Cross-KIC Project

End-to-end digitalised production test beds

CALL GUIDELINES

EIT Manufacturing | EIT RawMaterials | EIT Digital

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1 Digitalisation to create interconnected manufacturing eco-systems

Digitisation of manufacturing processes is a keystone of the move towards Industry 4.0. More than any other industrial revolution, digitalisation relies on data to enable the interconnection of processes with the goal to optimise the interaction of humans and machines on a holistic level. Ensuring the constant availability of reliable data is a challenging task. Certain machines might produce data due to already installed internal sensor technology, generating challenges regarding data access, data format, and data interpretation. Other machines might lack the ability to provide data and therefore require retrofitting of sensor technology to turn them into "smart devices". Additionally, new methods of production can arise benefitting directly from a new data environment. Often these types of machinery are represented in production lines, further increasing the complexity of creating interconnected manufacturing eco-systems. However, data accessibility and availability are only half the story. Only once data is processed and analysed in an appropriate manner, and used to support the decision-making process, the move from big data to smart manufacturing is achieved. Regarding data processing and analysis, advanced algorithms in the form of artificial intelligence technologies have proven their potential and are featured in a variety of applications, with process control, quality analysis, as well as predictive maintenance being only a few examples.

The implementation of digitalisation solutions poses multiple challenges for manufacturing and processing companies, especially within dedicated topics in the raw material business. As digitalization mostly progresses in a top-down approach starting from the End Product, more and more focus is put into the supply chains down to the raw material production sites. Identifying processes worth digitising, enabling data acquisition, performing analyses, and deriving measures requires expertise that is oftentimes not available to manufacturers and their equipment suppliers. Furthermore, availability of infrastructure and/or human capital, needed to embrace digital transformation is limited. Additionally, the manufacturers' inexperience with digitalisation technologies and circular economy aspects, further complicates communication between the parties. Even after successful digitisation of processes, this lack in experience among the manufacturers' staff poses challenges regarding application, maintenance, and potential advancement of the implemented solutions. Manufacturers, both of goods and equipment alike, are hence encouraged to add digitalisation expertise to their workforce~~.~~ This is especially true for the raw material industry in the production of e-drives[1], as they require a raw material input that cannot be met from European sources only (e.g. Permanent Magnets, Lithium batteries, Scandium). Therefore, this iniciative focuses the implementation of Testbeds for End-of-Life (EOL) products re-use or recycling approach of parts and assemblies.

2 Testbed development for e-drive production in the raw material sector

Digitalisation presents all industries with immense opportunities. At the same time, unawareness of untapped potential, insecurities on how to approach the subject, and an overall lack of expertise hamper widespread adaption of digitalisation technologies in certain industrial sectors.

To promote digitalisation activities, testbeds provide a real-life like environment and therefore reduce abstractness, enriching exchange between digitalisation experts, producers of goods, equipment suppliers, and other parties. Problems and therefore solutions become more tangible since they can be experienced first-hand in a controlled setting, that enables reliable recreation of scenarios and situations. Starting from this exchange, testbeds represent a "playground" for the development of innovative solutions on a smaller scale without affecting real-life production. This leads to decreased development cost and allows for testing and maturing, before implementing the solutions and possibly disrupting the actual production processes.

[1] Production of E-Drive includes not just the e-motors for automobile industries, but also the parts needed for wiring and charging as well as for other competeting sectors like renewable energies or robotics. E-Drives therefore include: E-Motors ranging from small step motors to big snychron motors but also Fuel Cells and Batteries.

Throughout these activities, testbeds represent an ideal environment for learning, and knowledge exchange. Developers of digitalisation solutions learn about branch-specific characteristics and challenges. At the same time, producers of goods and equipment suppliers learn about the digitalisation interfaces of their processes and machinery. By fostering collaboration, the parties learn about the potential and limitations of process digitisation, and how to approach digitalisation projects. Moreover, testbeds create a unique environment for "coopetition" – collaboration between companies that are naturally competitors. Under these circumstances, companies working in the same sector can learn from each other and leverage on synergies to overcome common challenges and become more effective and competitive.

The educational potential of this testbed approach, sometimes also described as a "learning factory" does not stop there. It can help train staff on how to operate within increasingly digitised process chains, reducing the risk of mistakes and even fostering deeper understanding of digitalisation and therefore acceptance. Additionally, this "learning factories" can provide a complementary and more practical learning experience for students, by bringing the theoretical aspects taught in classrooms to life.

This Testbeds and in a broader sense learning factories, have been available for manufacturing sectors like metal working and machining, for many years. Manufacturing sector specific digitalisation testbeds, as well as this non-consumer sector's increased technology focus, have helped establishing an advanced digitalisation maturity level.

The Raw material sector consists of a huge variety of companies, from very small to world -wide players with an extremely diverse level of digitalisation. The sector covers the whole value chain from exploration to recycling and circular economy. Many factors influence the supply of raw materials depending on the overall supply–demand balance. High demand can raise prices, making exploration, mining and refining projects or the search for substitution as well as recycling commercially more attractive.

The e-Drive sector is no exception to this. Figure 1 shows the interconnection of different raw materials for renewables and e-mobility sectors, sorted on the expected future supply risk from largest to smallest including different technologies. This also shows the diversity of the e-Drive sector as well as the different use cases for raw materials which can generate an additional demand, including defence, aerospace and digitalisation. For example, handheld devices also use batteries. With 74% of all battery raw materials provided from China, Africa and Latin America, with China alone supplying 66% of finished Li-batteries, this could become a bottleneck for the EU. For e-Motors we have a similar case regarding the permanent magnets, which ar not only used for traction motors but also for robotics, drones or even wind energy, with a market dominated by China and Japan as key players.

