Mission accomplished? – 6 Years of InData - International open Database Network Structure for Sustainable Construction

T Brockmann

1 BBSR Federal Institute for Research on Building, Urban Affairs and Spatial Development. Straße des 17. Juni 112. 10623 Berlin – Germany

tanja.brockmann@bbr.bund.de

Abstract. InData (International open data network for sustainable construction) started in 2015 as a voluntary initiative with the goal to establish an International open Database Network Structure for construction products based on EPD (environmental product declaration) information. In 2022 InData can proof its results by its release of the InData network with international participating databases. A key precondition was offering and giving support for producing machine readable EPD/LCA (life cycle assessment) data in a harmonized data format. All participants of the InData Network have committed to the format, including compliance rules. Beyond that, the works of InData have international significant relevance, as InData could implement its works in Standardization. And also, further key stakeholders have adopted the concept of an open database network structure. In this paper, the goals, results, and their relevance, as possible future key issues are presented.

Keywords: Life Cycle Assessment Data, Digitalisation, Environmental Product Declaration, Sustainable Construction, International Network

1. Framework

The climate change has become a key motivation for manifold political programs about climate mitigation and adaptation, e.g. Paris Climate Agreement, European Green Deal, and European Taxonomy. These usually put emphasis on different implications related to the climate change.

Decarbonisation is a global goal which needs to be dealt with in different sectors and levels, as a means of climate mitigation. This implies the formulation of global targets, and also public and private sector targets, on the one hand. On the other hand, reliable data and protocols on the emissions and environmental impacts need to be reported. This requires harmonized and measurable data collection, evaluation methods, and reporting formats.

In the construction sector, during the last years sustainability considerations have been established internationally in many states by referring to certification schemes. With these, the sustainability of a construction is evaluated, in most cases based on a voluntary basis. Currently, a move towards bindingly required sustainability considerations is observed, as some states formulate these requirements via legislation, or other bindingly formulated regulations.
The LCA is the central instrument within such sustainability considerations. With the method of LCA, the global ecological impact of a construction is calculated, expressed by environmental indicators, and the resource demand. In many political initiatives emphasis is put on the calculation of CO2 emissions (expressed as CO2-equivalent, GWP global warming potential) and the primary energy demand (embodied energy). Anyhow, with LCA, further relevant potential emissions are determined which may cause e.g. eutrophication, smog, ozone depletion, acid rain. LCA calculations on construction level refer to basis product data, which usually is provided by EPD or generic data. For the expected turn towards a decarbonisation in the construction sector LCA can be considered as a key element.

The InData initiative, from the very first, aimed at supporting already existing European and International standardization and programs related with LCA processes. InData contributed supportively to these by introducing digitalization methods for producing machine readable EPD, and generic LCA data, and offering the corresponding digitalized LCA processes with an open access to the data and the information. In this paper, the original vision of InData, the achievements, and awaiting challenges for future work items are presented.

2. About InData
InData was founded in 2015 after important talks related to sessions during WSBE 2014 in Barcelona, and it is chaired by BBSR (Federal Institute for Research on Building Urban Affairs and Spatial Development, Germany). It started with representatives from 10 institutions, while meetings now comprise up to 30 institutions. Out of these 17 are members, the other stakeholders are permanent guests, or sporadic participants. Also, the considerable growth in involved nations, from 6 to currently 13 nations, is a proof for an ongoing growing interest and the relevance of InData.

InData is an open, non-profit initiative of interested stakeholders who support the mission of InData. The stakeholders represent database providers, governmental organizations, EPD-program operators, LCA applicants, associations of industry, and individual stakeholders with specific competence in the field of EPD, LCA data, databases, and processes.

InData has evolved in a bottom-up process from a small group of highly interested and motivated founding members to an internationally acknowledged player in digitalization processes of LCA and standardization works. Even though it is an open and voluntary initiative, InData has established a professional structure with a lead, sub-groups as “data quality / compliance”, “generic data”, a Technical Committee “Data Format”, and an Editorial Board.

InData, on the hand, represents its members, structure, documents and results on its website. On the other hand, the established network with user access for data search is published there [8]. Currently around 1.600 datasets according to EN 15804, representing several international EPD programs and German national database ÖKOBAUDAT [9], are presented (Figure 1).

