve this, we rely on a **participatory research approach** that involves users and potential target groups in the development, implementation and evaluation phases. We will test the concept in at least one location/region. In an **in-depth exploratory single case study**, we will investigate how and under which conditions OSAT and open production spaces for technological empowerment and innovation in the field of digital manufacturing and product design can contribute to a new way of value creation. Specifically, we address the following questions in the project:

- Do OSAT and open production spaces enable new innovation opportunities in Tunisia and what added value does this create?
- Do OSAT and open production spaces lead to a sustainable economic strengthening in the Tunisian environment?
- How can the Tunisian textile industry be best supported by OSAT and open production spaces?
- What new products are created in the Tunisian textile sector through OSAT and open production spaces and how are they subsequently distributed locally?

By continuously involving industry partners in the network, while at the same time ensuring the sustainable financing of the production space after the funding period, we are generating our own case studies to explore alongside. In the implementation phase, these test cases are concrete and

industry-specific companies (textile industry) with a different regional context in relation to the first phase.

The results of the accompanying research will serve as a basis to derive further recommendations for policy makers in the field of technology / knowledge transfer, innovation and business development and to make concrete proposals on how to improve the application orientation of research and education at universities in Tunisia to benefit society and the local economy. For this purpose, in addition to business models for the sustainable operation of an open production space, several teaching modules for academic (esp. ENIT) and vocational-academic (esp. ENIM, ISET) training in the open source hardware sector as well as for business model development and idea generation will be developed and implemented so that the participants of the modules and workshops can subsequently do business and innovate sustainably.

Specifically, two mechanical engineering workshops are envisioned for the open manufacturing space, **with up to 80 participants trained on the open source machines**, up to **20 new machine trainers trained**, and **academic courses developed with up to 70 students participating**. The space should be able to be fully managed and sustained by on-site staff and helpers, strengthening the application and market orientation of the participating research institutions. In parallel, **practical recommendations for action to improve the research and innovation landscape** will be created for policy makers (white paper), which will take over a scaling of Open Labs in Tunisia politically in a follow up. Furthermore, the project and the white paper will strengthen the research and innovation policy advisory capacity in both countries.

The execution of the project and the implementation of the open production space will be done with local actors from research and industry **in the Tunisian textile sector**. The textile sector is particularly suitable for implementation through already existing open source hardware solutions, allowing for low-cost implementation and subsequent scaling.

Relation of the project to the funding policy objectives.

Our approach focuses on the development of an **open access strategy** in the field of digital manufacturing and distributed production, as well as research with experiential learning techniques and direct application in proprietary business models with appropriate industrial contexts (such as the digitization of textile production). To ensure orientation to industrial and societal needs, we will develop and implement appropriate measures **in collaboration with educational and industrial partners**. These include:

- **Skills training** for students and staff (in digital manufacturing technology skills and sustainable entrepreneurial education) at three Tunisian universities (ENIT, ENIM, ISET) in collaboration with their respective career centers. This includes the training of up to **80 participants on the open source machines**, the training of up to **20 new machine trainers**, and the development of **academic courses** in which up to **70 students** will have participated, strengthening the application and market orientation of the participating research institutions;
- A strategy and business model for an **incubator** focusing on **hardware product development** and machine tools (in the textile sector) will be directly linked to the universities' educational programs;
- Parallel development of **practical recommendations for action** (including lessons learned from the strategy and business model development) to improve the research and innovation landscape for policymakers (**white paper**), which will be used in a follow-on effort to politically adopt a scaling up of Open Labs in Tunisia. This will strengthen the research and innovation policy advisory capacity in both countries;
- **Supporting young scientists** by integrating German (Sonja Buxbaum-Conradi) and Tunisian (post-)PhD students with temporary or permanent residence in Tunisia.

In this way, we aim to promote **capacity building**, especially in the area of research, transfer and innovation in the field of manufacturing and digital production, and to improve the possibility of **application orientation** of higher education and research institutions in Tunisia.

Scientific and/or technical work objectives of the project

At the scientific and technological level, we aim to contribute to a deeper understanding of the transformation potential of open source hardware machines for forms of collaborative value creation, open innovation in hardware development and bottom-up economic development.
Based on a participatory research approach that involves both users and potential target groups in the development, implementation and evaluation phases, we aim to investigate how and under which conditions OSAT and open production spaces can contribute to technological empowerment and innovation in Tunisia. This will be achieved through a scientific evaluation in the form of a single case study in the NeoTex cluster (textile sector in Monastir). Concrete questions in this regard are:

- Do OSAT and open production spaces enable new innovation opportunities in Tunisia and what added values do they generate?
- Do OSAT and open production spaces lead to a sustainable economic strengthening in the Tunisian environment?
- How can the Tunisian textile industry be best supported by OSAT and open production spaces?
- What new products are created in the Tunisian textile sector through OSAT and open production spaces and how are they subsequently distributed locally?

In doing so, we aim to contribute to the exploration of open source hardware design, construction and manufacturing, and open production spaces as new forms of collaborative and networked value creation by demonstrating how open production spaces can be realized in practice. Therefore, we aim to further advance and disseminate the emerging and new field of open design and OSAT in engineering and related disciplines.

II. State of the art in science and technology; previous work.

Previous work of the applicant
Dr.-Ing. Tobias Redlich is a senior engineer at the Laboratory of Manufacturing Technology (LaFT). There, inter- and transdisciplinary approaches and teams are used to investigate and apply new value creation patterns in the field of Open Production (Open Source Hardware, OpenLabs). Especially with respect to the PISWI project, reference projects in which the LaFT and Dr. Redlich were also significantly involved include:

- Coordinator SPP 1476: Small Machine Tools for Small Workpieces (DFG).
- Knowledge and cooperation management for the aviation cluster Hamburg Aviation
- Initiator and project coordinator FabCity Hamburg

- Establishment and operation of OpenLab Hamburg
- Research project "Twinning for Innovation" (BMBF), investigation of open workshops
- Initiator: Interdisciplinary conference on the future of value creation

Through the operation of its own OpenLab at Helmut Schmidt University, the applicant also already has extensive experience with distributed, adaptive and decentralized production organized in networks and based on a shared (open) infrastructure (1) (2) (3) (4). Because OpenLabs enable on-demand production, they reduce logistics costs and emissions and support the development of regional economic cycles (5). In addition, prior experience from the field of production engineering is already available on how adapted, open and effective manufacturing technologies (e.g. additive manufacturing) can provide a basis for economically, ecologically and socially sustainable development (6) (7) (8). The design programs needed to operate such adapted machine tools are also already available as open source software. To this end, the applicant has researched approaches to combining open source hardware and software into new value creation patterns (6) (9) (10) (11) (12). In the field of social sciences, the applicant has already advanced new value creation patterns for socio-economic and socio-ecological transformation processes under different names (e.g. open innovation, co-creation, peer production or open production) (5) (13).