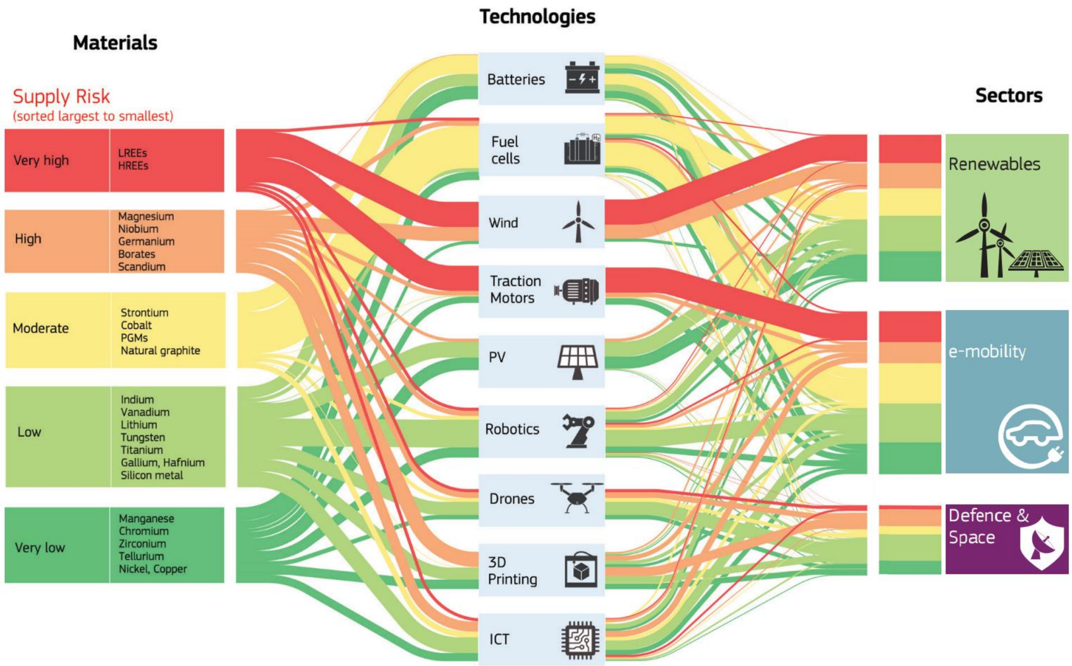

Figure 1: Systematic depiction of the interconnections of the e-drive sector and raw material supply chain (Source Critical RM for Strategic Technologies and Sectors in the EU, a foresight study, JRC ISBN 978-92-76-15336-8)

European Raw Materials Alliance (ERMA)

ERMA was established and tackles the current and future challenges and proposes actions to reduce Europe's raw materials' dependency on third countries, diversifying supply from both primary and secondary sources and improving resource efficiency and circularity while promoting responsible sourcing worldwide.

Aimed to:

- develop resilient value chains for EU industrial ecosystems
- reduce dependency on primary critical raw materials through circular use of re-sources, sustainable products and innovation
- strengthen domestic sourcing of raw materials in the EU
- diversify sourcing from third countries and remove distortions to international trade, fully respecting the EU's international obligations.

Cross-KIC initiative to promote implementation testbeds

Parallel and detached from ERMA, to address these issues in a focused way, the **cross-KIC project "end-to-end digitalised production testbeds"**, led by EIT Manufacturing and featuring EIT RawMaterials and EIT Digital was launched. Its goal is funding the development and implementation of digitalisation testbeds that address the industry's most pressing manufacturing and processing challenges. To ensure the testbeds meet the E-Drive sector raw material demands, the three KICs and a collection of partners, selected in a series of open calls, to ensure availability of expertise in the fields of raw material, manufacturing, and digitalisation, as well as to ensure geographical coverage, worked together. **The goal was to evaluate the current state of digitalisation in the raw material sector within the field of E-Drives, to identify high potential areas for digitalisation-driven improvements, and to derive suitable use-cases.**

3 Strategic objectives of the testbed development

Testbeds

Within this cross-KIC project, based on the exchange with project partners, the involved KICs developed a framework describing the characteristics and basic functions, the end-to-end digitalised raw material production testbeds should provide:

> *A testbed is an instalment of hardware components (process machines, logistics equipment, etc.) that depicts (a segment of) a real-life production line, by using either a scaled-down version of a process chain or life-size equipment. Within the testbed, the effectiveness/efficiency of the depicted manufacturing processes shall be improved by applying digitalisation solutions, like* ***Artificial Intelligence technologies, virtual and/or augmented reality functionality, blockchain integration, 5G connectivity, integration of additive manufacturing processes, etc.***
>
> *The testbed implementation activities include selection and integration of hardware components, as well as making data provided by the components or from external data sources accessible/usable. Alternatively, the creating of smart components by adding (low-cost) sensor technology can be considered. Finally, data processing and analysis, using advanced methods to support decision making processes and derive optimisation measures need to be addressed.*

Additionally, encouraging the establishment of sustainable structures, applying circular economy measures can increase long term competitiveness of companies, as it leads to preservation of (scarce) resources, to cost reduction, and to new business models, products, and services. Due to the general direction the testbeds should take, the aspect of circular economy as main driver should serve as a base requirement for the focus points.

Circular Economy aspects

The European Commission describes a circular economy as follows:

> *In a circular economy, the value of products and materials is maintained for as long as possible. Waste and resource use are minimised, and when a product reaches the end of its life, it is used again to create further value. This can bring major economic benefits, contributing to innovation, growth, and job creation.*

Regarding the E-Drive[2] production sector, applying circular economy measures can strongly impact the increase of the recycling/reuse rate of critical materials. To establish circular economy aspects, it is important to have the information on the materials' properties, the information on where these materials are required and what processes or situations the materials went through during their lifetime. Identifying and establishing measures to enhance circular economy aspects within an organisation, benefits from a greater information transparency, compared to external networks. However, depending on the range and variety of an organisation's process steps, the potential to apply circular economy measures internally is limited. Therefore, it is vital to take a holistic approach and to create networks of suppliers, manufacturers, recyclers and other actors to share necessary information.