InData initiative has no member fees, and is completely based on in-kind contributions. Thus, all work, like operating the website, organizing meetings and workshops, offering support, creating the network structure, publications, are enabled by financial or personal in-kind funding. Obviously, in the economically driven construction sector, this rather unconventional approach, which is based on a tremendous motivation and trust amongst members, could proof incredible success by its achievements (Section 4).

The goal of the kick-off meeting in 2015 was to exchange ideas about the harmonization of LCA and possibilities of exchanging basic LCA data. Soon, the main objective was formulated: to establish an open international LCA database network structure for EPD/LCA data for sustainable construction. The basis, and a major part for the progress of InData, were the developments in Germany, where a complete digital infrastructure for construction LCA had been established within BNB, and the German assessment system for sustainable construction. These developments, and also the concept of InData’s open international data network, have been presented in former SBE conferences [1], [2].
3. Mission and Goals of InData

InData considers LCA as a key approach for the evaluation of global environmental impacts in the construction sector. Only with this knowledge potential emissions and resource demand can be determined and possible reductions, by the choice of products and constructions, can be evaluated. Hence, the vision of InData was enhancing digitalization for an integrated international communication of data and information, and to broaden the application of construction LCA as “mainstream”. This implies to enhance knowledge and acceptance, support approaches for an open access to harmonized and consistent data and digitalization processes, all being based on the open source idea.

There was several motivation for the InData approach. For example, committing in a relevant circle to one harmonized format for EPD could avoid the development of many different formats on the market, which would be a barrier for use and acceptance of LCA and sustainable construction approaches, and also produce high cost for building products sector. Also, with an open source concept, not only economical dependency on commercial developments of e.g. software tools could be avoided.

Also, the EPD program operators and other InData members identified the need to become compatible with the upcoming digitalization demands in the planning and building processes in the construction sector, like e.g. BIM (building information modeling). InData showed the way on this path. Furthermore, the internationally harmonized approach was considered as a high motivation for a joint step forward to European and internationally formulated political goals.

The concept of InData, which is to offer methods for producing machine readable EPD (also generic data) and make these openly accessible for construction LCA in a digitalized way, is based on the following key elements:

3.1 Machine readable EPD

EPD are usually produced and organized by EPD program operators, who are obliged to publish the EPD as specified by the relevant standards. When InData started its activities, in most cases, EPD were published as pdf.files, and there was only limited use of the given information. Digitalization processes around construction LCA had not been established yet very widely. Hence, a decisive basis for InData activities was the development of a machine readable format for EPDs, the so-called EPD data format, i.e. the ILCD+EPD (International life cycle data system + EPD) format [3].

With an open source software tool, the EPD Editor, it is possible either to transfer an existing EPD (pdf.file) into the format, or directly create an EPD dataset in the data format [10]. As a consequence of this digitalization, the EPD can be stored and organized easily in digital databases. These usually are run by program operators. Also, there are other data suppliers and their data is to be found e.g. in national databases, which publish EPD, and also generic data, like German ÖKOBAUDAT [3], [9].
3.2 Open international database network structure

Within the open international database network structure the databases are interconnected digitally. Only the commitment of all data suppliers to a common digital data format, including a common core of information, and corresponding rules and requirements, allows to interconnect the databases. It is to emphasize that this is not the creation of an international database. Each database is operated by its responsible owner at any time, and the responsibility for the datasets stay there. Anyhow, the technical issues are kind of organized in the background (backend), while the user can see all InData compliant data in a search table on the InData website (frontend) [2]. Here, the user can search and filter data for its purposes, e.g. data supplier, product groups, type of data (EPD data, generic data), validity. Then, the chosen data collection can be transferred digitally to external construction LCA software tools, or other applications.

In the so-called “Decalogue” (even though there are listed 12 key issues) the main objective and the related requirements are formulated in a clear way (Figure 2). These form the commitments of all involved participants. The Decalogue has been the guiding principle all along the way of InData.

