Laboratory for Product Development and Lightweight Design
Faculty of Mechanical Engineering
Technical University of Munich

Digital Twin Trust Framework

Jakob Trauer, Sebastian Schweigert-Recksiek,

Thomas Baudisch, Tim Schenk

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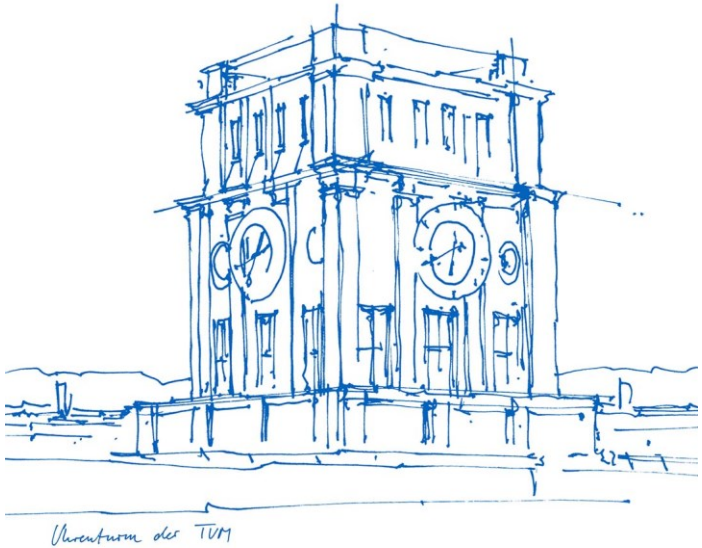
LPL

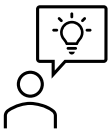
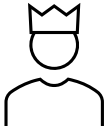


Stakeholders

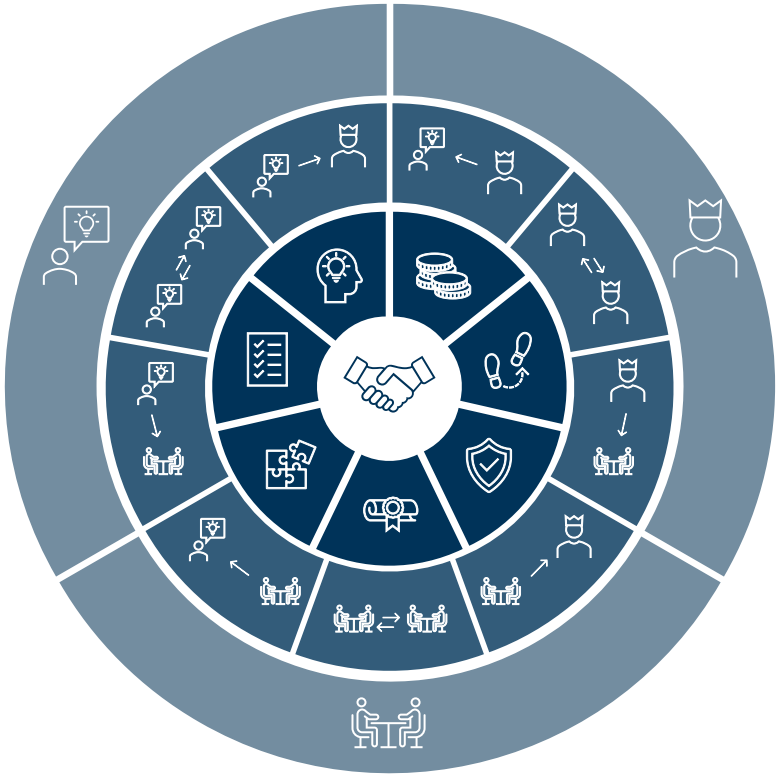
There are three basic types of stakeholders in the context of a Digital Twin:
A **Digital Twin Supplier**, a **User**, and **Partners of the User**. All three types can be either internal (different departments/disciplines/teams within the same organization) or external (business partners from different companies).

Dependent of the application scenario, one person or organization can have different roles. For instance, an automation equipment company may be the customer of a digital twin module in the tool suite of a software vendor, so that the automation equipment company is the user while the software vendor is the supplier of the digital twin. On the other hand, once the digital twin of a certain automation component or system is built, the automation equipment company may include the digital twin as an add-on to its existent product portfolio, taking the role of the digital twin supplier while companies buying the automation equipment are now taking the role of the user of the digital twin in a sense of (directly) paying for the benefits the twin offers.

The same is true for the creation of models. In some cases, the supplier may provide the abstract model types (e.g. regression models, FEM modules), while the user has to provide the concrete instances (e.g. input and output data or CAD models).


