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R2.4
Final Analysis on the BIM uses at EOL practices

BIM4D partners

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Executive summary

Building Information Modelling (BIM) is revolutionizing the construction sector as a collaborative work methodology that integrates digital tools to manage and share information throughout the project lifecycle. By fostering teamwork, improving efficiency, and supporting sustainable practices, BIM enables stakeholders to optimize design, construction, and maintenance processes.

The BIM4D consortium's work under Work Package 2 examined BIM's integration in five European countries—Belgium, Germany, Greece, Italy, and Slovenia—with a focus on its application in deconstruction. This includes addressing skill needs, policy gaps, and the role of BIM in advancing sustainable practices like selective dismantling and material reuse.

Key findings include

1. **Integration Gaps:** When used, BIM is widely applied in construction but underutilized in deconstruction, highlighting the need for specialized training to address this gap.
2. **Skill Shortages:** There is a widespread shortage of professionals skilled in both BIM and sustainable deconstruction, highlighting a demand for targeted training.
3. **Circular Economy Alignment:** BIM's potential to optimize material recovery supports the EU's sustainability goals but requires robust policy and practice frameworks.
4. **Localized Needs:** Diverse national regulations and digital maturity levels call for adaptable training approaches tailored to each country's context.

Key Research and Needs Assessment Outcomes

- **Surveys:** Across 224 respondents, high awareness of BIM contrasts with limited practical application in deconstruction. Training in digital workflows, selective dismantling, and material tracking is a priority.
- **Workshops:** Discussions between 163 participants emphasized collaboration among stakeholders, government incentives, and the need for role-specific training to overcome challenges like older building data and hazardous materials. Prior to adopting BIM, it appears essential to enhance digital skills within companies (use of management software, measuring devices, 3D applications, etc.).

National Highlights

- **Belgium:** Focus on gradual digital integration and professionalizing deconstruction roles.

- **Germany:** Strong digitalization momentum with interest in early vocational training for BIM.
- **Greece:** Emphasis on incentives and tailored deconstruction training.
- **Italy:** Advocates for unified standards and policy support for BIM-enabled deconstruction.
- **Slovenia:** Highlights circular economy goals and hazardous material management through BIM.

Conclusions and Recommendations for the development of training

BIM4D underscores the urgent need for modular, adaptable training programs that equip professionals with digital skills tailored to deconstruction tasks. Collaboration between vocational training providers and construction industry representatives is vital to ensure programs align with real-world needs, particularly for SMEs. A staged approach to training, combined with demonstrative case studies, can bridge skill gaps and foster digital transformation. By aligning BIM training with EU sustainability goals, this initiative supports the transition toward a circular economy, empowering the workforce to drive innovation in sustainable building practices.

To address skill gaps and enhance BIM integration in deconstruction practices, the following **training-focused recommendations** are drawn from the WP2 activities:

1. **Develop Role-Specific Training Programs**: Tailor training modules for different roles such as foremen, technicians, construction and deconstruction workers and facility managers, focusing on their respective responsibilities in BIM-enabled deconstruction.
2. **Offer Modular and Flexible Learning Tracks**: Provide beginner, intermediate, and advanced training tracks, allowing participants to progress at their own pace and ensuring accessibility for both SMEs and large enterprises.
3. **Define Key Training Topics**: Focus on essential subjects such as BIM fundamentals, Circular economy principles, Digital tools for material tracking, and Deconstruction techniques.
4. **Incorporate Practical Learning**: Include hands-on exercises, real-world case studies, and pilot projects to demonstrate the practical benefits of BIM in sustainable deconstruction.
5. **Adapt Training to Local Contexts**: Customize training content to align with local regulations, digital maturity levels, and sustainability goals, ensuring relevance and compliance.

Kurzfassung

Building Information Modelling (BIM) revolutioniert den Bausektor als kooperative Arbeitsmethodik, die digitale Werkzeuge zur Verwaltung und gemeinsamen Nutzung von Informationen während des gesamten Projektlebenszyklus integriert. Durch die Förderung der Teamarbeit, die Verbesserung der Effizienz und die Unterstützung nachhaltiger Praktiken ermöglicht BIM den Beteiligten die Optimierung von Planungs-, Bau- und Wartungsprozessen.

Die Arbeit des BIM4D-Konsortiums im Rahmen des Arbeitspakets 2 untersuchte die Integration von BIM in fünf europäischen Ländern - Belgien, Deutschland, Griechenland, Italien und Slowenien - und konzentrierte sich dabei auf dessen Anwendung im Rückbau. Dies beinhaltet die Untersuchung des Qualifikationsbedarfs, politischer Lücken und der Rolle von BIM bei der Förderung nachhaltiger Praktiken wie selektiver Rückbau und Materialwiederverwendung.

Die wichtigsten Ergebnisse sind

1. **Integrationslücken:** BIM wird im Bauwesen in großem Umfang angewandt, im Rückbau jedoch nur unzureichend, was den Bedarf an speziellen Schulungen verdeutlicht, um diese Lücke zu schließen.
2. **Qualifikationsdefizite:** Es besteht ein weit verbreiteter Mangel an Fachleuten, die sowohl in BIM als auch in nachhaltigem Rückbau geschult sind, was den Bedarf an gezielten Schulungen verdeutlicht.
3. **Ausrichtung auf die Kreislaufwirtschaft:** Das Potenzial von BIM zur Optimierung der Materialrückgewinnung unterstützt die Nachhaltigkeitsziele der EU, erfordert jedoch solide politische und praktische Rahmenbedingungen.
4. **Lokalisierte Bedürfnisse:** Unterschiedliche nationale Vorschriften und digitale Reifegrade erfordern anpassungsfähige Schulungsansätze, die auf den Kontext des jeweiligen Landes zugeschnitten sind.

