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Road testing organizational life cycle assessment around the world

Applications, experiences and lessons learned

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Contents

Executive summary

Organizational life cycle assessment (O-LCA) compiles and evaluates the inputs, outputs and potential environmental impacts of the activities associated with the organization, following a life cycle perspective. The "*Guidance on Organizational Life Cycle Assessment*", (or, O-LCA Guidance) published in 2015 by the Life Cycle Initiative, showed that the application of life cycle assessment at the organization level is relevant, meaningful and already possible. This seminal publication highlighted the potential of the approach and supported practitioners facing methodological challenges when using O-LCA.

After the successful launch of the O-LCA Guidance (with more than 10,000 downloads to date), the O-LCA flagship project embarked on an ambitious piloting process. O-LCA was applied by 12 organizations from around the world – the so-called O-LCA road testers – exhibiting a broad range of characteristics in terms of geographical region (Europe, Asia, Latin America and the Caribbean, and North America); sector (e.g., construction materials, automobile, cosmetics, chemicals, food, agricultural machinery, education, waste management, public sector and NGOs); size (from 4 to 280,000 employees); and prior experience with environmental tools (e.g., having already applied product LCA, corporate GHG accounting, EMS, etc.).

The following 12 organizations agreed to road test the new O-LCA methodology: 1) AKG Gazbeton, 2) Azbil Corporation, 3) Banco de México, 4) Daimler, 5) Demarchi industrial complex-BASF, 6) Faculty of Science and Technology-UPH, 7) Foundation Emmaüs, 8) Junk That Funk, 9) Maschio Gaspardo, 10) Natura Cosméticos, 11) Thanakorn Vegetable Oil Products, and 12) Tuzla Belediyesi. The purpose of the O-LCA road testing was manifold: to check and demonstrate its usefulness and applicability, to identify any remaining gaps and challenges, and last, to make available case studies on O-LCA implementation.

This publication complements the O-LCA Guidance in that it offers more in-depth insights into O-LCA application, developed from the outcomes of the road testing. It begins with a summary of the main features of O-LCA to set the context for the road testing. The subsequent sections present, first, the executive summaries of the O-LCA road testers' case studies, highlighting their intended applications, chosen methodological solutions, high-level results and challenges experienced; and second the results of a comprehensive survey through which the road testers share their experience, feedback and lessons learned. Drawing from previous sections, cross-cutting outcomes of the road-testing process are also presented.

Key road-testing takeaways

The road testing demonstrated the potential and relevance of the methodology: as noted in many of the case studies, applying the methodology also identified indirect impacts from value chain activities that, for many environmental aspects, played a significant, if not dominant, role. Further, it showed that applying a life cycle approach extends and complements organizations' often predominant and narrow focus on their direct emissions by including a significant share of the environmental burden. The road-testing process also confirmed that the method is applicable to companies of all sizes (i.e., SMEs to multinationals), sectors, and to different public bodies (e.g., municipalities, central banks).

A final positive outcome: all of the road testers have stated that they would recommend other organizations to perform O-LCA by using the O-LCA Guidance. Since one quarter of the road testers had no previous experience with either LCA or any other environmental management tool, this is a strong indication of the potential of O-LCA to be a catalyst or motivation to start environmental assessments.

The positive outcomes of the road testing have shown that no immediate updates to the O-LCA Guidance are needed, but some priority actions were identified in order to further ease the application of O-LCA, such as more explanations and examples on the categorization of the activities into direct, indirect upstream and indirect downstream; and more practical advice on how to handle and interpret the large amount of results that are usually derived from an O-LCA study.

Finally, the O-LCA case studies in this publication represent an important contribution to the existing body of examples and guidelines, which the authors hope will promote and inspire further application of O-LCA, more use of the O-LCA Guidance, and on-going enhancement of the O-LCA methodology.

Résumé executif

L'Analyse du Cycle de Vie Organisationnelle (ACV-O) compile et évalue les entrées, les sorties et les impacts environnementaux potentiels des activités associées à une organisation, en suivant une perspective de cycle de vie. L'Orientation sur l'Analyse du Cycle de Vie Organisationnelle (ou Orientation ACV-O) publiée en 2015 par UNEP/SETAC Life Cycle Initiative a montré que l'application de cette analyse du cycle de vie à un niveau organisationnel est bien pertinente, significative et déjà possible. Cette publication fondatrice a mis l'accent sur le potentiel de cette démarche et soutient les utilisateurs qui font face à des défis méthodologiques lorsqu'ils utilisent l'ACV-O.

Après le lancement réussi de l'Orientation ACV-O (avec plus de 10 000 téléchargements à ce jour), le projet phare ACV-O s'embarque dans un processus d'expérimentation ambitieux. L'ACV-O a été appliquée par 12 organisations du monde entier – appelés les testeurs d'ACV-O – exposant un large éventail de caractéristiques en terme de région géographique (l'Europe, l'Asie, l'Amérique latine, les Caraïbes, et l'Amérique du nord), de secteur (i.e. les matériaux de construction, le secteur automobile, les cosmétiques, les produits chimiques, l'agro-alimentaire, l'éducation, la gestion des déchets, les secteurs publiques et les ONG), de taille (de 4 à 280 000 employés), d'expérience antérieure avec les outils environnementaux (i.e. ayant déjà appliqué une analyse du cycle de vie d'un produit, comptabilisation des GES des sociétés, SME, etc.)

Les 12 organisations suivantes ont donné leur accord pour tester la nouvelle méthodologie ACV-O: 1) AKG Gazbeton, 2) Azbil Corporation, 3) Banco de México, 4) Daimler, 5) Demarchi industrial complex-BASF, 6) Faculty of Science and Technology-UPH, 7) Foundation Emmaüs, 8) Junk That Funk, 9) Maschio Gaspardo, 10) Natura Cosméticos, 11) Thanakorn Vegetable Oil Products, and 12) Tuzla Belediyesi. Les objectifs des essais ACV-O était multiples: vérifier et démontrer son utilité et son applicabilité, identifier les différences restantes et les challenges, et enfin implémenter les études de cas.

Cette publication complète l'Orientation ACV-O car elle fournit des réflexions plus poussées quant à l'application de l'ACV-O, développées grâce aux résultats des tests. Elle commence par un sommaire des principaux aspects de l'ACV-O afin de situer le contexte des essais. Les sections suivantes présentent dans un premier temps les résumés exécutifs des études de cas des testeurs d'ACV-O, en soulignant les applications envisagées, les méthodes choisies, les résultats à grande échelle et les défis rencontrés; dans un second temps, les résultats d'une enquête complète à travers laquelle les testeurs partagent leur expérience, leur retours et les leçons tirées. À la suite des parties précédentes, les résultats transversaux du processus de test sont aussi présentés.

Ce qu'il faut retenir des tests

Les tests ont démontré le potentiel et la pertinence de la méthodologie: comme figuré dans de nombreuses études de cas, pour de nombreux aspects environnementaux, le fait d'appliquer la méthodologie a identifié des impacts indirects à partir des activités de chaine de valeur qui ont joué un rôle très important, voire prépondérant. De plus, elle a montré qu'appliquer une démarche du cycle de vie étend et complète l'attention souvent prédominante et limitée des organisations sur leurs émissions directes en prenant en compte un partage important de la préoccupation environnementale. Le processus de ces tests a aussi confirmé que cette méthode est applicable à des entreprises de toute taille (i.e. des PME aux multinationales), de tout secteur, et s'adressant à des publics différents (par exemple les municipalités, les banques centrales).

Un résultat final positif : tous les testeurs ont établi qu'ils recommandent d'effectuer l'ACV-O à d'autres organisations en utilisant l'Orientation ACV-O. Étant donné qu'un quart des testeurs n'avait pas d'expérience antérieure avec l'ACV ni aucun autre outil de management de l'environnement, cela constitue une forte indication sur le potentiel de l'ACV-O à être un catalyseur ou une motivation pour commencer des analyses environnementales.

Le résultat positif des tests a montré que des mises à jour immédiates de l'Orientation ACV-O ne sont pas nécessaires, mais des actions à effectuer en priorité ont été identifiées dans le but de faciliter à l'avenir l'application de l'ACV-O, comme plus d'explications et d'exemples sur la catégorisation des activités directement, indirectement en amont ou indirectement en aval; et des conseils plus pratiques pour gérer et interpréter la grande quantité de résultats des études d'ACV-O.

Finalement, les études de cas de l'ACV-O de cette publication représentent une importante contribution à l'ensemble des exemples et des lignes directives existantes, dont les auteurs espèrent une promotion et une application plus poussée de l'ACV-O, plus d'utilisation de l'Orientation ACV-O, et une amélioration constante de la méthodologie ACV-O.

Resumen ejecutivo

El análisis de ciclo de vida de organizaciones (ACV-O) compila y evalúa las entradas, salidas y potenciales impactos ambientales de las actividades asociadas a la organización, y lo hace siguiendo una perspectiva de ciclo de vida. La "Guía para el análisis de ciclo de vida de organizaciones" (Guía ACV-O) publicada en 2015 por la Life Cycle Initiative, mostró que la aplicación del análisis de ciclo de vida al nivel de organización tiene sentido, es relevante, y ya es posible. Esta publicación fundamental subrayó las potencialidades del nuevo enfoque y proporcionó asistencia a los usuarios del ACV-O para enfrentar sus retos metodológicos.

Después del exitoso lanzamiento de la Guía ACV-O (con más de 10.000 descargas hasta la fecha), el proyecto insignia "ACV de organizaciones" se embarcó en una ambiciosa fase de testeo. El ACV-O fue aplicado por 12 organizaciones de todo el mundo – los llamados pilotos ACV-O – que exhiben una amplia gama de tipologías en términos de región geográfica (Europa, Asia, América Latina y el Caribe, y América del Norte); sector (por ejemplo, producción de materiales de construcción, automóviles, cosméticos, productos químicos, alimentos y maquinaria agrícola, educación, gestión de residuos, sector público y ONGs); tamaño (de 4 a 280.000 empleados); y experiencia previa con herramientas medioambientales (por ejemplo, ACV de productos, huella de carbono corporativa, sistemas de gestión ambiental, etc.).

Estas son las 12 organizaciones que accedieron a implementar la nueva metodología ACV-O: 1) AKG Gazbeton, 2) Azbil Corporation, 3) Banco de México, 4) Daimler, 5) Demarchi industrial complex-BASF, 6) Faculty of Science and Technology-UPH, 7) Foundation Emmaüs, 8) Junk That Funk, 9) Maschio Gaspardo, 10) Natura Cosméticos, 11) Thanakorn Vegetable Oil Products, y 12) Tuzla Belediyesi. El propósito del proceso de testeo fue múltiple: comprobar y demostrar la utilidad y aplicabilidad del ACV-O, identificar retos y deficiencias pendientes, y por último, proporcionar casos prácticos de aplicación de O-LCA.

Esta publicación complementa la Guía ACV-O, ya que ofrece una visión más profunda de su aplicación a partir del resultado de los pilotos. Comienza con un resumen de las principales características del ACV-O, que marcan el contexto del testeo. Las secciones posteriores presentan, por un lado, un resumen de cada uno de los pilotos, que incluye el uso previsto del estudio, las soluciones metodológicas elegidas, los principales resultados y los desafíos experimentados durante la aplicación de la metodología; y, por el otro, los principales resultados de una amplia encuesta a través de la cual los pilotos comparten su experiencia, puntos de vista y lecciones extraídas. A partir de esto, también se presentan los resultados transversales del proceso de testeo.

Aportes clave del proceso de testeo

Los pilotos demostraron el potencial y la pertinencia de la metodología. Como se observó en muchos de los casos, la metodología permite identificar también los impactos indirectos en la cadena de valor, los cuales, para un gran número de aspectos ambientales, tienen una contribución muy significativa, si no dominante. Además, mostró que la aplicación del enfoque de ciclo de vida amplía y complementa la perspectiva, a menudo predominante y limitada, de centrarse únicamente en las emisiones directas de una organización, al incluir una parte significativa de la carga ambiental. El testeo también confirmó que el método es aplicable a empresas de todos los tamaños (es decir, de PYMEs a multinacionales), a todos los sectores, y también a organismos públicos (por ejemplo, ayuntamientos o bancos centrales).

Un resultado final positivo: todos los pilotos han declarado que recomendarían a otras organizaciones que apliquen el ACV-O usando la Guía ACV-O. Dado que una cuarta parte de los pilotos no tenían ninguna experiencia previa con ACV ni con ninguna otra herramienta de gestión ambiental, esto es un indicador firme del potencial del ACV-O como catalizador o motivador para iniciar evaluaciones ambientales.

Los resultados positivos del testeo han demostrado que no se necesitan actualizaciones inmediatas de la Guía ACV-O, pero se identificaron algunas acciones prioritarias para facilitar su aplicación, como por ejemplo más indicaciones y ejemplos sobre la categorización de las actividades de una organización en directas, indirectas aguas arriba e indirectas aguas abajo; y más consejos prácticos sobre cómo manejar e interpretar la gran cantidad de resultados derivados de un estudio de ACV-O.

Por último, los casos de estudio de ACV-O en esta publicación representan una importante contribución al conjunto existente de ejemplos y guías, y los autores esperan que sirvan para promover e inspirar el uso del ACV-O, así como de la Guía ACV-O y para seguir fortaleciendo la metodología de ACV-O.

执行概要

组织机构生命周期评价方法 (Organizational life cycle assessment, O-LCA) 以全生命周期的视角对与组织相关活动的投入、产出及潜在环境影响进行评价。Life Cycle Initiative于2015年出版的“组织生命周期评估方法指南”(或称O-LCA指南)指出将生命周期评价应用于组织层面是一个重要、有意义、且可实行的方法。指南内容强调组织机构生命周期评价方法的应用潜力，并协助实行者处理实行上的困难。

继O-LCA指南成功推出后（迄今已超过一万次下载），O-LCA项目开始积极推行试点工作。来自世界各地的12个组织参与O-LCA试点工作，涵盖了广泛的地域（欧洲、亚洲、拉丁美洲和加勒比以及北美地区）、产业部门（例如建筑材料、汽车、化妆品、化学品、食品、农业机械、教育、废物管理、公立部门和非政府组织）、组织规模（从4名至28万名雇员）及环境影响评价工具使用经验（例如已应用产品生命周期评价、企业温室气体排放核算、环境管理体系等等）。

以下为参与O-LCA试点工作的12个组织：1) AKG Gazbeton、2) Azbil Corporation、3) Banco de México、4) Daimler、5) Demarchi industrial complex-BASF、6) Faculty of Science and Technology-UPH、7) Foundation Emmaüs、8) Junk That Funk、9) Maschio Gaspardo、10) Natura Cosméticos、11) Thanakorn Vegetable Oil Products 与 12) Tuzla Belediyesi。O-LCA试点工作有多种目的，包括检查及示范O-LCA的有效性与实用性、确定评价方法中的差距和挑战、完成实地案例研究。

根据试点工作案例的成果，本报告补充了O-LCA指南的内容，提供对O-LCA应用的深入了解。报告内容始于阐述O-LCA的主要特征，以设定试点工作的背景。随后章节首先总结12个试点工作案例，强调案例的预期应用、实行评价方法时所选择的解决方案、高层次观点的结果与实行上的困难。接着是针对参与试点工作组织的经验与反馈调查，并根据前述案例内容介绍试点工作案例跨领域的成果。

试点工作重要结论

试点工作案例显示了O-LCA方法的潜质与关联性：许多案例研究中指出，应用该方法能辩识价值链活动中所产生的间接环境影响，证明了该方法的重要性。此外，结果表明应用生命周期方法能广泛将环境影响纳入评价，拓展并补充了组织通常局限于测量直接排放的问题。试点工作也证实了该方法适用于各种规模的企业（从中小企业到跨国性企业），产业部门及不同的公共机构（例如市政部门与中央银行）。

另一正面成果：所有参与试点工作的组织都表示会建议其他组织使用O-LCA指南来执行组织机构生命周期评价方法。由于参与试点工作的组织中有四分之一没有使用产品生命周期评价或其他环境管理工具的经验，这也说明O-LCA有潜力成为企业开始实行环境评价的催化剂或动机。

试点工作的正面成果表示O-LCA指南不需要立即更新，但确定了一些优先措施从而进一步优化O-LCA的可操作性，例如提供更多解释和举例用于说明价值链中直接与间接上游组织、间接下游组织的活动分类； 并针对在O-LCA案例中，建议如何处理和解释案例中所得到的大量结果。

最后，本报告中的O-LCA案例研究对现有的示例与指南具有重要的贡献。作者希望案例研究成果能够促进和激励更多O-LCA的应用和使用O-LCA指南使用，并持续优化O-LCA方法。

Основные положения

Оценка жизненного цикла организаций (О-ОЖЦ) позволяет собирать данные и оценивать исходные параметры, результаты и потенциальные воздействия на окружающую среду, используя методику Оценки Жизненного Цикла. Руководящий документ „*Guidance on Organizational Life Cycle Assessment*“ (Руководство по применению Оценки жизненного цикла организаций, Руководство по О-ОЖЦ), изданное в 2015 году Life Cycle Initiative, продемонстрировало, что применение методики Оценки Жизненного Цикла на уровне организаций конструктивно и в настоящее время уже возможно. Данная публикация подчеркнула потенциал методики и оказала поддержку специалистам, столкнувшимся с трудностями при ее использовании.