**Decalogue**

**International open Data Network for Sustainable Building**

WG InData. July 2017

1. The main objective of WG InData is to establish an International LCA data network structure for construction products based on EPD information, open for other products.
2. The network structure will be based on a common data format (to transfer information) and common data network and quality rules.
3. A common core of information will be defined; national additional information is possible.
4. Data quality must be identifiable, e. g. by declaring used background database.
5. Third party verification of data according to EN 15804 is mandatory. Quality requirements for generic data is to be addressed in the future in order to better ensure data quality.
6. Databases can contain different types of data. E. g. generic, product specific, producer, association, representative values
7. EN 15804 is the common ground to start (modules, scenarios, etc.). Data network structure allows to address other standards in the future.
8. It is not the aim to develop additional rules complementing the standards.
9. Complementary information will be defined for classification of products (generic, average, BIM codes, etc.)
10. All the information will be available in English, and complementary in other languages.
11. As a data exchange format (i.e. the technical means of transferring information), the ILCID+EPD data format will be used.
12. All EPD data shall be exchanged free of charge within the network structure.

**Figure 2.** Decalogue, version July 2017.

The vision to establish an open international database network, as formulated in the Decalogue, implied manifold tasks:

- **Networking.** The small group of founding members, the “coalition of the willing”, started networking and convincing other potential stakeholders of the vision and concepts.
- **Internal Structure.** An internal structure of the initiative was developed (Section 2), and corresponding documents like statutes, letter of intents, questionnaires, self-declarations, and others were formulated.
- **Realization of network structure.** In parallel, the realization of the network structure had to be brought into practice. A common ground of rules, data format, technical specifications,
and standards had to be developed. All of these had to be formulated and accepted by all members.

- **Data format, compliance and quality.** InData has published the data format according to EN 15804:A1 and new amendment EN 05804:A2. This is based on research work in BBSR (Federal Institute for Research on Building, Urban Affairs and Spatial Development) [9]. Accordingly, the so-called InData compliance was defined. This commitment of InData members comprises the definition of optional and mandatory information to be given in the datasets, the technical means of the format, but also basic requirements on conformity with European Standards (e.g. EN 15804), verification, language, validity, and others. The relevant information has been published in the documents “InData Compliance Rules”, “Table of Definitions ILCD+EPD format, CPEN 2020 InData”, “Table of Definitions ILCD+EPD format, CPEN2018 InData”, “FAQ: ILCD+EPD format, CPEN2018 InData Compliance”, all of them published on the InData website [8].

- **Quality management.** For a working network structure, besides open access to the above mentioned documents, some further issues were relevant for the quality of data and processes. Within the network the published datasets are not quality proofed in any additional process by an InData instance. Thus, the data suppliers declare conformity with relevant European Standards and the InData requirements by signing the “Self Declaration”. Also they deliver some additional information on EPD program, generic database, product category rules (PCR), verification, and validation.

  For the technical aspects like validity and completeness of the published datasets, supportive information and tools are provided. There is given some information for technical development of the format. Before publication of data in the InData network, data must be checked with the validation tool. Within this tool the validation profile according to the used standard or compliance can be chosen, and then, with the tool the datasets are checked for plausibility and completeness. This procedure is an important means of quality assurance.

  The relevant documents, tools, or links are published on the InData website: “Developer Documentation ILCD+EPD v1.2 MR3”, “ILCD Validation Tool”, “InData 2018 Validation Profile” [8].

- **Website with open access to information, tools, and rules.** InData developed an own web presence, where it offers open access to information and tools (as mentioned above) for establishing the digitalized processes. As all developments are based on open source, the relevant tools and the format can be used, or implemented, by every interested stakeholder. There is no economic interest in the InData initiative, and hence there are no member, nor licence fees.

- **Meeting Platform.** Meetings had to be organized as InData became an important international meeting place for networking, exchange of information, joint projects, and workshops. These were held in different places, sometimes in the context of international conferences.

- **Support.** Personal support was offered to the interested stakeholders for setting up database structures, interfaces, with using the offered tools, e.g. program operator EPD Norge, and ECO Platform as umbrella organization for EPD program operators.