Digital Twin Trust Framework



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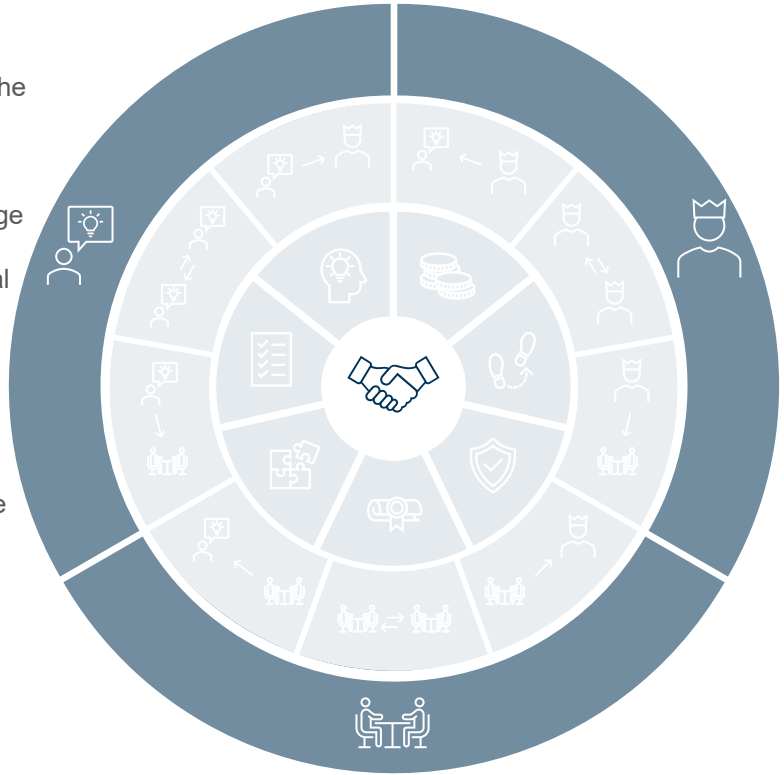
Digital Twin Supplier:

- connects digital models and data from the physical system
- in some cases produces models and/or data
- combines engineering domain knowledge with the necessary IT infrastructure
- can be internal or external, e.g. a central department or IT/consulting company
- sells the twin to the user

Partners of the User:

- large number of possible partners of the user
- sometimes supplier-OEM relationships (supplier has to use Digital Twin or provide data and models for it)
- e.g. independent regulatory bodies, certification agencies, actual end costumer



User of the Digital Twin:

- pays the supplier for the twin
- in many cases not even interested in the interior of the twin, but more in the results of its simulations
- sometimes (especially for operation twins) not necessarily with engineering background
- for the engineering twin: often delivers simulation models and/or necessary data
- can be part of the same organization as the supplier or from another company
- e.g. decision makers, sales, design, production, simulation, costumer service, sales

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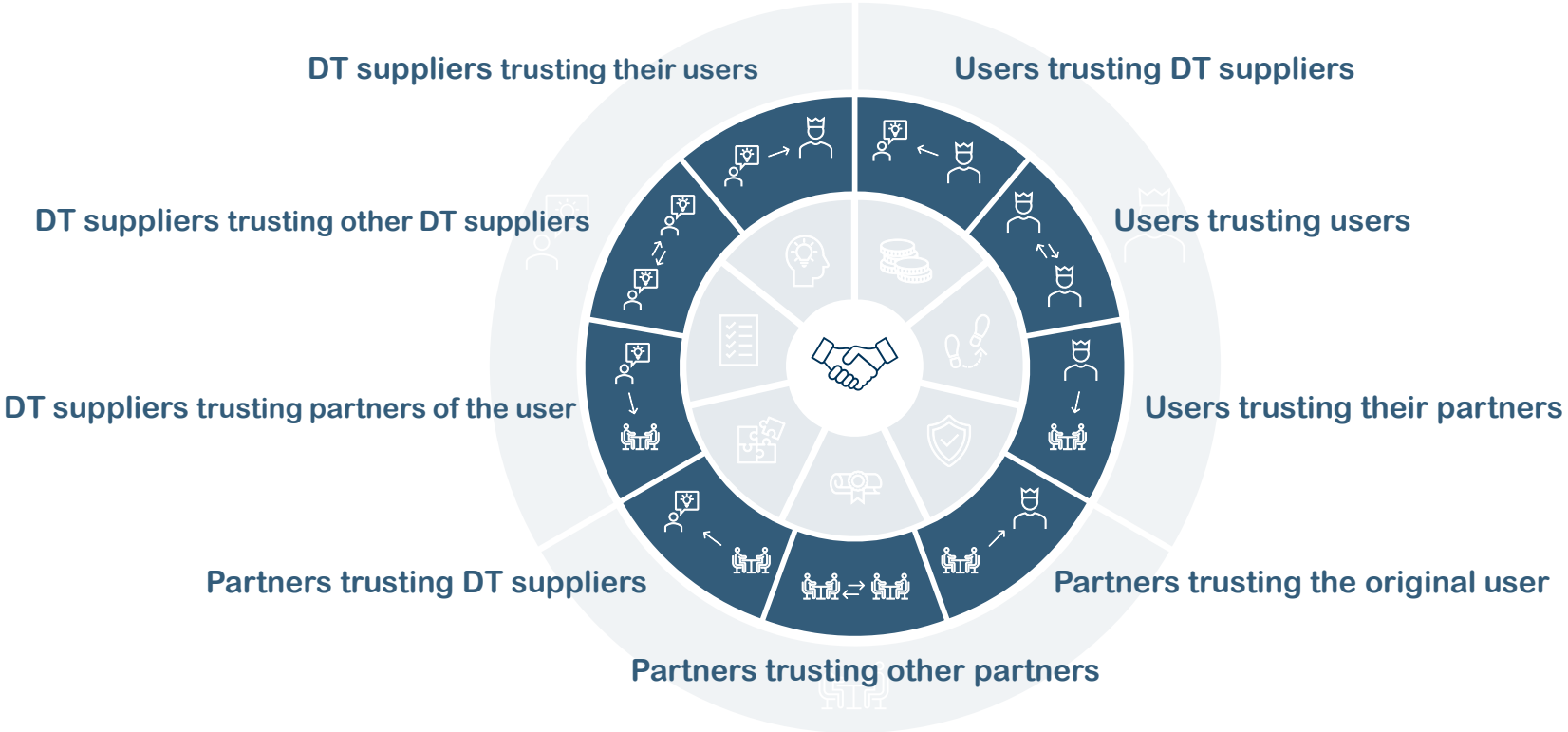