После успешного старта Руководства по О-ОЖЦ (более 10.000 экземпляров скачано по сегодняшний день) был запущен масштабный пилотный процесс флагманского проекта „LCA of Organizations“ (Оценка жизненнго цикла организаций). Применение О-ОЖЦ было продемонстрировано на 12 предприятиях со всего мира – так называемых «О-ОЖЦ первопроходцах» –, охватывающих широкий спектр показателей в плане географического положения (Европа, Азия, Латинская Америка и Карибский регион, Северная Америка); промышленных секторов (строительство, автомобилестроение, производство косметики, химическая и пищевая промышленность, производство сельскохозяйственной техники, образование, утилизация отходов, государственный сектор, неправительственные организации); размера организаций (от 4 до 280.00 сотрудников); а также наличия опыта в работе с инструментами по контролю за воздействием на окружающую среду (применение методики ОЖЦ на уровне изделий, расчет выброса парниковых газов, наличие систем экологического менеджмента).

Следующие 12 организаций дали согласие протестировать методику О-ОЖЦ: 1) AKG Gazbeton, 2) Azbil Corporation, 3) Banco de México, 4) Daimler, 5) Demarchi industrial complex-BASF, 6) Faculty of Science and Technology-UPH, 7) Foundation Emmaüs, 8) Junk That Funk, 9) Maschio Gaspardo, 10) Natura Cosméticos, 11) Thanakorn Vegetable Oil Products, 12) Tuzla Belediyesi. Тестирование заключало в себе различные цели: проверка и демонстрация целесообразности и возможности внедрения метода, установление недостатков и трудностей в применении, сделать доступными конкретные примеры реализации О-ОЖЦ.

Данная публикация является дополнением к Руководству по О-ОЖЦ, предоставляя более подробную информацию про применению О-ОЖЦ на основе результатов тестирования в предприятиях. В начале документа предоставлено резюме основных функций О-ОЖЦ, положенных в основу тестирования. Дальнейшие параграфы демонстрируют резюме отчетов по теститрованию О-ОЖЦ включая особенности применения в каждом конкретном случае, выбранные методологические решения, результаты и трудности, возникшие при внедрении методики. Помимо этого, в документе продемонстрированы результаты опроса, в котором участвовавшие в тестировании компании делятся почерпнутым опытом и дают отзывы о методике. Далее предоставлено базирующееся на предыдущих параграфах описание комплексных итогов тестирования.

Ключевые моменты тестирования

Результаты тестирования продемонстрировали возможности и актуальность методики: многочисленные примеры указывают на то, что в отношении множества экологических аспектов косвенные экологические воздействия, возникающие в результате процессов в производственно-сбытовой цепочке, играют значительную, а во многих случаях доминирующую роль. Помимо этого, тестирование показало, что применение методики Оценки Жизненного Цикла расширяет и дополняет экологический фокус предприятий, часто учитывающий только непосредственные выбросы, включая в оценку значительную часть экологических воздействий за пределами организации. Также тестирование подтвердило, что метод может быть применен к компаниям различного размера (от малых и средних предприятий до международных корпораций), разным промышленым секторам и общественным структурам (муниципалитеты, центральные банки).

Заключительный положительный результат: все компании, участвовавшие в тестировании, указали на то, что они рекомендуют другим организациям осуществить О-ОЖЦ, используя Руководство по О-ОЖЦ. Учитывая то, что четверть участников тестирования не имела предыдущего опыта работы с ОЖЦ или иными инструментами экологического менеджмента, данные итоги являются существенным показателем потенциала О-ОЖЦ быть катализатором для начала оценки экологических воздействий.

Положительные результаты тестирования указали на отсутствие необходимости внесения оперативных изменений в Руководство по О-ОЖЦ. Несмотря на это была идентифицирована необходимость первоочередных действий для упрощения использования О-ОЖЦ, включая более подробные пояснения и примеры в отношении категоризации процессов на прямые, косвенные в производственно-сбытовой цепочке до и после границ органиции; необходимость практических указаний по обработке и интерпретации большого объема результатов, получаемых при проведении О-ОЖЦ.

В заключение, примеры реализации О-ОЖЦ, приведенные в данной публикации, представляют собой важный вклад в существующие руководства и, как надеются авторы, будут способствовать продолжающемуся развитию методики О-ОЖЦ.

Zusammenfassung

In der organisationsbezogenen Ökobilanz (organizational LCA, O-LCA) werden Inputs, Outputs und potenzielle Umweltauswirkungen von Aktivitäten in Zusammenhang mit einer Organisation nach dem Prinzip der Lebenswegbetrachtung zusammengetragen und ausgewertet. Der 2015 von der Life Cycle Initiative veröffentlichte „Leitfaden für organisationsbezogene Ökobilanzen" (oder O-LCA-Leitfaden) zeigt, dass die Anwendung der Ökobilanzmethode auf Organisationsebene sinnvoll und bereits möglich ist. Diese zukunftsträchtige Veröffentlichung verdeutlicht das Potenzial des Ansatzes und unterstützt Anwender dabei, die methodologischen Herausforderungen bei der Umsetzung von O-LCA anzugehen.

Nach der erfolgreichen Veröffentlichung des O-LCA-Leitfadens (mit bisher über 10.000 Downloads) initiierte das O-LCA-Flaggschiff-Projekt einen ambitionierten Pilotprozess. Zwölf Organisationen aus aller Welt – die sog. O-LCA-Road-Tester – setzten O-LCA um. Diese Road-Tester decken ein breites Spektrum an Regionen (Europa, Asien, Lateinamerika und Karibik und Nordamerika), Sektoren (Baustoff- und Fahrzeugherstellung, kosmetische Produkte, Chemikalien, Lebensmittel, landwirtschaftliche Maschinen, Bildung, Abfallmanagement, öffentlicher Sektor und Nichtregierungsorganisationen), Größen (zwischen vier und 280000 Mitarbeiter) und vorheriger Erfahrung mit Umweltbewertungsmethoden (produktbezogene Ökobilanz, unternehmensweite Treibhausgasberechnung, Umweltmanagementsysteme, etc.) ab.

Die Organisationen sind: 1) AKG Gazbeton, 2) Azbil Corporation, 3) Banco de México, 4) Daimler, 5) Demarchi industrial complex-BASF, 6) Faculty of Science and Technology-UPH, 7) Foundation Emmaüs, 8) Junk That Funk, 9) Maschio Gaspardo, 10) Natura Cosméticos, 11) Thanakorn Vegetable Oil Products, and 12) Tuzla Belediyesi. Zu den vielfältigen Zielen der Pilotphase gehörten: den Nutzen und die Anwendbarkeit der Methode aufzuzeigen und zu überprüfen, Schwächen und Herausforderungen zu identifizieren und Fallstudien für die Anwendung von O-LCA verfügbar zu machen.

Die vorliegende Publikation ergänzt den O-LCA-Leitfaden indem, ausgehend von den Erfahrungen der Pilotstudien, detaillierte Einblicke in die Anwendung von O-LCA gewährt werden. Die Veröffentlichung beginnt mit einer Zusammenfassung der wichtigsten Eigenschaften der O-LCA, um den Rahmen für den Pilotprozess zu setzen. Des Weiteren folgen die Zusammenfassungen der Fallstudien der O-LCA-Road-Tester mit Schwerpunkt auf den jeweiligen Anwendungszweck, die jeweils ausgewählten methodologischen Optionen, die Ergebnisse und die Herausforderungen. Zusätzlich werden die Ergebnisse einer umfassenden Befragung, in welcher die Road-Tester ihre Erfahrung und die gewonnenen Erkenntnisse teilten, dargestellt. Basierend auf den vorherigen Kapiteln werden anschließend Querschnittsergebnisse des Pilotprozesses präsentiert.

Wichtigste Schlussfolgerungen der Pilotphase

In der Pilotphase wurden das Potential und die Bedeutung der Methode verdeutlicht. In vielen Fallstudien wurde durch die Anwendung von O-LCA festgestellt, dass durch die Anwendung der Methode indirekte Umweltauswirkungen durch die Wertschöpfungskette identifiziert werden konnten, die für viele Umweltaspekte eine bedeutende, wenn nicht sogar dominante Rolle spielten. Weiterhin wurde deutlich, dass die oftmals vorherrschende Fokussierung von Organisationen auf ihre direkten Emissionen durch die Anwendung des Lebenszyklusansatzes signifikant erweitert und ergänzt werden kann. Der Pilotprozess bestätigte auch, dass die Methode auf Unternehmen aller Größen (von KMUs bis hin zu multinationalen Konzernen), Sektoren und verschiedene öffentliche Einrichtungen (z. B. Gemeinden, Zentralbanken) anwendbar ist.

Es kann besonders positiv hervorgehoben werden, dass alle Road-Tester sowohl die Methodenanwendung als auch die Nutzung des O-LCA-Leitfaden zur Durchführung von O-LCA empfehlen würden. Dass ein Viertel der Road-Tester bisher keine Erfahrungen mit LCA oder anderen Umweltmanagementtools hatte, deutet darauf hin, dass O-LCA als Katalysator und Motivation dienen kann, Umweltbewertungen durchzuführen.

Die positiven Ergebnisse des Pilotprozesses zeigten, dass keine sofortigen Aktualisierungen des O-LCA-Leitfadens erforderlich sind. Jedoch wurden einige vorrangige Maßnahmen identifiziert, um die Anwendung von O-LCA zu erleichtern. Dazu zählen weitere Erklärungen und Beispiele zur Kategorisierung der Aktivitäten in direkt, indirekt (vorgelagert) und indirekt (nachgelagert) sowie praktische Ratschläge für die Interpretation der zahlreichen Ergebnisse, die oft aus einer O-LCA Studie abgeleitet werden.

Die O-LCA-Fallstudien in der vorliegenden Publikation stellen eine wichtige Ergänzung der vorhandenen Beispiele und Leitfäden dar. Die Autoren erhoffen sich, dass diese zur Anwendung von O-LCA, zur Nutzung des Leitfadens und zur laufenden Verbesserung der O-LCA-Methode beitragen kann.

エグゼクティブサマリー

組織のライフサイクルアセスメント（O-LCA）では、対象組織に関連した活動への投入物、排出物、および潜在的環境影響をライフサイクルの視点で評価する。Life Cycle Initiativeによって2015年に発行された"組織のライフサイクルアセスメントに関するガイダンス"（O-LCAガイダンス）は、組織レベルにおけるライフサイクルアセスメントの適用が適切かつ有意義であり、可能であることを示した。この独創的なガイダンスの発行はO-LCAの可能性を強調するとともに、O-LCAを利用する際に方法論的課題に直面する実務者を支援するものであった。

このO-LCAガイダンスの順調な滑り出しの後（現在までに10,000を超えるダウンロード数）、組織のLCAプロジェクトは野心的な実験的プロセスに乗り出した。O-LCAは世界中から参加する12の組織により適用された。これらの12組織はO-LCA試行事業者と呼ばれ、地域（欧州、アジア、南米およびカリブ海地域）、業種（建設材料、自動車、化粧品、化学、食品、農業機械、教育、廃棄物処理、公務および非政府組織）、組織の規模（従業員4人から28万人）および環境ツールに関する過去の経験（製品LCA、企業のGHG算定、EMSなどの実施）などの点において多様性を有している。

次の12組織が新しいO-LCA手法の試行に同意した：1) AKG Gazbeton, 2) Azbil Corporation, 3) Banco de México, 4) Daimler, 5) Demarchi industrial complex-BASF, 6) Faculty of Science and Technology-UPH, 7) Foundation Emmaüs, 8) Junk That Funk, 9) Maschio Gaspardo, 10) Natura Cosméticos, 11) Thanakorn Vegetable Oil Products, and 12) Tuzla Belediyesi。O-LCA試行事業者の目的は、O-LCAの有用性や適用可能性を確認・実証すること、O-LCAガイダンスでは不明確であったことや実施上の課題を特定すること、そして新しいケーススタディーを実施し、その結果を得ること、と多岐にわたる。

本書は、O-LCAの適用に関して試行事業の成果により得られたより深い知見を提供することでO-LCAガイダンスを補完するものである。本書は試行事業に向けた状況整理としてO-LCAの主要な特徴の要約から始まる。次に、まずO-LCA試行事業者によるケーススタディーの概要を、実施目的、手法上の課題に対して選択した解決策、高度な分析結果および経験した課題などに焦点を当てて述べる。続いて、試行事業者に共通する経験や試行事業者からのフィードバック、並びに試行事業者が得た知見について総括的に調査した結果を紹介する。これらに続いて、試行事業プロセスの分野横断的な成果についても示す。

試行事業からの鍵となる知見

試行事業は、O-LCA手法の可能性や適切さを実証するものであった。これは、この手法が、その企業の活動による主要な影響ではないにしても、重要な役割を果たすバリューチェーンの活動からの間接的な影響を特定することに適用された結果として、多くのケーススタディーにおいて、また様々な環境側面について指摘された。さらにこの試行事業は、間接的な環境負荷がかなりの割合を占めることを示すことで、ライフサイクルアプローチの適用が、企業がしばしば陥りがちな企業の直接的排出だけに着目するという狭い視野を広げ、また補完することを示した。

また、この試行事業により、O-LCA手法はあらゆる規模(例えば、中小企業から多国籍企業)の企業や様々な産業、さらに様々な公共団体(例えば、自治体、中央銀行)にも適用可能であることが確認された。

最後の建設的な成果として、すべての試行事業者がO-LCAガイダンスを用いてO-LCAを実施することを他の組織に推奨すると明言した。試行事業者の1/4は過去にLCAや他の環境管理ツールの経験を有していなかったことは、O-LCAが環境評価に取り掛かる動機になり、それを促進する可能性を有していることを強く示唆している。

試行事業の建設的な成果からはO-LCAガイダンスを即座に更新する必要性は示されていないが、より簡便にOーLCAを適用するためにいくつか優先的課題が明らかとなった。例えば、評価対象活動の直接、間接的上流および間接的下流への分類に関するより多くの説明や事例、ならびにO-LCA事例で得られる多くの結果をどのように取り扱い、解釈するかに関するより実践的なアドバイス、などである。

最後に、本書の中のO-LCAケーススタディーは既存の事例やガイドラインへの重要な貢献を果たすものである。そしてそれはO-LCAのさらなる実践、O-LCA

ガイダンスの利用、ならびに現在進んでいるO-LCA手法の向上を促進、啓発するものになることを筆者らは望んでいる。

نتائج اختبار الطريق الرئيسية

لقد اظهرت عملية اختبار الطريق امكانية وأهمية المنهج من حيث انه قد لوحظ فى كثير من دراسات الحالة وبالنسبة لكثير من الجوانب البيئية ان استخدام المنهج قد حدد آثارا غير مباشرة للعمليات الأنتاجية وذلك من خلال ممارسة انشطة سلسلة القيمة، و أوضح الدور الهام ان لم يكن الدورالأساسى الذى تلعبه هذه الأنشطة فى تحديد الجوانب الأنتاجية. بالأضافة الى ذلك فقد اظهرت الدراسة ان تطبيق منهج دورة الحياة يمتد العمليات لهذه البيئية الشاملة ويكمل النظرة الضيقة للمؤسسات والتى تركزبالدرجة الأولى على الغازات المنبعثة منها، وذلك من خلال ادراج جزءا كبيرا من العبئ البيئي فى عملية التقييم . كذلك أكدت عملية اختبار الطريق انه يمكن تطبيق هذا المنهج على جميع انواع المؤسسات بجميع أحجامها (أى انه يمكن تطبيقها فى كل من المشروعات الصغيرة والمتوسطة الحجم وكما يمكن تطبيقها فى الشركات المتعددة الجنسيات)، كذلك يمكن تطبيق المنهج فى جميع القطاعات والهيئات العامة المختلفة مثل البلديات والبنوك المركزية.