- **Public Relations.** Publications of relevant documents and information is given on InData website. Also, international networking like organizing workshops, or sessions during international conference, press releases, publications by single stakeholders of the initiative, presentations in international meetings etc. were always a relevant task in promoting the activities of InData.
4. What has been achieved? A Review

“Mission accomplished?” The answer to this question in the title of this paper is a very clear “Yes! Mission accomplished!”

All goals, as formulated in the Decalogue, have been implemented into practice. It is an outstanding success that a voluntary-based, bottom-up initiative InData, managed to realize its vision within 5 years. InData started in 2015 and launched the InData Network in 2020 on its website. With its internal structures InData has mastered the challenges successfully.

Currently, the open international data network connects the following databases: IBU.data (Germany), EPD Norge Digi (Norway), EPD International Data (Sweden), EPD Italy (Italy), ÖKOBAUDAT (Germany) (Figure 3). A survey of existing databases provided either governmentally or by EPD program operators, is published on the InData website [12]. Also, in several European studies analysis of different databases has been carried out.

![InData Network - participating stakeholders.](image)

Figure 3. InData Network - participating stakeholders.

InData has managed to establish the idea of creating digital EPD, storing them in databases, which can be interconnected and thus offer harmonized and consistent EPD, and generic data, openly for construction LCA.

InData has convinced key stakeholders of the concept. Also, InData offered open source tools, information, and support for them, to establish their own digitalized EPD databases and the related processes of creating EPD data and transferring them to subsequent software applications. Any interested stakeholder can use all of the published information and with this, participate in using the data format, and in the network structure.

Important to mention are the impacts of these developments that have been motivated by, but go beyond the works of the InData initiative.

- **International acceptance of data format.** The data format has found broad international acceptance. It is not only the 5 participating databases in the current InData network, but also other databases, that are using the ILCD+EPD format, like e.g. TurComDat (Turkey). Others are about to establish, implement, or accept the data format for their databases like e.g. Spain (opendap), UK (BRE), or France (INIES).

Some actors have initiated further developments of the format. Sweden developed a national appendix to the format with required metadata [7]. In InData it will be discussed to implement these in the InData compliance.
Some other players have used the format as a basis for their database developments, but adopted to their needs, e.g. Finland.

- **International use of data.** Data from the InData network can easily be used in LCA software tools, or other applications. Beyond that, many players benefit from the digitalized databases, even outside the context of InData. Only the digitized format allows easy handling and data transfer from single databases to software tools, or other calculation accesses. This is widely known for ÖKOBAUDAT. The data is addressed in national certification assessment schemes, e.g. in Denmark (LCAbyg), Luxemburg (Lenoz), or is implemented in LCA software tools, or even excel applications, and thus used worldwide for LCA calculations.

- **Standardisation work.** Members of InData are involved in major standardization committees, such as CEN/TC 350 “Sustainability of construction works”, mastermind of EN 15804 “Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products” [4].

  InData members explicitly were invited to participate in standardization work for ISO 20577 “Sustainability in buildings and civil engineering works – Data templates for the use of environmental product declarations (EPDs) for construction products in building information modelling (BIM)” [5]. The ILCD+EPD successfully was implemented in this standard. With this, the formulated goal of InData, that the data format offers compatibility with, or transfer of data to BIM applications used for the planning and construction processes, is fulfilled.

- **Co-operation InData and ECO Platform.** ECO Platform is an international non-profit association established by EPD program operators as well as supporting members from industry, green building organizations, LCA practitioners and tool operators. Due to a substantial overlap of stakeholders, being member of both, InData and ECO Platform, an intense exchange between both initiatives was given. In 2019 InData and ECO Platform have stipulated their common objectives about facilitating construction LCA with a harmonized digital format for product data in the published document “Cooperation InData and ECO Platform”, see InData website [8].

  Furthermore, InData and ECO Platform have organized joint meetings, or workshops during international conferences, e.g. during the digital conference “Beyond 2020” with a joint session “Digitalization and global communication of product data (EPD) for Building LCA”; with a session in 2019 during international conference “Cities to Be” in Angers, France, and with the first joint meeting in September 20218 in Milano, Italy.