Digital Twin Trust Framework

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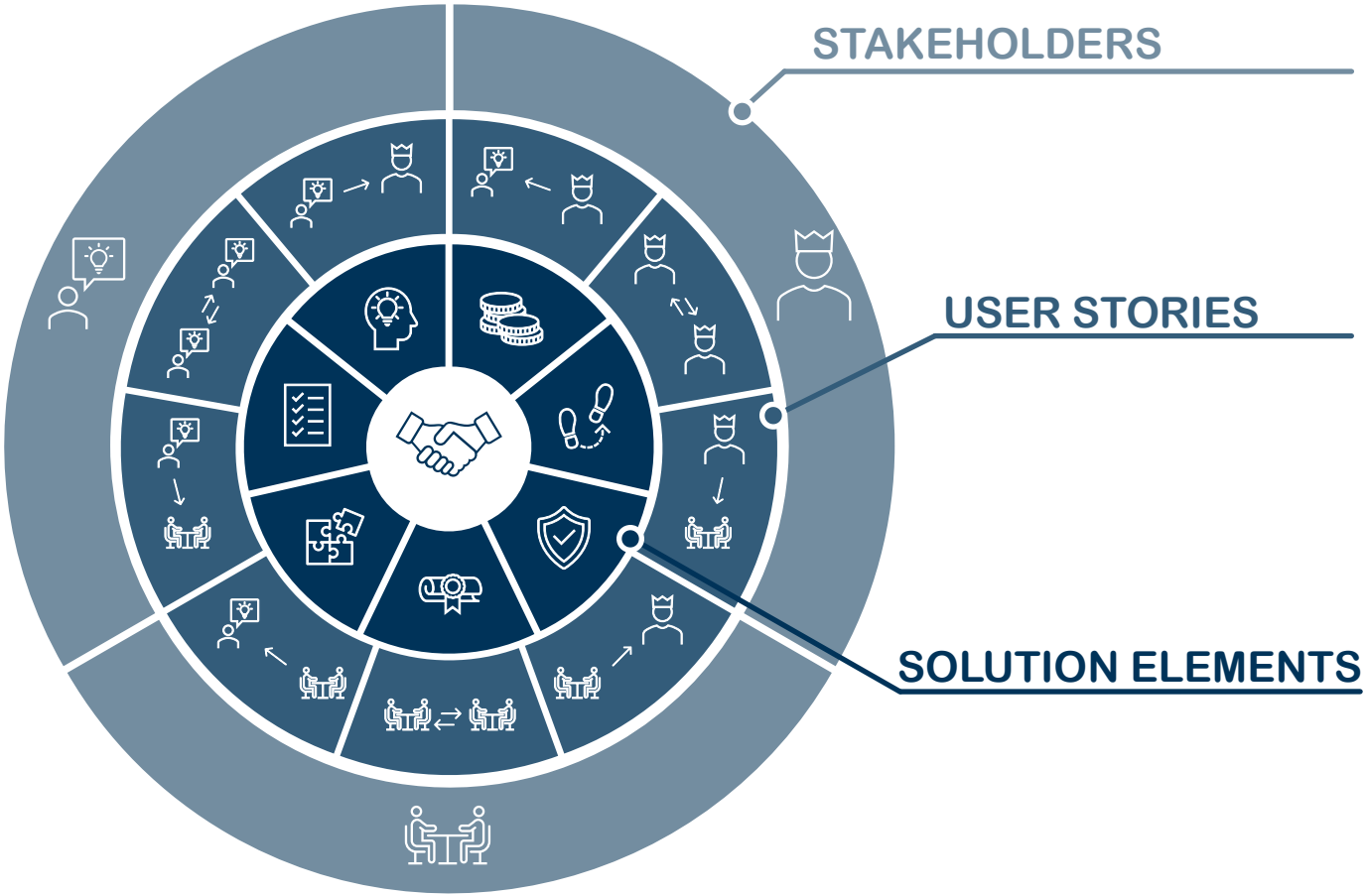
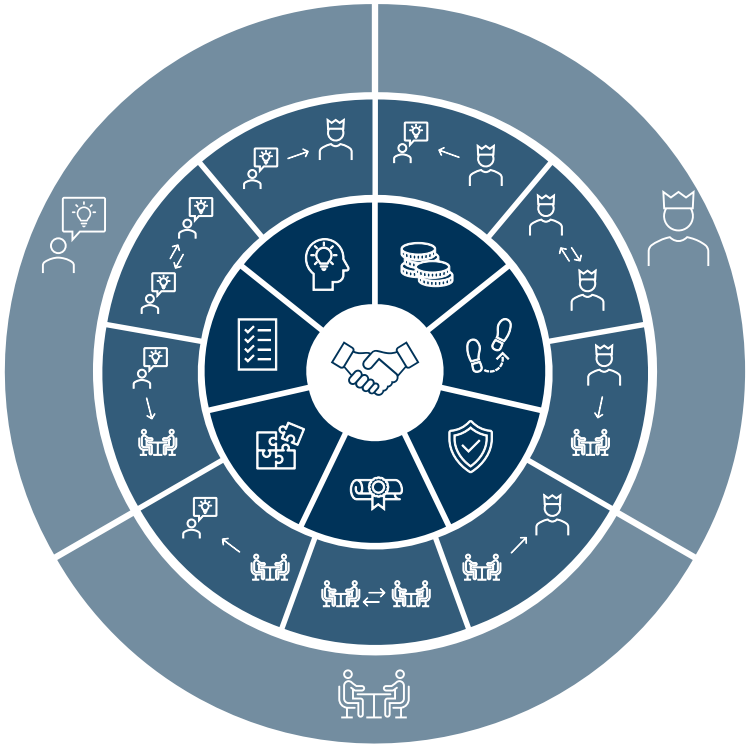