In addition, the applicant is researching sustainable (economic, social, and ecological**) added values and value creation** as well as possible **business models** that arise from the use of open source hardware and from collaborative work in networks. Case studies show that the use of OSH with an underlying business model creates (economic) added value for developers (fast time-to-market, lower development costs) as well as for users (e.g. lower acquisition costs), which means that society as a whole can benefit sustainably from OSH. In addition, the applicant has several years of experience in business model development for FabLabs/Makerspaces through its own OpenLab, which have already been successfully implemented in other Makerspaces, but from a scientific perspective still need to be investigated in other contexts (e.g. regional or industry-specific). (16) (17) (18) (4) (6) (8) (15)

State of the art in science and technology (including alternative solutions, rights conflicting with the exploitation of results, information searches).

The approaches behind the concept of OpenLabs as self-replicable spaces for innovation, production and technological learning are based on insights from various scientific fields.

Especially in the field of **production engineering**, technological innovations offer effective and efficient manufacturing technologies (such as additive machine tools) that can serve as a basis for economically, environmentally and socially sustainable development (7) (8). In this context, so-called **distributed manufacturing systems** are being further explored as one approach to more sustainable manufacturing approaches (19). This type of manufacturing system is decentralized, adaptable, and more flexible, and usually organized in networks based on a common (hence open) infrastructure. Because they enable on-demand production, they also reduce logistics costs and emissions and support the development of regional economic cycles (5).

Recent research in this area has combined concepts of distributed manufacturing systems with research on further advances in open-source design software (e.g., CAD software) and open-source Appropriate Hardware. (9) (20). This combination has already served as the basis for collaborative value creation efforts, e.g., in vehicles (local motors) (21) (22) (10), computers, agricultural engines (open source ecology), audio devices (Home-brew D-STAR radio), drones, machine tooling (e.g., laser / vinyl cutters, CNC machines, 3D printers such as RepRap, Fab @ home, open source modular knitting and sewing machines), and many other physical artifacts (11) (12). Another challenge in this field is the technical documentation and standardization of processes that serve as the basis for quality, reproducibility, and modifiability, as well as further development of the artifacts by the respective networks and communities of practice.

It becomes clear that such an approach must incorporate insights from economics and social sciences, as it relies on the collaboration and participation of users organized in heterogeneous networks.

Against this background, research into the potential of new value creation patterns for socioeconomic and socioenvironmental transformation processes is being pursued in the field of **social sciences** under various names, e.g., sharing economic activities with regard to consumption patterns; open innovation, co-creation, peer production, or open production with regard to value creation and innovation processes (5) (13). However, most empirical studies in this area focus on intangible artifacts (such as software or software-driven business models) that do not require physical infrastructure for production (i.e., means of production such as machines, labs for prototypes, etc.). The integration of openness thinking into such collaborative spaces and the creation of an open, shared physical infrastructure for the creation of networked value, with a focus on hardware development, has not yet been sufficiently tested empirically or analyzed and evaluated scientifically.

Although FabLabs are often distributed in developed countries, they are considered to have very high potential in developing and emerging regions (e.g., North Africa). They are already actively used there to develop and manufacture technical solutions for local needs and as educational venues. The sites can be replicated locally through the use of open source hardware (3) (5) (14) (15) (23).

From a SWOT analysis conducted by the applicant among others, strengths in (North) Africa include opportunities for experiential learning, building team dynamics, and access to production machinery and materials. Weaknesses are currently still insufficient machines, materials and space on site. In addition, the training level of employees and funding for the sites are still inadequate. Opportunities are seen in, among other things, the possibility of learning and digitization, collaboration with other organizations and the increasing spread of open production spaces in Africa. Potential risks listed include insufficient support, bureaucracy and corruption, as well as insufficient funding and economic and political problems (14) (15). This underscores the importance of the project.

Furthermore, the project has not yet been the subject of any other research, development, investigation or any patents. Therefore, this project in no way infringes existing property or patent rights.

Selected publications by the applicant and LaFT staff:

1) Buxbaum-Conradi, S.; Basmer-Birkenfeld, S.; Branding, J-H.; Osunyomi, B.D.; Redlich, T.; Langenfeld, M.; Wulfsberg, J.P.: Local Embedding and Global Collaboration of Open Innovation, Production and Maker Spaces - The (uncovered) potential of knowledge transfer and collaboration at the grassroots level. Insights from the growing FabLab community. In: 1st interdisciplinary conference on the future of value creation (conference proceedings), Hamburg 2016, pp 37-52.

2) Moritz, M.; Redlich, T.; Buxbaum-Conradi, S.; Basmer-Birkenfeld, S.; Osunyomi, B. D.; Wulfsberg, J. P.; Krenz, P.; Heubischl, S. (2016): OpenLabs - Open Source Microfactories, En-hancing the FabLab Idea, HICSS 16.

3) Buxbaum-Conradi et al. (2019): Open Labs: Experience-based, networked learning in open production sites, in: lernen und lehren 3/2019, pp. 115-120.

4) Redlich, T./Moritz, M./Wulfsberg, J.P. (2019): Co-Creation - Reshaping Business and Society in the Era of Bottom-up Economics Springer, Berlin.

5) Redlich T./Moritz, M.: The future of value creation - decentralized, networked and collaborative. In: Redlich et al. (eds.): Interdisciplinary Perspectives on the Future of Value Creation, Springer 2017, 1-8.

6) Moritz, M.; Redlich, T.; Wulfsberg, J.P.: Value Creation in Open-Source Hardware Communities: Case Study of Open Source Ecology, in: 2016 Proceedings of PICMET '16: Technology Management for Social Innovation, with acad. quality assurance.