  Between 2019 and 2021 there was a very intense dialogue between both initiatives with considerations about a merging into one organization. Finally, it was decided to keep both initiatives separately. Nonetheless, this intense exchange obviously boosted significant developments within ECO Platform (see next section).

- **International acceptance of concept of open database structure.** ECO platform has launched the ECO Portal by the end of 2020 as access point to digital product data for building and construction LCA. It follows the proposed concept of InData in all fundamental aspects. “With the ECO Portal, ECO Platform is offering a central access point for users to digital EPD data. …There won't be a "super database" offering all required data. The solution is an open database network based on a common digital format (ILCD+EPD) and qualities, and rules for data exchange and use. …” [11]. These, and also the other formulated principles for digital data exchange fully comply with the principles and concepts of InData. The adoption of the InData concept by ECO Platform as a powerful international player for construction LCA, is a great success, which proofs the acknowledgment, and applicability of the works of InData. These developments are a milestone, which shows that InData has managed to bring its approach to “mainstream”. The ECO Portal will allow access and data transfer to a wide
range of relevant data for construction LCA. **Table 1** shows currently active data providers in InData and those which followed afterwards within ECO Portal using ILCD+EPD format.

- **Support European and International goals.** The concept was established in conformity with existing standards and initiatives, and at the same time it offers a high flexibility for adoption of new amendments in standardization. The initiation of InData, and the up-taking of InData’s concept by internationally relevant stakeholders proofs significant relevance of the activities. All of these aim at facilitating decarbonization by provision of credible data for construction LCA. Digitalization significantly reduces the efforts of data generation and communication. It also supports harmonization efforts in the LCA processes and thus, data quality improvements.

InData stimulated the setting up of databases and network structures. There was an intense exchange of relevant stakeholders which led to enormous quality improvements and progress in digitalization processes. Thus, InData considers its work as a support for European and internationally formulated goals. With providing an open source digital EPD format InData has created the basis for the upcoming challenges for more sustainable built environment within future climate change. Determination of global emissions like global warming potential is currently becoming a binding part in construction sectors, and thanks to digital format of EPD the construction sector is prepared for the creation of a significantly rising amount of EPD and their application within LCA of constructions. Also, the system is ready to integrate other indicators related to resource demand or climate adaption.

**Table 1.** Participating Databases or data provider InData and ECO Portal.

| Database by EPD program or national database | State(1)   | Data hub InData / ECO Portal |
|---------------------------------------------|------------|-----------------------------|
| Bau EPD GmbH(2)                             | Austria    | X / X                       |
| BRE-EPD Hub by BRE                          | UK         | - / X                       |
| DAPHabitat                                  | Portugal   | - / X                       |
| EPD Denmark                                 | Denmark    | - / X                       |
| EPD_Ireland by EPD Ireland                  | Ireland    | - / X                       |
| EPD_Italy by ICMQ S.p.A                     | Italy      | X / X                       |
| EPD-Norway_Digi by EPD Norway               | Norway     | X / X                       |
| IBU_Data by Institut Bauen und Umwelt e.V.  | Germany    | X / X                       |
| Environdec by the International EPD system  | Sweden     | X / X                       |
| ITB_Poland by ITB-EPD Poland                | Poland     | - / X                       |
| MRPI by MRPI(2)                             | Netherlands| X / X                       |
| ÖKOSAUDAT (national database)               | Germany    | X / -                       |
| Kiwa BCS Öko-Garantie GmbH                  |            |                             |
| ift Rosenheim GmbH                          |            |                             |
| Europäischer Aluminiumverband               |            |                             |
| Thünen-Institut (providing representative data) |         |                             |
| Sphera Solutions GmbH (providing generic data) |          |                             |

**5. What will be mission and goals in future? A Preview**

Due to the observed climate change and the formulated goals of decarbonization the recognition of LCA as an evaluation method for the emission potential and resource demand in the construction sector has grown significantly. There is a trend to bindingly demanded LCA on construction level via legislation, or other regulations. There are somewhat different approaches in different nations, but there are obvious challenges to all stakeholders in this process: It will be rather governmental role to formulate requirements on data, data quality, calculation methods to be used, and to define benchmarks / target...
values. The construction sector will need to generate the required data, and appropriate calculation tools. All of this to be embedded in standardization works, and national, European, and International approaches. Obviously digitalization can and will be a key issue in these processes. In the best case, a high level of harmonization of data and processes on international level, and a high flexibility for digital transfer of data and results in different planning stages can be achieved.