Digital Twin Trust Framework



Due to confidentiality reasons, parts of the framework have been removed, or modified.

Digital Twin Supplier

Typical Profile/Exemplary Persona

Internal: The central data insight team gathered simulation and product models from various departments and combined them in a digital twin. Their goal is to spread this powerful tool and thereby support the design, service, and sales departments.

External: A major software vendor/implementation partner has built a framework of a digital twin that makes use of its tool suite in order to connect simulation models and product (use phase) data. After large investments they seek for application cases.

Tasks in the DT Context

The supplier of the Digital Twin creates the twin in a sense of connecting the models and the data from the physical system. Producing the models and/or the data can be part of their job, but not necessarily. They have to combine engineering domain knowledge with the necessary IT infrastructure in order to build a Digital Twin. Thus, the Digital Twin Supplier can be internal or external, e.g. a central department or an IT or consulting company.

Key Needs and Pain Points

The supplier creates the digital twin and wants to sell / supply it to the users. Therefore, the supplier needs to create some kind of trustworthiness. This can be done by various options and depends on the target group. First the supplier needs to make sure that the user does not have any wrong expectations or perceptions of the twin. Otherwise, the users will be disappointed in the result and will not any more trust in the supplier. But the supplier also needs to trust in the users, as well as their partners. Even if the models would work perfectly, the supplier needs to trust, that the user as well as its partners will provide the right data in the right format and uses the twin in the intended way.