To ensure the digitalisation testbeds contribute to improving secondary raw material production from recycling of EOL products or to reduce the demand through reuse of parts in a meaningful and productive way, the following focus points for testbed development were identified by the KICs and the partners involved in the project:

- Improve part design for recycling, re-use & prolonged lifetime
- Increasing the recycling rate for critical materials from EOL products
- Improvement of the supply chain for EOL products

By addressing these problems, against the background of the three dimensions of sustainability (social/health, climate/environmental, and economic/business), the production testbeds will support the digitalisation of the raw material sector and will help provide affordable, competitive raw materials produced in Europe.

[2] Production of E-Drive includes not just the e-motors for automobile industries, but also the parts needed for wiring and charging as well as for other competeting sectors like renewable energies or robotics. E-Drives therefore include: E-Motors ranging from small step motors to big snychron motors but also Fuel Cells and Batteries.

3.1 Improve part design for recycling, re-use & prolonged lifetime

To improve the part design for recycling, re-use or prolonged lifetime it is necessary to analyse different products and to determine which elements and raw material can be re-used in a most efficient way, maybe even taking into account a premature EOL. To gain information about the materials' properties and the changes occurring, it is necessary to find measures to perform analyses on the material performance and to define categories to sort these materials by, based on the information accessible.

For this and to enhance the circular economy aspect, it is therefore essential to take into account the design, the lifetime and the manufacturing of the products:

- A better design for parts meant for recycling, could help to approach these goals. As the part design does not only take into account an easy and fast production with a low energy consumption. In case of defective or EOL products deconstructability is an important factor as to how much and how easy the raw material can be removed. Some products could also be transferred to previous processing steps to be refactored and again rise in efficiency, and therefore increase the total amount of raw material which can be recycled as well as safe energy and time in the processes needed for this operation.

- If reusage of parts or whole assemblies for the E-Drive production is not an option, the materials could be suitability for other branches like energy storage for renewable energy. Therefore, a secondary use case has to be found, which allows this already partially spent products, as the efficiency or functionality is not sufficient for its original use case anymore, to resume into a new life cycle. A prolonged lifetime can also be a suitable way to approach this as there is no need for additional work and energy to be consumed by needed re-using processes and operations.

- Another big topic is the valorization of waste. During processing and assembling a lot of failures can occure as well a there may be some loss due to the not optimized and digitalized prossesing machines and methods. Waste valorization changes unusable material into constituent parts that can be utilized, and have value beyond the cost of the energy needed to process the transformation. Besides this a Zero Waste production is the best course of action to should be targeted if possible.

Enhancing the circular economy of E-Drive production is not limited to recovery & recycling of waste and by-products. Resource efficiency of manufacturing processes can be enhanced by applying circular economy measures. Energy, mainly in the form of heat, emitted by the production processes can be utilised at other stages of the facilities.

3.2 Increase the recycling rate of critical materials from end-of-life E-Drive parts

Through the heightened need on raw material parts in the E-Drive sector it became clear that Europe became very dependent on external suppliers regarding the raw material production on specific critical materials. For example, every magnet used for E-Drives in the automobile, or the renewable energy sector is imported outside from Europe, (Japan and China), making this a highly valuable resource with the prospect of an even higher demand coming up in future years. The same reasoning applies to other materials used in the E-Drive sector (e.g. Lithium or Scandium). Increasing the source of secondary raw materials through higher recycling/reusing rates of this scarce resources could be one way to meet the demand from inside of Europe without the need to depend on long supply chains throughout different other continents.

Given this situation, it appears that EOL products containing critical materials should be the main source and focus for this digitalised production testbeds call. The identification of EOL as well as waste sources to generate a stable supply of parts and material, which can be processed at a suitable cost compared to primary sources for a measurable impact on the resource import, is the first step. Also taking into account possible losses during the processing process of these materials. Amplify the efficient use and cut down the need as far as possible is a valuable improvement. The much higher quantity of products that is and will be generated in the future will aid and push both approaches, given that scarce materials are highly valuable and a high efficiency in production is a key to success on a broad scale for recycling of parts as well as for production.

- Most of the waste occurs at the end of a lifetime of a given product. For newly invented or newly excessively applied technologies most of the recycling processes are not yet explored, some may even be unknown. The first step would be to sort the parts based on different criteria like raw materials included or functionality before retreating them. Depending on the first assessment there are different approaches ranging from an obvious dissembling of the products into their components, which in case of lithium batteries needs a specific knowledge, environment and safety measures, up to the reuse of whole assemblies in different sectors, which work on lower performance levels than needed for the initial use case.

- The quality or functionality standards of parts including the raw materials accounts for other waste and loss possibilities. Through their lifetime materials wear or may lose some properties and therefore not meet market & quality standards making them unusable. This could also originate from the material & properties evaluation & quality check methods which might be too superficial, or the quality standards needed are too high and therefore lead to increased and premature waste.

- Further along the process chain in production, mistakes lead to elimination of entire products. Examples for these non conformities, that can either by committed by personnel or by machinery, are application of false processing parameter like temperature or pressure, machine wear and damages to products during packaging or transport. Awareness of the current wear status of machines and equipment is also a key factor in reducing machine failure and related machine downtimes. Especially for new machines without sufficient training data, which focus a new production methode in depth analysis can result in fruitful results, contributing to increase equipment availability and reducing operating cost

3.3 Improvement of the supply chain for EOL products

Manufacturers especially SMEs, face constant pressure to offer their products at competitive prices, creating high incentives to reduce production costs. One approach is to reduce material cost, which is closely related to the waste/loss and circular economy aspects. Increasing the efficiency and effectiveness of processes along the supply chain, provides positive effects beyond material cost. While often used interchangeably, effectiveness refers to the activities performed to achieve a goal ("doing the right things"), whereas efficiency refers to optimal use of resources to accomplish these goals ("doing the things right").

