Chapter 13
The Role of Digital Building Logbooks for a Circular Built Environment

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Abstract Digital building logbooks (DBLs) are digital repositories of building-related data gathered throughout the full life cycle of a building. DBLs help increase transparency and access to information during the design, construction, operation, and end-of-life phase of a building. They thereby facilitate an efficient and cost-effective transition to a zero energy and circular built environment. DBLs could slow down resource loops by extending the service life of buildings through better coordination of maintenance and repair and close resource loops by promoting adaptability and reuse of the whole building and/or its components with multi-cycle approaches. This chapter analyses examples of DBLs developed in five countries to show that they are useful tools at different life stages of the building and for different stakeholders (homeowners, property managers, or building professionals). Challenges for establishing DBLs as a central tool for a circular built environment lie in improving the user experience and ease of implementation; enhancing interoperability; and effectively collecting, managing, and transforming data into actionable information for the management, maintenance, and reuse at building and district levels.

Keywords Digital building logbooks · Building passports · Whole life cycle data · Traceability · Data management

13.1 Introduction

Building logbooks are repositories of building-related information. They are also commonly referred to as building passports, electronic building files, and, in specific cases, building renovation passports. They provide a single source for inputting, accessing, and visualising all the information associated with a building that can be continuously monitored and updated (Hartenberger et al. 2021). As data is captured

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and managed throughout a building's whole life cycle, DBLs facilitate transparency, trust, and informed decision-making in the construction sector and are considered enablers of a circular built environment (Dourlens-Quaranta et al. 2021). While material passports (MPs) (see Chap. 5 by Honic et al. on this topic) focus on the material-related data of a product and its underlying components, such as life cycle impacts or circular characteristics (van Capelleveen et al. 2023), digital building logbooks (DBLs) can include technical, spatial, and functional characteristics as well as environmental, social, and financial performance data of a building.

A DBL is intended to be a flexible repository of building-related information that can be accessed and managed in different ways by different stakeholders. These stakeholders should be able to manually enter, upload, and update information, import data from external sources, or link to external databases. DBLs have the potential to cover a wide range of building-related information: static data (such as administrative documents, building plans, bills of materials, etc.) and dynamic data (such as maintenance logs, operational energy consumption, etc.) (Hartenberger et al. 2021). DBLs allow centralised access to information and can cluster digital product passports (DPPs) and MPs at the component and material level, including information on energy performance certificates and renovation roadmaps towards minimum energy performance requirements.

13.2 Digital Building Logbooks (DBLs)

13.2.1 DBLs in the European Built Environment

Several European policy documents, ranging from European legislation to future recommendations, have been established to pave the way for a low carbon, digital, and circular Europe. Despite the emphasis on the 'energy efficiency first' principle, there is a clear trend towards the inclusion of embodied greenhouse gases and whole life carbon in order to meet climate targets and decouple growth from resource use (European Commission 2019). In this context, the review of the Ecodesign framework, foreseen by 2025, will establish mandatory DPPs to improve the traceability of products along the value chain (Directorate-General for Environment European Commission 2022), including construction-related products. At the building scale, DBLs are specifically referred to in the Energy Performance in Buildings Directive (EPBD) recast proposal (European Commission 2021a), as tools to promote circular economy principles throughout the life cycle of buildings. The EPBD recast proposal (European Commission 2021a) also outlines the concept of a building renovation passport as a customised action plan for a specific building to help it achieve a higher level of energy efficiency.

In 2020, the European Commission commissioned a study on the development of a European Union framework for the DBLs (Dourlens-Quaranta et al. 2021). In several European countries, DBLs are already in use or in the process of being introduced (Jansen et al. 2022; Gómez-Gil et al. 2022). Some of these can be