اما النتيجة الأيجابية الأخيرة فقد اقر جميع مختبرى الطريق بأنهم سيقومون بتوصية مؤسسات أخرى بالقيام بتنفيذ . وحيث ان ربع مختبري الطريق لم يكن لديهم (O-LCA Guidance) واستخدام ارشادات المنهج O-LCA خبرات سابقة بأية مناهج لتقدير دورة الحياة أو أى من ادوات ادارة البيئة فقد اعطى هذا مؤشرا عن قدرات منهج من حيث انه يعطينا حافزا قويا للبدء بالتقييمات البيئية. O-LCA

-Oهذا، وقد اوضحت النتائج الأيجابية لعمليات اختبار الطريق انه لا توجد حاجة الى أية تحديثات فورية لتوجيهات الا انه تم تحديد بعض الأجراءات ذات الأولوية من اجل زيادة تيسير تطبيق المنهج ، مثل المزيد من LCA التفسيرات والأمثلة على تصنيف الأنشطة الى أنشطة مباشرة وغير مباشرة واعطاء بعض النصائح العملية عن كيفية التعامل مع الكم الهائل من المعلومات لنتائج الدراسات المستخدمة لمنهج. O-CLA

وأخيرا فان دراسات الحالة التى تمت فى اطار هذا التقرير تمثل اضافة هامة لمجموعة الأمثلة والمبادئ التوجيهية والأستفادة من O-LCAالقائمة والتى يأمل المؤلفون فى تشجيعها حيث انها تحث على المزيد من التطبيق لمنهج التقييم المستمرله. توجيهاته و

ملخص تنفيذى

بجمع وتقييم المدخلات (organizational LCA, O-LCA)تقييم دورة الحياة للمؤسسات يقوم منهج والمخرجات والاثار البيئية المحتملة لكافة الأنشطة المرتبطة بهذه المؤسسات، وذلك من خلال منظور دورة الحياة. وقد اظهرت الأرشادات الخاصة للمؤسسات بتقييم دورة الحياة (Guidance on Organizational Life Cycle Assessment) او ارشادات O-LCA التى نشرت من قبل مبادرة دورة الحياة عام 2015 (Life Cycle Initiative) ان منهج تقييم دورة الحياة هو منهجا مناسبا ويمكن تطبيقه بالفعل فى المؤسسات. وقد القت هذه الأرشادات الضوء على امكانيات هذا المنهج لتقديم ما يمكن من مساعدات للممارسين له لما يواجهون من تحديات منهجية عند استخدام O-LCA.

(مع مايزيد عن عشرة آلاف تنزيل الكترونى حتى الآن)، قام المشروع الرئيسي O-LCA بعد نجاح ارشادات O-LCA (O-LCA flagship project) دورة الحياة للمؤسسات لتقييم سياقه تطبيق في بعمل تجريبى طموح تم . وقد تنوعت مواصفات هذه >>مختبرى الطريق<< من قبل اثنى عشر مؤسسة حول العالم بما يطلق عليهم LCA المؤسسات من حيث المنطقة الجغرافية (من أوروبا واسيا وامريكا اللاتينية ومنطقة البحر الكاريبى وشمال امريكا) وتنوعت ايضا القطاعات (فشملت مواد البناء والسيارات ومستحضرات التجميل والكيماويات والأغذية والآلات الزراعية والتعليم وادارة النفايات والقطاع العام والمنظمات غير الحكومية) كذلك اختلف حجم هذه المؤسسات .(من (حيث تراوح عدد الموظفين فيها من 4 الى 280 الف موظف) كما اختلفت الخبرات السابقة لهذه المؤسسات حيث تعاملاتها السابقة مع أى من ادوات التقييم البيئي لمنتجاتها والتطبيق الفعلى لمنهج تقييم دورة الحياة LCA لهذه المنتجات الخ).

وقد اتفقت المؤسسات الاثنى عشر التالية على عملية اختبار الطريق لمنهج O-LCA الجديد: 1) AKG Gazbeton, 2) Azbil Corporation, 3)Banco de Mexiko, 4) Daimler, 5) Demarchi industrial complex-BASF, 6) Faculty of Science and Technology-Universitas Pelita Harapan, 7) Foundation Emmaus, 8) Junk that Funk, 9) Maschio Gaspardo, 10) Natura Cosmeticos, 11)Thanakorn Vegetable Oil Products, and 12) Tuzla Belediyesi.

وقد كان الهدف من عملية اختبار الطريق باستخدام O-LCA متعدد الوجهات من حيث التحقق من فائدة المنهج واثبات فاعليته وكذلك لتحديد الثغرات والتحديات التى تواجهه واخيرا لتقديم عدد من دراسات الحالة التى قامت بتطبيقه.

ان المنشور الحالى يقوم باستكمال ارشادات O-LCA من حيث انه يعطى رؤى اكثر تعمقا فى تطبيق المنهج . وقد تم استكمال هذا المنشور من خلال نتائج عمليات اختبار الطريق المشار اليها. ويبدأ المنشور بملخص للسمات الرئيسية لمنهج O-LCA وذلك لتحديد السياق لعملية أختبار الطريق. وتقدم الأجزاء اللاحقة اولا الملخصات إلقاء التنفيذية لمجموعة دراسات الحالة التى اجراها القائمون بعملية اختبار الطريق، مع الضوء على التطبيقات النتائج والتحديات التى تم التعرض لها، ونتائج تقدم المستهدفة و الحلول المنهجية التى قاموا باختيارها، كما أخيراً الدراسات الاستقصائية الشاملة التى شارك فيها مختبرو الطرق بخبراتهم وتعليقاتهم و الدروس المستفادة من ممارسة المنهج. ويأتى بعد ذلك وبناء على الأقسام السابقة عرض للنتائج الشاملة لعملية اختبار الطريق.

CHAPTER

1. Introduction to O-LCA

©Natura Cosméticos

1.1 Definition and intended applications

Organizational life cycle assessment (O-LCA) is a compilation and evaluation of the inputs, outputs and potential environmental impacts of the activities associated with the organization adopting a life cycle perspective (ISO, 2014a). Since the portfolio of an organization usually includes more than one product, O-LCA enables the entire set of goods and services provided by the organization, as well as the activities necessary for their provision, to be assessed at the same time, following a life cycle perspective.

O-LCA extends the benefits of the life cycle approach, which has been recognized as a robust quantitative tool for environmental decision making, to the more complex prospect of organizational assessment. It has significant potential to help corporations, authorities, institutions and other organizations improve their environmental performance by providing credible and complete information. An important step toward an improved environmental performance is the implementation of comprehensive assessment schemes that frame the organization's strategy and decision making, including environmental aspects – apart from technical and economic considerations.

With a life cycle perspective organizations can take environmental strategy and action beyond on-site resource efficiency and pollution avoidance by identifying more effective improvement opportunities for different actors along the entire value chain. Furthermore, O-LCA is an environmental multi-impact approach, meaning that it aims to capture a variety of environmental impacts, inputs and outputs, and can lead to decisions that find the right balance among those impacts.

This methodology can serve multiple goals at the same time. It offers insight to the organization and its value chain, and identifies hotspots where action should be taken. Furthermore, it provides a structure for environmental performance tracking and target achievement as defined by the organization's environmental strategy. Finally, O-LCA results support reporting and communication to third parties.

Nevertheless, the methodology is not envisaged to be used for comparative assertions between organizations intended to be disclosed to the public. Comparative assertions or benchmarking of organizations based on O-LCA results are neither robust nor meaningful and there is not a consistent basis for comparison.

Energy production, construction, transportation, and goods and services provision – the main contributors to environmental impacts – are all mainly driven by organizations, which means they have an important environmental stewardship role to play. Large corporations can leverage their experience and influence with their extensive value chains to globally address the global depletion of resources and emission of pollutants and toxic substances. Small and medium-sized enterprises (SMEs) are usually a part of the abovementioned value chains, but can also be influencers themselves and make a significant collective contribution to address environmental impacts within their sphere of influence. Public organizations have a further responsibility as enablers through the implementation of a conducive policy framework that facilitates closing loops and circular flows, while also showing leadership for change toward more sustainable practices.

1.2 Main features of the methodology

O-LCA follows the four-phase approach as proposed by ISO 14040 for product LCA, including goal and scope definition, inventory, impact assessment and interpretation. Indeed, O-LCA is governed by the same principles, requirements and guidelines as product LCA, however, it has its own particularities due to the higher complexity of the object assessed. See Martínez-Blanco et al. (2015a).

Scoping phase. In this phase, major methodological differences with product LCA occur. The scope defines the breadth, depth and detail of the study in accordance with the stated goals. The specific elements for organizational LCA are reporting organization, reporting flow, and system boundary. The reporting organization determines who the organization understudy is and should be described in terms of subject of study, sites that are to be partially or totally considered, and period when the organization is depicted. The reporting flow is a measure of the outputs from the reporting organization during the reference period, on a physical basis or others, like economic revenue. Finally, the system boundary determines the resource uses and emissions, and thus also impacts, categorized into direct (i.e., from sources that are owned or controlled by the reporting organization) and indirect (i.e., occur at sources owned or controlled by another organization, a supplier or the user/consumer, but are a consequence of the activities of the reporting organization).

Inventory phase. In the inventory phase, the system is modelled and data are collected. The inventory should consist of all resource use and emissions necessary for the activities involved in the provision of the reporting flow and considering the system boundary definition. Data collection can be performed with a bottom-up approach (at the product level), a top-down approach (at the organization or facility level) or a hybrid approach. In general, better quality and more specific data can be expected for activities inside the reporting organization.

Impact assessment phase. The impact assessment is aligned with the recommendations and requirements for product LCA, and the same impact categories and methods can be applied. The selection of impact categories should reflect a comprehensive set of environmental issues related to the system being studied.

Interpretation phase. The interpretation phase is also aligned with the recommendations and requirements for product LCA. Interpretation should indicate the consistency of the results according to all the aspects defined during the goal definition and scope phase.

CHAPTER

2. O-LCA road testing context

©AKG Gazbeton

LCA of organizations is becoming of increasing interest not only as a complement to product-based analyses, but also as a stand-alone methodology. In 2015, the United Nations Environment Program (UN Environment) and the Society of Environmental Toxicology and Chemistry (SETAC) partnership Life Cycle Initiative launched the flagship project “LCA of Organizations”, whose main outcome was the document “*Guidance on Organizational Life Cycle Assessment*” (henceforth, O-LCA Guidance). A total of 100 participants from all over the world and with different backgrounds contributed to the O-LCA Guidance preparation (Figure 1).

2.1 The *Guidance on Organizational Life Cycle Assessment*

The O-LCA Guidance (Figure 2) showed that the benefits and the potential of the life cycle approach are not limited to the application to products and that the use in organizations is relevant, meaningful and already possible.

Other processes exist or are underway on the development and agreement of approaches for the multi-impact assessment of organizations from a life cycle perspective. Apart from the O-LCA Guidance, two main guideline documents have been published: the “ISO/TS 14072: Environmental management — Life cycle assessment — Requirements and guidelines for organizational life cycle assessment”, (ISO 2014a) and the “Organisation Environmental Footprint (OEF) Guide” from the European Commission (EC 2013), which includes follow up initiatives to promote the development of the O-LCA concept in specific sectors and organizations. Also “ISO 14046: Environmental management — Water footprint — Principles, requirements and guidelines” (ISO 2014b) foresees the application to organizations and includes a water-related multi-impact approach within the framework of water footprint profiles.

The O-LCA Guidance highlights the potential of an organizational perspective within life cycle thinking and especially strives to align with ISO/TS 14072, and thus with “ISO 14040:2006: Environmental management — Life cycle assessment — Principles and framework” and “ISO 14044:2006: Environmental management —

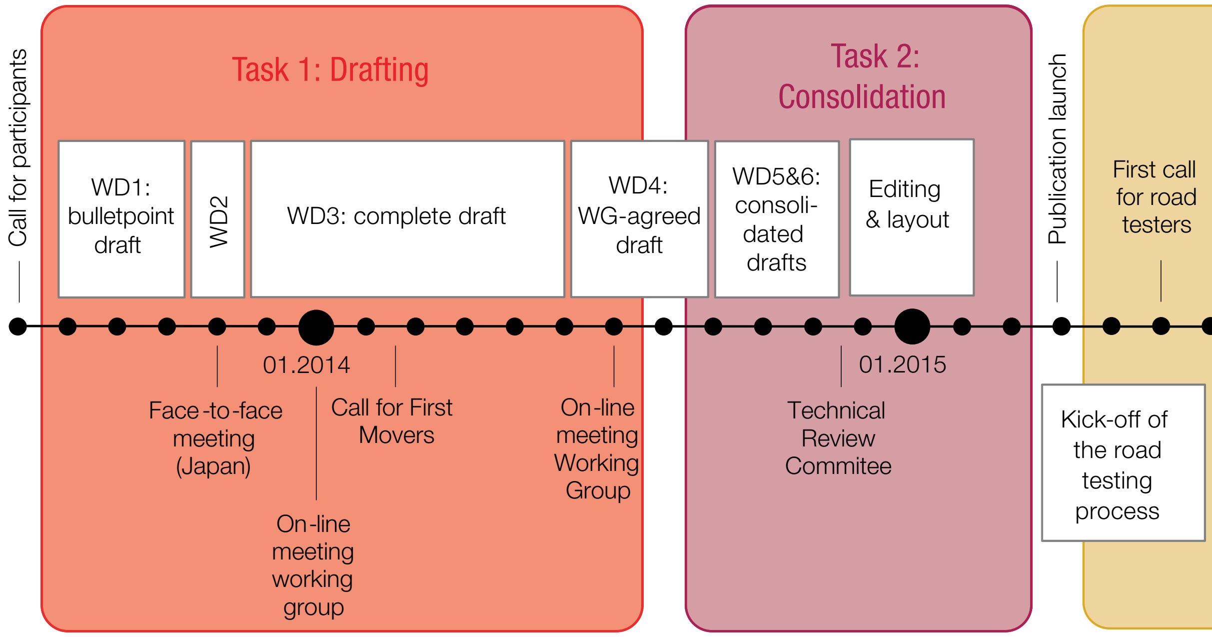


Figure 1: Phases of the Life Cycle Initiative flagship project: LCA of organizations.

Note: WD=Working Document.

Life cycle assessment — Requirements and guidelines". At the same time, it complements the standard and aims to be a more detailed accompanying document. The document also builds on other existing works and initiatives on the assessment of the environmental performance of organizations, like the "Greenhouse Gas Protocol Initiative". The O-LCA Guidance includes recommendations about the specific methodological issues to be considered while applying O-LCA, but does not attempt to cover in detail those aspects of the methodology that are common with product LCA.

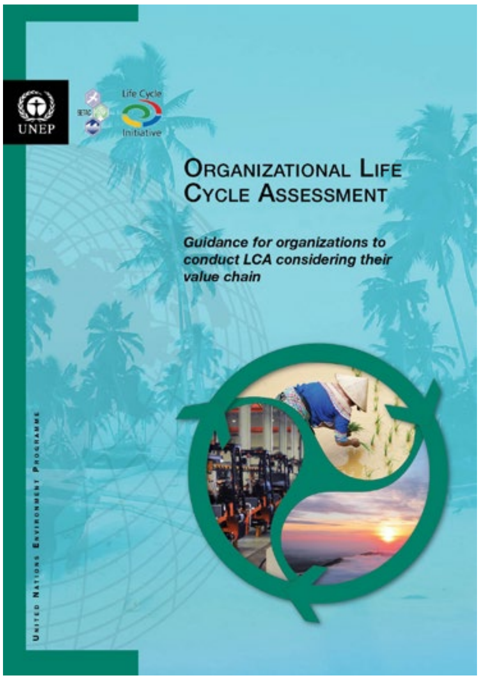
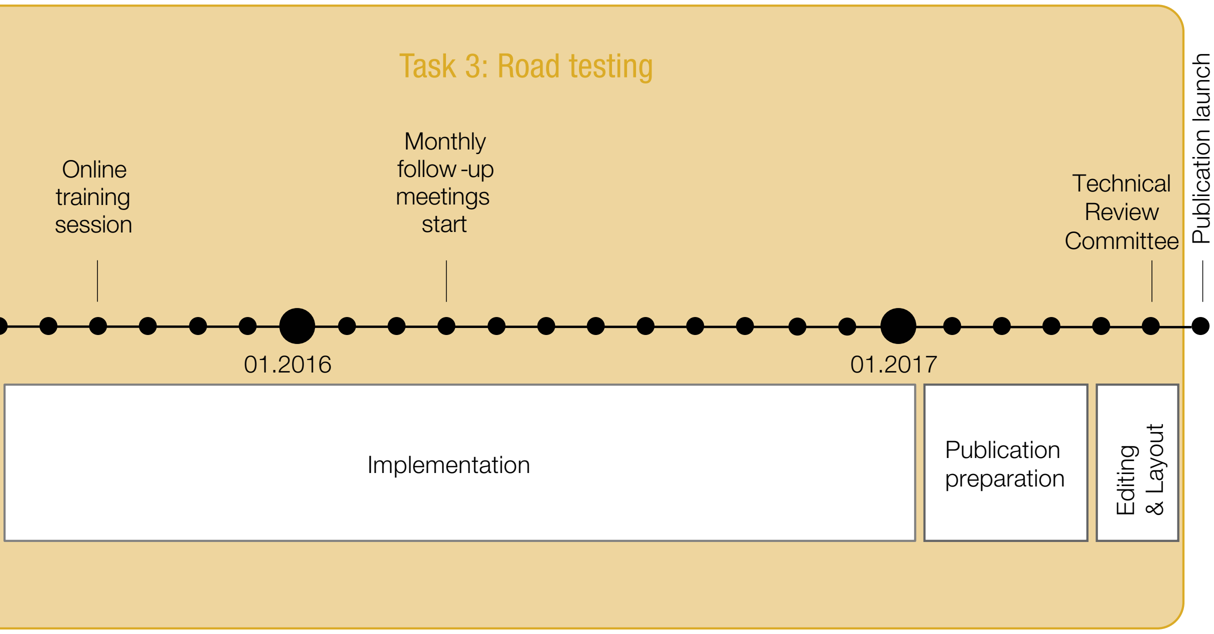


Figure 2: Cover of the "*Guidance on Organizational Life Cycle Assessment*". Source: UNEP (2015)

The publication has 6 main chapters: Introduction, Overview of O-LCA, Technical Framework for O-LCA, Operationalizing O-LCA, and Reporting, assurance and communication to third parties. Key guiding questions are included at the beginning of each chapter to facilitate locating the relevant information. It is a comprehensive document with more than one target audience. Recommended reading itineraries are included and signaled along the document for decision makers, practitioners, methodology developers and consumers or other stakeholders. The publication also features "Boxes", which are dedicated to additional explanations, clarifications or recommendations, and "Reports", that support understanding of the main text by portraying real case studies from organizations that had already begun to implement aspects of O-LCA.