Wichtige Ergebnisse der Forschung und Bedarfsanalyse

- **Erhebungen:** Bei 224 Befragten steht einem hohen Bekanntheitsgrad von BIM eine begrenzte praktische Anwendung im Rückbau gegenüber. Die Schulung in digitalen Arbeitsabläufen, selektivem Rückbau und Materialverfolgung hat Priorität.
- **Workshops:** Die 163 Teilnehmer betonten in ihren Diskussionen die Zusammenarbeit zwischen den Akteuren, staatliche Anreize und den Bedarf an rollenspezifischen Schulungen, um Herausforderungen wie ältere Gebäudedaten und gefährliche Materialien zu bewältigen. Vor der Einführung von BIM scheint es wichtig zu sein, die digitalen Fähigkeiten in den Unternehmen zu verbessern (Nutzung von Verwaltungssoftware, Messgeräten, 3D-Anwendungen usw.).

Nationale Höhepunkte

- **Belgien:** Schwerpunkt auf schrittweiser digitaler Integration und Professionalisierung der Aufgaben im Rückbau.
- **Deutschland:** Starke Digitalisierungsdynamik mit Interesse an früher Berufsausbildung für BIM.
- **Griechenland:** Schwerpunkt auf Anreize und maßgeschneiderte Rückbauschulungen.
- **Italien:** Setzt sich für einheitliche Normen und politische Unterstützung für den BIM-gestützten Rückbau ein.
- **Slowenien:** Hervorhebung der Ziele der Kreislaufwirtschaft und des Gefahrstoffmanagements durch BIM.

Schlussfolgerungen und Empfehlungen für die Entwicklung der Ausbildung

BIM4D unterstreicht den dringenden Bedarf an modularen, anpassungsfähigen Ausbildungsprogrammen, die Fachleuten digitale Fähigkeiten vermitteln, die auf Rückbauaufgaben zugeschnitten sind. Die Zusammenarbeit zwischen Berufsbildungsanbietern und Vertretern der Bauindustrie ist von entscheidender Bedeutung, um sicherzustellen, dass die Programme den realen Bedürfnissen entsprechen, insbesondere für KMU. Ein stufenweiser Ansatz für die Ausbildung, kombiniert mit anschaulichen Fallstudien, kann Qualifikationslücken schließen und den digitalen Wandel fördern. Durch die Ausrichtung der BIM-Ausbildung an den EU-Nachhaltigkeitszielen unterstützt diese Initiative den Übergang zu einer Kreislaufwirtschaft und befähigt die Arbeitskräfte, Innovationen im Bereich nachhaltiger Baupraktiken voranzutreiben.

Um Qualifikationsdefizite zu beseitigen und die Integration von BIM in die Rückbaupraxis zu verbessern, wurden aus den WP2-Aktivitäten die folgenden**, auf die Ausbildung ausgerichteten Empfehlungen** abgeleitet:

1. **Entwicklung rollenspezifischer Schulungsprogramme**: Schneiden Sie Schulungsmodule für verschiedene Rollen wie Vorarbeiter, Techniker, Bau- und Rückbauarbeiter und Facility Manager zu, die sich auf ihre jeweiligen Verantwortlichkeiten beim BIM-gestützten Rückbau konzentrieren
2. **Modulare und flexible Lernwege**: Bieten Sie Kurse für Anfänger, Fortgeschrittene und Profis an, so dass die Teilnehmer in ihrem eigenen Tempo vorankommen können und die Zugänglichkeit sowohl für KMU als auch für große Unternehmen gewährleistet ist
3. **Definieren Sie wichtige Schulungsthemen**: Konzentrieren Sie sich auf wichtige Themen wie BIM-Grundlagen, Grundsätze der Kreislaufwirtschaft, digitale Werkzeuge für die Materialverfolgung und Rückbautechniken.

4. **Praktisches Lernen einbeziehen**: Praktische Übungen, reale Fallstudien und Pilotprojekte, um die praktischen Vorteile von BIM beim nachhaltigen Rückbau zu demonstrieren
5. **Anpassung der Schulung an lokale Gegebenheiten**: Passen Sie die Schulungsinhalte an die lokalen Vorschriften, den digitalen Reifegrad und die Nachhaltigkeitsziele an, um Relevanz und Konformität zu gewährleisten.

Synthèse

La modélisation des informations du bâtiment (BIM) transforme le secteur de la construction avec une méthode de travail collaborative qui intègre des outils numériques pour gérer et partager les informations tout au long du cycle de vie d'un bâtiment. En favorisant le travail d'équipe, en améliorant l'efficacité et en soutenant les pratiques durables, le BIM permet aux parties prenantes d'optimiser les processus de conception, de construction et de maintenance.

Le consortium BIM4D a étudié, dans le cadre du *Work Package* 2, l'intégration du BIM dans cinq pays européens (Belgique, Allemagne, Grèce, Italie et Slovénie) en se concentrant sur la déconstruction. Cette étude a notamment abordé les besoins en compétences, les lacunes en matière de politiques publiques et le rôle du BIM dans le développement de pratiques durables, comme le démantèlement sélectif et le réemploi des matériaux.

Principaux constats

1. **Lacunes dans l'intégration** : Quand il est utilisé, le BIM est appliqué à la construction mais reste sous-exploité dans la déconstruction, ce qui souligne la nécessité de formations spécialisées pour combler cette lacune.
2. **Besoins en compétences** : La pénurie généralisée de professionnels maîtrisant à la fois le BIM et les pratiques de déconstruction durable met en évidence l'urgence de développer des formations spécialisées.
3. **Alignement avec l'économie circulaire** : Le BIM offre un fort potentiel pour optimiser la récupération des matériaux et soutenir les objectifs de durabilité de l'UE, mais cela nécessite des cadres politiques et pratiques solides.
4. **Besoins nationaux spécifiques** : Les réglementations nationales et les niveaux de maturité numérique variés appellent à des formations adaptées aux contextes locauxt.

Résultats clés de la recherche et de l'analyse des besoins

- **Enquêtes** : Parmi les 224 répondants, une forte sensibilisation au BIM contraste avec une application limitée dans la déconstruction. Les besoins prioritaires identifiés incluent les formations aux flux de travail numériques, démantèlement sélectif et suivi des matériaux.
- **Ateliers** : Les discussions entre 163 participants ont mis en évidence l'importance de la collaboration entre les parties prenantes, des incitants gouvernementaux et de la formation adaptée à chaque métier pour surmonter des obstacles tels les données obsolètes sur les bâtiments et la gestion des matériaux dangereux. Avant l'adoption du BIM, il semble crucial d'améliorer les compétences numériques dans les entreprises (utilisation de logiciels de gestion, appareils de mesure, applications 3D, ...).