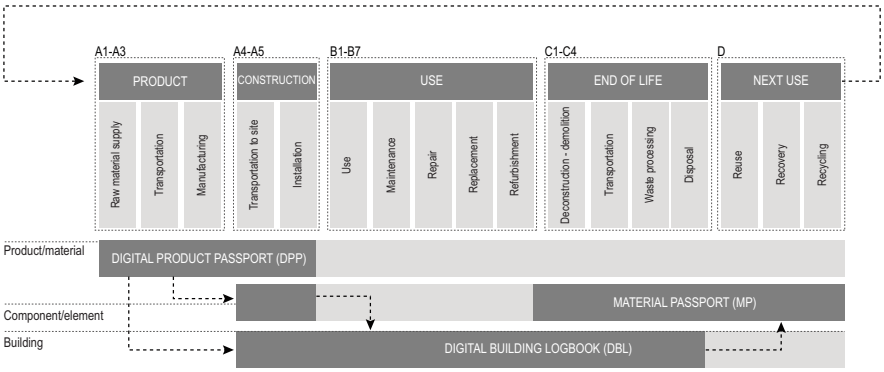

Fig. 13.1 Relation of DPPs, MPs, and DBLs across scales and life cycle stages, with the darker shade highlighting the focus life cycle stages

identified as a DPP or MP. The differences in scope between these digital tools are still a topic of discussion, as they can be related to the scale of implementation (from material and product to building), life cycle stages coverage, and scope of the contents. All three – DBLs, DPPs and MPs – are intended to be useful throughout the whole life cycle of a product. However, they have different focus: DPPs are created in the moment of production; MPs can be created during design and construction or at the end-of-life stage of a product or a building (Honic et al. 2021), but their most essential contribution lies at the beginning and at the end-of-life and next-use stages, enabling reuse and recovery of materials (see Chap. 5 by Honic et al.); and the main focus of DBLs is the use stage, as represented in Fig. 13.1. DBLs might 'nest' lower-level passports (such as DPPs or MPs), so that information can be inherited at a higher (building) level from underlying levels (components or materials) (Platform CB'23 2020). Furthermore, DBLs can be seen as 'living' logbooks that can be updated, automatically or not, during the life cycle stages, and they can include information related to energy performance, health and comfort, and operational management, while DPPs and MPs tend to be more static.

13.2.2 DBLs for a Circular Economy

The EU Parliament's Strategy for a Sustainable Built Environment, aiming to set the legislative priorities for the built environment regarding the implementation of the European Green Deal, refers to the importance of DBLs to increase material efficiency and to reduce the climate impact of the built environment, in particular by promoting circularity principles throughout the life cycle of buildings (European Parliament 2023). DBLs are an 'important means to achieve a more circular construction sector, as they promote reuse at the material, product, element, and building scale' (Platform CB'23 2020). In addition, DBLs can promote the principles of

durability, adaptability, and circularity principles throughout the life cycle of a building (Hartenberger et al. 2021). As with DBLs, information on the installed construction elements, components and materials, their lifespan, and the possibilities for dismantling, reuse, and recycling can be systematically collected, organised, and updated. In this way, DBLs can improve the overall transparency, trust, and cooperation between different stakeholders and support sustainable decision-making when it comes to modifying actions during the life cycle of a building, ultimately preserving the value of the materials. DBLs can help maintain the value of the building throughout its life cycle and contribute to smarter use of materials and products (narrowing the loop), extending the life of buildings and components (slowing the loop) and ensuring beneficial end of life (closing the loop).

13.2.3 Examples of DBLs in Europe

This section presents examples of DBLs developed in five geographical contexts with different local drivers and normative frameworks: France (CLÉA), the UK (Residential Logbook Association/Chimni), Germany (CAPSA), Belgium (De Woningpas), and the Netherlands (CIRDAX). These DBLs were chosen to showcase the wide variety of legal and market backgrounds, level of maturity, functionalities, and target audiences. The DBLs are analysed in terms of functionalities, data management, data fields, and contribution to circularity strategies.

CLÉA, France

Since January 2023, French regulations have made the 'Carnet d'Information du Logement' (dwelling information file) mandatory for all new buildings; however, digitalisation is not mandatory. In this context, Qualitel, a French certification body, has developed CLÉA – a DBL that was launched to the market in October 2020. Currently, CLÉA is used in 50,000 dwellings (45,000 privately owned multi-family homes and 5000 single-family homes). This business-to-consumer (B2C) DBL is intended for building owners and tenants, either directly or through real estate managers. The CLÉA DBL is divided into different information categories, namely: general dwelling information (cadastre information); documents (repository of pdf files with invoices, rules, or minutes of residents' association); equipment (user guides and maintenance alerts for heating, ventilation, and air conditioning (HVAC) equipment); news (blog); and energy monitoring (connected to smart meters).