O-LCA can complement an organization's environmental toolbox and gain benefit from it, in that previous experience with environmental tools and the existence of relevant data can facilitate O-LCA application. In the O-LCA Guidance, four "experience-based pathways" are described according to an organization's previous environmental experience, and recommendations are given on how organizations can use this as a basis for the O-LCA approach (Table 1). Specific recommendations are also provided for the implementation of O-LCA by SMEs.

Experience-based pathways	Tools / Data	How do these tools streamline the application of O-LCA?
Pathway 1: Limited initial environmental experience and information	-	-
Pathway 2: Existing environmental assessment gate-to-gate	ISO 14001, EMAS, etc.	The organizational on-site assessment offers data for direct activities and guides the identification of the targeted suppliers.
Pathway 3: Existing environmental life cycle assessment at the product level	ISO 14040-44, PEF, EPDs, product carbon footprint, etc.	It may roughly identify some important hotspots in the value chain that should be further assessed. O-LCA may consist of the addition of the different LCAs weighted by the amount of products produced.
Pathway 4: Existing single-indicator environmental assessment at the organizational level and including value chain	GHG Protocol, ISO 14064, etc.	The overall analytical framework, the data collection procedures and tools developed for the single-indicator assessment may guide the scoping definition of the multi-impact approach.

Table 1: Experience-based pathways

Note: The application of O- LCA is simplified depending on the type or class of tools already applied in the organization.

On-the-ground experiences of eleven 'First Movers' were identified and presented as a body of initial practical experience in the use of approaches that encompass O-LCA. They illustrate some methodological facets and the benefits of applying an environmental multi-impact assessment of organizations and their value chain.

Finally, the document explains how O-LCA can be a key element in an organization's decision-making system and for environmental performance reporting with voluntary sustainability reporting schemes.

2.2 The road-testing process of the O-LCA Guidance

The third task (Figure 1) of the "LCA of Organizations" flagship project was to conduct road testing of the O-LCA Guidance in voluntary organizations, which aimed to demonstrate the usefulness and potential of the methodology, add more experiences that would promote its further use, identify main challenges of O-LCA application through direct feedback from the practitioners, as well as test the clarity of the O-LCA Guidance.

Immediately following the publication of the O-LCA Guidance in May 2015, a call to solicit interest from organizations to implement the methodology was launched. A key consideration for selecting the participants was to include as much variability as possible. Other important decision factors were the willingness of the organization to participate and the availability of staff and economic resources to implement the O-LCA Guidance.

The 12 road-testing organizations selected represent a broad range of examples in terms of region, sector, size and previous experience with environmental tools. The flagship project's secretariat made extensive efforts to ensure the participation of SMEs, and organizations from developing countries and the public sector. Moreover, the selected organizations are placed at different levels within the value chain (i.e., raw material producers, manufacturers, retailers of products/services, and waste managers), and are characterized by a varying degree of vertical integration.

On the top of organizations' own resources, the flagship project's secretariat provided individual support and advice during both the implementation of the methodology and the preparation of the deliverables: (1) a preliminary report (outlining goal, scope and generally mapping the organization's O-LCA study); and (2) the final report, including the complete O-LCA study. The secretariat reviewed report drafts during the entire implementation process against the guidelines and requirements of the O-LCA Guidance and the ISO/TS 14072. Detailed explanations, recommendations and proposals were provided at each review round.

All participants were offered training at the beginning of the road testing. Additionally, once the implementation of the methodology had reached an intermediate stage, online "Follow-up Meetings" were held online every one or two months to enable the road testers to exchange experiences and knowledge. Support from the secretariat to answer questions was also available for each road tester during the entire implementation process.

2.3 Publication outline

This publication, "*Road testing Organizational Life Cycle Assessment around the world: Applications, experiences and lessons learned*" describes the main outcomes and learnings of the road-testing process.

Sections 1 and 2 provide the context for the road-testing phase, including an introduction to O-LCA and a description of the Life Cycle Initiative's flagship project on Life Cycle Assessment of Organizations.

Section 3 details the individual road testers' O-LCA methodology implementation, including a summary of the O-LCA experience, a general description of each organization, and a broad description of the four O-LCA phases.

Section 4 presents summary of the survey results, which provide insights and details of the pilot organizations' extraordinary efforts.

Finally, Section 5 summarizes the outcomes and lessons learned from the road-testing process.

CHAPTER

3. Road tester executive summaries

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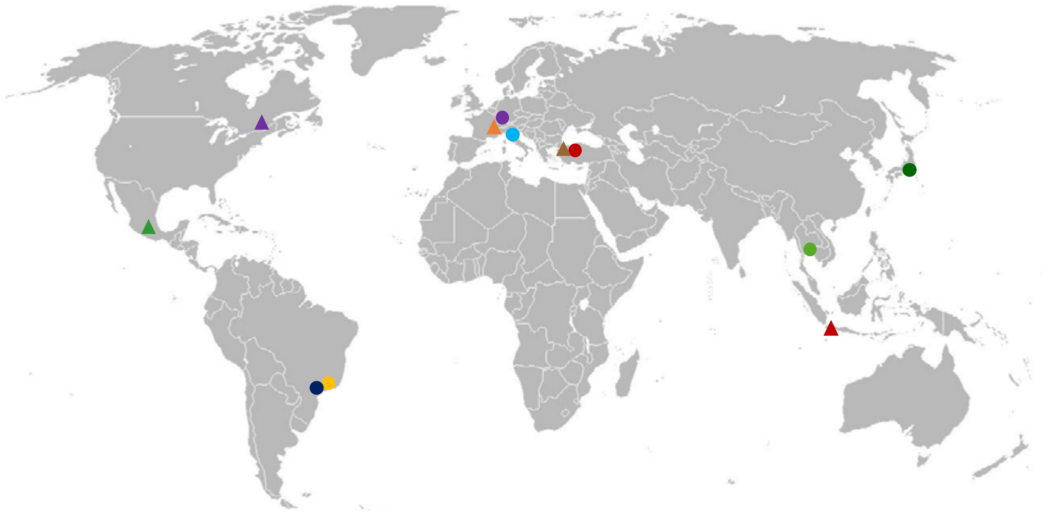
The road testers and their executive summaries

The 12 road testers are based in ten different countries (i.e., Turkey, Mexico, France, Canada, Italy, Brazil, Thailand, Germany, Japan and Indonesia, see Figure 3) spread across four world regions (i.e., Europe, Asia, Latin America and the Caribbean, and North America). In addition to seven companies from diverse manufacturing sectors (i.e., construction material; automotive; cosmetics, fragrances and toiletries; chemicals; food; measuring equipment and automation; agricultural machinery), a small enterprise (waste management sector), a university, a central bank, a municipality, and a non-governmental organization (lodging and recycling activities) took part in the road testing. The road testers vary greatly with regard to the number of employees, ranging between four and approximately 280,000, as well as their scale of activity, which ranges from local to international scale with four of the organizations owning or controlling only one facility, and five organizations with activities in several countries.

According to the different sizes, motivations and capacities, the responsibilities for environmental issues within the organizations are very diverse. Seven of the road testers do not have a specific department devoted to environmental or sustainability issues. Most road testers regularly perform environmental communication through an environmental and/or sustainability report, while for three organizations, O-LCA represented the first environmental reporting experience.

Using the O-LCA Guidance as their basis for action, every organization found its own way to apply the methodology (Table 2). For one third of the studies, the subject assessed (i.e., the reporting organization) was the whole organization, while two thirds considered a part thereof (e.g., one brand or line of products, a region, etc.). For the



● AKG Gazbeton	Construction materials	▲ Foundation Emmaüs	Social and recycling NGO
● Azbil Corporation	Electric appliances	▲ Junk That Funk	Waste management
▲ Banco de México	Central bank	● Maschio Gaspardo	Agricultural equipment
● Daimler	Automotive	● Natura Cosméticos	Cosmetics, fragrances, toiletries
● Demarchi - BASF	Coatings	● Thanakorn	Food
▲ FaST - UPH	Academia	▲ Tuzla Belediyesi	Municipality

Figure 3: The twelve O-LCA road testers

Note: Circles refer to industrial sector; triangles refer to public or service sector.

latter, most of the cases claimed that the study was undertaken as a pilot, which would be extended to the whole organization in the future. Regarding determination of the system boundary, seven road testers used a cradle-to-grave approach, although two of these omitted the use phase.

Regarding the challenging task of inventory data collection, half of the road testers applied a top-down approach because data at the organizational level and/or environmental assessments of the whole organization for a single indicator (e.g., greenhouse gases) were available. The other half combined organizational data, in addition to using previously available data at the product level. For indirect activities, LCA databases and input-output databases were the primary data source, complemented in some cases by direct measurements. The road testers applied a broad range of established impact assessment methods and life cycle inventory databases.

Road tester	Headquarters	Sector	Employees	Regional influence
AKG Gazbeton	Turkey	Construction materials	431 (2016)	Produces in Turkey. Exports to more than 20 countries.
Azbil Corporation	Japan	Electric appliances	5,146 (2016)	Produces in Japan and abroad. Sales all over the world
Banco de México	Mexico	Central bank	+3,000 (2016)	Operates in Mexico
Daimler	Germany	Automotive	284,015 (2016)	Produces in Germany and abroad. Sales all over the world
Demarchi industrial complex - BASF	Brazil	Coatings	1,200 (2016)	Produces and sells in Brazil.
Universitas Pelita Harapan	Indonesia	Academia	1,000 (2016)	Operates in Indonesia
Foundation Emmaüs	France	Social and recycling NGO	38 (2016, employees and volunteers)	Operates worldwide
Junk That Funk	Canada	Waste management	4 (2016)	Operates in Canada
Maschio Gaspardo	Italy	Agricultural equipment	1,800 (2016)	Produces and sells in several countries
Natura Cosméticos	Brazil	Cosmetics, fragrances, toiletries	7,700 (2016)	Mainly produces in Brazil and sells in many countries
Thanakorn Vegetable Oil Products	Thailand	Food	200 (2016)	Produces in Thailand. Exports to more several countries.
Tuzla Belediyesi	Turkey	Municipality	335 (2016)	Operates in Turkey

Table 2: Detail information of the case studies

Each organization provided a summary of their O-LCA study in order to inform the public about the specific environmental background, study design, results and lessons learned. The summaries are presented in the following section.

Every organization gave their best efforts, despite limitations and barriers, to produce a study with a quality according to their goals. In some cases, the methodology and recommendations were noted to be loosely interpreted. The road-tester leaders come from very different backgrounds and work in organizations with a broad range of prior experience; some of the methodological decisions taken and derived strategic actions could perhaps be questioned. This notwithstanding, the authors believe the study results to be valid for making recommendations and useful for promoting further activity in this area.

Subject of study	System boundary	Data collection approach	Experience-based pathway
The whole organization (three production plants and offices)	Cradle-to-grave	Hybrid	Pathway 3
The whole organization (including subsidiaries and plants abroad)	Cradle-to-grave	Hybrid	Pathway 2 and 4
Facilities for design, production, distribution and shredding of the banknotes	Cradle-to-grave (excluding use phase)	Hybrid	Pathway 3
One division, Mercedes-Benz Cars with facilities worldwide	Cradle-to-grave	Hybrid	Pathway 2 and 3
The whole organization (Demarchi industrial complex)	Cradle-to-gate	Top-down	Other pathways
One of the faculties and some common facilities of the university	Cradle-to-gate	Top-down	Pathway 1
One local Emmaüs community in Switzerland	Cradle-to-gate	Top-down	Pathway 1
The whole organization (one facility)	Cradle-to-gate	Top-down	Pathway 1
Italian production plants	Cradle-to-grave	Hybrid	Pathway 4
Organization's operations in Brazil	Cradle-to-grave	Hybrid	Pathway 4
The whole organization (one facility)	Cradle-to-grave (excluding use phase	Top-down	Pathway 3 and 4
The whole organization (24 directorates and Mayor's office)	Cradle-to-gate	Top-down	Pathway 1

3.1 AKG Gazbeton

Construction materials manufacturer

Typification of the road tester

Name: AKG Gazbeton İşletmeleri San. Tic. A.Ş.

Sector: Construction materials

Region (country): Turkey

Number of employees: 431

Study leader(s): Ergül Doğan (AKG Gazbeton, Quality Assurance Chief) and Hüdai Kara (Metsims Sustainability Consulting)

Description of the organization

AKG Gazbeton manufactures autoclaved aerated concrete (AAC) products with heat insulation, fireproof characteristics, and light wall material for buildings, mineral insulation boards and adhesives.

Environmental approach of the organization

The company has certification to ISO 9001:2008 Quality, ISO 14001:2004 Environmental Management Systems and OHSAS 18001 Occupational Health and Safety Management Systems in all its production facilities located in İzmir, Çorlu and Kırıkkale in Turkey. In addition, the company obtained ISO 14025 and EN 15804 compliant Environmental Product Declaration (EPD, Declaration No: EPD-AKG-20130049-CBD1-EN) in 2013 for their autoclaved aerated concrete products.

Experience-based pathway(s)

Pathway 3: existing environmental life-cycle assessment at the product level, as the company had previous LCA experience from the EPD obtained for its aerated concrete products.

Motivation and goals

The aim of the study is to provide a better understanding of the environmental impacts derived from AKG Gazbeton's activities, considering its upstream, direct and downstream stages. With such comprehensive information, the company can identify the hotspots and begin reducing their carbon footprint and/or other relevant environmental impacts. The results can also be used to establish a basis for planned sustainability practices, such as GRI reporting, CDP and Borsa Istanbul (BIST) Sustainability Index, to communicate with stakeholders on its environmental awareness and approach in a more transparent way.

Scope: Reporting organization and reporting flow

Subject of study: The reporting organization is AKG Gazbeton with its entire operations.

Consolidation method: AKG Gazbeton has both financial and organizational control over its three production facilities located in İzmir, Çorlu and Kırıkkale in Turkey.

Reference period: 2015

Reporting flow: 1,357,022 m^3 AAC block, 32,521 m3 R-AAC block, 6,980 m^3 Minepor insulating board and 3,288 tons of fine joint adhesive manufactured in its all three production facilities on 2015.