Connected User Stories

DT suppliers trusting their users

DT suppliers trusting other DT suppliers

DT suppliers trusting partners of the user

Testimonial from Interviews

„Overall, the concept of the digital twin is still in its infancy. We have to succeed in generating trust in it in order to be able to sell this concept.“
(Management Consultant Intelligent Industries – Engineering Consulting Company)

References

https://em360tech.com/business_agility/tech-news/top-10-digital-twin-vendors
https://new.siemens.com/global/en/company/stories/research-technologies/digitaltwin/digital-twin.html

Digital Twin User

Typical Profile/Exemplary Persona

The head of the R&D of an automation equipment company approaches a software vendor to build a digital twin of their products. He/She has informed himself about the possibilities of digital twins and has a basic understanding of the (data) models, IT infrastructure and use phase data. He/She wants to know how the twin works in principle, but at a certain point in the project, once trust has been built, he/she focusses on the use cases and leaves the implementation to the software vendor.

Tasks in the DT Context

The user of the digital twin pays for the twin in a sense of buying it from the supplier. In most cases, the user provides domain knowledge necessary to built the digital twin and implement the use cases to the supplier. That can include instances of simulation models and (use phase) data. Thus, in most cases, the user will not only utilize the twin once it is built, but contributes to it, giving the supplier the opportunity to built trust before the twin is even used.

Key Needs and Pain Points

In both the creation and implementation as well as during the usage of the digital twin, the user has to share a lot of unique know-how and domain knowledge with their partners and especially the supplier. This leaves them vulnerable to know-how loss and IP theft. Therefore, next to the functionality of the digital twin, a major need of the user is data safety. This also affects the collaboration with partners. Suppliers have to deliver models in the right granularity, with the right functionality and with clear and safe interfaces for the twin to work as well as to ensure data safety to the user.

Connected User Stories

User trusting the supplier

Users trusting other users

Users trusting their partners

Testimonial from Interviews

„In the digital world, you very quickly come to the issue of intellectual property and company secrets. And this is all information that you never give out under any circumstances. You should design the Digital Twin in such a way that the issue of data security is not even a problem in the first place. It also has to be clear what I gain from it in business terms. That's where you have to look at the trade off of effort versus the business benefit."
(Vice President Methods, Analyses & Materials – Aerospace & Defense Company)

Reference

[Wang, B. T., & Burdon, M. (2021). Automating trustworthiness in digital twins. In Automating Cities (pp. 345-365). Springer, Singapore.]

Partners of the Digital Twin User

Typical Profile/Exemplary Persona

Since their customer, a major automation equipment manufacturer, has introduced the concept of the digital twin to them, the R&D engineers of a pumping systems supplier face major challenges. Next to the pumping systems that they have delivered to their customer for years, they are now also asked to deliver CAD and simulation models as well.

Tasks in the DT Context

The partners of the User have to deliver models and data to be fed into the digital twin the supplier creates. They have to comply to certain model formats, specific interfaces and deliver models and data in the right granularity as well as the right quality so that they can be connected to the other models and data already present in the digital twin of the user. In many cases, this involves direct exchange with the supplier of the DT and other partners.

Key Needs and Pain Points

The main concern of partners of the Digital Twin User is data security and the danger of loosing knowhow. By not only providing the actual product as in the past, the partners now have to deliver models and data as well. As in many cases the building of these models and the generation and analysis of the respective data are the core knowhow of the supplier, there is a great need for the assurance of data security. This is especially true as the partners do not only have to provide data and models to the user, i.e. their customer. In many cases, the models and data will also be available to the supplier of the digital twin and other partners, enlarging the threat of painful knowhow loss and IP theft.

Connected User Stories

Partners trusting the supplier

Partners trusting other partners

Partners trusting the user

Testimonial from Interviews

“For me, it's always about the commercial aspects. What happens to my data and how can I continue to create value from it even after the sale? If things should work in the long term, the know-how has to stay in-house. But this also stands in the way of a complete, true digital twin, which in the ideal case is openly designed.“
(General Manager – Automation Engineering Company)

Trust from User to Supplier of the Digital Twins

Description

As a User of the Digital Twin, I need trust in the supplier to deliver a Twin with the correct functionality with the right granularity as well as guarantees safety while using it and has a viable business model for me.

Example Scenarios

An automation equipment company may be the customer of a digital twin module in the tool suite of a software vendor, so that the automation equipment company is the user while the software vendor is the supplier of the digital twin. The equipment company is willing to implement a Digital Twin module in their company. However, they fear loss of IP, high costs, and lower quality and functionality as expected. As every Digital Twin module is unique and those parties never worked together before, it is hard for the user to trust in the supplier of the Digital Twin.

Solution Elements

Explain your Twin properly!

Share a common incentive!

Prove your quality!

Testimonial from Interviews

“There are some stakeholders who definitely believe in Digital Twins, trust them and want to use this concept. However, there are also some - especially in more traditional areas (e.g. construction, mechanical engineering) - who think that models can't really be trusted. They always complain about the accuracy of the models and think that the whole simulation thing is just a gimmick.”
(Head of Function Development & Software Engineering – Energy and Climate Solutions Company)

Trust from Partners of the User to the User

Description

As a Partner of the Digital Twin user, I need to trust the user that they protect my know-how when exchanging data.