Points saillants par pays

- **Belgique** : Accent sur l'intégration progressive du numérique et la professionnalisation des rôles liés à la déconstruction.
- **Allemagne** : Forte dynamique de digitalisation, avec un intérêt pour la formation professionnelle initiale au BIM.
- **Grèce** : Importance des incitants gouvernementaux et de formations adaptées à la déconstruction.
- **Italie** : Plaidoyer pour des normes unifiées et un soutien politique pour le BIM dans la déconstruction.
- **Slovénie** : Focus sur les objectifs de l'économie circulaire et la gestion des matériaux dangereux grâce au BIM.

Conclusions and Recommendations for the development of training

BIM4D souligne l'urgence de créer des programmes de formation modulaires et flexibles, capables d'équiper les professionnels avec des compétences numériques adaptées aux tâches de déconstruction. La collaboration entre les organismes de formation professionnelle et les représentants du secteur de la construction est essentielle pour aligner les programmes sur les besoins réels, notamment pour les petites et moyennes entreprises (PME). Une approche progressive, soutenue par des cas pratiques, peut combler les lacunes en compétences et accélérer la transformation numérique. En alignant les formations BIM sur les objectifs de durabilité de l'UE, cette initiative contribue à la transition vers une économie circulaire et donne aux professionnels les outils pour innover dans les pratiques de construction durables.

Pour combler les lacunes en compétences et renforcer l'intégration du BIM dans les pratiques de déconstruction, les **recommandations suivantes, axées sur la formation**, sont issues des activités du WP2 :

1. **Développer des formations spécifiques aux métiers :** Concevoir des modules de formation adaptés aux différents métiers, comme les chefs de chantier, les techniciens, les ouvriers de (dé)construction, ainsi que les gestionnaires d'installations, en se concentrant sur leurs responsabilités respectives dans les projets de déconstruction assistée par BIM.
2. **Proposer des parcours d'apprentissage modulaires et flexibles** : Offrir des formations pour débutants, intermédiaires et avancés, permettant aux participants de progresser à leur rythme tout en garantissant une accessibilité aussi bien pour les PME que pour les grandes entreprises.
3. **Définir les sujets clés de formation :** Mettre l'accent sur des thématiques essentielles telles que les fondamentaux du BIM, les principes de l'économie circulaire, les outils numériques pour le suivi des matériaux, et les techniques de déconstruction.

4. **Intégrer un apprentissage pratique** : Inclure des exercices concrets, des études de cas réels et des projets pilotes afin de démontrer les avantages pratiques du BIM dans la déconstruction durable.
5. **Adapter les formations aux contextes locaux** : Personnaliser le contenu des formations pour qu'il soit en adéquation avec les réglementations, niveaux de maturité numérique et objectifs de durabilité locaux, tout en assurant leur pertinence et leur conformité.

Σύνοψη

Το Building Information Modelling (BIM) έχει φέρει επανάσταση στον κατασκευαστικό κλάδο ως μεθοδολογία εργασίας που ενσωματώνει ψηφιακά εργαλεία για τη διαχείριση και την ανταλλαγή πληροφοριών καθ' όλη τη διάρκεια του κύκλου ζωής του έργου. Ενισχύοντας την ομαδική εργασία, βελτιώνοντας την αποδοτικότητα και υποστηρίζοντας βιώσιμες πρακτικές, το BIM δίνει τη δυνατότητα στους ενδιαφερόμενους να βελτιστοποιήσουν τις διαδικασίες σχεδιασμού, κατασκευής και συντήρησης.

Οι εργασίες του Ευρωπαϊκού προγράμματος BIM4D στο πλαίσιο του Πακέτου Εργασίας 2 εξέτασαν την ενσωμάτωση του BIM σε πέντε ευρωπαϊκές χώρες - Βέλγιο, Γερμανία, Ελλάδα, Ιταλία και Σλοβενία - με έμφαση στην εφαρμογή του BIM στην αποδόμηση. Αυτό περιλαμβάνει την αντιμετώπιση των αναγκών σε δεξιότητες, τα κενά πολιτικής και τον ρόλο του BIM στην προώθηση βιώσιμων πρακτικών όπως η επιλεκτική κατεδάφιση και αποσυναρμολόγηση και η επαναχρησιμοποίηση υλικών.

Τα βασικά ευρήματα περιλαμβάνουν

1. **Κενά ενσωμάτωσης:** Αυτό υπογραμμίζει την ανάγκη εξειδικευμένης κατάρτισης για την αντιμετώπιση αυτού του κενού.
2. **Ελλείψεις δεξιοτήτων:** Υπάρχει εκτεταμένη έλλειψη επαγγελματιών με εξειδίκευση τόσο στο BIM όσο και στη βιώσιμη αποδόμηση, γεγονός που αναδεικνύει τη ζήτηση για στοχευμένη κατάρτιση.
3. **Ευθυγράμμιση της κυκλικής οικονομίας:** Υποστηρίζει τους στόχους βιωσιμότητας της ΕΕ, αλλά απαιτεί ισχυρά πλαίσια πολιτικής και πρακτικής.
4. **Τοπικές ανάγκες:** Οι διαφορετικοί εθνικοί κανονισμοί και τα επίπεδα ψηφιακής ωριμότητας απαιτούν διαφορετικές προσεγγίσεις κατάρτισης προσαρμοσμένες στο πλαίσιο κάθε χώρας.