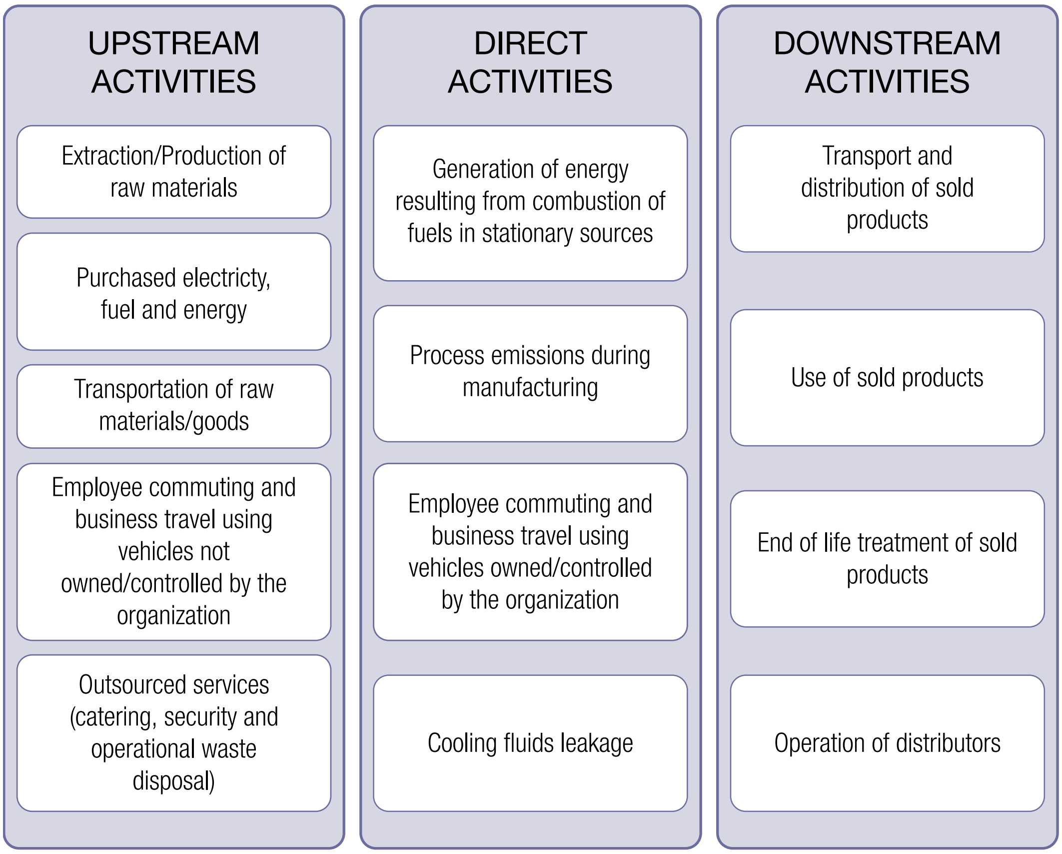


Figure 4. AKG Gazbeton – System boundary

Scope: System boundary

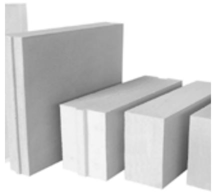
The system boundary (Figure 4) covers the production of raw materials, all relevant transport down to factory gate, manufacturing by AKG Gazbeton and related organizational activities, transport and delivery of manufactured products, use phase and end of life treatment of sold products, (cradle to grave).

Inventory: Data collection approach

A hybrid data collection approach is followed for primary data. All production data are from AKG Gazbeton's production lines for 2015. Energy and water consumption, process emissions, vehicle use, waste disposal, energy production, transport within facilities, annual production and outsourced services data are collected at the plant level for each facility. Raw materials, packaging materials, energy and water consumption during manufacturing and distribution of the final product data are collected at product level.

Inventory: Data sources

Primary data are captured mainly from the company's SAP system, as well as from purchasing and sales departments' records. Real energy consumption data are also collected from several product distributors. Secondary data are sourced from the Turkish Life Cycle Inventory Database (TLCID, developed by Metsims Sustainability Consulting with the financial support of Turkish Centre for Sustainable Production Research and Design (SÜRATAM)) for production relevant to Turkish conditions, Ecoinvent, EU&DK and USA Input-Output databases. The use phase of the products is modelled according to product installation manuals. At the end of life, AKG Gazbeton products are assumed to be disposed of at construction and demolition waste landfills.



Impact assessment results

As the products manufactured form the major part of AKG Gazbeton's activities, the indicators for the life cycle impact assessment selected are the same as for the EPD for AAC block products (Table 3).

ENVIRONMENTAL IMPACT CATEGORIES - CML-IA baseline (v4.2) method within SimaPro					
PARAMETER	UNIT	Indirect Upstream Activities	Direct Activities	Indirect Downstream Activities	Total
Global Warming Potential	tonnes CO_2 eq.	266,000	22,800	59,100	348,000
Ozone Depletion Potential	kg CFC11 eq.	17	1	11	30
Formation Potential of Tropospheric Ozone Photochemical Oxidants	kg C_2H_4 eq.	36,534	829	10,506	47,869
Acidification Potential	kg SO_2 eq.	674,969	177,790	247,258	940,017
Eutrophication Potential	kg PO43- eq.	178,307	4,753	58,301	241,361
Abiotic Depletion Potential for Non-Fossil Resources	kg Sb eq.	655	0	149	805
RESOURCE USE - Cumulative Energy Demand (ver. 1.09) methodology within SimaPro					
Total use of renewable primary energy resources	GJ	110,000	4,880	13,400	128,000
Total use of non-renewable primary energy resources	GJ	1,919,000	3,810	948,000	2,870,000
INVENTORY LEVEL INDICATORS - Primary data provided by AKG Gazbeton					
Hazardous waste disposed	ton	92			
Non-hazardous waste disposed	ton	310			
Use of net fresh water (well)	m^3	542,000			

Table 3. AKG Gazbeton – Impact assessment results for 2015

The O-LCA study shows that upstream supply chain activities are the dominant life cycle stage (Table 3). Regarding energy, upstream activities have higher energy requirements (embodied) compared to direct and downstream activities. Within upstream activities, raw materials appear to be the dominant activity on environmental impacts assessed, followed by transport of sold products within downstream activities. The use of Portland cement, an important ingredient of the AACs, is critical for reducing impacts due to products. It is also important to note that direct activities have the lowest environmental impacts.

Impact reduction opportunities are, for example, efficient use of materials noted above, use of recycled materials when viable, exploration for potential substitutes for high-impact materials, and low-carbon alternatives to calcite-based formulations.

LCI databases have shortcomings, such as high uncertainty in monetary-based environmental impacts and in the use of generic (non-localized) databases. In sectors based on heavy raw material use, such as construction products as in the case of AKG Gazbeton, these uncertainties are lower due to the use of country-specific localized datasets such as TLCID. Still, there is potential for further improvement via availability of local databases for the O-LCA.

Limitations and options for improvement

Also, data collection from the value chain involving distribution channels was difficult due to their scale and diversity. In Turkey, only one fifth of AKG Gazbeton's distributors responded to a request for information. Hopefully, with the communication of this report, the organization will improve its value chain's perception and understanding, hence easing the data collection for future environmental studies.

Strengths and opportunities yielded by the O-LCA study

- Gaining comprehensive view of environmental impacts of whole product groups and auxiliary activities of the company. This created opportunity for the development of key sustainability manufacturing indicators.
- With the help of this study, the company noticed that there is more impact of indirect activities than direct activities on LCA. This information gives an idea about the importance of sustainability targets of indirect activities.
- Multi-criteria assessment beyond carbon footprinting at the organizational level
- Science-based assessment to enable reduction targets on hotspots relevant to the organization
- Being the first in the sector to conduct O-LCA
- Quantitative assessment as a basis for future sustainability reporting
- Communicate quantitative environmental impact results relevant to the sector.

Documentation

The full report is intended to be used internally. A summary report is planned to be published on organizations' website (www.akg-gazbeton.com).

3.2 Azbil Corporation

Measuring equipment and automation provider

Typification of the road tester	**Name**: Azbil Corporation **Sector**: Electric Appliances **Region (country)**: Japan **Number of employees**: 5,146 (As of March 31, 2016) **Study leader(s)**: Ayako Nagayama (Azbil Corporation, Supervisor), Hiromu Hatano (Azbil Corporation, Manager) and Masaharu Motoshita (National Institute of Advanced Industrial Science and Technology, external expert)
Description of the organization	Azbil produces products and services relative to building automation, advanced automation for factories and plants, and life automation for essential services and people's health and well-being. The azbil Group companies are located in Japan, China, South Korea, Thailand, India, Vietnam, Belgium and U.S.A. The company's main market is Japan, although it is actively expanding in overseas markets, like Asian, North American and European.
Environmental approach of the organization	The company undertakes basic and proactive environmental initiatives based on its environmental management system (ISO 14001) by planning mid-term environmental conservation targets. At the product level, design for environment is used for setting the LC-CO_2 reduction target of new products. At the organizational level, the company has calculated SCOPE 3 since FY2012 as well as EMS by ISO 14001.
Experience-based pathway(s)	Combined approach of pathway 2 and pathway 4: based on experience from EMS certification (ISO 14001) and through SCOPE 3 GHG emission calculation following the GHG protocol.
Motivation and goals	Before implementing the O-LCA, Azbil qualitatively mapped out environmental pressures related to its entire value chain. The company wants to apply O-LCA to define materiality quantitatively through the entire value chain and utilize the results to set mid-term environmental management policy targets. The O-LCA study results are intended for internal communication (including executive board members).
Scope: Reporting organization and reporting flow	**Scope of study**: The reporting organization is the azbil Group, including Azbil Corporation, its consolidated subsidiaries in Japan, and its main manufacturing facilities based overseas. **Consolidation method**: Operational control **Reference period**: Fiscal year 2015 (April 2015 to March 2016) **Reporting flow**: Net sales in fiscal year 2015 of JPY 256,889 million
Scope: System boundary	The whole value chain from cradle to grave is included within the system boundary, including use and end-of-life (EoL) stages of the products and services. Activities in operations, production, managerial, marketing, design and R&D departments, sales and outsources services are also assessed. However, transport of purchased goods from suppliers, business travel and employee commuting are not assessed.




Inventory: Data collection approach

Azbil has experience in SCOPE 3 calculation of GHG emissions at the organizational level, therefore, a top-down approach is adopted to collect relevant data in the boundary of the assessment. Except for use and EoL stages, actual financial and physical data are collected. For use and EoL stages, modelled data at the product level are adopted (Figure 5).

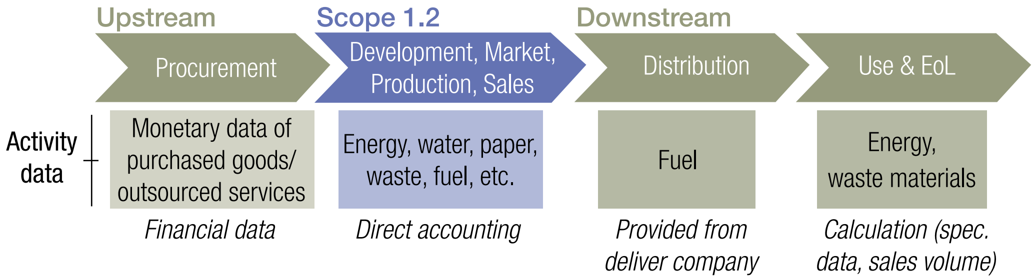


Figure 5. Azbil – Data collection through the value chain

Inventory: Data sources

Specific financial-transaction-based data of purchased goods/services and direct accounting data at production and operation sites (for EMS) are the main sources of primary data. For use and EoL stages, product performance information and sales data are the sources of specific data. Regarding the calculation of environmental emissions of purchased goods and services, generic life cycle inventory data are adopted from LCA software (MiLCA) and other public databases. The quality of collected primary data and selected generic life cycle inventory data are assessed based on an internally developed scheme with 5 criteria and 5 grade scores.

Impact assessment results

Ten impact categories are assessed using the LIME2 method. These target impact categories are grouped and weighted according to their relevance to three societies defined in the Japanese Ministry's environmental initiatives as desirable societies for sustainability (Figure 6), where: Low-carbon Society includes climate change; Resource-circular Society includes resource depletion and waste; and Natural-symbiosis Society includes photochemical oxidant, acidification, eutrophication, eco-toxicity, urban air pollution and human toxicity.

Resource depletion and waste (most relevant to "Resource-circular Society") demonstrates a dominant share of the procurement phase impacts, followed by climate change impacts (relevant to the "Low-carbon Society") in use phase. This result indicates that reduction of the use of materials during manufacturing and energy consumption of products at use stage are the key materiality of our business.

The results of this study led to the conclusion to focus on "energy saving design" and "virgin material saving design" by, for example, downsizing of products, increasing recycled-material use in products, and improvement of energy efficiency of products during use. The results will also enable an employee briefing to explain the background and significance of these initiatives in a quantitative way.

Impact assessment results (cont.)

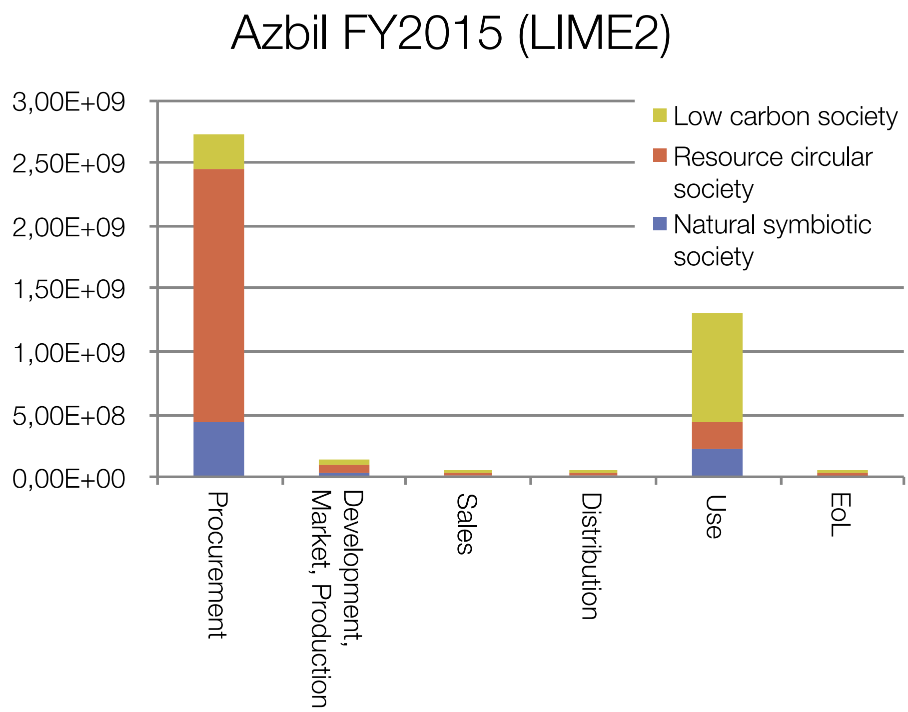


Figure 6. Azbil – Impact assessment results for fiscal year 2015

Limitations and options for improvement

The assessment of use and EoL stages were completed by using a modelling approach to estimate the inventory of our product use and disposal, due to the limitation of data availability. On the other hand, an assessment of the data quality showed that the uncertainty related to those data may not lead to a significant variation of the assessed results. The selection of appropriate generic background data for purchased goods/services from suppliers was a challenge due to the extensive effort that would be required to obtain specific, relevant data from the broad range of Azbil's goods/services procurement and relative number of suppliers.

Strengths and opportunities yielded by the O-LCA study

Results of the O-LCA help to define materiality and enable discussions on priority measures for environmental initiatives and planning for mid-term targets of the environmental management system. In particular, the results of the O-LCA show a different conclusion (i.e., significance of the procurement stage) from that of the SCOPE3 GHG calculation (i.e., significance of the use stage) by considering a broader variety of impact categories.

Documentation

The report is intended to be used internally.

3.3 Banco de México

Central bank, Mexico

Name: Banco de México

Number of employees: 3,000+

Sector: Central bank

Region (country): Mexico

Study leader(s): José Luis Ruiz Cortina (Banco de México, Process Reengineering and Development Manager), Sandra Zepeda Mollinedo (Banco de México, Industrial Engineering Deputy Manager) and Leonor Patricia Güereca Hernández (Universidad Nacional Autónoma de México, external expert)

Typification of the road tester

Banco de México is the Central Bank of Mexico. By constitutional mandate, it is autonomous in both its operations and management. Its main function is to provide national currency (Mexican peso) in the quantity, denomination and geographical distribution demanded by the public, and to maintain the purchasing power of the currency through the regulation of monetary policy.

Description of the organization

Banco de México has successfully implemented pre-emptive and corrective measures to reduce its environmental impact, which led to the obtaining of the "Clean Industry Level II" certification, granted by the national environmental regulator. In 2014, Banco de México decided to perform the first life cycle analysis of banknotes in Latin America, in which two scenarios were assessed: the environmental impact of the banknotes in polymer substrate compared with banknotes in high durability cotton substrate.

Environmental approach of the organization

Pathway 3: based on the fact that a previous LCA was performed on Mexican banknotes.

Experience-based pathway(s)

The aim of the study is to determine which activities within the organization generate the most environmental impacts, with the goal of creating mitigation strategies for the most significant environmental burdens. The results are to be used internally to guide the decision-making process at a top management level.

Motivation and goals

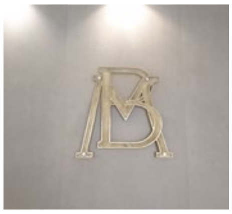
Subject of study: The reporting organization is Complejo Legaria, where the processes of design, production, distribution and shredding of the banknotes withdrawn from circulation are performed. Complejo Legaria is part of the Currency Issuance General Directorate, one of the General Directions of Banco de México.

Consolidation method: Banco de México possesses absolute control over the physical and economical activities of its facilities, and does not possess subsidiaries; the consolidation approach takes into account 100% of Complejo Legaria.

Reference period: 2013

Reporting flow: Quantity (kg) of cotton- and polymer-based banknotes produced during 2013: approximately 1,200,000 kg.

Scope: Reporting organization and reporting flow



The O-LCA considers the complete life cycle of all the denominations of the Mexican banknotes, as well as all the materials, energy and emissions required for the activities within Complejo Legaria. In accordance with the O-LCA Guidance, the assessment in Banco de México includes the direct and indirect activities in a cradle-to-grave assessment. The activities and the inventory are categorized to suit the characteristics of the processes within Complejo Legaria (Figure 7).