7) Redlich, T.; Moritz, M.; Wulf, S.: Digital Production: Bottom-up Economics In: Stengel, O.; van Looy, A.; Wallaschkowski; S. (Eds.) Digitalzeitalter - Digitalgesellschaft, Springer, 2017.

8) Basmer, S.; Buxbaum-Conradi, S.; Krenz, P.; Redlich, T.; Wulfsberg, J. P.; Bruhns, F. L.: Open Production: Chances for Social Sustainability in Manufacturing In: Procedia CIRP 26 (2015), pp. 46-51, 12th Global Conference on Sustainable Manufacturing - Emerging Potentials, with acad. quality assurance.

9) Redlich, T.; Moritz, M: Bottom-up Economics: Foundations of a theory of distributed and open value creation In Ferdinand, J.-P. and Petschow, U. (Eds.): The decentralized and networked future of value creation - 3d printing and its implications for society, industry, and sustainable development. Springer 2016.

10) Moritz, M.; Redlich, T.; Krenz, P.; Buxbaum-Conradi, S. and Wulfsberg, J.P.: Tesla Motors, Inc. - Pioneer towards a new strategic approach in the automobile industry along the open source movement? In: 2015 Proceedings of PICMET '15: Management of the Technology Age, Portland, USA, pp. 85-92, IEEE Catalog Number: CFP15766-USB; PICMET ISBN USB: 978-1-890843-32-8, with acad. quality assurance.

11) Redlich, T.; Wulfsberg, J. P., Lehmann, J.; Bruhns, F. L.: Square Foot Manufacturing - A versatile production system for the manufacturing of micro parts, in: Werkstatttechnik online (2008) 98 (5), 337-344.

12) Wulfsberg, J. P.; Röhlig, B.: Paradigm change: Small machine tools for small workpieces, in: Production Engineering (2013), 7 (5), 465-468.

13) Redlich, T.: Wertschöpfung in der Bottom-up Ökonomie, Springer Heidelberg 2011.

14) B. D. Oladele-Emmanuel, H. B. Rejeb and T. Redlich, "Strategic Management: SWOT Analysis of the African Digital Fabrication Laboratories," 2018 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC), Stuttgart, 2018, pp. 1-7.

15) B. D. Osunyomi, T. Redlich, S. Buxbaum-Conradi, M. Moritz, and J. P. Wulfsberg, "Impact of the Fablab Ecosystem in the Sustainable Value Creation Process," Int. J. Sustain. Dev, vol. 9, no. 1, pp. 21-36, 2016.

16) Moritz, M.; Redlich, T.; Günyar, S.; Winter, L.; Wulfsberg, J.P., "On the Economic Value of Open Source Hardware-Case Study of an Open Source Magnetic Resonance Imaging Scanner." Journal of Open Hardware 3 (1) 2019.

17) Krenz, P.; Basmer, S.; Buxbaum-Conradi, S.; Redlich, T.; Wulfsberg, J.P., "Knowledge Management in Value Creation Networks: Establishing a New Business Model through the Role of a Knowledge-Intermediary." Procedia CIRP 16 (2014) pp. 38-43.

18) Redlich, T.; Krenz, P.; Basmer, S.; Buxbaum-Conradi, S.; Wulf., S.; Wulfsberg, J.P., "The Impact of Openness on Value Co-Creation in Production Networks." Procedia CIRP 16 (2014) pp. 44-49.

Further reading:

19) Wittbrodt, B. T.; Glover, A. G.; Laurento, J.; Anzalone, G. C.; Oppliger, D.; Irwin, J. L.; Pearce, J. M.: Life-cycle economic analysis of distributed manufacturing with open-source 3-D printers, in Mechatronics (2013), 23 (6), 713-726.
20) Megan, K.; Pearce, J. M.: Environmental life cycle analysis of distributed three-dimensional printing and conventional manufacturing of polymer products, ACS Sustainable Chem. Eng., 2013, 1 (12), 1511-1519.
21) Baier, A. & Hansing, T. & Müller, C. & Werner, K. (Eds.): Repairing the World. Open source and do-it-yourself as postcapitalist practice. Bielefeld: Transcript 2016
22) Walter-Hermann, J. & Büching, C. (Eds.): FabLab: Of Machines, Makers and Inventors. Bielefeld: Transcript 2014.
23) B. Gaeiras, "Fablab Lisboa: When a municipality fosters grassroots, technological and collaborative innovation," F. Actions Sci. Rep., vol. 16, no. 1, pp. 30-35, 2017.

III. Detailed description of the work plan

The project consists of five main work packages (WP). They will be carried out by the different project partners and managed by LaFT. The five main packages consist of:

- **WP1** Project coordination and management;
- **WP2** Case study design and scientific evaluation;
- **WP3** Educational program development;
- **WP4** Implementation of educational programs and test operations with industry;
- **WP5** Visibility, outreach and sustainability.

From the person-months, it is clear that ENIT, as the on-site project coordinator, is taking early and major responsibility for the implementation of the project in Tunisia. It is supported by ENIM, ISET and by MFCP, which also take over tasks independently, on their own responsibility and at an early stage (as also evidenced here by the planned person-months). In addition, the HSU is responsible as its own work in the subsequently presented work plans, in particular for the further coordination, control and implementation of the project as shown. This also includes the scientific evaluation in cooperation with the Tunisian partners.

Milestone planning

Please refer to Figure 1 or the Annex for the milestone planning including the applicable responsibilities and the presentation of the project over time. Due to the chronologically distributed and different milestones in the process planning including different responsibilities, the incorporation of the latest findings (also from third parties, e.g. from further information research in the context of the project-accompanying control) and associated changes or a termination of the project is guaranteed. This is supported by the applicant's reporting obligations (especially interim reports on the implementation of work packages and milestones).