Example Scenarios

A large-scale automotive company is collaborating with many suppliers. These partners of the user are involved in design, simulation, and testing activities. The automotive company is contracting a software vendor to implement a Digital Twin module in their engineering department. This twin module requires data, models, and knowledge from all suppliers involved. Before trusting in the supplier of the twin or the other partners, the partner of the user needs to trust the user. The user will be the main stakeholder of this module, collecting and handling all data, models, and knowledge. Therefore, they especially need to trust the user to ensure as much protection as possible with regards to their know-how.

Solution Elements

Protect the IP!

Ensure a uniform environment!

Document thoroughly!

Testimonial from Interviews

“When it comes to trust, it's important not to be too generic. I think you will have difficulties with generic digital twins that are meant for many use cases. There are local rationalities that change the context and the use cases, a lot. Organizations have a history that means a lot to their people. This is often hard to change.”
(Research Associate – University for Digital Studies)

Explain your twin properly!

Description

There is a huge divergence in the different existing definitions of and case studies on Digital Twins. This leads to a confusion in industry, which reduces trust:

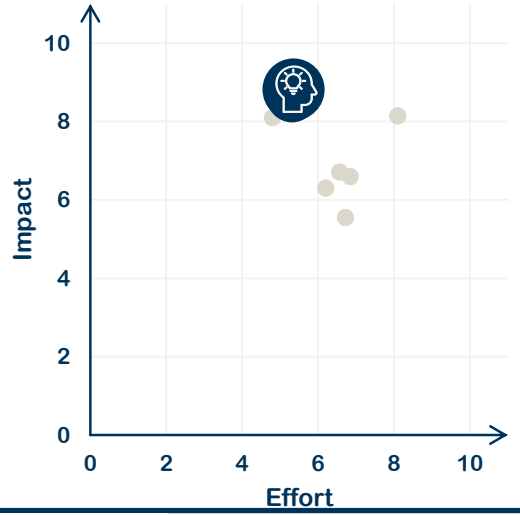
- People have wrong expectations on DTs, especially when it comes to effort-value ratios
- For many published use cases, the scope and boundary conditions are unclear.

Therefore, it is essential to generate trust by clear statements about the capabilities, functionality, and limitations of the DT, which also increases transparency. This is especially important when collaborating with unexperienced stakeholders.

Concrete Measures

Due to confidentiality reasons, this part has been removed.

Rating by Experts



Testimonial from Interviews

„The general question is: When do I trust a simulation? Simulations are also very rarely used for approval issues because you have to trust not only the models, but also the procedures by which they were generated. The problem with the digital twin is the scope of validity. Often the context of the data is missing. It is unclear what has been considered and what has been neglected. Which effects should be considered and to what accuracy?"
(Team lead – Electrical Equipment Company)

References

To twin or not twin and when is a twin not a twin? – Design and Manufacturing Futures Lab (dmf-lab.co.uk)

Trauer, J., Schweigert-Recksiek, S., Engel, C., Spreitzer, K., & Zimmermann, M. (2020). WHAT IS A DIGITAL TWIN? – DEFINITIONS AND INSIGHTS FROM AN INDUSTRIAL CASE STUDY IN TECHNICAL PRODUCT DEVELOPMENT. *Proceedings of the Design Society: DESIGN Conference, 1*, 757-766. doi:10.1017/dsd.2020.15

Create a common (economic) incentive!

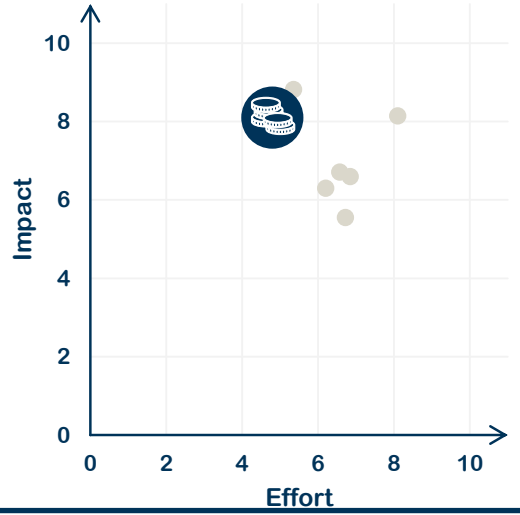
Description

When the motivation of the stakeholders involved are not clear, mistrust can remain as stakeholders fear to be left alone once the transaction is finished. From reviewing Appstores and marketplaces, it becomes clear that a common economic incentive is a proven concept to generate trust. This ensures that all stakeholders invest effort and resources over the whole life cycle in order to make the digital twin a success and thereby all parties benefit from it.