Residential Logbook Association, the United Kingdom

In the UK, there is no specific building logbook legislation. In 2021, the Coalition for the Energy Efficiency of Buildings (CEEB) developed a standardised framework for

Building Renovation Passports in the UK to help finance a net-zero carbon built environment. In this context, the Residential Logbook Association brings together several DBL companies to contribute to the regulatory process. Approximately 250,000 homes have a DBL verified by the RLBA. Chimni is one of these business-to-business (B2B) and B2C DBLs. It is tailored for homeowners, estate agents, and house builders for existing and new buildings. Information categories currently included in this DBL are pictures and floor plans; geolocation; document storage (deeds, certificates, etc.); utility dashboard (connecting to gas, electricity, and water companies); and property history timeline.

De Woningpas, Belgium

The Woningpas (De Woningpas, 2023) is a DBL owned and developed by the Flemish government as part of the implementation trajectory for the renovation wave and the regional decree on building passports (Vlaams Overheid, 2018). It makes building passports available for all building units in Flanders. The Woningpas was launched in December 2018 as a B2C DBL for residential building units, and an extension of the DBL to all non-residential buildings is planned for the end of 2023. The DBL data is linked to external platforms via Application Programming Interfaces (APIs), connecting all available information from public authorities or other institutions (e.g. inspection organisations of energy network operators). In this way, the Woningpas is automatically fed with data and made freely available to the building owners of all 4 million individual building units in Flanders. A building owner can add information about work carried out and certificates (pdf files) in a digital environment and also can share the information in this DBL with the public. The information categories currently offered by this DBL include building information (cadastre information); energy (energy performance certificate, renovation advice, renovations work); insulation, glazing, and installation characterisation; soil characterisation; building permits; dwelling quality; mobility; water and sewage; flood sensitivity; biodiversity level; and asbestos.

CAPSA, Germany

Chillservices is a commercial company that has been providing building logbooks for large food retailers since 2016. In 2021, the company launched a new variant for office and residential buildings – CAPSA, which is currently applied to 50,000 apartments in Germany, but also in smaller test cases in Scotland, the Netherlands, and Italy. CAPSA is a B2B DBL to support housing owners and facility managers. It consists of a smartphone app to collect primary data, supported by geo-positioning and image recognition. The collected data is stored in a cloud-based platform and interpreted with the support of external data sources. Functionalities currently offered by this DBL include the following information categories: calculation of energy performance; surface area; material catalogue and embodied carbon; asset

management (condition assessment, monitoring, and maintenance advice); and semi-automated calculation of decarbonisation roadmaps.

CIRDAX, the Netherlands

CIRDAX (2023) is a commercial materials management system launched in 2016 in the Netherlands by the company Re-Use Materials. As the focus of this DBL is mostly on materials, it can be considered an MP (see Chap. 5 by Honic et al. on material passports). However, CIRDAX is also an example of an integrative approach of digitalisation, as it combines the inventory of materials and components in a building scale with a digital twin (see Chap. 1 by Koutamanis on BIM and digital twinning) and includes building management functionalities, and should therefore be considered as a DBL. The data collected by 3D-scanning or manual inputs are aggregated in a DBL, linked to a blockchain to provide verifiable information about the ownership of materials for future transactions. CIRDAX is a B2B DBL, currently used by governmental organisations and real estate organisations for in-depth digitalisation of existing real estate portfolios. This DBL currently includes material passport; 3D Digital Twin; CO_2 balance calculator; management and maintenance (condition assessment and maintenance alerts); performance dashboards (circular potential, financial value, and CO_2 emissions); and material marketplace.

13.3 Data Fields Supporting Circular Strategies

Table 13.1 presents a summary of the most relevant data fields enabling circularity in the built environment present in the analysed DBLs. All analysed tools include geolocation of the building, a data field that can be linked to GIS (see Chap. 2 by Tsui et al) to optimise distances in the construction and end-of-use stages, encourage smart use of available space, track, and trace available resources (from materials to energy, including space), and encourage excess resource exchange.