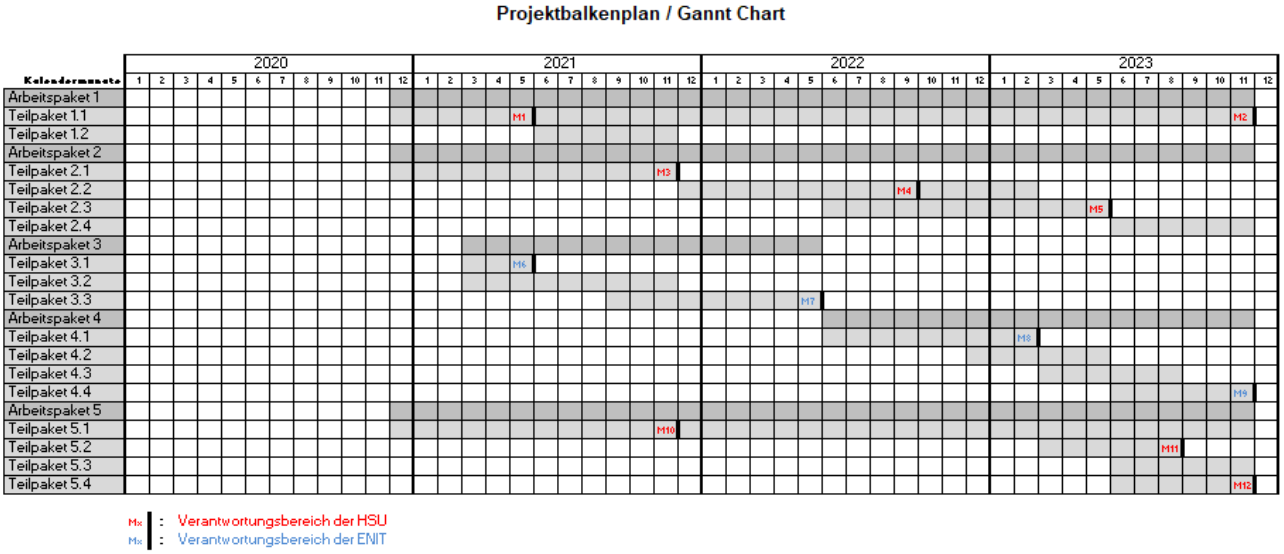

Figure 1: Gantt chart with milestone planning

Work plan

The research assistant, Dr. Des. Sonja Buxbaum-Conradi is the project coordinator (PC HSU) and responsible for the further planning, coordination, organization, implementation as well as evaluation of the project. Furthermore, she will be the contact person for all involved actors of the project and will issue political as well as economic recommendations for action for relevant actors in the field. In order to perform this challenging task, interdisciplinary knowledge and thinking is necessary in addition to a university degree. Therefore, one full time position has been budgeted for 36 months project duration.

Work package 1	**Project coordination and management**	**Effort per employee**

Management	HSU (LaFT)	PC HSU: 4 PM PC ENIT: 10 PM ENIM: 6 PM ISET: 6 PM
Partner	ENIT, ENIM, ISETKH, MFCPole	
Objective	Objective To ensure quality and efficiency, to verify the feasibility of measures and to establish communication and working structures.	
Duration	36 months	
WP 1.1.	Coordination of activities with all stakeholders Development and maintenance of an efficient communication structure, including feedback loops, knowledge and information management Project controlling	
WP 1.2.	Risk assessment and prevention (including possible adjustments of measures)	
Milestones	Communication structure established (M1), project evaluation completed (M2)	
Results	Project communication structure Project management folder	
Activities	Sonja Buxbaum-Conradi • Activities Sonja Buxbaum-Conradi • Set up and coordinated all activities with all stakeholders throughout the project period in weekly meetings • Responsible for the development and subsequent maintenance of an efficient communication structure over the entire project period; communication takes place online (cloud systems, video conferences, Kanban board...) and offline in project workshops • Lead and participate in weekly coordination meetings • Quality assurance through risk assessment and prevention • Responsible for project controlling ENIT (PC, 1 person, postdoc) • Set-up and coordination of all activities, especially in Tunisia, with all stakeholders throughout the project period in weekly coordination and in agreement with PC HSU • Contribute to the development and subsequent maintenance of an efficient communication structure throughout the project period; communication will be done online (cloud systems, video conferencing, ...) and offline in project workshops organized by ENIT PC • Participation in risk assessment and prevention; mediation between German and Tunisian partners, if necessary. • Participation in weekly coordination meetings • Continuous multiplication of information in and out of the university ENIM (1 person, postdoc/postgrad) • Participation in risk assessment and prevention activities • Weekly participation in voting • Continuous multiplication of information in and out of the university ISET (1 person, postdoc/postgrad) • Participation in risk assessment and prevention activities • Weekly participation in voting • Continuous multiplication of information in and out of the	

	university	
Activities of partners not funded by the BMBF	ENIT (2 persons, postdoc, in-kind) • Participation in risk assessment and prevention activities • Regular participation in coordination • Regular coordination with ENIT PC MFCP (1 person, project manager, in-kind) • Participation in risk assessment and prevention • Regular participation in coordination	ENIT: 3 PM MFCP: 1.5 PM

Work package 2	**Case study design and scientific evaluation**	**Effort per staff member**
Management	HSU (LaFT)	HSU PC: 6 PM ENIT PC: 9 PM ENIM: 6 PM ISET: 6 PM
Partner	ENIT, ENIM, ISETKH	
Objective	To gain new insights into the potentials and challenges of OSAT and open production spaces for technology transfers, innovation and new business models.	
Duration	36 months	
WP 2.1.	Development of a case study design using qualitative methods (grounded theory)	
WP 2.2.	primary data collection using triangulation through document analysis, interviews, and participant observation (i.e., during mechanical engineering workshops, hackathons, etc.)	
WP 2.3.	Data preparation (transcription, primary coding) Data analysis (sectoral and theoretical coding). Derive a list of key codes/variables and a map of interrelationships.	
WP 2.4.	Scientific data analysis	
Milestones	Case study design completed (M3), data collection completed (M4), data analysis completed (M5)	
Results	Contributions to the interdisciplinary research field of open design and the potential of open production spaces for new forms of value creation Best Practice / Framework Joint scientific publication(s)	
Activities	Activities Sonja Buxbaum-Conradi • If necessary, adapt or concretize the currently planned questions through new findings: o Do OSAT and open production spaces enable new innovation opportunities in Tunisia and what added values do they generate? o Do OSAT and open production spaces lead to a sustainable economic strengthening in the Tunisian environment? o How can the Tunisian textile industry be best supported by OSAT and open production spaces? o What new products are created in the Tunisian textile sector through OSAT and open production spaces and how are they subsequently distributed locally? Responsible for the very extensive development of the case study design using grounded theory as a social science approach to systematically collect and analyze data to generate theory • Contribution of experience from scientific work and previously	