Scope: System boundary

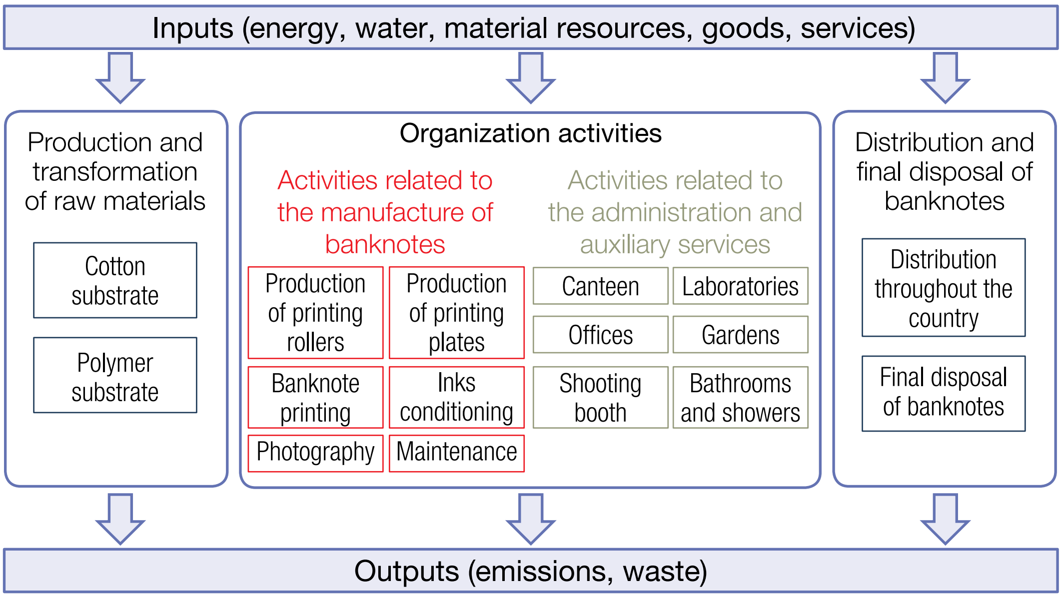


Figure 7: Banco de México – System boundary

Inventory: Data collection approach

Banco de México's data collection follows a hybrid approach. First, a bottom-up approach takes into account the LCA of the products of the organization (banknotes), and second, a top-down approach incorporates data regarding the facilities of the organization.

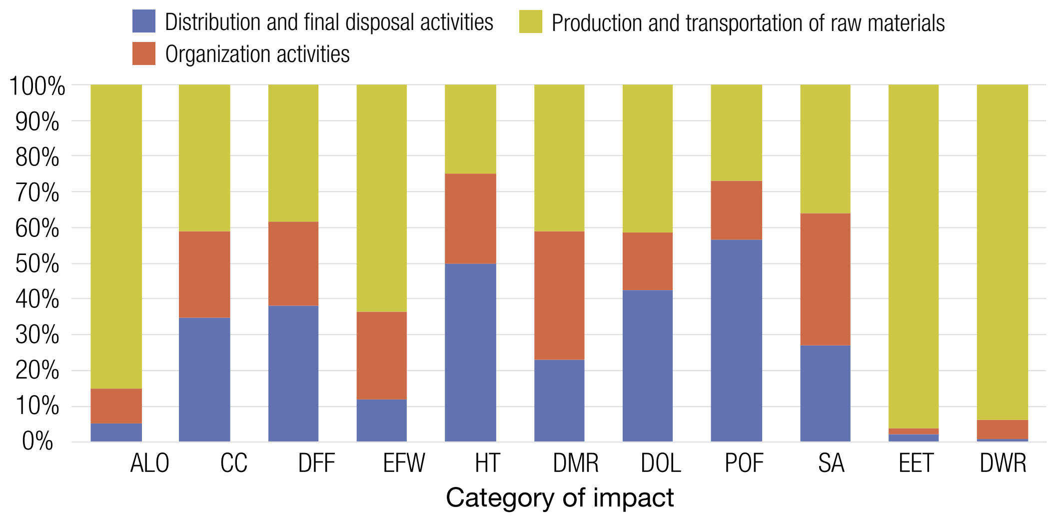
Inventory: Data sources

The inventory data obtained corresponds to the information reported during the year 2013. Information regarding the organization's activities, distribution and final disposal activities is extracted from official reports requested by government regulators; this is considered to be high-quality data. The information is complemented by inquiries to suppliers, models for several inputs and outputs, and the life cycle inventory database Ecoinvent v3.1 database and bibliographical references for the production of certain materials.

Impact assessment results

Banco de México evaluates 11 impact categories using the ReCiPe Midpoint method.

Activities related to the production and transportation of raw materials are the main contributors to the organization's environmental impacts (Figure 8). Moreover, the O-LCA results show that the distribution and final disposal stages produce significant atmospheric emissions primarily due to air and land distribution of the banknotes throughout the Mexican territory. Finally, regarding the organization's activities, auxiliary services (i.e., canteen and steam generators) contribute the largest environmental impact.



ALO: Agricultural land occupation
CC: Climate change
DFF: Depletion of fossil fuels
EFW: Eutrophication of fresh water
HT: Human Toxicity

DMR: Depletion of mineral resources
DOL: Depletion of the ozone layer
POF: Photochemical oxidants formation
SA: Soil acidification
EET: Earth eco-toxicity
DWR: Depletion of water resources

Figure 8: Banco de México – Impact assessment results for 2013

Impact assessment results (continued)

After reviewing the results, the proposals for improvement focused on activities where Banco de Mexico exerts influence. Thus, the organization is considering the inclusion of renewable energy in Complejo Legaria, and a switch from diesel- to natural-gas powered vehicles for the distribution of the banknotes throughout the country.

Limitations and options for improvement

The administrative units, Regional Cashiers and Correspondents Banks are not included in the analysis, since some of these are not located within Complejo Legaria or are private entities. In addition, worker travel and commuting are not taken into account due to the necessity for individuals' private information for the collection of this data. A recommendation for the future is to perform O-LCA to the administrative units and regional cashiers that form the enlarged organizational structure of the Currency Issuance General Directorate of Banco de México.

Strengths and opportunities yielded by the O-LCA study

The O-LCA methodology enabled the organization to obtain broad and detailed information of its environmental impacts, and to create environmental management strategies that could make a significant difference on the high-impact processes. The O-LCA study also reinforces the Banco de México's commitment to environmental protection, and solidifies its position as the only national central bank that has applied this methodology.

Documentation

The report is intended to be used internally. The full report will not be made available to the public due to confidentiality aspects, but an executive summary will be published to www.banxico.org.mx.

3.4 Daimler

Automobile manufacturer, Germany

Typification of the road tester

Name: Daimler AG

Number of employees: 284,015

Sector: Automotive

Study leader(s): Martin Henßler (Daimler AG, environmental advisor)

Region (country): Germany

Description of the organization

The Daimler AG, with its five divisions (Mercedes-Benz Cars, Daimler Trucks, Mercedes-Benz Vans, Daimler Buses and Daimler Financial Services), is one of the biggest producers of premium cars and the world's biggest manufacturer of commercial vehicles with a global reach.

Environmental approach of the organization

For Daimler AG, product responsibility requires a combination of three things: the greatest possible customer benefit, the highest safety standards, and maximum environmental and climate compatibility.

Daimler AG publishes for Mercedes-Benz models environmental product information called "environmental certificates". Part of every environmental certificate is a detailed product LCA. The product LCA is externally audited by the TÜV Süd, assuring the conformity to ISO 14040 and ISO 14044.

Since 2000, Daimler calculates and documents its CO_2 emissions in accordance with the 2004 Corporate Accounting and Reporting Standard of the Greenhouse Gas Protocol Initiative (Scopes 1 to 3) and documents the environmental impacts transparently over the whole vehicle life cycle, from development to production and product use, as well as disposal and recycling.

Experience-based pathway(s)

Combined approach that integrates pathways 2 and 3: according to the environmental information available. The specific life cycle data and emissions are available from product LCAs according to pathway 3. For the activities not linked to vehicles' life cycle, CO_2 emissions accounting according to the GHG Corporate Protocol (scope 1 and 2) are used (pathway 2).

Motivation and goals

The aim of the study is to analyze the company's environmental impact, focusing on hotspots along the Daimler AG value chain. Identifying opportunities to improve the environmental performance of the company requires a holistic methodology that extends current accounting and reporting approaches. For Daimler AG, a multinational company with a broad product portfolio, applying a comprehensive approach that can identify critical process or activities is critical.

Subject of study: The reporting organization is the Mercedes-Benz Cars (MBC) business unit as it has high economic significance compared to other business units. Production sites all over the world are included within the scope of this study. However, the largest impacts in the use phase are caused by trucks (high fuel consumption, mileage). Due to the absence of a worldwide fleet emission standard for trucks (currently in progress), the study does not consider the trucks business unit in this study.

Consolidation method: Financial control

Reference period: 2015

Reporting flow: Number of sold passenger cars (Mercedes-Benz Cars including Smart) in 2015 – a total of 2,001,438 vehicles.

Scope: Reporting organization and reporting flow

In this study, a cradle-to-grave approach is applied. Besides direct activities associated with the company, upstream and downstream process, (e.g., use and end-of-life phase of products) are included. The following table shows the indirect and direct activities within the system boundary (Figure 9).

Indirect upstream activities	Direct activities	Indirect downstream activities
Extraction and production of purchased materials, goods and services	Generation of energy resulting from combustion of fuels in stationary sources	Distribution of sold cars
Transportation and distribution of materials and goods between suppliers and from suppliers in vehicles not owned by the company	Manufacturing of passenger vehicles	Use phase of sold cars (driving emissions)
Extraction, production and distribution of purchased electricity, steam and heating energy	Business travels with owned vehicles	Fuel production for use phase of sold cars
Business travels with not owned vehicles (e.g., train, airplane)	Employee commuting using vehicles owned	End-of-life treatment of sold cars

Figure 9: Daimler AG – System boundary

Scope: System boundary

In general, a hybrid approach is applied. As Daimler regularly conducts product LCAs, performs sustainability reporting, and reports to Carbon Disclosure Project, various data already exist that can be used when applying O-LCA methodology. The existing product LCAs are multiplied with the specific sales number (bottom-up) and supporting activities are added (top-down).

Inventory: Data collection approach

Both specific (primary) and generic (secondary) data are encompassed in this study. Primary data exist for the "extraction, production and distribution of purchased electricity, steam and heating energy", as well as the "generation of energy resulting from combustion of fuels in stationary sources" and "manufacturing of passenger vehicles" for the single indicator CO_2. The data are collected from the 23 facilities via the existing local experts on environmental management systems and documented in company consistent database system (DUDIS).

Inventory: Data sources



Inventory: Data sources

Fuel consumption and CO_2 emissions of the vehicle use phase are calculated on the basis of official type-approval data (generic operational performance of 150,000 km). Driving emissions (i.e., NOX, CO, NMVOC and CH4) are calculated on the basis of threshold values of exhaust-emission legislation (Euro 6). LCA calculations are based on the GaBi software and its database.

Impact assessment results

The environmental impact categories are calculated using the impact assessment method CML-IA baseline developed by the Institute of Environmental Sciences, Leiden University, Netherlands (Figure 8). The selection of the applied categories relies on various LCA studies of the European automotive industry.

The largest share of primary energy consumption and CO_2 emissions over the life cycle of a vehicle is attributable to the use phase. In the case of a car with a combustion engine, it is about 80%. The remaining 20% is consumed almost entirely during the manufacturing process. Vehicles with alternative drive systems have lower CO_2 emissions during the use phase. However, the primary energy consumption of these vehicles generally increases during production because of the energy needed to manufacture certain components such as batteries, electric motors, and electronic control systems.

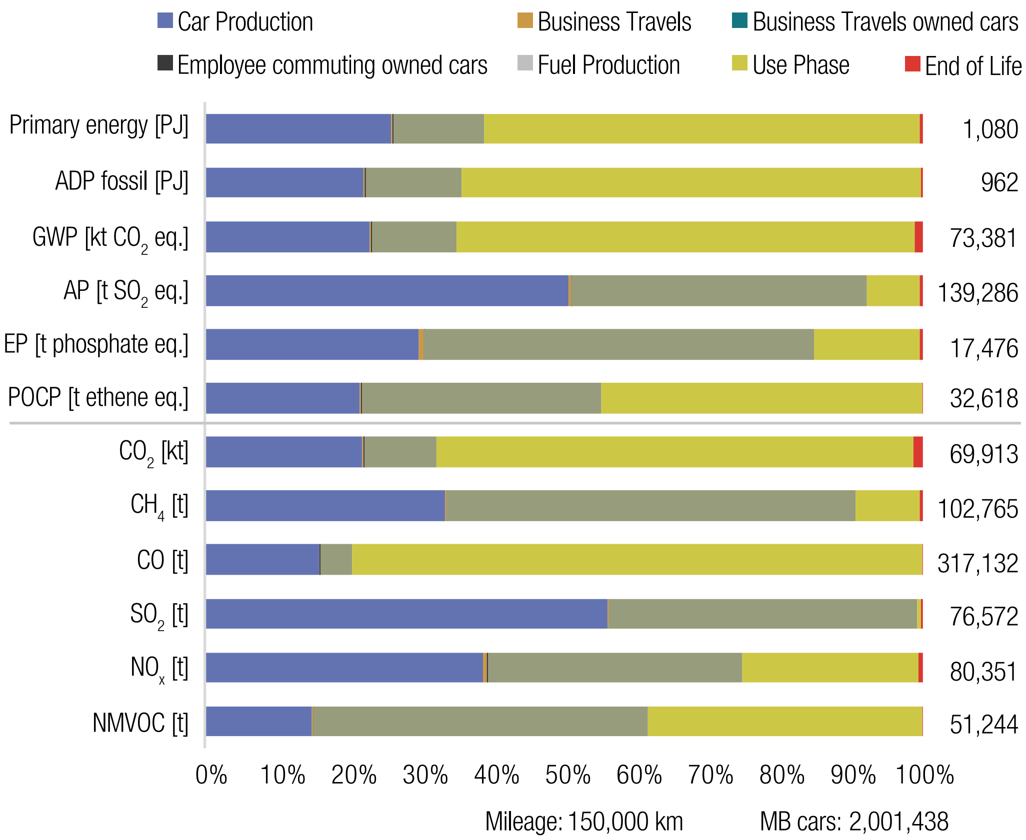


Figure 10: Daimler AG – Impact assessment and inventory results for 2015

Since the company reports to many institutions their main interest is to have consistent definitions. Here It would be desirable to use uniform nomenclatures and categories for the GHG and the O-LCA studies.

An expansion of the organizational boundaries in order to include more business divisions, beyond the Mercedes-Benz cars, will be considered in future

Limitations and options for improvement

In general, the complexity of the automobile industry does not allow for comparisons of different car manufacturers in the framework of an overall reporting scheme. However, an annual comparison within the same company is feasible. For consistent comparisons, data, methods and tools should be simplified and generalized to a large extent, but then it would not be possible to identify real ecological improvements.

Strengths and opportunities yielded by the O-LCA study

In contrast to other environmental reporting schemes, the O-LCA methodology helps to identify the organization's environmental impacts within the whole life cycle for all impact categories and avoids shifting the environmental burdens from one life cycle phase into another.

Documentation

The full report is intended to be used internally. A partial disclosure of results in form of a scientific publication is planned.

3.5 Demarchi industrial complex-BASF

Coatings manufacturer, Brazil

Typification of the road tester

Name: Demarchi industrial complex-BASF S.A.

Number of employees: 1,200

Sector: Coatings

Study leader(s): Max Wilson Silva (BASF, Applied Sustainability Analyst), Sueli Aparecida de Oliveira (BASF, Applied Sustainability Consultant)

Region (country): Brazil

Description of the organization

BASF Demarchi is one of the industrial complexes of BASF SA Group, is located in São Paulo, Brazil and produces paints, enamels, varnishes and resins per year. At this site, automotive, industrial, automotive refinishing and decorative paints (including the Glasurit and Suvinil brands) are produced.

Environmental approach of the organization

BASF South America has established regional performance targets for 2025 (with the baseline of 2013) for waste (-30%), water (-20%), and energy efficiency (+10%). The company prepares its annual report considering consumption, emissions (guided by the GHG Protocol and industry-specific standards) and performance. The Demarchi+Eco-Efficient Project is a local initiative that is being designed to be replicated in other factories and was already included as a case study in the O-LCA Guidance. It includes the supply chain and foresees the involvement of employees in a process of internalization of the "life cycle thinking" concept

Experience-based pathway(s)

Other pathways: existing multi-impact environmental assessment of the organization and its value chain (upstream) from 2010 to 2015, according to the company-own Demarchi+Eco-Efficient method.