Βασικά αποτελέσματα της έρευνας και αξιολόγησης αναγκών

- **Έρευνες:** Σε 224 ερωτηθέντες, η υψηλή ευαισθητοποίηση για το BIM έρχεται σε αντίθεση με την περιορισμένη πρακτική εφαρμογή στην αποδόμηση. Η εκπαίδευση στις ψηφιακές ροές εργασίας, την επιλεκτική αποσυναρμολόγηση και την παρακολούθηση των υλικών αποτελεί προτεραιότητα.
- **Workshops:** Οι συζητήσεις μεταξύ των 163 συμμετεχόντων έδωσαν έμφαση στη συνεργασία μεταξύ των ενδιαφερομένων, στα κυβερνητικά κίνητρα και στην ανάγκη για εκπαίδευση σε συγκεκριμένους ρόλους για την αντιμετώπιση προκλήσεων όπως τα παλαιότερα δεδομένα κτιρίων και τα επικίνδυνα υλικά. Πριν από την υιοθέτηση της BIM,

κρίνεται απαραίτητη η ενίσχυση των ψηφιακών δεξιοτήτων εντός των επιχειρήσεων (χρήση λογισμικού διαχείρισης, συσκευών μέτρησης, τρισδιάστατων εφαρμογών κ.λπ.).

Κύρια Εθνικά Σημεία

- **Βέλγιο:** Έμφαση στη σταδιακή ψηφιακή ενσωμάτωση και στην επαγγελματικοποίηση των ρόλων αποδόμησης.
- **Γερμανία:** BIM: Ισχυρή δυναμική ψηφιοποίησης με ενδιαφέρον για πρώιμη επαγγελματική κατάρτιση για BIM.
- **Ελλάδα:** Έμφαση στα κίνητρα και την προσαρμοσμένη εκπαίδευση στην αποδόμηση.
- **Ιταλία:** Υποστηρίζει ενιαία πρότυπα και υποστήριξη πολιτικής για την αποδόμηση με τη χρήση BIM.
- **Σλοβενία**: Επισημαίνει τους στόχους της κυκλικής οικονομίας και τη διαχείριση επικίνδυνων υλικών μέσω του BIM.

Συμπεράσματα και συστάσεις για την ανάπτυξη της κατάρτισης

Το BIM4D υπογραμμίζει την επείγουσα ανάγκη για προσαρμόσιμα προγράμματα κατάρτισης που θα εφοδιάζουν τους επαγγελματίες με ψηφιακές δεξιότητες προσαρμοσμένες στις εργασίες αποδόμησης. Η συνεργασία μεταξύ παροχών επαγγελματικής κατάρτισης και εκπροσώπων του κατασκευαστικού κλάδου είναι ζωτικής σημασίας για να διασφαλιστεί ότι τα προγράμματα ευθυγραμμίζονται με τις ανάγκες του πραγματικού κόσμου, ιδίως για τις μικρομεσαίες επιχειρήσεις (ΜμΕ). Μια σταδιακή προσέγγιση της κατάρτισης, σε συνδυασμό με μελέτες περιπτώσεων, μπορεί να γεφυρώσει τα κενά δεξιοτήτων και να προωθήσει τον ψηφιακό μετασχηματισμό. Ευθυγραμμίζοντας την κατάρτιση του BIM με τους στόχους βιωσιμότητας της ΕΕ, η πρωτοβουλία αυτή υποστηρίζει τη μετάβαση προς μια κυκλική οικονομία, ενδυναμώνοντας το εργατικό δυναμικό για να προωθήσει την καινοτομία στις βιώσιμες κατασκευαστικές πρακτικές.

Για να αντιμετωπιστούν τα κενά δεξιοτήτων και να ενισχυθεί η ενσωμάτωση του BIM στις πρακτικές αποδόμησης, οι ακόλουθες **συστάσεις με επίκεντρο την κατάρτιση** προκύπτουν από τις δραστηριότητες του Πακέτου Εργασίας 2:

1. **Ανάπτυξη εκπαιδευτικών προγραμμάτων για συγκεκριμένους ρόλους**: Προσαρμογή εκπαιδευτικές ενότητες για διαφορετικούς ρόλους όπως εργοδηγοί, τεχνικοί, εργαζόμενοι στην κατασκευή και την αποδόμηση και διαχειριστές εγκαταστάσεων, εστιάζοντας στις αντίστοιχες αρμοδιότητές τους στην αποδόμηση με χρήση BIM
2. **Δημιουργία ευέλικτων εκπαιδευτικών προγραμμάτων:** Παροχή εκπαιδευτικών προγραμμάτων για αρχάριους, μέσους και προχωρημένους, επιτρέποντας στους συμμετέχοντες να εξελίσσονται με το δικό τους ρυθμό και εξασφαλίζοντας προσβασιμότητα τόσο για τις ΜΜΕ όσο και για τις μεγάλες επιχειρήσεις

3. **Καθορισμός βασικών θεμάτων κατάρτισης**: Ψηφιακά εργαλεία για την παρακολούθηση υλικών και τεχνικές αποδόμησης

4. **Ενσωμάτωση πρακτικής μάθησης**: Συμπερίληψη πρακτικών ασκήσεων, μελετών περίπτωσης από τον πραγματικό κόσμο και πιλοτικά έργα για την ανάδειξη των πρακτικών οφελών του BIM στη βιώσιμη αποδόμηση

5. **Προσαρμογή της κατάρτισης στα τοπικά πλαίσια**: Προσαρμογή του περιεχόμενου της κατάρτισης ώστε να ευθυγραμμιστεί με τους τοπικούς κανονισμούς, τα επίπεδα ψηφιακής ωριμότητας και τους στόχους βιωσιμότητας, εξασφαλίζοντας συνάφεια και συμμόρφωση.

Sintesi

Il Building Information Modeling (BIM) sta rivoluzionando il settore delle costruzioni come metodologia di lavoro collaborativo che integra strumenti digitali per gestire e condividere informazioni durante l'intero ciclo di vita del progetto. Promuovendo il lavoro di squadra, migliorando l'efficienza e supportando pratiche sostenibili, il BIM consente alle parti interessate di ottimizzare i processi di progettazione, costruzione e manutenzione.

Il lavoro del consorzio BIM4D nell'ambito del Work Package 2, è consistito nell'esaminare l'integrazione del BIM in cinque paesi europei (Belgio, Germania, Grecia, Italia e Slovenia) con un focus sulla sua applicazione nella decostruzione. Ciò ha incluso affrontare le esigenze di competenze, le lacune politiche e il ruolo del BIM nel promuovere pratiche sostenibili come lo smantellamento selettivo e il riutilizzo dei materiali.