- In this specific case the identification and classification of suitable secondary raw material sources has to be found and verified. A digitalised environment would help to assess the status of the raw material as well as help to understand what happened during the lifetime of the product, also taking into account aspects for the circular economy. Therefore, a lifetime tracking tool could assess the optimal point for a reuse in a specific different environment or sector. An estimation of the best lifetime point for reuse would also help to generate a stable secondary raw material supply as it would not wholly depend on part failure, but track the break-even between efficiency of the product and effectiveness of a recycling/reusing approach.

- Furthermore, the supply chain can be optimized to reduce mainly the labour cost for dissembling of the products as the many steps needed impact heavily on the final price, but also including energy saving aspects. Energy consumption can be reduced, by ensuring that machinery and equipment are operating at their optimum. This entails among other things the identifying of worn-out components to reduce friction losses.

For manufacturers to properly tackle supply chain issues as well as loss and waste in critical materials, they should establish close collaboration with the other agents of the supply chain, both upstream (retailers, consumers) and downstream (primary sector) and also explore other alternatives for surplus or by-product application (other industries).

3.4 Impact metrics

Cross-KIC activities are centred around a mission approach and want to encourage applicants to strive to achieve ambitious impact goals. Depending on the testbed use-case, one ore multiple of the defined strategic objectives needs to be addressed by the proposal. To ensure beneficial impact on the consortium participants, as well as a sensible cost-benefit ratio, applicants are asked to demonstrate that the testbed proposal will contribute to fulfilling at least one of the following or a suitable similar impact metrics as there are many more:

- Improve part design for recycling, re-use & prolonged lifetime
  - Increase in the re-usability of materials by 20 %.
  - Increase the re-use of discharge material by 10 %.
  - Increase the lifetime of critical assemblies by 20%
  - Increase of by-product utilisation by 20 %.
  - Reduction of packaging material by 20 %.
- Higher Recycling Rate
  - Increase recycling rate of critical materials by at least 20%.
  - Improve quality check methods for raw materials by 20%
  - Reduce quality needed for effectiveness 10 %.
  - Reduce processing mistakes by 20%
- Improvements to supply chain in regards of products at the end of their lifetime
  - Reduction of machine downtimes for recycling by 35 %.
  - Reduction of energy consumption for recycling by 15 %.
  - Reduction of manufacturing lead time between end of life and re-life/use by 30%.
  - Reduction of water consumption for recycling by 15 %.

Given the E-Drive industry's incredible heterogeneity, featuring a variety of sectors and therefore different critical resources used as well as different processes and different approaches towards applications of digitalisation, this call is <u>OPEN</u> to accept <u>additional impact metrics</u>. These need to be presented in a convincing and comprehensive manner, to allow for an evaluation of the proposal's impact.

4 Proposal structure and submission

In this cross-KIC project, EIT Manufacturing, EIT RawMaterials, and EIT Digital plan to fund the implementation of end-to-end digitalised production testbeds for the raw material sector. For this purpose, the three KICs will request 2,1 million EUR from EIT to enable 2 to 3 selected consortia to realise their proposed testbed at various locations in Europe. The funding period runs throughout the year 2022. Funding will occur in the form of two grant lanes:

- Big grant lane
  In the big funding lane, between 1 and 1.2 million EUR will be granted to 1 or 2 selected consortia to implement their testbed.

- Small grant lane
  In the small funding lane, between 300.000 and 500.000 EUR will be granted to each of 1 to 2 consortia.

Applying consortia are asked to indicate for which funding lane they apply. Furthermore, consortia applying for the big grant lane should lay out if their testbed proposal could also be realised as part of the small grant lane, and which adaptions to their proposal would be necessary. This will support the independent reviewers in deciding whether transferring a promising big lane application into the small lane could be a valid option.

The grant money is to be used to cover the cost of implementing the testbed and to make it operational. This includes personnel cost for the consortium-members' staff involved in the testbed project, cost for hardware (machinery, equipment, operating supplies, etc.) and software, as well as room and energy cost, and related services. Also, expenses for project related travel activities are covered.

In accordance with Horizon Europe principles, a 25 % cost overhead is granted additionally. The KICs will furthermore comply with EIT's cost eligibility rules.

For this cross-KIC initiative, a 30% co-funding rule applies, meaning that a maximum of 70% of the budgeted cost will be covered by EIT funding. The rest of the budget needs to be obtained from other sources (e. g. own funds, local funding bodies, etc.). The co-funding rule applies on a consortium level, meaning that individual consortium members (e. g. start-ups, universities) can be fully funded, if other consortium members agree to receive reduced funding.

Due to the funding being asked for while this call is in progress, changes in the total amount of the available money can occur.

4.1 Testbed use-case

The grant applications need to demonstrate how the proposed testbed use-case is in line with at least one of the identified strategic objectives described in section 4. This entails describing the product(s) and/or process(es) to be depicted in the testbed setup, as well as the associated challenges to overcome by means of digitalisation. Furthermore, the required setup and infrastructure to depict the designated use-case as a testbed needs to be described:

- Machinery and equipment (e. g. ovens, coolers, processing machines, etc.)
- Hardware components (e. g. sensors, cameras, robots, edge computers, etc.)
- Software (e. g. control software, AI platforms, deep/machine learning software, etc.)
- Processing materials (e. g. magnets, Lithium-Ion, Scandium products/product stand-in)

Interaction of these components needs to be described, and component setup should be outlined in a schematic sketch, e. g. visualising the flow of materials and/or information. The sketch should furthermore illustrate the estimated dimensions of the finalised testbed. Also, the future location of the testbed environment should be specified in the application.