Currently, a next phase is beginning. The usage of machine readable EPD/LCA data in other systems like construction LCA software, or BIM applications is already in practice, and it is a field with growing interest. There are manifold formulated requirements, like offering dynamic visualizations of the effect of choice of products, or construction elements during different planning stages. There is also the wish to get an idea about the effects in relation to the target values. Besides getting the LCA results, there is also the requirement to get information about life cycle costing, about other environmentally or health relevant impacts of the chosen materials or the construction. There are aspects which are not addressed in sufficient way yet, like regarding transports, processes at the construction site, etc. Just to bring up, some issues, which are sometimes, but not commonly established yet. The manifold requirements entail the development of several approaches for digitalization. InData offers one out of other approaches – and most important will be that different systems can communicate with each other via interfaces, mapping etc.

Anyhow, the upcoming challenges demand keeping the format up-to-date based on new requirements (LCA in legislation; higher amount of EPD; digitalized processes, standardization) and market developments (construction projects with stronger emphasis on sustainability aspects, EU Taxonomy, emphasis also on resource aspects, climate adaption, digitalization). So again, for InData the answer to the question to “Mission accomplished” is “yes” regarding the fulfilment of establishing a data network structure for sustainable construction, but there are many challenges waiting.

Currently, InData is in a finding process – thus it is to mention, that the following section represents ideas, and a tendency of the new focal issues of InData, but there are no final decisions on this. ECO platform adopted the concept of an open international network structure, and EPD data can be published there. For this reason, InData will put focus on the data format, and data quality with special focus on generic data.

- **Data format.** Initiated by InData a Technical Committee data format was established. The idea is, that a group of experts debates and decides, or recommends about new data elements and their definitions in the open source based ILCD+EPD format. The success of the open data network approach depends on keeping the format up to date to the mentioned requirements. For this reason, InData will put its focus on maintaining, optimizing, and further developing the ILCD+EPD format.

- **Data quality.** Related to the data format is the issue of data quality. The work shall be focused on concepts which help to assess and select EPD/LCA data at construction level, this implies the assessment and selection of life cycle inventory data sets where EPD data is not available. Issues are e.g. integrating metadata, optimize the presentation of text given information for digitalized datasets. Also, different approaches for addressing data quality will be compiled and analyzed, e.g. EN 15804 [4], EN 15941 [6], Q metadata [7], environmental footprint approach by European Commission. It will be investigated which information and which data quality metrics are required for specific needs (users, verification process, cross-compliance, software, databases).

- **Generic data.** The rather special issue of generic data is gaining in importance with the shift to bindingly required LCA. Some nations already did, or do start to establish national databases with generic data for the use in the construction LCA. Harmonization processes in the creation, and review process of generic data will be considered.

- **Propose idea of network structure in European/International context.** InData will also in future propose the idea of an open database network structure. There are decisive advantages compared to plans of central European, or International database, which is run
by one player, and thus can cause commercial implications and dependencies. Governmental side should rather formulate the compliance requirements on the data to be used within their context.

- **Open source.** InData will continue to offer information, definition of the format, and developers support. The format is very flexible, and multi-lingual, open source. Hence, there is a high potential also for non-industrial countries to use offered support and establish own processes around LCA.

6. **Outlook**

InData, organized as a voluntary group, sees its strength in its independency. It successfully has managed to set up professional internal structures, which proof by the results of work and international relevance that goes beyond InData, as presented in this paper. InData decided to keep to its open and voluntary structure, and trusts in producing relevant results also in future based on a high motivation of its members for the identified issues and a common sense of an open and trustful working base. Further works will concentrate on the maintenance and development of the format, which is open source and open to all interested stakeholders. The basis data usually is provided by EPD program operators or governmental databases. Planners and architects rather have an indirect use as the data is implemented in the software calculation tools used by them.

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