Risultati chiave inclusi

1. **Lacune di integrazione:** quando utilizzato, il BIM è ampiamente applicato nell'edilizia ma sottoutilizzato nella decostruzione, evidenziando la necessità di una formazione specializzata per colmare questa lacuna.
2. **Carenza di competenze:** esiste una carenza diffusa di professionisti qualificati sia nel BIM che nella decostruzione sostenibile, il che evidenzia la necessità di una formazione mirata.
3. **Allineamento all'economia circolare:** il potenziale del BIM per ottimizzare il recupero dei materiali supporta gli obiettivi di sostenibilità dell'UE, ma richiede quadri politici e pratici solidi.
4. **Esigenze localizzate:** le diverse normative nazionali e i diversi livelli di maturità digitale richiedono approcci formativi adattabili e su misura per il contesto di ciascun Paese.

Risultati chiave della ricerca e della valutazione dei bisogni

- **Sondaggi:** tra 224 intervistati, l'elevata consapevolezza del BIM contrasta con la limitata applicazione pratica nella decostruzione. La formazione sui flussi di lavoro digitali, lo smantellamento selettivo e il monitoraggio dei materiali è una priorità.
- **Workshop:** le discussioni tra 163 partecipanti hanno sottolineato la collaborazione tra le parti interessate, gli incentivi governativi e la necessità di una formazione specifica per ruolo per superare sfide come i vecchi dati di costruzione e i materiali pericolosi. Prima di adottare il BIM, sembra essenziale migliorare le competenze digitali all'interno delle aziende (uso di software di gestione, dispositivi di misurazione, applicazioni 3D, ecc.).

Eventi nazionali salienti

- **Belgio:** concentrarsi sulla graduale integrazione digitale e sulla professionalizzazione dei ruoli di decostruzione.
- **Germania:** forte impulso alla digitalizzazione con interesse per la formazione professionale precoce per il BIM.
- **Grecia:** enfasi sugli incentivi e sulla formazione personalizzata alla decostruzione.
- **Italia:** sostiene standard unificati e politiche di supporto per la decostruzione basata sul BIM.
- **Slovenia:** evidenzia gli obiettivi dell'economia circolare e la gestione dei materiali pericolosi attraverso il BIM.

Conclusioni e raccomandazioni per lo sviluppo della formazione

BIM4D sottolinea l'urgente necessità di programmi di formazione modulari e adattabili che forniscano ai professionisti competenze digitali su misura per le attività di decostruzione. La collaborazione tra i fornitori di formazione professionale e i rappresentanti del settore edile è fondamentale per garantire che i programmi siano in linea con le esigenze del mondo reale, in particolare per le PMI. Un approccio graduale alla formazione, combinato con casi di studio dimostrativi, può colmare le lacune di competenze e promuovere la trasformazione digitale. Allineando la formazione BIM agli obiettivi di sostenibilità dell'UE, questa iniziativa supporta la transizione verso un'economia circolare, consentendo alla forza lavoro di guidare l'innovazione nelle pratiche edilizie sostenibili.

Per colmare le lacune di competenze e migliorare l'integrazione del BIM nelle pratiche di decostruzione, le seguenti **raccomandazioni incentrate sulla formazione** sono tratte dalle attività del WP2:

1. **Sviluppare programmi di formazione specifici per ruolo** : personalizzare i moduli di formazione per diversi ruoli quali capisquadra, tecnici, operai addetti alla costruzione e alla decostruzione e facility manager, concentrandosi sulle rispettive responsabilità nella decostruzione abilitata dal BIM.
2. **Offrire percorsi di apprendimento modulari e flessibili** : fornire percorsi di formazione per principianti, intermedi e avanzati, consentendo ai partecipanti di progredire al proprio ritmo e garantendo l'accessibilità sia alle PMI che alle grandi imprese.
3. **Definire gli argomenti chiave della formazione** : concentrarsi su argomenti essenziali quali i fondamenti del BIM, i principi dell'economia circolare, gli strumenti digitali per il monitoraggio dei materiali e le tecniche di decostruzione.
4. **Incorporare l'apprendimento pratico** : includere esercizi pratici, casi di studio reali e progetti pilota per dimostrare i vantaggi pratici del BIM nella decostruzione sostenibile.

5. **Adattare la formazione ai contesti locali** : personalizzare i contenuti della formazione per allinearli alle normative locali, ai livelli di maturità digitale e agli obiettivi di sostenibilità, garantendo pertinenza e conformità.

Povzetek

Building Information Modeling (BIM) revolucionira gradbeni sektor kot metodologija sodelovalnega dela, ki vključuje digitalna orodja za upravljanje in izmenjavo informacij v celotnem življenjskem ciklu projekta. S spodbujanjem timskega dela, izboljšanjem učinkovitosti in podpiranjem trajnostnih praks BIM omogoča deležnikom optimizacijo procesov načrtovanja, gradnje in vzdrževanja.

V okviru delovnega paketa WP2 je projektni konzorcij preučil integracijo BIM v petih evropskih državah – Belgiji, Nemčiji, Grčiji, Italiji in Sloveniji – s poudarkom na njeni uporabi pri dekonstrukciji. To vključuje obravnavanje potreb po znanjih in spretnostih, vrzeli v politiki in vlogo BIM pri spodbujanju trajnostnih praks, kot sta selektivna demontaža in ponovna uporaba materialov.

Ključne ugotovitve vključujejo:

1. **Integracijske vrzeli:** Uporaba BIM v gradbeništvu je vse bolj razširjena, ne pa tudi v fazi dekonstrukcije, kar poudarja potrebo po specializiranem usposabljanju za odpravo te vrzeli.
2. **Pomanjkanje spretnosti:** Obstaja izrazito pomanjkanje strokovnjakov, usposobljenih za BIM in obenem za trajnostno razgradnjo, kar poudarja povpraševanje po ciljno usmerjenem usposabljanju.
3. **Uskladitev s krožnim gospodarstvom:** Potencial BIM za optimizacijo materialne predelave podpira trajnostne cilje EU, vendar zahteva trdne, definirane okvire politike in prakse.
4. **Lokalizirane potrebe:** Različni nacionalni predpisi in stopnje digitalne zrelosti zahtevajo prilagodljive pristope k usposabljanju, primerne kontekstu vsake države.