Acquisition cost of the components need to be specified in the application and must be in line with EIT's eligibility rules. As the budget is limited and the handling of some raw material poses a lot of danger, at least a first laboratory environment should be already in place to minimise possible project risks.

4.2 Timeline and challenges of testbed implementation

Proper planning of the necessary activities, their duration, and the involved members of the consortia needs to be demonstrated as part of the grant application. Timeline planning should be illustrated using Gantt charts to provide an overview of the project activities. Planning should be structured in a comprehensive manner and should feature relevant milestones that are to be accomplished at certain times throughout the project run-time. Project management activities should be handled as a stand-alone task, running in parallel to the project's activities, and should entail, among other things, planning for regularly occurring meetings of the consortium members. This timeline and activity planning should serve as basis for the personnel cost calculations.

Applicants are furthermore asked to identify and describe potential challenges during the implementation phase, as well as what impact in, in terms of time-delay, cost increase, and/or testbed functionality, etc. is to be expected. The applications should demonstrate, that the testbed implementation strikes a balance between not being trivial, on the one hand, and being feasible given the financial and temporal conditions, by relying on the combined knowhow of the consortium, on the other hand.

4.3 Eligibility and consortium structure

This call for proposal is an open call. Therefore, applying consortia do not have to consist **solely** of partners of the three participating KICs (EIT Manufacturing, EIT RawMaterials, EIT Digital). Each consortium **must however feature at least one partner of one of the involved KICs**. Participation of organisations that are not KIC-partners is possible, following an invitation by a KIC partner. The KICs will review the invitation and decide if the organisation is approved.

The minimum number of partners per consortium is three. Applications need to demonstrate that expertise in the fields of raw materials, manufacturing, and digitalisation are featured among the consortium members. There is no maximum limit to the consortium size. However, applications need to demonstrate clearly which strengths and expertise is provided by each member of the consortium, how these complement each other, and why a member's participation is vital to the project's success.

Possible members for consortia are large, and small and medium sized enterprises (SME), start-ups, as well as research institutions from academia and from research and technology organisations (RTO). In line with EIT's focus on promoting the innovation capabilities of small and young enterprises and organisations, if comparably evaluated testbed proposals are encountered, consortia consisting of SME and start-ups will be favoured over consortia featuring large enterprises.

Another aspect to consider when assembling a project consortium is **European dimension**. Organisations forming a consortium need to stem from **at least two different European countries**, to be eligible to receive funding. Eligible countries are member states of the European Union, the United Kingdom, as well as countries eligible for Horizon Europe funding. Applicants are furthermore encouraged to engage with countries and regions that are part of EIT's Regional Innovation Scheme (RIS). Either by featuring organisations from these countries/regions, and/or by demonstrating how implementation of their testbed proposal benefits the raw material sector in RIS areas.

4.4 Testbed operation and financial sustainability

The applications need to describe which activities will take place in the testbed environment once the implementation phase is finalised and the testbeds are operational. Additional to describing the use-case and the expected digitalisation-based improvements (section 6.1), the day-to-day operating activities should be outlined. Among other things, this may entails describing if genuine raw materials will be used during testbed operation, or if the properties of these materials can be emulated by substitutes. If genuine products are processed in the testbed, usage of the products and by-products should be discussed (e.g. reselling, disposal). Additional activities to ensure reliable testbed operation (e. g. maintenance, cleaning, etc.) should also be featured in the application.

Besides physical goods and materials to be involved during testbed operation, availability of information and data is a key aspect to ensure regular and reliable testbed operation. Especially for applications involving artificial intelligence technologies, quality, and amount of available data are of great importance to sufficiently train models. Therefore, applications need to demonstrate how enough quality data will be made available to enable reliable testbed operation. Preferred source of data are real-life production facilities, for example provided by consortium members. If data generation by testbed operation is proposed, a rough estimation/calculation to demonstrate the approach's feasibility is required.

Finally, the party (or parties) responsible for operating the testbed, its location (if not a mobile solution), and possible future expansion of/extensions to the testbed environment should be described.

Financial sustainability

The end-to-end digitalised production testbeds are supposed to be platforms for exchange, development, and education for years to come. Given that the project is publicly funded, public accessibility to the testbeds – especially for EIT activities – needs to be ensured. To ensure financial sustainability of the testbed environments, applicants are asked to develop a **commercialisation plan** and to present and adequate **revenue model**.

- Commercialisation plan
  The plan should describe users and therefore beneficiaries of the proposed testbed environment, and their respective needs. Users can be categorised based on their products, their geographical location, their functionality, or other aspects. The application needs to show how the proposed testbed environment caters to those needs, and why potential users are going to use it.

  For this purpose, applicants are asked to disclose relevant information about the users (e. g. market size, number of employees) and derive the future demand for the testbed environment (if possible, supported by sources, data, etc.). To complete the commercialisation plan, information about potential competition to the proposed testbed environment should be provided.

- Revenue model
  A revenue model needs to be detailed by the applicants, describing which services or other activities will contribute to generating revenue from operating the testbed, to ensure financially sustainable testbed operation for at least five years after the initial funding period ends. Depending on the proposed testbeds' design, various potential revenue streams are conceivable.

  One possible way to structure the revenue streams considers their temporal horizon:
  - **Steady revenue streams** can be annual payments by the partners of an operating consortium, that allows them to access and use the testbed environment following a common agreement. This approach does not need to be limited to partners of the original applying consortium but could be open to other parties as well.