Motivation and goals

The main aim of the study is to diagnose the environmental impact generated on the site (direct activities) and in the value chain (upstream indirect activities), and identify critical points and opportunities for improvement at the organizational level. The results obtained are used for internal decisions to improve processes on-site and along the value chain and are not intended to be used to make comparisons with other industries or company producers.

Scope: Reporting organization and reporting flow

Subject of study: The reporting organizations is the BASF Paints and Varnishes Industrial Complex located in the Demarchi neighborhood in São Paulo, Brazil.

Consolidation method: The organization has the whole financial and operational control, owning and controlling all its units. The seven plants at the industrial site are considered.

Reference period: From 2010 to 2015

Reporting flow: Amount (kg) of products available on shelf (produced) every year at the Demarchi site, which comprises paints, enamels, varnishes and resins (Table 4).

	2010	2011	2012	2013	2014	2015
Plant 1 (varnishes)	34,485	32,077	30,226	27,639	28,931	25,881
Plant 3 & 6 (automotive coatings)	14,287	14,210	13,858	13,696	9,195	5,714
Plant 4 (automotive paints)	1,719	1,469	1,459	1,450	1,044	817
Plant 5 (automotive coatings)	810	709	711	1,407	1,303	1,103
Suvinil (decorative paints)	218,239	231,828	222,110	213,918	206,428	196,023
Resin (resins)	78,712	83,236	78,501	74,296	68,823	61,620
Total	348,251	363,529	346,864	332,406	315,723	291,158

Table 4: Demarchi industrial complex-BASF – Reporting flow (kg)

Note: Plant 2 is a stock building and not a production plant.

Scope: Reporting organization and reporting flow (continued)

This cradle-to-gate study considers raw materials extraction and processing, transportation to Demarchi, production and landfill disposal of waste produced at the facilities (Figure 11). The use phase is not considered, because no data are available and the organization's initial main objective is to map out direct opportunities for improvements. Only production-related activities are considered; administrative activities are excluded.

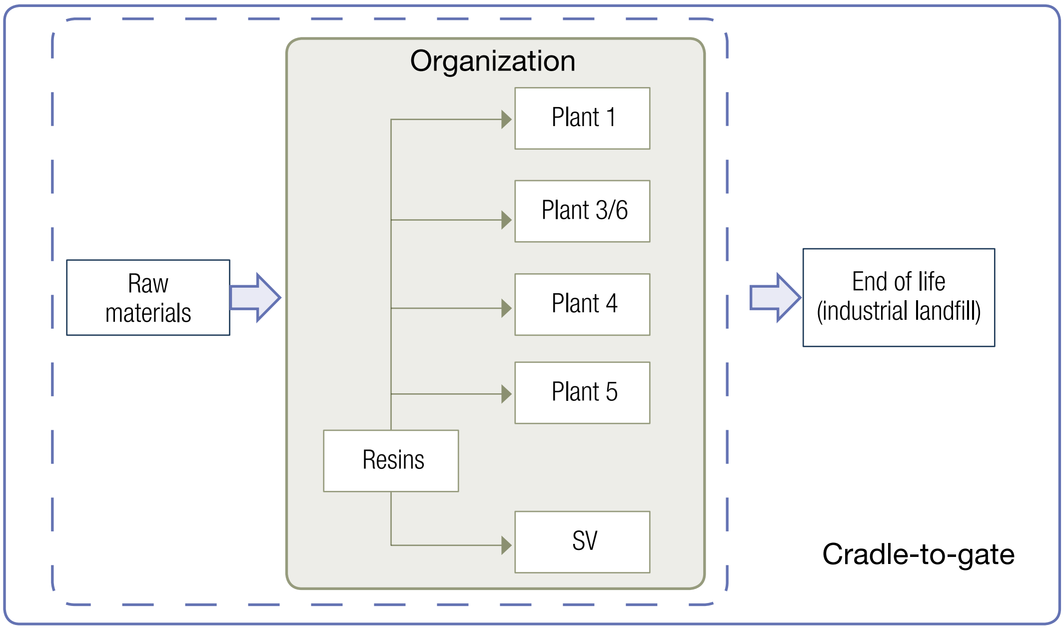


Figure 11: Demarchi industrial complex-BASF – System boundary

Scope: System boundary

A top-down approach (or inventory-oriented approach) is used for the quantification of inputs and outputs linked to the production of a defined mix of products. Those raw materials with a mass representation below a certain threshold are cut off, unless they were deemed critical, from a toxicity or economic point of view, by the managers of each plant.

Inventory: Data collection approach

For the collection of primary data, it is possible to obtain information from the SAP system and from the Annual Production Report, containing the quantity, volume and details of all raw materials consumed by the site. Additionally, the correspondent MSDS (Material Safety Data Sheet), Emergency Sheets and technical information for the various raw material inputs in the processes serve as data sources. Life-cycle assessments at product level are available for some products from other BASF sites that serve as raw materials for Demarchi.

Inventory: Data sources

The results are shown in a single-score overall scheme internally called Environmental Fingerprint (Figure 12). Values for each category are normalized by dividing each category result by the highest value reached in the same category in the six years considered.

The indicators of the scheme include and conjugate categories at the inventory and impact assessment levels, in some cases not fully agreeing with ISO 14040, while it is useful for the organization. The sub-categories "solid waste" (potential cost of disposal and/or treatment is accounted for waste as a metric to establish the level of impact of solid waste, and total cost aggregated), "air emissions" (which includes global warming, photochemical ozone creation, ozone depletion and acidification) and "water emissions" (based on the dilution volume approach, inventory indicator) are aggregated and weighted into the Emissions category. Resources correspond to abiotic depletion (CML 2001); Land use corresponds to ecosystem damage; Human toxicity potential corresponds to the European Union H-phrase system; for Energy consumption, the cumulative energy demand is used; and the Potential accidents and occupational diseases considers the number of professional accidents throughout the life cycle.

Impact assessment results

Some initiatives are being taken to allow the site to improve the performance over the years, and in addition to internal communication work with employees, there are also parallel projects already under way such as the Zero Landfill Initiative and the adaptation of the site technology to obtain ISO 50001 Energy Efficiency Certification.

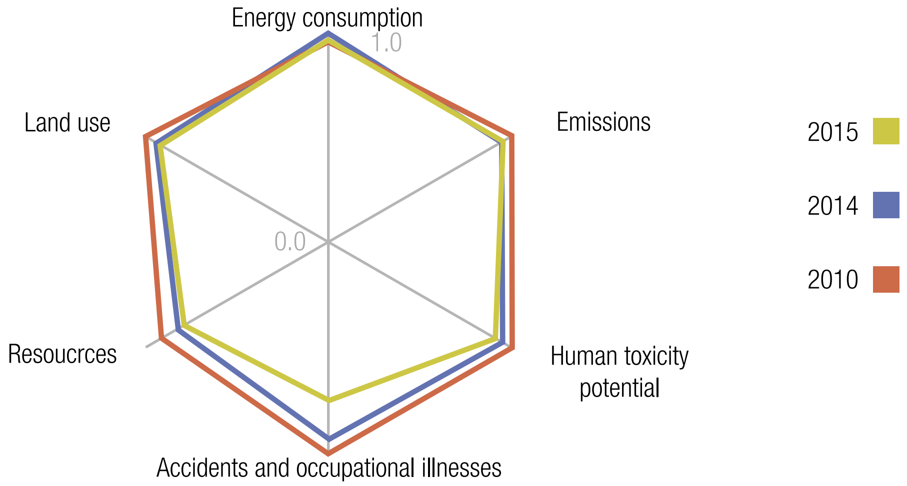


Figure 12: Demarchi industrial complex-BASF – Impact assessment and inventory results

Limitations and options for improvement

Up to now, an impact assessment tool and inventory data that were structured on an Excel basis has been used. In the next versions, a platform to increase user-friendliness will be applied. Also, more detailed information on the specific consumption of certain equipment could be better elaborated so as to facilitate the mapping of improvement opportunities. Finally, in order to extend the scope of the study to the use phase, a specific database will be needed.

Strengths and opportunities yielded by the O-LCA study

The format used in the project not only helped to establish sustainability performance indicators, but also to sensitize and empower the stakeholders that were directly involved. The project enabled the organization to analyze the maturity of BASF's internal and external information system for an O-LCA study. Based on this experience, applying the O-LCA method to other sites is feasible and recommended. Moreover, the O-LCA experience made the company conscious about the opportunities and advantages afforded by strong cooperation with other value chain stakeholders.

Documentation

The report is intended to be used internally.

3.6 Faculty of Science and Technology-UPH

Academia, Indonesia

UPH UNIVERSITAS PELITA HARAPAN

Name: Universitas Pelita Harapan (UPH)

Number of employees: 1,000

Sector: Academia

Study leader(s): Jessica Hanafi (Universitas Pelita Harapan, Researcher / Lecturer)

Region (country): Indonesia

Typification of the road tester

Universitas Pelita Harapan (UPH) is a leading private university in Indonesia established in 1994. It is located at Karawaci, in the outskirt of Jakarta Capital Region. UPH consists of 13 faculties and 29 study programs that run regular programs, online learning, joined degree, and dual degree programs.

Description of the organization

UPH is well known in Indonesia for its green campus and excellent facilities. The university was certified for ISO 9001 and since 2010, the university has an internal quality assurance system based on ISO 9001. Although many research activities related to sustainability and environmental management system have been conducted, it has not been a university-wide commitment. The university has not disclosed any sustainability reporting so far. The O-LCA study is implemented as a pilot project in the Faculty of Science and Technology (FaST).

Environmental approach of the organization

Pathway 1: Due to limited previous environmental management effort taken by the university.

Experience-based pathway(s)

The goal of the study is to raise environmental awareness around the university and incorporate environmental indicators into the university's overall performance. By conducting a pilot project on O-LCA, the faculty can show that the effort in providing quality environmental data on education activities is worth being disclosed. The results will be useful for the faculty and university leaders to take strategic decisions in the future and can be used as marketing tool promoting UPH as a sustainable university.

Motivation and goals

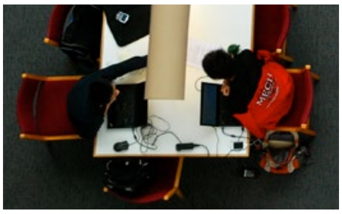
Subject of study: The reporting organization is the FaST, as a pilot project in UPH. To represent other facilities available in the university, the swimming pool, the dormitory, and the garden are (partially) included.

Consolidation method: The FaST is one of the 13 faculties in UPH. The university has operational control over the faculties as well as over the supporting activities identified in the study.

Reference period: 2015

Reporting flow: Number of students enrolled at the FaST – i.e. 1,220 during 2015.

Scope: Reporting organization and reporting flow



Scope: System boundary

The university provides services for the students and the community. Since students are the reporting flow in this study, the downstream activity would be the products or services produced by the graduates. It is difficult to measure this, especially due to the graduates' varied career opportunities. Therefore, the system boundary of the study is defined as a cradle-to-gate assessment (Table 5).

Upstream Indirect Activities	Direct Activities
Production of materials or products purchased	Employee business travel using vehicles owned/ controlled by the organization
Purchased electricity and fuel	Student commuting using vehicles owned or controlled by the organization
Production of tap water	Community service using vehicles owned or controlled by the organization
Employee commuting and business travel using vehicles not owned/controlled by the organization	
Student commuting and business travel using vehicles not owned/controlled by the organization	
Management of e-waste and paper waste produced by the university	
Outsourced services (e.g., cleaning service, gardening service)	
Transportation of materials purchased	

Table 5: Faculty of Science and Technology-UPH – System boundary

Inventory: Data collection approach

The life cycle inventory is compiled by using a top-down approach. Data for direct activities is either based on the data documented at each department or recorded at the university level and then allocated to the faculty (e.g. electricity and water).

Inventory: Data sources

Data are collected based on surveys, interviews, faculty documentation, and the university database management system. The data on purchased materials or products are acquired from the University Procurement Department and University Maintenance Department. Activities related to travels and vehicles usage are compiled based on the travel documents and assignment letters from the faculty administration office and University Human Resources Department. Only data on waste paper and e-waste are available. It was not possible to collect data directly from suppliers, therefore the production processes and value chain were modelled with Ecoinvent v3.1.

Impact assessment results

The life cycle impact assessment is conducted by using ReCiPe midpoint (H) and Cumulative Energy Demand (Table 6). The Pfister 2009 water scarcity method was initially selected for this study but was excluded after a first screening because it does not capture the actual condition at the location of the study.

Impact Category	Unit	Total	Upstream Indirect Activities	Direct Activities	Method
Climate change	kg CO_2 eq	1,616,782	1,613,097	3,685	ReCiPe
Marine ecotoxicity	kg 1,4-DB eq	50,310	50,135	175	ReCiPe
Freshwater ecotoxicity	kg 1,4-DB eq	55,206	55,005	201	ReCiPe
Freshwater eutrophication	kg P eq	1,484	1,483	1	ReCiPe
Human toxicity	kg 1,4-DB eq	1,408,409	1,407,212	1,197	ReCiPe
Particulate matter	kg PM10 eq	19,063	19,058	5	ReCiPe
Water depletion	m3	119,918	119,902	16	ReCiPe
Cumulative energy demand	MJ	24,473,451	24,416,719	56,732	CED

Table 6: Faculty of Science and Technology-UPH – Impact assessment results for 2015

Impact assessment results

The main contributors to the environmental impacts are purchased electricity, transportation using medium-sized passenger cars used for employee commuting to West Jakarta, and CRT monitors in e-waste. Impacts can be reduced by developing the energy-saving policy, tracking energy consumption, incorporating sustainable activities around the campus into university-wide policies, using carpool system or employee shuttle busses, encouraging Bike-to-Work, and selecting responsible e-waste management vendors.

Limitations and options for improvement

From the study, it was derived that data availability is an important factor. Management of data, especially related to water use and waste management, needs to be further improved. Specific information related to the manufacture of the materials and products at suppliers' sites would also enhance the quality of the study.

Strengths and opportunities yielded by the O-LCA study

By doing O-LCA, being more sustainable and becoming a sustainable university is possible. The O-LCA results enable the university to plan focused measures within the campus. This result highlights the importance of an environmental management policy in the university. It also opens up the need for a structured data collection and database to improve resource efficiency.

Documentation

The full report is intended to be used internally. A partial disclosure of results in the form of a scientific publication is planned.

3.7 Foundation Emmaüs

Recycling NGO, France

Typification of the road tester

Name: Foundation Emmaüs

Number of employees and volunteers: 38

Sector: Social and recycling NGO

Region (country): Switzerland and France

Study leader(s): José Manuel Gil Valle (Foundation Emmaüs, project leader), Alain Capmas (Emmaüs Bougival, responsible) and Juan Pablo Chargoy Amador (Center for Life Cycle Assessment and Sustainable Design, México, external expert)

Description of the organization

Emmaüs is a non-religious movement actively working against poverty and exclusion. It brings together 350 organizations in 37 countries across four world regions. Their common objective is to empower people experiencing poverty and social exclusion to take back control over their lives and demonstrate that a fairer world is possible.

Environmental approach of the organization

The core concept of Emmaüs' communities consists in involving excluded individuals in recycling activities. Although a multi-impact approach is applied for the first time in this O-LCA study, previously, the Emmaüs Bougival Community (Île-de-France, France) and Traperos de Emmaüs (Navarra, Spain) performed a precise analysis of their CO_2 emissions. The carbon balance calculated in Bougival demonstrated the positive effect of the recuperation and reuse activity of the Emmaüs groups, since all the objects recycled by Emmaüs reduce the need to produce new ones.

Experience-based pathway(s)

Pathway 1: Little or no initial environmental experience or data was available for the community assessed. The complementary recommendations of the O-LCA Guidance for a simplified implementation of O-LCA in SMEs were taken into account.

Motivation and goals

Given its environmental focus, Emmaüs has an interest in assessing the environmental impacts of its own activities throughout the whole value chain. The results enable the identification of environmental hotspots, and will set a reference for performance tracking over time for all the groups in Emmaüs. The study will deliver the basis for environmental communication with stakeholders and reporting and demonstrate an expanded internal environmental awareness for marketing purposes.

Scope: Reporting organization and reporting flow

Subject of study: The reporting organization is a local Emmaüs Community, located in Etagnières, Switzerland, that recovers furniture, textiles, books, electrical appliances, trinkets, etc.

Consolidation method: The local Emmaüs Community has operational control over all of the activities of the organization identified in the study.

Reference period: 2015

Reporting flow: Amount of annual sales at the secondhand store expressed in mass (kg).