Concrete Measures

Due to confidentiality reasons, this part has been removed.

Rating by Experts



Testimonial from Interviews

"When it comes to digital twins, I always start by clarifying what the intended use is. What does the customer want? You are not done when the simulation is finished. You have to check the system and make sure the data is correct. In the end, it is important to have a community that shares the same intentions. This improves trust."
(General Manager – Automation Engineering Company)

Make one step at a time!

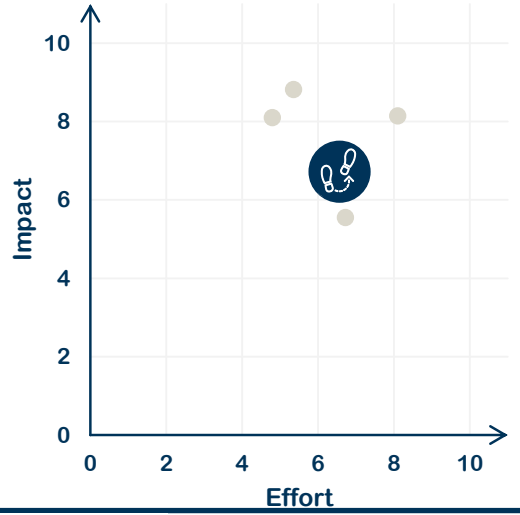
Description

As the concept of a Digital Twin is often regarded as very broad and hard to grab, mistrust can result from stakeholders not seeing a way how to realize this goal. It is therefore of high importance to proceed in small steps, so that also the risk of each step is reduced to a manageable amount. Further, it is easier for stakeholders to understand the functionality and to get involved in regular gates and check points. As a result, frequent feedback can be incorporated, and emerging mistrust can be tackled right away.

Concrete Measures

Due to confidentiality reasons, this part has been removed.

Rating by Experts



Testimonial from Interviews

"It has proven that small steps are helpful to create trust on the one hand and on the other hand to show what is possible and in which direction it can develop. Above all, small results or small successes can be achieved quickly."
(Head of Function Development & Software Engineering – Energy and Climate Solutions Company)

References

Trauer, J., Schweigert-Recksiek, S., Engel, C., Spreitzer, K., & Zimmermann, M. (2020). WHAT IS A DIGITAL TWIN? – DEFINITIONS AND INSIGHTS FROM AN INDUSTRIAL CASE STUDY IN TECHNICAL PRODUCT DEVELOPMENT. *Proceedings of the Design Society: DESIGN Conference, 1,* 757-766. doi:10.1017/dsd.2020.15

Protect the IP!

Description

For the Digital Twin to work and incorporate all necessary models and data, it is inevitable for stakeholders to exchange a high amount of information. Especially in security-relevant areas IT security and IP protection is a must. Once stakeholders do not trust in the security of their IP, no collaboration is possible. Therefore, measures have to be taken right from the beginning of the project so that mistrust in this area cannot even come up in the first place.

Concrete Measures

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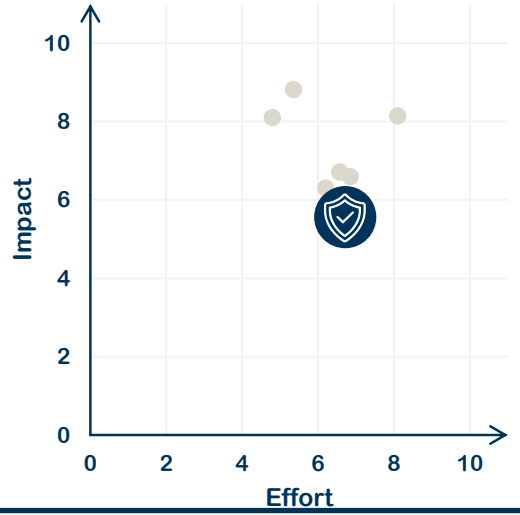
Rating by Experts



Testimonial from Interviews

"It is quite clear that merely clarifying liability issues is not the right direction; it is a blunt sword. The concept must be such that a very high level of safety is established, ensured and also continuously maintained from the start. Anything else is just a plaster on a wound that is too big and cannot repair the damage."
(Vice President Methods, Analyses & Materials – Aerospace & Defense Company)

Prove your quality!

Description

Once the market for digital twin has evolved, there will be a variety of stakeholders, users, and third-party partners that have collaboration in order to build a digital twin. Therefore, stakeholders compete with others and have to show their qualities. As trusts heavily depends on positive experiences, it has to be built be continuously proving that it is justified. This is true for all stakeholders as trust is necessary in all directions before information and data can be shared.