  - **Recurring revenue streams** by offering services focused on and related to the testbed environment to companies, universities, and other organisations, testbed operators should be able to generate recurring revenue streams. Dependent on the testbed proposal, various services are likely to be offered. Some examples include:
    - Conduction of process analytics
    - Organisation of workshops and trainings
    - Renting the testbed environment to researchers or entrepreneurs for research and development activities
    - Providing the testbed environment as location for industry events

  - **Individual revenue streams** include publicly funded projects that build upon the existing testbed infrastructure. The established end to end digitalised testbeds can be a starting point for further digitalisation activities and projects and represent an asset for applications to future grant calls. Availability of suitable calls and the likelihood of applying successfully is of course subject to fluctuations and difficult to predict. This should be considered by the applicants.

Revenue sharing

Goal of the commercialisation plan and the revenue model is to demonstrate that the testbed proposals are financially sustainable and will be operational for at least five years after the initial funding period.

Financial sustainability is also an important factor for the involved KICs. The approved proposals and therefore funded testbed environments are required to contribute to the KIC's financial sustainability.

The preferred approach is to determine an agreement on sharing between 15 and 20 % of revenues created through testbed related activities (e. g. workshop/training fees, rent) with the KICs. Distribution of the shared revenues among the KICs will follow the distribution key of the initial implementation cost. This agreement must be valid for at least 5 years after the initial implementation and funding period ends. Variable revenue models, featuring staggered increase of the share over the years are also possible.

Given the expected heterogeneity of testbed proposals, alternative approaches to contribute to the KICs' financial sustainability (e. g. licensing rights, participation in patents) can be proposed by the applicants.

4.5 Dissemination

Contributing to the creation of innovative services and products for consortium members, is an important indicator for successful testbed implementation. To ensure that the testbeds' capabilities benefit other parties, beyond the consortia and the KIC networks, as well as to create awareness of the cross-KIC activity, applicants are asked to present a dissemination strategy as part of their proposal.

For a dissemination strategy to be effective, strong proactive communication activities are required. These activities should occur along two dimensions:

- Project corporate identity
  Part of an effective corporate identity is shaping the project's visuality. This incorporates designing of an appropriate project logo and definition of slogans. Co-branding, highlighting the KICs' involvement in the testbed activities is a vital aspect. Furthermore, a website showcasing the testbed activity, providing information comprehensible and informative for experts and the public alike. Finally, information materials (e. g. posters, flyers), as well as social media related activities or campaigns are required.

- Involvement of relevant eco-system representatives
  The strategy needs to show to be able to reach the following target groups/ relevant eco-system representatives:

  - Industry and end-users
    The consortium will approach relevant industries to enable them to participate in shaping the implementation, by addressing industrial stakeholders at European level. The KICs will support these activities by providing the consortium with access to relevant companies. The consortium will address SMEs in particular, to actively involve them in the development. Possible approaches are addressing associations and federations, connected to the raw material sector as well as to the industry working on E-Drives, via popular-science publications. Or by providing interactive platforms to enable direct communication, or by establishing an accompanying committee that continuously discusses the project results.

  - Political decision makers and the public
    Regular communication of milestone results towards politics, to promote early addressing of e. g. regulatory issues and enable the transfer of project results into political measures. For this purpose, the consortium will ensure visibility of project activities through a range of traditional and electronic publications, e. g. news press (I. e. at least one press release every 3 months), or project newsletters.

  - Scientific manufacturing, raw material, and digitalisation communities
    With respect to involved scientific communities at European level, the consortium will organise workshops, aimed at research institutions. Therefore, participation in relevant national and European events (workshops, conferences, and trade fairs), to offer opportunity for regular exchange and broaden awareness for the project is also requested. Furthermore, relevant initiatives related to the project (e. g. standardisation or certification bodies), should be linked to the project to exchange experiences and best practice examples.

Other possible activities along the second dimension include:

- **Public events,** explaining the advantages of the technologies and demonstrating their capabilities. Consortium partners could use these events to demonstrate their solutions to a wide audience. Cooperation with national and European partners is encouraged.

- **Thematic working groups**, involving both consortium members and outsiders should be organised to gather ideas for the design of additional functionalities. These working groups will bring together specialists from the field of manufacturing technologies.

- **Matchmaking events** organised by the KICs. These events provide an opportunity to bring together potential users and creators of the developed solutions. Early-stage investors can also be informed about the topics.

- **Cluster events** featuring other relevant initiatives, to share knowledge and seek coordinated efforts.

5 Review process and selection criteria

Ensuring a transparent and fair selection process is a top priority for EIT and the KICs involved in this cross-KIC project. Therefore, the upcoming paragraphs will provide applicants with information on how the selection process will take place, and which aspects will receive attention by the reviewers.

5.1 Excellence and strategic fit

The strategic objectives of this cross-KIC initiative are described throughout chapter 4 of this document. Proposals will be reviewed, based on the degree to which their digitalisation use-case is able to address, individual or multiple aspects of the three identified focus points. The level of the solution's innovation, as well as the severity of the addressed problem/challenge. Therefore, it is important for applicants, to describe how their testbed proposal provides true competitive advantages for the involved parties, as well as to describe the proposal's added-value in relation to existing products, services, other solutions, and to the state-of-the-art.

The benefits for the user of the solution should also be declared while the severity of the problem needs to match the applicability of the solution.

Beyond the proposed testbed's functionality and ability to improve raw material manufacturing processes for E-Drive parts, the proposal will be evaluated regarding their fit with the EIT's knowledge triangle, consisting of business, education, and innovation (see Figure 5). As described in the beginning of this document, testbeds should be designed to serve as platforms to foster exchange, development, and learning. Applications should therefore showcase, how their proposals are in line with and contribute to the knowledge triangle, and how businesses, innovation activities, and education facilities will benefit from their vision of an end-to-end digitalised production testbed for the E-Drive raw material sector.