Ključni rezultati raziskav in ocenjevanja potreb

- **Raziskave:** Med 224 anketiranci je, v nasprotju z omejeno praktično uporabo pri dekonstrukciji, prisotna visoka ozaveščenost o BIM. Usposabljanje za digitalne delovne tokove, selektivno razstavljanje in sledenje materialu je prednostna naloga.
- **Delavnice:** Razprave med 163 udeleženci so poudarile sodelovanje med deležniki, pomen vladnih spodbud in potrebo po usposabljanju za posamezne vloge za premagovanje izzivov, kot so podatki, vezani na starejše stavbe in nevarne materiale. Pred uvedbo BIM se zdi nujno izboljšati digitalne spretnosti v podjetjih (uporaba programske opreme za upravljanje, uporaba merilnih naprav, 3D aplikacij itd.).

Nacionalni povdarki

- **Belgija:** Osredotočenost na postopno digitalno integracijo in profesionalizacijo vlog pri razgradnji.
- **Nemčija:** Močan zagon digitalizacije z zanimanjem za zgodnje poklicno usposabljanje za BIM.
- **Grčija:** Poudarek na spodbudah in prilagojenem usposabljanju za dekonstrukcijo.
- **Italija:** Zagovarja enotne standarde in politično podporo za dekonstrukcijo, ki jo omogoča BIM.
- **Slovenia:** Poudarja cilje krožnega gospodarstva in uporabo BIM za ravnanje z nevarnimi materiali.

Sklepi in priporočila za razvoj usposabljanja

BIM4D poudarja nujno potrebo po modularnih, prilagodljivih programih usposabljanja, ki naj strokovnjake opremijo z digitalnimi veščinami, prilagojenimi nalogam dekonstrukcije. Sodelovanje med ponudniki poklicnega usposabljanja in predstavniki gradbene industrije je ključnega pomena za zagotovitev usklajenosti programov z resničnimi potrebami, zlasti za MSP. Postopni pristop k usposabljanju v kombinaciji s predstavitvenimi študijami primerov lahko premosti vrzeli v znanju in spretnostih ter spodbudi digitalno preobrazbo. Z uskladitvijo usposabljanja BIM s trajnostnimi cilji EU ta pobuda podpira prehod na krožno gospodarstvo in opolnomoča delovno silo, da spodbuja inovacije v trajnostnih gradbenih praksah.

Za odpravo vrzeli v znanju in izboljšanju vključevanja BIM v prakse dekonstrukcije so iz dejavnosti delovnega paketa WP2 pridobljena **naslednja priporočila, osredotočena na usposabljanje**:

1. **Razvijte programe usposabljanja, specifične za vloge:** Prilagodite module usposabljanja za različne vloge, kot so delovodje, tehniki, gradbeni in dekonstrukcijski delavci ter upravljavci objektov, s poudarkom na njihovih odgovornostih pri dekonstrukciji, ki jo omogoča BIM.
2. **Ponudite modularne in prilagodljive učne poti:** Zagotovite začetne, srednje in napredne poti usposabljanja, ki udeležencem omogočajo napredovanje v lastnem tempu in zagotavljajo dostopnost tako za MSP kot za velika podjetja.
3. **Opredelite ključne teme usposabljanja:** Osredotočite se na bistvene teme, kot so osnove BIM, načela krožnega gospodarstva, digitalna orodja za sledenje materialom in tehnike dekonstrukcije.
4. **Vključite praktično učenje:** Vključite praktične vaje, študije primerov iz resničnega sveta in pilotne projekte, da pokažete praktične prednosti BIM pri trajnostni dekonstrukciji.
5. **Prilagodite usposabljanje lokalnemu kontekstu:** Prilagodite vsebino usposabljanja lokalnim predpisom, stopnjam digitalne zrelosti in trajnostnim ciljem, s čimer zagotovite ustreznost in skladnost.

Introduction

Building Information Modelling (BIM) is an innovative and transformative technology in the construction industry, offering a 3D digital representation of the physical and functional characteristics of buildings and infrastructure. BIM facilitates improved collaboration, efficiency, and sustainability throughout the lifecycle of a project, from design and construction to operation and maintenance.

Europe has been at the forefront of BIM adoption, with varying degrees of implementation and maturity across countries. The Directive 2014/24/EU on public procurement, adopted by the European Union in 2014, plays a pivotal role in promoting the use of BIM across Europe. This directive encourages member states to consider digital tools, such as BIM, for public works contracts. The aim is to enhance efficiency, transparency, and innovation in public procurement processes.

A.2.1 has provided detailed research to conform a report on the status of BIM uses providing an overview of the status of BIM in Belgium, Germany, Greece, Italy, and Slovenia, the countries that are represented in the BIM4D consortium. The second part of the research has been devoted to the use of BIM for deconstruction considering various elements: theoretical perspectives, benefits, current skills needs, challenges, relating policies and links with sustainable waste management.

A.2.2 - Needs assessment on current skills needs of the use of BIM at EOL practices has been implemented via a survey to understand the skills required for effectively using Building Information Modeling (BIM) in the deconstruction phase of construction projects and detect skills needs to design the training within the BIM4D project.

A.2.3 - Exchange between construction/deconstruction workers and education professionals on the BIM use at EOL practices: Strengths and challenges has been implemented via workshops designed to foster exchange between construction, deconstruction workers, and education professionals regarding the use of Building Information Modeling (BIM) in End of Life (EOL) practices.

A.2.4 - Final Analysis on the BIM uses at EOL practices builds on the findings from earlier WP2 research and needs assessment activities. These insights serve as the foundation for developing the innovative BIM4D training program, designed to enhance digital and green skills for applying BIM in deconstruction processes. On the digital front, the emphasis is on more effective use and mastery of a broader range of digital applications. On the ecological side, the focus shifts to raising awareness of raw material scarcity and driving our society toward a circular economy.