The focus of most DBLs is on energy in the use stage of the buildings: information on maintenance and use of HVAC equipment (CLÉA, Chimni, Woningpas, CAPSA), links to energy certificates (Woningpas), invoices and consumption data from utilities (Woningpas, Chimni), or live monitoring through smart meters (CLÉA, CAPSA). Thus, they support the narrowing of resource loops in the use stage, by improving and tracing energy efficiency in buildings, with energy renovation roadmaps (such Woningpas and CAPSA) and encouraging the reduction of primary energy inputs, by integrating renewable energy sources and analysis of solar potential (Woningpas).

Slowing resource loops is also an important aspect tackled by the analysed DBLs. By integrating data about the heritage values of the building, tools like Chimni and Woningpas reinforce the emotional connection with the users so that the users feel attached to their buildings (Çetin et al. 2021). Together with information about user

Table 13.1 Data fields related to circularity strategies

			Digital building logbook				
Category	Data field	Strategy	CLÉA	CHIMNI	WONINGPAS	CAPSA	CIRDAX
Plot	Geolocation	ALL	×	×	×	×	
	Soil characterisation	Regenerate			×		
	Flood sensitivity	Regenerate			×		
	Water & sewage	Narrow/regenerate			×		
	Blue-green level	Regenerate			×		
	Solar potential	Narrow			×		
	Mobility	Narrow/regenerate			×		
Building	Construction date	Slow	×	×	x		
	Heritage listing	Slow		×	×		
	Building timeline	Slow		×			
	Home quality	Regenerate			×		
	Surface area	Slow		×		×	x
	Architectural characteristics	Slow/close		×	×	×	×
Services	HVAC systems	Narrow	×	×	×	×	
	HVAC user guides	Slow	×	×			
	HVAC maintenance alerts	Slow	×	×		×	
	Energy performance	Narrow	×	×	×	×	
	Energy consumption	Narrow	×	x	×		
	Energy monitoring	Narrow	×			×	
Components and materials	Characterisation	Slow/close				×	×
	Embodied carbon	Narrow/close				×	×
	Circular potential	Close					×
	Marketplace	Close					×
	Residual financial value	Close					×

(continued)

Table 13.1 (continued)

			Digital building logbook				
Category	Data field	Strategy	CLÉA	CHIMNI	WONINGPAS	CAPSA	CIRDAX
Maintenance	Condition assessment	Slow				×	×
	Monitoring hotspots	Slow				×	
	Maintenance strategies	Slow		×		×	×
Roadmaps	Energy renovation	Narrow			x	×	
	Project templates	Slow		×			

guidance, condition assessment, and maintenance (for instance, in CAPSA and CIRDAX), these strategies contribute to redesign strategies that extend the service life of the building.

By including modules related to materials, such as an inventory of materials and components and analysis of embodied carbon, CIRDAX and CAPSA show the potential of DBLs to contribute to closing resource loops, avoiding waste, and bringing resources back into the economic cycle. CIRDAX's MP links to a circular potential analysis (Potting et al. 2017) and the residual value of the building and connects supply and demand for material reuse with blockchain technology (see Chap. 12 by Shojaei and Naderi on the topic). Woningpas is the only DBL analysed to include information on the plot and city level, such as soil characterisation, mobility, and blue-green levels. It also includes information related to the quality of the indoor environment (home quality assessment), making this the only analysed tool already targeting the regeneration of natural and human systems, promoting biodiversity, healthy environment, and exchange of resources at the community level.

13.4 Business Models for DBLs

As identified in the European Commission study on building logbooks, several European approaches to DBLs do not yet have a clear business model that can be easily be replicated (Carbonari 2020). For the stakeholders involved, the lack of definition of business models is a significant barrier to the development of a DBL or its replication (Carbonari 2020). The analysis of the five DBLs identified some common benefits highlighted by all the DBLs analysed: the centralisation of information, which becomes easier to find and to share, resulting in streamlined workflows, the reduction of sectoral fragmentation, and the reduction of administrative burden. At the same time, the availability of reliable information contributes to greater transparency in all the processes, reducing risks, speeding up transactions, and, ultimately, increasing the property value. Despite the very different market groups, the benefits presented by the different DBLs tend to be overarching and thus may miss the unique value proposition for each specific stakeholder.