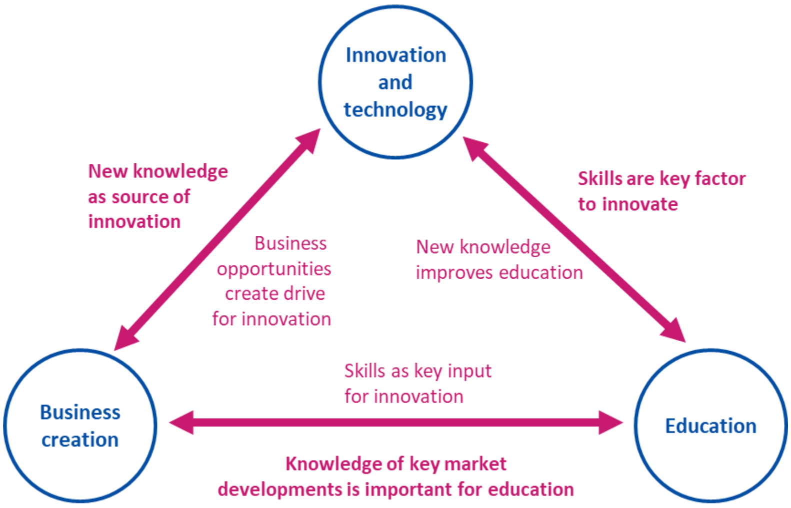

Figure 2: Components of EIT's knowledge triangle

5.2 Impact

It is important for testbed proposals to demonstrate how their testbed use-case is in line with the strategic objectives of this project. The impact of the proposals will be evaluated with respect to two viewpoints:

- Impact of the digitalisation solution on the depicted process
  As presented in section 3.4, details on how the goals defined in the impact metrics will be achieved need to be presented by the applicants. Furthermore, besides describing the direct impact that is to be expected on the processes of the involved consortium members, an outlook (based on calculations and/or estimations) of the solution's impact on a regional or over-regional level should be provided. This entails, among other things, describing the number of companies, organisations, and individuals that are likely to benefit from and to be reached by testbed related activities, both within and external to the consortium's network of partners and associates. This also entails stating existing venues that provide services comparable to the testbed proposal and therefore might be competing for users/customers.

  Furthermore, since it is this initiative's goal to implement ever-evolving, sustainable testbeds, another impact factor to consider are the testbed's connection points to future activities and projects, as well as the potential for future upgrades and extensions to the implemented infrastructure. This aspect is strongly related to the proposed business and dissemination plans.

- Impact of the testbed with regards to KIC-specific and EIT-overall strategic objectives
  Applications should demonstrate in which ways their testbed use-case contributes to the overall strategic objectives of the involved KICs. An overview of these strategic objectives can be found in Table 1. Regarding EIT's overall strategic objectives, applicants also need to demonstrate how their proposal contributes to strengthening RIS organisations and regions, as well as to developing, testing, and rolling out of new products and services.

5.3 Implementation

The final aspect of proposal evaluation is implementation. On this metric, a proposal's credibility, feasibility, and the overall quality of the proposed workplan and milestones are evaluated and reconciled with the initiative's strategic objectives. Part of the overall quality evaluation of the proposal is the degree to which the SMART principles have been applied, thus, how well the outputs, deliverables, and impacts are defined.

Furthermore, qualification and expertise of the consortium members, and how well these fit with the proposed activities and challenges are evaluated. Therefore, precise descriptions of the members' backgrounds and experiences, and how these translate to the demands of the project's work packages should be provided.

The allocated budgets, planned costs, and estimated income and revenue streams are the final aspect of the implementation metric. Reviewers will evaluate if the budget is allocated evenly/fairly, if proposed cost are realistic, and therefore if the requested funding is adequate to achieve the proposal's objectives. With regards to the long-term operability and financial sustainability of the project, the quality, and the prospects of success of the proposed business plan and dissemination activities will be evaluated.

5.4 Cross-KIC specific KPIs

Additional to the impact metrics described earlier, the testbed influence on and contribution to the overall values of the involved KICs needs to be considered and made measurable. For this purpose, it is important to define key performance indicators (KPIs).

The heterogeneity in possible project for E-Drive parts production will lead to strongly heterogeneous testbed proposals that will differ in terms of handled raw materials as well as general focus. Applicants are therefore free to select at least two suitable KPIs from each of the following categories. If an applicant's testbed proposal provides opportunities that can be measured by applying KPIs different from those presented above, applicant' are encouraged to explain and define these KPIs. Suitability and acceptance of these KPIs will be evaluated by the external reviewers accordingly.

Education/training

- Number of educational products launched: 2 over 4 years
- Number of hosted workshops
  - During implementation: 1
  - During operation: 2 per year
- Number of university courses visiting the testbed
  - During implementation: 2
  - During operation: 2 per year
- Number of staffers trained
  - During implementation: 5
  - During operation: 15 per year

Innovation

- Number of spin-offs generated: 1 over 3 years
- Number of Start-up/Scale-ups supported as part of the "Accelerate" program: 2 over 5 years
- Number of companies supported as part of the "Transformation" program: 2 over 5 years
- Number of supported Start-up/Scale-ups in RIS countries: 2 over 5 years
- Number of patents generated: 2 over 5 years
- Number of organisations renting the testbed: 2 per year
- Number of processes digitalised: 3 over 5 years
- Number of follow-up innovation projects acquired: 1 over 5 years

Dissemination

- Number of projects related do dissemination with other KICs: 1 over 5 years
- Number of new connections between EU value network actors: 10 over 5 years

- Number of new connections to the ERMA value network actors: 20 over 5 years

- Number of individuals from RIS countries engaged
  - During implementation: 5
  - During operation: 15 per year

- Number of visitors to the testbed
  - During implementation: 20
  - During operation: 40 per year

- Number of talks at relevant conferences/fairs etc.
  - During implementation: 1
  - During operation: 2 per year

- Number of published papers in relevant outlets
  - During implementation: 1
  - During operation: 2 per year

- Number of multi-media posts in social media
  - During implementation: 2
  - During operation: 2 per year

The following table summarizes the selection criteria once more. Based on the evaluations and the overall available funding, the Cross-KIC Group will rank the proposals and select the winning proposals. The total maximum score for a project is 15 (3 criteria, each with a maximum score of 5).