Findings from WP2 activities

A2.1 Report

The BIM4D A2.1 report identified key shared needs across Belgium, Germany, Greece, Italy, and Slovenia, including:

1. **Integration of BIM and Deconstruction**: All countries highlight a lack of practical integration of BIM into deconstruction processes, suggesting the need for specialized training programs that bridge this gap.

2. **Skill Development**: A widespread shortage of skilled professionals proficient in both BIM and sustainable deconstruction techniques is a common challenge.

3. **Circular Economy and Sustainability**: There is a strong focus on reducing waste through deconstruction, which BIM can optimize, calling for training in sustainable practices.

4. **Adaptability to Local Contexts**: Varying national standards and regulations make it clear that an adaptable BIM training approach is necessary to ensure compliance across different countries and regions. More detailed insights on the specific BIM skills and needs for each country can be found in the BIM4D A2.1 report (link).

A2.2 Surveys

BIM4D surveys in numbers

Country	Number of responses collected
Belgium	50
Germany	23
Greece	51
Italy	51
Slovenia	49
TOTAL	**224**

Common findings

1. **Awareness vs. Implementation Gaps**

In all countries, BIM's potential is widely recognized, yet its actual application, even in construction, remains limited. When implemented, BIM is predominantly focused on design and construction, with significantly less use in demolition or renovation stages, highlighting a gap between awareness and practical usage. While the potential of digital twins for deconstruction and material recovery simulation is acknowledged, their real-world application remains uncommon, especially among smaller companies.

2. **Interest in Developing Internal Digital Processes**

Across all countries, there is a notable interest in enhancing internal processes through BIM and digitization, with many organizations recognizing the benefits of transitioning to digital workflows.

3. **Demand for Upskilling and Training**

In all countries, there is a strong call for targeted training in digital tools, BIM and EOL processes (such as selective dismantling, recycling, and material reuse). Training is widely seen as essential

for fostering a skilled workforce capable of utilizing BIM and digital tools effectively across the building lifecycle.

4. **Importance of Detailed Component Data**

Respondents in all countries emphasized the need for accurate and detailed digital data on building components, which is critical for sustainable practices in deconstruction and material recovery (efficient dismantling, tracking, and reuse of materials).

5. **Challenges with Older Buildings**

Access to information on older buildings is a recurrent challenge, as they were not designed with BIM. The lack of digital data for these structures complicates planning for deconstruction, inventory management, and recycling efforts.

National specificities

Belgium

- **Digital Maturity Gaps**: Significant digital gaps exist, particularly among small and medium-sized enterprises (SMEs), which are less engaged with BIM compared to larger firms.
- **Workforce and Training Constraints**: Labor shortages and urgent demands for energy-efficient renovations limit the sector's ability to focus on BIM and deconstruction training.
- **Role-Specific Training Needs**: Training must be tailored to various roles within organizations to ensure relevant staff can access digital data (BIM and others) and use it collaboratively.

Germany

- **Steady Progress in Digitalization**: Germany's construction industry shows good momentum in BIM adoption for site management, though it's still rare in demolition and renovation.
- **Simulation for Dismantling**: BIM simulations for optimized material recovery are seen as important for sustainable demolition practices.

Greece

- **Emphasis on Deconstruction Training**: Greece highlights a unique demand for training focused on deconstruction, recyclability, and waste reduction using BIM.
- **As-Built Scope Management**: Interest in training also includes "as-built" scope management, which underscores a focus on defining roles and responsibilities in BIM-enabled deconstruction.

Italy

- **BIM Leadership by Architects and Engineers**: Architects and engineers lead BIM adoption, with a need to expand its use among contractors and facility managers for broader impact.
- **Implementation Challenges with Standards**: While there is high awareness of international standards (ISO 19650), actual application in deconstruction remains limited, requiring better standardization.
- **Need for Policy Support**: Italy faces a need for clearer policies and standardized processes to facilitate BIM's role in sustainable demolition.

Slovenia

- **Circular Economy Focus**: Slovenia emphasizes BIM's role in advancing the circular economy, with a call for detailed material databases and recycling data. In the optics of the importance of digital traceability during the decommissioning of buildings, the financial burden has also been exposed: the costs of analyzing construction waste to determine its fitness for reuse in construction.
- **Asbestos Management in BIM**: Due to older building stocks, asbestos management is prioritized, suggesting BIM integration of hazardous material data to comply with EU regulations.
- **Incentives for Public Projects and SMEs**: Recommendations include government incentives for BIM adoption, especially for projects involving asbestos and by SMEs, to ensure safety and regulatory compliance.

A2.3 Workshops

BIM4D workshops in numbers

Country	Number of workshops	Number of participants
Belgium	1	37
Germany	1	14
Greece	1	20
Italy	2	43 (26 + 17)
Slovenia	2	49 (9 + 40)
TOTAL	**7**	**163**

Common findings

1. **Training and Education**: A recurring theme across all countries is the need for comprehensive training in BIM, especially in relation to its application in the deconstruction phase. Workshop participants in Belgium, Germany, and Slovenia emphasize the necessity of specific training for all roles involved in construction and deconstruction, ensuring that both new graduates and experienced professionals are well-equipped to effectively use digital project data.

2. **Integration of BIM in Deconstruction**: While BIM is widely used in construction, its adoption in the deconstruction phase remains rare across all countries. There is a strong call for further exploration and development of BIM's role in deconstruction, particularly for material recovery and reuse.

3. **Collaboration and Stakeholder Engagement**: Collaboration between industry stakeholders, including contractors, architects, facility managers, and policymakers, is critical. Countries such as Belgium, Germany, and Slovenia highlight the need for a collaborative approach to foster digital transformation and sustainable practices.

4. **Policy and Government Support**: Governments are encouraged to provide incentives, clear regulations, and financial support to encourage the adoption of BIM, particularly for deconstruction projects. This is emphasized in Slovenia and Greece, where there is a clear need for stronger legislative frameworks and incentives to promote BIM integration.

5. **Technological and Digital Maturity**: There is a shared recognition that advancing digital maturity is essential for the construction industry's transition to more sustainable practices. This includes the integration of BIM with AI, GIS, and other technologies to enhance the deconstruction process, material sorting, and recycling.