Concrete Measures

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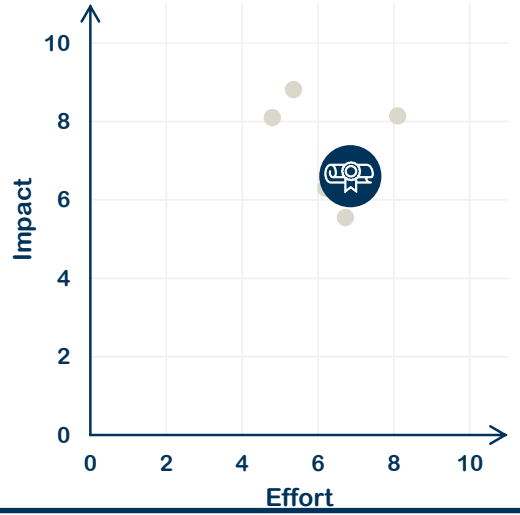
Rating by Experts



Testimonial from Interviews

"In the context of trust, it is also important to make the whole thing more tangible. In other words, we should perhaps stop using buzz words that are too generic and instead analyze concrete use cases and business cases. Really demonstrating industry-specific and product-specific by associations, communities or also by tangible best practices and publications how it could work. "
(Management Consultant Intelligent Industries – Engineering Consulting Company)

Ensure a uniform environment!

Description

As models and data for a digital twin will have to come from different sources, a lack of transparency may emerge that results in mistrust in the digital twin and its capabilities as well as the security. However, when a basic form of trust in the environment is present, this also increases the trust in the digital twin module that was developed or is offered in it. This solution element is also well known from appstores, where a standardizes platform for developers ensures a basic level of quality.

Concrete Measures

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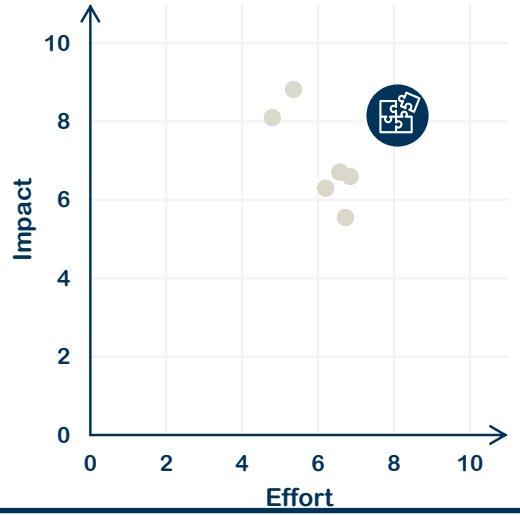
Rating by Experts



Testimonial from Interviews

"We now have a wide variety of stakeholders who want to access a central data set. You need a consensus, i.e. you need standards for the interfaces and also an agreement that defines who can access when and how. The experience of a community or a network can simply add a lot of value here."
(Management Consultant Intelligent Industries – Engineering Consulting Company)

Document thoroughly!

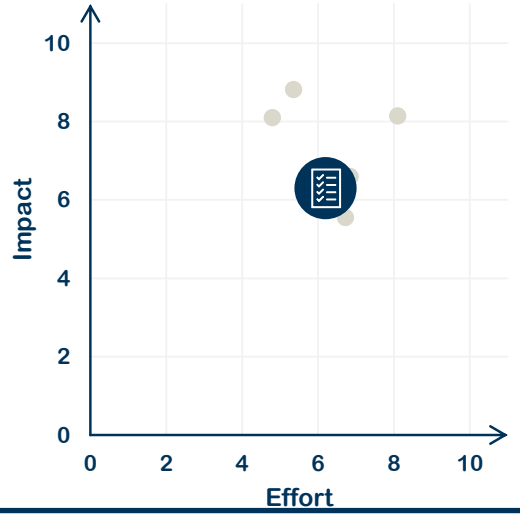
Description

As many stakeholders have to contribute to the digital twin, a certain level of complexity is inevitable. This will make it necessary to have a set of proper documentation also for stakeholders joining the process in later stages or using already existent twin modules. By documentation in a thorough way, understanding of the twin as well as its functionality is supported, maintenance is enabled, and transparency is created.

Concrete Measures

Due to confidentiality reasons, this part has been removed.

Rating by Experts



Testimonial from Interviews

“Also, the topic "unresolved care and maintenance concept": How is an update of the data done? The validity of the information chains must be respected and, accordingly, the Digital Twin must be updated. With Digital Twins, there is a certain risk of a jungle of information that is somehow networked, in which case it becomes very uncertain.”
(Team Lead – Electrical Equipment Company)

Thank you for your attention!

Jakob Trauer, M.Sc.
Sebastian Schweigert-Recksiek, M.Sc.

jakob.trauer@tum.de

www.linkedin.com/in/jakob-trauer
www.linkedin.com/in/sebastian-schweigert-recksiek/

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