	conducted grounded theories (e.g. (1)(3)(8)) (central contact person for the whole consortium) • As overall coordinator responsible for primary data collection (analysis of documents from a search in Google Scholar, Scopus, Springer Link and the like, interviewing selected experts in the field of OSAT in Tunisia, participant observation during the workshops) • Generation and selection of appropriate (concrete and textile industry specific) case studies with extended regional context. • Transcription and coding of primary data • Merging of supplied primary data • Responsible for theory generation • Allocate 5 PM to prepare and conduct grounded theory (is very extensive) • Conduct final project analysis • Processing of data and analysis to develop recommendations for action for Tunisian decision-makers • Evaluation of the sustainability of the project based on the case study and the scientific analysis • For the follow-up of the grounded theory 1 PM is estimated ENIT (PC, 1 person, postdoc) • Coordination of primary data collection in Tunisia • Support of the HSU PC and taking over of subtasks in common agreement • Provide technical and local support in generating and selecting appropriate (concrete and textile industry specific) case studies with extended regional context • Coordination of transcription and coding in different languages (English, French if necessary) • Merging of supplied primary data • Evaluation of the sustainability of the project based on the case study and the scientific evaluation on the Tunisian side ENIM (1 person, postdoc/postgrad). • Primary data collection using triangulation through document analysis, interviews, and participant observation • Transcription and coding • Preparation and summarization of relevant data ISET (1 person, postdoc/postgrad). • Primary data collection using triangulation through document analysis, interviews, and participant observation • Transcription and coding • Preparation and summarization of relevant data	
Activities of partners not funded by BMBF	ENIT (2 persons, postdoc, in-kind) • Primary data collection by triangulation through document analysis, interviews and participant observation • Transcription and coding • Preparation and summarization of relevant data ENIM (1 person, postdoc/postgrad, in-kind) • Primary data collection using triangulation through document analysis, interviews, and participant observation • Transcription and coding • Preparation and summarization of relevant data ISET (1 person, postdoc/postgrad, in-kind)	ENIT: 6 PM ENIM: 2 PM ISET: 2 PM

	• Primary data collection using triangulation through document analysis, interviews, and participant observation • Transcription and coding • Preparation and summarization of relevant data	

Work package 3	**Development of educational programs**	**Effort per Employee**
Management:	ENIT / HSU	HSU PC: 7 PM ENIT PC: 7 PM ENIM: 5 PM ISET: 5 PM
Partner	HSU, Career Center ENIT, ENIM and Career Center ENIM, ISET and Career Center ISET, MFCP	
Objective	Objective To develop a consistent and interdisciplinary educational program that promotes technology and knowledge transfer by taking into account the needs and requirements of the stakeholders involved and future target groups.	
Duration	15 months (1st and 2nd workshop in winter/spring 2021)	
WP 3.1	Identification and definition of relevant competence fields and specializations in the areas of: ▪ Open source hardware machine development and manufacturing (including reverse engineering and technical documentation). ▪ Business model development in the context of networked value creation and bottom-up economics ▪ Entrepreneurship and entrepreneurship education	
WP 3.2	Development of academic curricula in the area of a) Mechanical and electrical engineering b) Economics, Business (Management and Social Studies)	
WP 3.3	Development of interdisciplinary modules for existing mechanical engineering curricula (esp. ENIT for academic teaching, esp. ISET and ENIM from the perspective of vocational-academic education) and for career centers as well as the NeoTex incubator program	
Milestones	Definition of competence fields and specialization / implementation of the two expert workshops (M6), completion of the modules with teaching instructions (M7)	
Results	2 modules for academic (esp. ENIT) and vocational-academic (esp. ENIM, ISET) training in the areas of open source hardware design and manufacturing with use of additive and other manufacturing processes (including software and electronic components) as well as business model development, ideation and entrepreneurship in/management of OpenLabs / FabLabs.	
Activities	Activities Sonja Buxbaum-Conradi • Participation in the identification and definition of relevant competence fields to be covered by the teaching modules • Supporting the development of interdisciplinary academic and vocational-academic modules for Tunisian universities (ENIT, ENIM, ISET) and for the career centers as well as NeoTex incubator program. • Contributing the experience and contact person for the development and production of open source hardware machines from HSU's OpenLab. • Contribution in the development of the module parts for the economic part/for the business model development related to Tunisian conditions • Contribution of the experience from German teaching	

	ENIT (PC, 1 person, postdoc) • Responsible for the identification and definition of relevant competence fields to be covered by the teaching modules • Responsible for the development of interdisciplinary academic and vocational-academic modules for Tunisian universities (ENIT, ENIM, ISET) and for the career centers as well as NeoTex incubator program • Responsible for the development of the module parts for the economic part/for the business model development related to Tunisian conditions • Contribution of experience from Tunisian teaching and business operations • Management and implementation of coordination processes with local authorities • Coordination with Tunisian career centers and the NeoTex incubator of the MFCPoles ENIM (1 person, postdoc/postgrad) • Identification and definition of relevant competence fields to be covered by the teaching modules • Development of interdisciplinary academic and vocational-academic modules for Tunisian universities (ENIT, ENIM, ISET) and for the career centers as well as NeoTex incubator program • Development of the module parts for the economic part/for the business model development related to Tunisian conditions • Implementation of coordination processes with local authorities • Coordination with Tunisian career centers and the NeoTex incubator of the MFCPoles ISET (1 Person, Postdoc/Postgrad) • Identification and definition of relevant competence fields to be covered by the teaching modules • Development of interdisciplinary academic and professional-academic modules for Tunisian universities (ENIT, ENIM, ISET) and for the career centers and NeoTex incubator program. • Development of the module parts for the economic part/for the business model development related to Tunisian conditions • Implementation of coordination processes with local authorities • Coordination with Tunisian career centers and the NeoTex incubator of MFCPoles	
Activities of partners not funded by the BMBF	ENIT (2 persons, postdoc, in-kind) • Identification and definition of relevant competence fields to be covered by the teaching modules • Development of interdisciplinary academic and vocational-academic modules for Tunisian universities (ENIT, ENIM, ISET) and for the career centers as well as NeoTex incubator program • Development of the module parts for the economic part/for the business model development related to Tunisian conditions • Implementation of coordination processes with local authorities • Coordination with Tunisian career centers and the NeoTex incubator of MFCPoles ENIM (1 person, postdoc/postgrad, in-kind) • Identification and definition of relevant competence fields to be covered by the teaching modules • Development of interdisciplinary academic and vocational-academic modules for Tunisian universities (ENIT, ENIM, ISET)	ENIT: 22 PM ENIM: 13 PM ISET: 13 PM MFCP: 0.5 PM