6. **Role of Demonstrative Case Studies and Pilot Projects**: Workshops participants underscored the importance of showcasing successful BIM integration through real-life case studies. These case studies help validate processes, engage stakeholders, and demonstrate the practical benefits of using BIM in deconstruction projects.

National specificities

Belgium

- **Deconstruction Thinking from the Outset**: Belgian workshop participants stressed the importance of embedding deconstruction considerations at every stage of the project lifecycle. For new buildings, this means planning for dismantling from the beginning, while for renovations, it focuses on maximizing resource reuse by salvaging materials.
- **Role Creation and Professionalization**: Belgian workshop participants emphasized the creation of new professions in the field of sustainable deconstruction. This translates into the development of new skills, such as inventorying materials to be recovered from a building, dismantling properly, and managing stocks of disassembled materials to be redistributed to new users.
- **Gradual Digital Integration**: Belgian workshop participants advocated for a gradual, step-by-step approach to digital integration, ensuring that both large and small companies, as well as workers, feel supported during the transition.

Germany

- **Focus on Facility Managers**: German workshop participants highlighted the importance of training facility managers to use BIM throughout the building lifecycle, ensuring that data is continually updated.

- **Focus on Early Training**: German workshop participants advocated for incorportating BIM fundamentals into vocational training early on, especially in the first year of apprenticeships.

Greece

- **Slow BIM Adoption and Technical Integration Challenges**: Greece faces challenges related to the slow adoption of BIM and the technical difficulties in integrating it with existing systems. There is a need for tailored training programs that align with the latest European BIM standards and specific deconstruction needs.
- **Incentives for BIM Adoption**: Greece suggests creating incentives to encourage companies to adopt BIM and recommends modules tailored to different roles in the construction process, particularly focusing on deconstruction, renovation, and material reuse.

Italy

- **High Interest in BIM for Deconstruction**: While BIM is widely used in the construction phase, there is increasing interest in its application to the deconstruction phase. Italian workshops participants highlighted the need for specific training focused on the end-of-life use of materials and the integration of BIM into the deconstruction phase.
- **Clear Rules and Unified Standards**: Italian workshops participants called for the development of clear, unified rules and standards for BIM use in deconstruction to facilitate its wider application and ensure consistency across all involved stakeholders.

Slovenia

- **Emphasis on Sustainable Planning and Recycling**: Slovenian workshop participants placed a strong emphasis on integrating advanced technologies like AI and machine learning to optimize deconstruction processes and improve material recovery.
- **Hazardous Materials Management**: A significant concern shared by Slovenian workshop participants is the integration of hazardous materials (e.g., asbestos, lead, PCBs) into BIM models for safe deconstruction and compliance with regulations.
- **Legislative Support and Case Studies**: Slovenian workshop participants stressed the need for government support through financial incentives and clearer regulations. It also advocates for validating BIM models through smaller deconstruction projects to build best practices.

Conclusion

BIM4D WP2 findings emphasize a clear need for targeted vocational training to support BIM and digital tools integration in deconstruction processes. Belgium, Germany, Greece, Italy, and Slovenia all face common challenges in applying BIM during end-of-life building phases, particularly for selective demolition, resource recovery, and sustainable material reuse. To bridge these gaps, vocational training providers, in collaboration with sectoral representatives, could lead the way in developing targeted programs that focus on BIM's unique requirements in sustainable deconstruction, aligning with EU circular economy goals.

A key priority for vocational providers is to create modular, role-specific courses that address both foundational digital skills and advanced deconstruction techniques, enabling professionals—such as architects, contractors, and facility managers—to effectively integrate digitisation across all stages of the building lifecycle. Collaboration with construction sectoral representatives would add value by helping to identify specific skill gaps within different roles and ensuring that training aligns with actual industry needs. Sectoral input would be invaluable for tailoring programs that are both relevant and immediately applicable across varying company sizes and project types.

Given the diverse levels of digital readiness within the construction industry, a staged, adaptable approach to BIM training is essential. Training providers could develop beginner to advanced tracks, offering flexibility for both SMEs and larger firms to progress at their own pace. Sectoral representatives could further support this by promoting digital competency benchmarks across the industry, fostering a culture of digital transformation that encourages companies at all levels to embrace BIM adoption. This would be particularly beneficial in countries where smaller companies often face barriers to digitalization.

Hands-on skills in BIM application are also crucial for practical deconstruction tasks. Training providers should incorporate modules on digital twins, component data management, and material tracking, which are critical for effective planning, deconstruction, and material recovery. Sectoral representatives could facilitate this by advocating for demonstrative case studies and pilot projects that showcase BIM's benefits in real-world deconstruction scenarios, thereby encouraging industry-wide engagement and validating BIM practices for sustainable building.

In summary, vocational training providers and construction sectoral representatives, have a pivotal role in advancing BIM proficiency for sustainable deconstruction across Europe. By developing adaptable, role-specific training that emphasizes practical applications and aligns with industry standards, they can equip the workforce with the skills needed to support a sustainable, circular future.

Recommendations for the Development of Training

To address skill gaps and enhance BIM integration in deconstruction practices, the following training-focused recommendations are drawn from the WP2 activities:

6. **Develop Role-Specific Training Programs**: Tailor training modules for different roles such as foremen, technicians, construction and deconstruction workers and facility managers, focusing on their respective responsibilities in BIM-enabled deconstruction.
7. **Offer Modular and Flexible Learning Tracks**: Provide beginner, intermediate, and advanced training tracks, allowing participants to progress at their own pace and ensuring accessibility for both SMEs and large enterprises.
8. **Define Key Training Topics**: Focus on essential subjects such as BIM fundamentals, Circular economy principles, Digital tools for material tracking, and Deconstruction techniques.
9. **Incorporate Practical Learning**: Include hands-on exercises, real-world case studies, and pilot projects to demonstrate the practical benefits of BIM in sustainable deconstruction.
10. **Adapt Training to Local Contexts**: Customize training content to align with local regulations, digital maturity levels, and sustainability goals, ensuring relevance and compliance.