Three business models were identified in the five DBLs analysed: a B2B sale (product-oriented), where DBLs are sold to real estate promotors for a limited period of time; a B2C sale, where DBLs are sold directly to individual end-users; and B2B (use-oriented) commercial licence, where DBLs are offered as a service. The B2C approaches (CLÉA and Chimni) are currently free for individual users as an experimental approach to attract new users but are likely to gradually become 'freemium' services, combining some free features with more advanced features available only for a fee. The commercial licence fees are associated with the use of a software tool and are targeted at real estate owners and housing corporations with larger real estate portfolios. For example, access to the full list of functionalities identified for

CIRDAX requires the payment of a premium licence per month, per user, and per building.

Depending on the objective of the DBL, business models should be based on the clearly defined added value of using a DBL. This could result, on the one hand, in a single unique selling proposition such as a B2B/B2C opportunity that by using a DBL in which a maintenance company has access to building-related data, actual maintenance and operational costs decrease. For example, a technical installer with a maintenance contract with a private homeowner could timely plan maintenance because the operational efficiency of the installation decreases with collaterally higher energy consumption (and thus costs). On the other hand, business models based on the clear added value of DBLs could result in a multitude of B2C opportunities, for instance, for covering flood-related insurance costs, assessing photovoltaic potential, or estimating the costs of asbestos removal. A pre-condition for these business models would be a certain level of data sharing between the different parties involved.

13.5 Discussion

13.5.1 Future Developments for DBLs

Ambitions for developing DBLs and increasing the contribution to a circular built environment vary widely depending on the current level of complexity and stakeholders targeted. Most of the current DBLs still have a one-dimensional focus on the use phase and operational energy consumption, with little coverage of the whole cycle (Hartenberger et al. 2021). DBLs such as Woningpas are aiming to integrate external data from smart meters to monitor real performance, and CAPSA has already done so. Some of the DBLs presented already provide users with automated renovation advice (Woningpas) or detailed decarbonisation roadmaps (CAPSA), which can support the renovation of the building stock, investment decision-making, and access to EU funding, green financing, and insurance products.

According to the European Commission, the automatic input of data from a BIM model (see Chap. 1 by Koutamanis) is considered important for the majority of stakeholders (Dourlens-Quaranta et al. 2021), as it would contribute to speeding up the processes and reducing costs – two major barriers to the implementation of DBLs (Dourlens-Quaranta et al. 2021). This is not yet common practice, as the analysis of cases demonstrated, with only CIRDAX offering that possibility, and Chimni actively working on its integration with the DBL.

Collaboration is an essential strategy in the transition towards a circular built environment (Çetin et al. 2021), which will require integrating needs and expectations of multiple stakeholders at multiple scales. Understanding the building as a part of a larger complex system shaped by social, economic, and environmental forces is important for identifying flows of material products and waste across different scales. DBLs contribute to a better overview of the existing building stock and can enhance

collective approaches that significantly reduce impacts at the neighbourhood and urban levels. DBLs, together with GIS technologies (see Chap. 2 by Tsui et al.), can support community-driven decarbonisation and the decentralisation of water, energy, and waste flows and simultaneously establish urban mining networks with information on the location and availability of materials.

To improve the contribution towards a circular built environment, the next generation of DBLs needs to go beyond energy and support sustainable flows throughout the entire life cycle of the building and beyond. In the study of the European Commission, participating stakeholders identify the building material inventory as one of the most important features (Dourlens-Quaranta et al. 2021). However, the analysis of the practical cases in this chapter shows that DBLs integrating this feature are still the exception and not the common practice. Requiring a bill of materials could increase the completeness and accuracy of the DBLs (Platform CB'23 2020) in the early stages and, later on, facilitate the traceability of embodied carbon and life cycle costing (Hartenberger et al. 2021). It also would offer an opportunity to integrate DBLs with current policy frameworks, such as LEVEL(s), by providing the necessary information to assess resource efficiency and material life cycles (European Commission 2021b), as soon required by the EPBD (European Commission 2021a).