Erreur ! Source du renvoi introuvable.

	and for the career centers and NeoTex incubator program. • Development of the module parts for the economic part/for the business model development related to Tunisian conditions • Implementation of coordination processes with local authorities • Coordination with Tunisian career centers and the NeoTex incubator of the MFCPoles ISET (1 person, postdoc/postgrad, in-kind) • Identification and definition of relevant competence fields to be covered by the teaching modules • Development of interdisciplinary academic and vocational-academic modules for Tunisian universities (ENIT, ENIM, ISET) and for the career centers and NeoTex incubator program. • Development of the module parts for the economic part/for the business model development related to Tunisian conditions • Implementation of coordination processes with local authorities • Coordination with Tunisian career centers and the NeoTex incubator of the MFCPoles MFCP (1 person, project manager, In-kind) • Support for business model development • Needs assessment for OSH machine development module • Consultation with project partners for queries regarding NeoTex incubator	

Work package 4	**Implementation of educational programs and test operations with industry**	**Effort per employee**
Management:	HSU / ENIT	HSU PC: 11 PM ENIT PC: 8 PM ENIM: 9 PM ISET: 9 PM
Partner	MFCP, ENIM, ISET, external trainers, companies from the network	
Objective	▪ Start of the test lab and its operation in the incubator of the NeoTex cluster. ▪ Successful embedding in local educational and industrial structures as well as global knowledge communities and networks	
Duration	18 months	
WP 4.1	Train-the-trainer and first mechanical engineering workshop	
WP 4.2	Train-the-trainer and second (large) mechanical engineering workshop at NeoTex Incubator.	
WP 4.3	Test services with industry	
WP 4.4	Start and delivery of academic modules in the respective curriculum (see WP 3.2.).	
Milestones	Approximately 80 people trained on site, 20 people certified as "trainers" and / or lab leaders (M8), 50-70 people participated in new academic lectures and seminars (M9).	
Results	Workshop modules are prepared and then available as blueprints. Participants learn the basic skills to build and repair machines for the NeoTex incubator machinery. Train-the-trainer participants can conduct their own training, become lab managers, build machines, develop hardware products and related business models, and "replicate" the OpenLab idea.	

Activities	Sonja Buxbaum-Conradi
	• Responsible (with ENIT PC) for developing workshop content in the form of workshop modules.
	  o Testing of the machines to be built in cooperation with external partners
	  o Development and preparation of the workshop schedule and program
	  o Development and preparation of the educational workshops as a multiplier course for future trainers ("train-the-trainer") for the local business community in order to sustainably train new trainers and business multipliers
	• Responsible (with ENIT PC) for the organization, implementation and follow-up of the mechanical engineering workshops and the hackathon
	  o Planning of the premises
	  o Participant management
	  o Planning of sleeping and eating capacities
	  o Central coordination and moderation on the mechanical engineering workshop days and during the hackathon
	  o Assist with the delivery of the mechanical engineering workshops held by external partners
	  o Independent delivery of the educational workshops as a multiplier training course for future trainers ("train-the-trainer").
	• Support the implementation of testing services with industry in the NeoTex incubator.
	• Support in starting and implementing academic and vocational-academic modules in the respective curriculum (based on AP3.3)
	ENIT (PC, 1 person, postdoc)
	• Responsible (with HSU PC) for developing workshop content in the form of workshop modules.
	  o Review of machines to be built in collaboration with external partners.
	  o Development and preparation of the workshop schedule and program
	  o Development and preparation of the educational workshops as a multiplier course for future trainers ("train-the-trainer") for the local business community in order to sustainably recruit new trainers and business multipliers
	• Responsible (with HSU PC) for the organization, implementation, and follow-up of the mechanical engineering workshops and hackathon
	  o Planning of the premises
	  o Participant management
	  o Planning of sleeping and eating capacities
	  o Central coordination and moderation on the mechanical engineering workshop days and during the hackathon
	  o Assist with the delivery of the mechanical engineering workshops held by external partners
	  o Independently deliver the educational workshops as a multiplier training course for future trainers ("train-the-trainer").
	• Responsible for implementing testing services with industry in the NeoTex incubator.
	• Responsible for starting and implementing academic and	

	vocational-academic modules in the respective curriculum (based on AP3.3) ENIM (1 person, postdoc/postgrad) • Assist in the development of workshop content in the form of workshop modules. • Assist in the organization, execution, and follow-up of the mechanical engineering workshops and hackathon • Implementation of testing services with industry in the NeoTex incubator. • Follow-up of the implementation of test services • Consultation with local industry on test results • Implementation of academic and vocational-academic modules in the respective curriculum (based on AP3.3) ISET (1 person, postdoc/postgrad). • Assist in the development of workshop content in the form of workshop modules. • Assist in the organization, execution, and follow-up of the mechanical engineering workshops and hackathon • Implementation of testing services with industry in the NeoTex incubator. • Follow-up of the implementation of test services • Consultation with local industry on test results • Implementation of academic and vocational-academic modules in the respective curriculum (based on AP3.3)	
Activities of partners not funded by BMBF	ENIT (2 persons, postdoc, in-kind) • Support in the development of workshop content in the form of workshop modules • Support in the organization, implementation and follow-up of the mechanical engineering workshops and hackathon • Implementation of testing services with industry in the NeoTex incubator. • Follow-up of the implementation of test services • Consultation with local industry on test results • Implementation of academic and vocational-academic modules in the respective curriculum (based on AP3.3) ENIM (1 person, postdoc/postgrad, in-kind). • Assist in the development of workshop content in the form of workshop modules. • Assist in the organization, execution, and follow-up of the mechanical engineering workshops and hackathon • Implementation of testing services with industry in the NeoTex incubator. • Follow-up of the implementation of test services • Consultation with local industry on test results • Implementation of academic and vocational-academic modules in the respective curriculum (based on AP3.3) ISET (1 person, postdoc/postgrad, In-kind). • Assist in the development of workshop content in the form of workshop modules. • Assist in the organization, execution, and follow-up of the mechanical engineering workshops and hackathon • Implementation of testing services with industry in the NeoTex incubator. • Follow-up of the implementation of test services	ENIT: 24 PM ENIM: 19 PM ISET 19 PM MFCP: 3.5 PM