Maximum score	Description of criteria
5	Excellence and strategic fit ▪ Tackling of strategic objectives ▪ Innovativeness of the idea ▪ Cost-benefit ratio of the proposal (KPI-Improvement in regards to costs) ▪ Contribution to the aspects of the knowledge triangle
5	Impact ▪ Expected impact measured by the defined metrics ▪ Impact on regional, over-regional level ▪ Contact points for future activities and testbed expansions ▪ Involvement of RIS organisations and regions
5	Implementation ▪ Overall coherence of the proposal ▪ Description of challenges and subsequent mitigation activities ▪ Suitability of consortium members (Profiles, related previous projects, tasks) ▪ Clarity of the budget plan, timeline and milestones ▪ Coherence of the financial sustainability description

In relation to each of the criteria above, the score ranges from 0 to 5 according to the following scale:

0	Non-existent: no relevant information provided in the application file or cannot be judged because out of range/scope
1	Very poor: The criterion is addressed in a very incomplete and unsatisfactory manner
2	Poor: There are serious inherent weaknesses in relation to the criterion in question

3	Fair: The criterion is somewhat addressed, but there are significant weaknesses
4	Good: The proposal addresses the criterion well, although some improvements are possible
5	Excellent: The proposal successfully addresses all relevant aspects of the criterion in question. Any shortcomings are minor only.

5.5 Review by external experts

EIT KICs rely on the professional expertise of independent experts to ensure that only proposals of highest quality and significance are select for funding. Those independent experts must not represent any organization involved in the current call for proposal. Evaluation is performed by independent experts, using the evaluation criteria mentioned in this document. In addition, the KICs involved in this initiative will check all proposals regarding their eligibility to Horizon Europe, and EIT criteria.

The names of the independent experts assigned to individual proposals are not made public. Any direct or indirect contact about the evaluation process between applicants (legal entity or person) and independent experts involved in the evaluation process, will be viewed as attempt to influence the evaluation process, and is strictly forbidden. Infringement of this rule can constitute an exclusion from the selection process.

Feedback to applicants

Following the evaluation, the KICs will provide feedback through their respective intranet to the activity leader submitting the proposal. The aim is to inform applicants about the result of the expert evaluation and the decision of the management teams of the involved KICs about the inclusion of proposals to the respective business plans.

Appeal and redress procedure

Applicants may wish to lodge an appeal against a proposal's rating. The redress procedure is not meant to call into question the judgement made by the independent experts. It will consider only procedural shortcomings and factual errors. Objections may be raised in case of suspected shortcomings in the way a proposal was evaluated or assumed incorrections in the results of the eligibility checks.

Requests for redress must be made within two weeks of receipt of the evaluation feedback, and must

- address complaints against the evaluation process or the eligibility check.
- provide a clear justification for the appeal.

A reply will be provided no later than 3 weeks after the redress was received. The redress is examined by the management teams of the KICs, who will ensure a coherent interpretation of requests and equal treatment of applicants. Depending on the nature of the complaint, the management teams may review the evaluation report, the individual comments and examine the CVs of the independent experts. If there is clear evidence of a shortcoming that could affect the funding decision, it is possible that all or part of the proposal may be re-evaluated. Unless there is clear evidence of a shortcoming there will be no follow-up or re-evaluation.

6 Application documents

The following section describes the documents that applying consortia need to provide. Applying consortia are asked to provide the documents collectively via a consortium's leader. The documents should be crafted in a way that

- demonstrates the proposal's relevance to the described focus points (chapter 3),
- considers the described structural aspects (chapter 4), and
- highlights the proposal's excellence/strategic fit, impact, and implementation (chapter 5).

Applications are to be submitted using the EIT Manufacturing mailing adress:

digitaltestbeds@eitmanufacturing.eu

Please consider, that incomplete applications can not be considered.

6.1 Testbed proposal

- Minimum of 20.000, maximum of 50.000 characters (excluding spaces)
- Sketch/rendering of proposed testbed environment (including testbed dimensions)
- Use of helpful and informative figures, graphs, and tables

6.2 Consortium profile

- Individual profiles of each consortium member (maximum of 15.000 characters without spaces)
- Description of complementary synergies between members, and contributions of each member to the project's success (maximum of 15.000 characters without spaces)

6.3 Project and budget/cost plan

- Gantt chart (week-based), containing activities, involved members of the consortium, and milestones/deliverables.
- Mitigation/contingency plan for potential challenges/problems occurring during implementation.
- Budget/cost plan for expected cost for personnel, hardware, software, services
    - Consortium member individually, and aggregated for the whole consortium
    - Details on co-funding procedure are also required.

6.4 Dissemination, commercialisation plan, and financial sustainability

- Minimum of 12.000 characters (excluding spaces)
- Tables/figures describing users and potential demand for testbed usage
- Tables/figures describing running cost and expected revenue streams

6.5 Annex

- Quotations of suppliers supporting information on cost and expenses
- Other relevant documents

7 Timeline

The following dates are to be considered by applicants. Please consider, that applications reaching the KICs after the deadline will be not processed

- Call opening: September 01, 2021
- Question & Answers & Matchmaking September 15, 2021
- Submission deadline: November 12, 2021 – 2 p.m. (CET)
- Announcement of selected proposals: December 06, 2021
- Start of the project activities: January 3, 2022
- MID Term Review June 30, 2022
- Final Results - Report & Discussion January, 2023
- Continuation Visit November, 2023