13.5.2 Market Uptake

To ensure that DBLs are effectively useful tools, a more systematic and aligned approach to data collection, storage, and exchange is needed. Passports should allow comparison and interchange of information, and 'it is important that everyone uses the same technical terms and uses the same definitions' (Platform CB'23 2020). The five practical cases analysed show that the same functionalities may mean different things in the different DBLs. This was clear in the data fields related to general cadastre information and building characterisations, for instance, and in the integration of maintenance advice or environmental product declarations (EPDs). Future developments need to establish protocols and tools to ensure interoperability and compatibility of information so that DBLs are effective tools for information sharing and not obstacles to access. A harmonised framework of minimum requirements and protocols for DBLs is essential to ensure that accurate and correct data is available while still allowing for a diverse range of DBLs to meet different market needs and local drivers. Standardisation of minimum requirements goes hand in hand with the financing of the development of DBLs (Dourlens-Quaranta et al. 2021): certain mandatory aspects can be developed by the public sector (such as Woningpas), ensuring transparency and harmonisation, while more advanced features can be developed with commercial purposes, targeting stakeholders' specific needs (such as CIRDAX). The highest value for the end-users will be achieved when both approaches can be combined.

User-friendliness is a key factor determining the success of DBLs. Greater market uptake depends on the extent to which governments impose obligations (Platform CB'23 2020), but also on a better understanding of users' needs, attitudes, and personal motivations (Gonçalves et al. 2021), as there is no 'one-size-fits-all' solution for DBLs. Despite the overarching benefits of implementing DBLs identified in the findings, not all levels of information are relevant to all stakeholders. Therefore, DBLs, despite their role as an information hub, need to allow for different levels of granularity and user roles to avoid overburdening stakeholders with additional work and costs for data storage and management (Hartenberger et al. 2021). A key issue for the successful development and large-scale application of DBLs will depend on the business model. While the overarching objectives of DBLs are in line with the EU and national ambitions, it does not seem to be the case here as well; there is no one-size-fits-all solution for DBLs. Some will be based on a B2B model, B2C model, or fully supported by governments. For the B2B and B2C models, it will be key to define clear unique selling propositions that generate value for the customer.

13.5.3 DBLs as Enablers of Circular Economy

DBLs have the potential to contribute to three main circularity goals: (1) measuring achieved circularity; (2) management and maintenance in the use phase; and (3) facilitating future reuse and value retention (Platform CB'23 2020). Despite the different levels of complexity and detail, all the five DBLs presented in this chapter contribute to the second goal, facilitating the maintenance of the existing building stock; CAPSA and CIRDAX include some functionalities that contribute to the first goal, namely the material inventory and calculation of embodied carbon, but only CIRDAX actively aims at future circularity, value retention, and circular potential. Future developments should integrate renovation advice with MPs (see Chap. 5) and reuse marketplaces with blockchain technology (see Chap. 13). This would allow to balance achievements on operational and embodied carbon and make the most of the resources already existing in the building or its surroundings to avoid disposal and loss of value and enable multiple life cycles.

The development of DBLs presents challenges ahead, but the practical cases of DBLs already implemented demonstrate the potential of DBLs to enable a circular economy in the four strategies proposed by Çetin et al. (2021). They facilitate the upgrade and improvement of energy efficiency in buildings in the use phase (narrowing resource loops); contribute to extending buildings' lifetime through maintenance and repair, and enabling smart reuse of space (slowing resource loops); enable tracking, tracing, and bringing material resources back into the economic cycle in the next-use phase (closing resource loops); and contribute to a net positive impact when including indicators on biodiversity, surplus resources, and environmental quality (regenerating resource loops).

13.6 Key Takeaways

- Digital building logbooks (DBLs) provide transparency and access to building-related data throughout the full life cycle of a building.
- Reliable data can help improve the design, construction, and management of buildings, increase market transparency, create innovative services and business models, and lead to more effective policymaking.
- DBLs have the potential to promote a circular economy by facilitating energy efficiency of buildings, lifespan extension, intelligent reuse, and tracking and tracing material resources for future use.
- DBLs can contribute to creating a net positive impact if they include indicators related to biodiversity, surplus resources, and environmental quality at the building and neighbourhood level.
- A life cycle thinking approach to DBLs can support decision-making based on resource optimisation and circularity principles.
- Future developments should integrate renovation advice with material passports and marketplaces to balance achievements on operational and embodied carbon performance.
- Despite the benefits of DBLs to support a circular built environment, a successful business model has not yet been proved on the market with fully defined unique selling propositions in a challenging context with high expectations, policy requirements, and a competitive environment with more and more DBL developers.

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