	• Consultation with local industry on test results • Implementation of academic and vocational-academic modules in the respective curriculum (based on AP3.3) MFCP (1 person, project manager, In-kind). • Preparation and execution of the mechanical engineering workshops • Preparation and execution of the hackathon • Preparation and execution of testing services at NeoTex incubator	

Work package 5	**Visibility, outreach, and sustainability**	**Effort per employee**
Management:	HSU / ENIT	HSU PC: 8 PM ENIT PC: 2 PM ENIM: 10 PM ISET: 10 PM
Partner	MFCP, ENIM, ISET, network of associated partners and companies	
Objectives	Create public awareness, initiate replication processes elsewhere and in other areas, expand network and political support, create permanent and sustainable structures	
Duration	36 months	
AP 5.1	Marketing, PR and organization of events	
AP 5.2	Develop a business model for the test lab in the NeoTex cluster that makes it self-sustaining	
AP 5.3	Networking with international and local networks (network and knowledge management)	
AP 5.4	Derive recommendations for the public sector (e.g. Tunisian Ministry of Higher Education, Ministry of Industry and SMEs)	
Milestones	Marketing concept paper (M10), business model for Lab at NeoTex Incuabtor and successful embedding in global networks and local socio-economic environment (M11), white paper with policy recommendations (M12).	
Results	A policy white paper that aims to use research and innovation results to shape policy making, present a self-sustaining business model developed for the Lab at NeoTex Incuabtor, increase public awareness of the OpenLab concept and its impact on education, innovation, and business development, and expand and strengthen a supportive network	
Tätigkeiten	Activities Sonja Buxbaum-Conradi • Responsible for coordination and execution of marketing and PR as well as organization of events • Development and operation of a project website • Development and production of flyers • Responsible for business model development for the NeoTex test lab based on experiences from the OpenLab and other preliminary work • Responsible for networking activities and personnel with national and international networks • Making the project visible and promoting it in its own network • Responsible for the development of policy recommendations (WhitePaper) based on project results and experience from previous projects	

	ENIT (PC, 1 person, postdoc) • Support in coordination and implementation of marketing and PR as well as organization of events • Support in the development and production of flyers • Business model development for the NeoTex test lab, especially taking into account local and industry-specific contexts • Making the project visible and promoting it in its own network • Support in the development of political recommendations for action (WhitePaper) based on project results • Coordination with local authorities and partners ENIM (1 person, postdoc/postgrad) • Maintenance of the website • Development, creation and dissemination of flyers • Implementation of marketing, PR and events • Visibility and promotion of the project in own network and at own university • Development of political recommendations for action (WhitePaper) based on project results • Coordination with local authorities and partners ISET (1 person, postdoc/postgrad) • Maintenance of the website • Development, production and distribution of flyers • Implementation of marketing, PR and events • Visibility and promotion of the project in own network and at own university • Development of political recommendations for action (WhitePaper) based on project results • Coordination with local authorities and partners	
Activities of partners not funded by BMBF	ENIT (2 persons, postdoc, in-kind) • Maintenance of the website • Development, creation and distribution of flyers • Implementation of marketing, PR and events • Visibility and promotion of the project in own network and at own university • Development of policy recommendations (WhitePaper) based on project results • Coordination with local authorities and partners ENIM (1 person, postdoc/postgrad, in-kind) • Maintenance of the website • Development, creation and distribution of flyers • Implementation of marketing, PR and events • Visibility and promotion of the project in own network and at own university • Development of political recommendations for action (white paper) based on project results • Coordination with local authorities and partners ISET (1 person, postdoc/postgrad, in-kind) • Maintenance of the website • Development, creation and distribution of flyers • Implementation of marketing, PR and events • Visibility and promotion of the project in own network and at own university	ENIT: 17 PM ENIM: 2 PM ISET 2 PM MFCP: 3.5 PM

	• Development of political recommendations for action (WhitePaper) based on project results • Coordination with local authorities and partners MFCP (1 person, project manager, in-kind) • Visibility and promotion of the project in own network • Development of policy recommendations (white paper) based on project results • Coordination with local authorities and partners	

Contracts for the mechanical engineering workshops and hackathon will also be tendered and awarded at the start of the project.

IV. Exploitation Plan

As the applicant university, Helmut Schmidt University confirms with respect to the publication of project results that the consortium cannot prevent the publication of project results and that prior to the publication of project results, they will be reviewed for usability.

Economic prospects for success

During the project, business models for incubators and improvement of product development will emerge, which are expected to have economic prospects of success. Prospects and time horizons are shown in the table below.

	Short-term (<2 years)	***Medium-term (>2-5 years)***	***Long-term (>5 years)***
Economic prospects for	Success of expected results Very good prospects for success in terms of access to digital means of production and related know-how with potential for new jobs; improvement of living conditions of Tunisian citizens; development of OS solutions for the Tunisian textile sector	Very good prospects for success in terms of first innovations, spin-offs and first (new) jobs in the textile sector; product development and licensing procedures in the field of OS/CC completed	Good prospects for success in terms of increased innovation, profitability, entrepreneurship and job creation; replication of the Open Labs and the economic idea in other Tunisian cities
Concrete steps	For implementation, opening of the career centers and the NeoTex incubator by all project stakeholders; initiation of development processes with the research institutions in conjunction with MFCPole	Textile machinery development, testing and start-up creation in the NeoTex incubator by companies from MFCPole and surrounding areas, OS/CC licensing by ENIT, ENIM, ISET and HSU carried out and completed	Dissemination (replication) and consulting of the Open Lab in the textile sector by MFCPole with the support of Tunisian research institutions

Scientific and/or technical prospects for success

At the scientific level, we expect to gain further insights into the mechanisms of open production and the co-development, design and application of OSAT in open production workshops that foster local innovation and value creation activities. The results (e.g., the white paper) can be used as a basis for developing general recommendations for decision-making by policymakers and business actors in Tunisia to initiate more spaces for innovation and experiential learning, improve conditions, and create research- and innovation-relevant governance structures that prepare students and SMEs for future industrial challenges of digitized production. The results will be directly integrated and applied in the existing structures of education, research, innovation and policy in both cooperation countries. Therefore, the expected results will have a significant impact on the societal and economic spheres, including (but not limited to) the following aspects:

- Increased participation of individuals in value creation processes (through open access to manufacturing inputs, resources and know-how),

- Education and empowerment through increasing technological literacy, collaboration, and sustainability, leading to entrepreneurship and job creation,
- Independent, self-organized, and collaborative micro-level development (with bottom-up developed and user-centered innovations),
- Fostering innovative practices and production in hardware and digital manufacturing.
- In sum, the results benefit academic institutions, civil society, and the public alike. The perspectives and time horizons (likely achievement of exploitation goals) are shown in the table below.

	Short-term (<2 years)	***Medium-term (>2-5 years)***	**Long-term (>5 years)**
Scientific / technical / structural prospects	Success of expected results Access to digital means of production and related know-how; open innovation and production practices in the textile sector in the Monastir area; very good prospects of success through initial activities with partners in the concept phase; development of OS solutions for the Tunisian textile sector	Expanded access to digital means of production in different OpenLabs; first innovations, spin-offs and first jobs to be gained in the textile sector; Good prospects to contribute to the interdisciplinary research field of Open Design and Open Production and to promote academic training and knowledge exchange; product development and licensing procedures in OS/CC completed	Wide national access to digital production; high multiplication rate of Open-Labs based on self-replicability of technologies, designs and processes; Increased innovation, entrepreneurship, and job creation.
Concrete steps of implementation	Creation of OpenLabs at the NeoTex cluster incubator with a self-sustaining business model. Possibility to implement OpenLabs at ISET / ENIM; start development processes with the research institutions in conjunction with MFCPole	Permanent integration of open source digital manufacturing and networked value creation principles in the academic curriculum at three universities in Tunisia and related career centers; textile machinery development and testing in the NeoTex incubator by companies from MFCPole and surrounding area	Comprehensive integration in various networks, dissemination of "best practices" via marketing, PR and media.

Wissenschaftliche und wirtschaftliche Anschlussfähigkeit

	Expected result	Späteres Produkt Later product	Exploitation steps	Time horizon
1)	Joint scientific publications	Publications in journals and contributions at conferences for the general public	Evaluation and set-up of publications by project partners	Already in the project, Subsequent scientific work after PE
2)	Policy White Paper	Elaborated recommendations based on the project for decision making by policy makers and business actors in Tunisia to improve economic (more jobs, more spin-offs, higher innovation rate) and social (applied education in learning spaces, meeting place, self-help workshop) conditions through open production and innovation centers in the textile sector	a) Present paper to policy makers and business actors for feedback by MFCPole and local actors (PC ENIT, coordinator, ENIM, ISET) b) Subsequently process feedback and develop concrete recommendations with Tunisian ministries and industry and education actors involved in the project. c) Implement recommendations in Tunisia with all project stakeholders and Tunisian ministries, starting in Monastir (NeoTex incubator environment), scattering to MFCPole environment and then scaling nationwide	a) Month 2-3 after PE b) Month 3-6 after PE c) Month 6 onwards after PE.
3)	Initial access to digital production tools and associated know-how	Disseminated access to digital production tools through distributed OpenLabs	a) Implement Open Labs in NeoTex cluster by MFCPole and research institutions. b) Integration of the OpenLab and courses in partner universities. c) Integration into further networks and dissemination of know-how and "best practices" through public relations	a) Year 1-2 after PE b) Year 2-5 after PE c) Year 5 onwards

V. Work sharing/collaboration with third parties

In addition to the partners funded by the BMBF directly or through referral (HSU PC, ENIT PC, ENIM, ISET), there are other partners involved in the project that are funded differently (see "Activities of partners not funded by the BMBF" in tables of the individual work packages).

Partner	Funding	Person months
ENIT	Three-year full-time position through in-kind-contribution (ENIT budget)	36 PM
ENIT	Three-year full-time position through in-kind-contribution (budget funds "Ministry of Higher Education and Scientific research")	36 PM
ENIM	Three-year full-time position through in-kind-contribution (ENIM budget)	36 PM
ISET	Three-year full-time position through in-kind-contribution (ISET budget)	36 PM
MFCP	9 PM through in-kind-contribution (MFCP budget)	9 PM

A cooperation agreement will be concluded between the partners. This shall include, but not be limited to, the following:

(a) The partners must comply with higher-ranking law, in particular EU competition law.

b) Each collaborative partner shall be entitled to make unrestricted use of the results generated by it within the scope of the collaborative project.

c) Each collaborative partner shall contribute its own experience, knowledge and industrial property rights to the collaboration.

d) For the purpose of carrying out the collaborative project, the collaborative partners shall grant each other a non-exclusive, royalty-free right of use to know-how, copyrighted results, inventions and granted industrial property rights which exist at the start of the collaborative project or arise within the scope of the collaborative project.

VI. Necessity of the Grant

The grant funds are necessary for Helmut Schmidt University (HSU) to carry out the research project, as there are no other financing options (neither third-party nor own funds for project implementation). This also applies to the sub-projects of the École Nationale d'Ingénieurs de Tunis (ENIT) and the ENIM and ISET. In accordance with the requirements of the funding conditions, the participating partners make a substantial contribution to the implementation of the overall project. However, there are not enough own funds or funds from third parties available for the financing of all necessary work. No other means of financing can be expected, since, as with any research project, there are risks that can lead to the failure of a project. The amount of the grant is necessary to further anchor the open production workshop system locally. In order to save considerable additional costs, open source machines are already being assembled for the workshop equipment in workshops by the workshop participants with guidance from the German and third party partners. The amount of the grant for the HSU is necessary to enable the staff to pass on the extensive expertise already available through the OpenLab to the Tunisian partners and to evaluate the project using scientifically sound methods. Furthermore, as the project coordinator on site, ENIT is responsible for a large part of the work in Tuensia on its own, which is why personnel costs are also incurred here that cannot be borne by ENIT independently. The planned development of educational programs, the implementation of the programs including test operations and the visualization of the project also require a large amount of personnel for the partners ENIM and ISET, which can also not be borne independently and require funding.