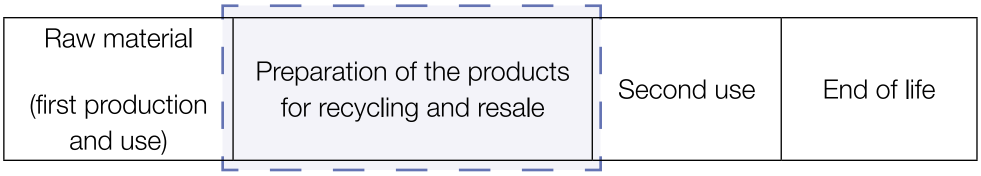


Figure 13: Foundation Emmaüs – Life Cycle Assessment of products for resell and recycling

Scope: System boundary

The system boundary (Figure 13) will consider a cradle-to-gate approach and involves the inputs and outputs necessary for each of the activities included, extended by also considering the customers' transport of sold goods. The production and first use of products are not considered, nor are the use and end-of-life of the sold recycled goods. The activities considered are categorized into indirect upstream activities and direct activities. Supporting activities like the organization's buildings and employee commuting are taken into account.

Inventory: Data collection approach

A top-down approach is used as first approximation to obtain a basis for future studies. Transport data are collected with higher granularity and in order to differentiate between truck transport, donor transport and customer transport. Energy data are disaggregated into energy production on site (boiler), and electricity production from the grid and from own solar installation.

Inventory: Data sources

Data from the organization, literature, statistics and databases were collected, including both generic and specific. Data quality is controlled using a scheme with the following criteria: reliability, completeness, temporal correlations, geographical correlation, and further technological correlation.

Impact assessment results

The impact assessment methods used are ReCiPe endpoints (Hierarchist) and IPCC 2013 GWP 100a.

	Direct activities	Indirect activities	Total
Climate change - human health	2,294.4	11,594.3	13,888.7
Ozone depletion	0.0	4.6	4.6
Human toxicity	73.2	1,513.6	1,586.8
Photochemical oxidant formation	0.2	0.6	0.8
Particulate matter formation	543.4	1,704.0	2,247.4
Ionising radiation	0.0	145.3	145.4
Climate change - ecosystems	1,451.9	7,336.4	8,788.3
Terrestrial acidification	4.8	9.9	14.8
Freshwater eutrophication	0.0	8.2	8.2
Terrestrial ecotoxicity	3.3	21.8	25.1
Freshwater ecotoxicity	0.0	42.0	42.0
Marine ecotoxicity	0.0	8.3	8.3
Agricultural land occupation	0.2	493.8	494
Urban land occupation	0.0	95.5	95.5
Natural land transformation	0.0	409.2	409.3
Metal depletion	3.3	950.6	953.9
Fossil depletion	3.0	11,615.1	11,618.2
Total	**4,378.0**	**35,953.2**	**40,331.2**

Table 7: Emmaüs Foundation – Impact assessment results for 2015, absolute value (pt)

Impact assessment results (continued)

The assessment enables the identification of environmental hotspots in the impact categories climate change - human health, and climate change - ecosystems, followed by fossil depletion and particle matter formation (Table 7). Electricity production, the organization's buildings, and transport of purchased goods are found to be relevant activities. The impacts related to the transportation of sold materials represent an overall contribution of 41%. Actions to reduce transport-related impacts, such as selling points next to potential customers and online sales are recommended.

Limitations and options for improvement

The main limitation of the study is the exclusion of certain capital goods, such as trucks and the boiler, due to capacity limitations. The same applies for cleaning products, medicines, gardening products and personal care products, due to lacking inventory data. The analysis of these aspects is planned for the future because of the potential effects of micro-pollutants. Facilities, such as kitchen, and green and gardening areas were also not included since these have already been targeted in the framework of a food recuperation program.

Moreover, the use and end-of life phases of the sold recycled products was not taken into account in this study, due to the high complexity of assessing the environmental effects of actually extending the life of products that otherwise would most likely end up as waste.

Strengths and opportunities yielded by the O-LCA study

Through the O-LCA study, hotspots could be detected, which when addressed, could help to improve the image of the Community with regard to its environmental impacts. Emmaüs' study was a pilot and serves as example for other Emmaüs communities around the world, and as a baseline for future performance tracking in the Community. In this regard, the tool developed for this study will also be used for future applications and can be useful for further Emmaüs Communities and NGOs in general. As a first application in an NGO, Emmaüs' O-LCA experience has the potential to be a landmark for environmental assessment activities among charitable organizations.

Documentation

The full report is available at:
http://emmaus-europe.org/wp-content/uploads/2017/05/EN_Emmaus-Etagnieres-OLCA-Final-Report-.pdf

3.8 Junk That Funk

Waste management, Canada

Name: Junk That Funk (JTF)

Number of employees: 4

Sector: Waste management

Region (country): Canada

Study leader(s): Rob Sianchuk (Junk That Funk, LCA Researcher)

Typification of the road tester

Junk That Funk (JTF) was founded in 2007 and services the greater Ottawa Carleton region. It is a junk removal company servicing residential, industrial, and commercial customers for junk, rubbish, and electronics waste (e-waste) removal services. Since 2009, the organization has taken part in the City of Ottawa's "Take It Back Program", a local initiative that offers Ottawa's residents a convenient option to dispose of specialty items that are no longer wanted or needed. JTF is known for providing free e-waste drop-off events that also raise funds for local sports charity, Their Opportunity.

Description of the organization

Previous efforts of the organization include quantifying and reporting recycling rates of waste removed, while the environmental strategy at the organization is to donate and recycle as much of the waste removed as possible.

Environmental approach of the organization

Pathway 1: JTF has no previous experience with environmental analysis tools.

Experience-based pathway(s)

The aim of the study is to help JTF manage its environmental impacts from a life cycle perspective. The study is intended for monitoring of environmental performance over time and answer the question: "Where should JTF focus on improving their environmental performance?"

The intended audiences are internal and external to JTF, including local clients and community, and the international community. JTF is the commissioner of this O-LCA study.

Motivation and goals

Subject of study: The reporting organization is JTF, a full-service junk removal service provider operating in the Ottawa, Canada region. It is a small sole proprietorship with control of two facilities. JTF has no ownership or share of any other organization's facilities, franchises or companies.

Consolidation method: Financial control

Reference period: 2015

Reporting flow: Volume of waste removed from Ottawa in 2015, totaling 183 m^3.

Scope: Reporting organization and reporting flow

This O-LCA study takes a cradle-to-gate perspective of JTF (Figure 14). Activities associated with any input/output mass or energy flow that contributed more than 2% to any impact category in the life cycle impact assessment profile are included. All downstream activities (i.e., use and end-of life stages) are excluded since JTF has no influence on these stages and because there are numerous potential marketable uses for these recovered materials.

Scope: System boundary

Scope: System boundary (continued)

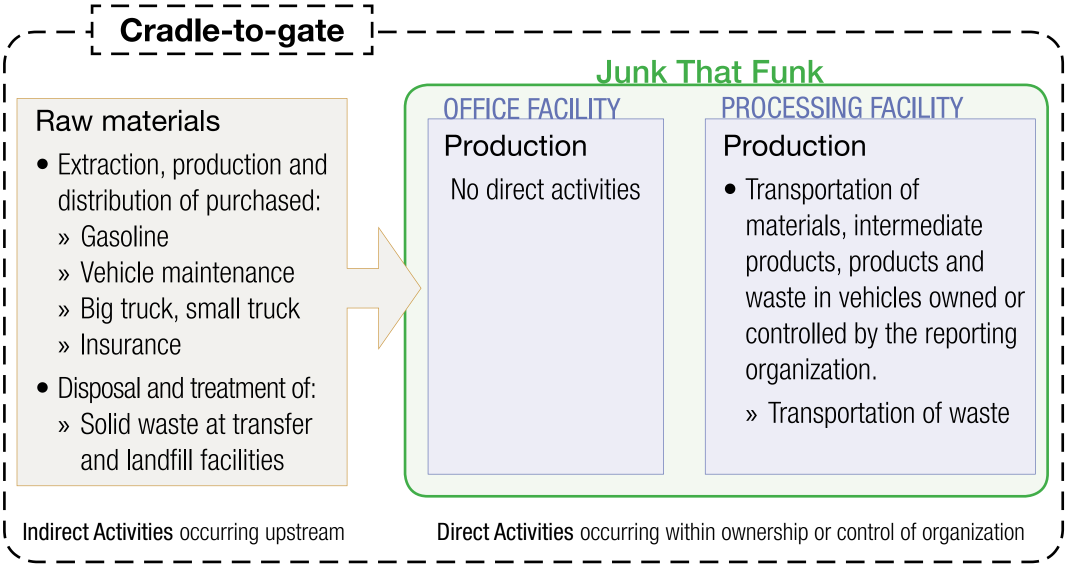


Figure 14: Junk That Funk – System boundary

Inventory: Data collection approach

A top-down data collection approach is followed. Upstream activity models for all inputs are added to JFT's direct activity model (e.g., transportation of waste materials).

Inventory: Data sources

Specific product flow data sources include accounting records, disposal weight bills, and owner estimates for direct activities. Generic life cycle inventory data sources include the US LCI Database, and environmentally-extended input-output (EEIO) datasets from Statistics Canada's Environmental Accounts and the Canadian National Pollutant Release Inventory (NPRI).

A data quality rating (DQR) evaluation was used that is based on the data quality criteria proposed by the O-LCA Guidance: temporal, geographic, and technological representativeness, and precision, completeness, reproducibility and reliability.

Inventory results

The processing and office facility flows, reference units, and description of data collected are described in Table 8.

Product Flow	Unit	Description of product data collected
Transported waste materials	L	Liters of gasoline combusted in big/small trucks, typically hitched to big or small trailer to transport removed waste materials (including empty backhauling).
Purchased gasoline	$CAD	Cost of regular 87 gasoline.
Purchased big truck	$CAD	Depreciation of 2008 F250 Super Duty XLT SuperCab Long Bed 4WD with 144L fuel tank and a mass of 4.3 MT.
Purchased small truck	$CAD	Depreciation of 2007 F250 Super Duty XLT 2WD with 110L fuel tank and a mass of 4.0 MT.
Purchased vehicle maintenance	$CAD	Cost of various vehicle maintenance purchases, including oil changes, tire change and adding windshield washer fluid.
Disposed waste	$CAD	Cost of landfilling waste.
Insurance	$CAD	Cost of vehicles and business insurance.

Table 8: Junk That Funk – Description of data collected in the inventory

IMPACT 2002+ is the impact method used. The three damage categories are selected primarily due to the default settings in Open IO-Canada (Table 9), the tool used to model indirect downstream activities.

Impact assessment results

Activity Type	Activity Description	Climate change (tCO2 eq)	Ecosystem quality (PDF*m2*yr)	Human health (DALY)
Direct	All direct activities	28	580	0.01
Indirect Upstream	All indirect upstream activities	27	310	0.02
Total	All direct and indirect activities	56	900	0.03

Table 9: Junk That Funk – Impact assessment results for 2015

The interpretation of the life cycle impact assessment results indicate that transporting waste with JTF's trucks makes the largest contribution to climate change, ecosystem quality and human health impacts. Specifically, JTF should search for truck improvements that address these impacts, and aim to purchase fuel and vehicle maintenance with a lower environmental impact.

Limitations and options for improvement

Future O-LCA iterations should therefore strive to use specific life cycle inventory data on the transportation of waste (i.e., direct emissions measurements). Only generic life cycle inventory datasets were used, therefore specific life cycle inventory data or EPDs from indirect upstream activities should be considered in the future.

Also, including all impact categories from IMPACT 2002+ would improve the quality of the impact assessment.

Strengths and opportunities yielded by the O-LCA study

This first application of the O-LCA at JTF has afforded the organization a significant learning opportunity into the methodology. Awareness raising about O-LCA in the Ottawa region has revealed an interest from stakeholders in the process.

Documentation

The full report will be available from the Junk That Funk website:
http://junkthatfunk.com/how-we-different

3.9 Maschio Gaspardo

Agricultural equipment manufacturer, Italy

Typification of the road tester

Name: Maschio Gaspardo S.p.A.

Number of employees: 1,800 (worldwide)

Sector: Agricultural equipment

Region (country): Italy

Study leader(s): Enrico Breda (Maschio Gaspardo, Energy Manager), Alessandra Zamagni (Ecoinnovazione, external expert) and Gioia Garavini (Ecoinnovazione, external expert)

Description of the organization

Maschio Gaspardo Group produces agricultural machineries (e.g., for tillage, seeding, crop care, green maintenance, hay making), offering a wide range of implements to answer farmers' needs worldwide. The company has 10 production plants and 12 commercial branches in Europe, Asia and North America.

Environmental approach of the organization

The Maschio Gaspardo Group started its pathway toward environmental impact assessment in 2012 and 2013 with the quantification of the carbon footprint of the headquarters and production plants in Campodarsego (Padova), according to the Carbon Trust. Afterwards, the Group decided to voluntary apply the methodology for the quantification of the Organisation Environmental Footprint (OEF) (EC 2013), for the Italian production plants fully controlled by the Group, namely Campodarsego, Cadoneghe, Morsano and Portogruaro plants.

Experience-based pathway(s)

Pathway 4: The organization has already quantified the carbon footprint of the headquarters according to the Carbon Trust. Moreover, the organization has carried out the organisation environmental footprint of the Italy-based production plants.

Motivation and goals

Several applications of the results are foreseen: the identification of the organization's environmental hotspots, including those related to the supply chain; and the identification of measures for improvement.

With this study, the organization aims to track its environmental performance over time for internal purposes, and to demonstrate the company's commitment toward environmental protection; obtain key information on the benefits related to the application of lean manufacturing; extend the system boundary of the study to include the use phase and the end-of-life of the manufactured products; and finally, improve internal management procedures.

The intended audience is the management committee of Maschio Gaspardo.

Subject of study: The reporting organization is limited to the production plants in Italy that design and produce the company's product portfolio (i.e., agricultural equipment for tillage, seeding, crop care, green maintenance and hay making). Sales branches outside Italy are excluded.

Consolidation method: Only the plants located in Italy and over which Maschio Gaspardo has the full financial control (100% owned) are considered.

Reference period: 2012 (complementarily, 2013 is assessed)

Reporting flow: Overall annual production (expressed in number of sold products) of the subset of the Italian plants: 23,196 units sold in 2012, amounting to 76% of the units sold worldwide in that year.

Scope: Reporting organization and reporting flow

The system boundary (Figure 15) follows a cradle-to-grave approach: the so-called product stage that includes raw materials extraction and pre-processing, and transport of the raw materials and semi-finished products to the production plants; the production plants stage, including the manufacturing of the finished products, disposal and treatment of waste, employee commuting, organization personnel travel, and client and visitor transportation; and finally, use phase and end-of-life of sold products.

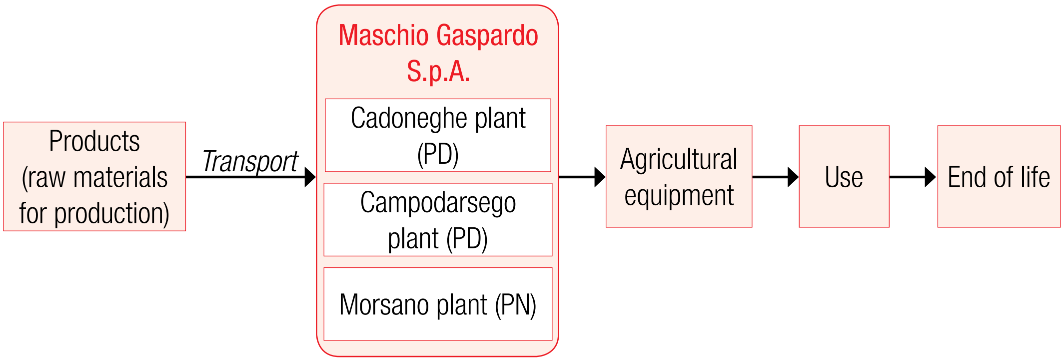


Figure 15: Maschio Gaspardo – System boundary

Scope: System boundary

The data collection follows a hybrid approach, which is mainly top-down, considering the reporting organization as a whole, and bottom-up, used for the accounting of raw materials and its transport, and for use phase and end-of-life. For each product category, a representative product has been selected (the one with the highest sales), modelled and considered as representative of the rest.

A cut-off criterion based on the economic value is applied for the collection of the data on the products and their modelling. These cut-off products (23% in total) are made of the same materials already accounted for in the representative products, and from the point of view of the weight, differences are negligible compared to the products accounted for. Then, the cut-off of products are considered through representation by the most representative product categories.

Inventory: Data collection approach

Data sources (for specific data) are represented by invoices/bills for energy and resource consumption, a mileage claim form, an annual report provided for business travel, an environmental declaration form, etc. Data on raw materials, use and end-of-life phases are estimated. Commercial databases, such as GaBi, are also used.

Data collection involved creating data collection sheets and distributing them to the Maschio Gaspardo technical experts; face-to-face meetings with Maschio Gaspardo's staff; telephone meetings; and contacts by email.

Data Quality scheme and rating as per organisation environmental footprint is used.

Inventory: Data sources

The applied ILCD/PEF recommended impact assessment method, midpoint, v.1.09 considers all the environmental impact categories. A selection of the relevant impact categories is applied in this study for the interpretation, only those belonging to Level I and II (according to the classification of robustness in the ILCD Handbook) are considered.

Impact assessment results

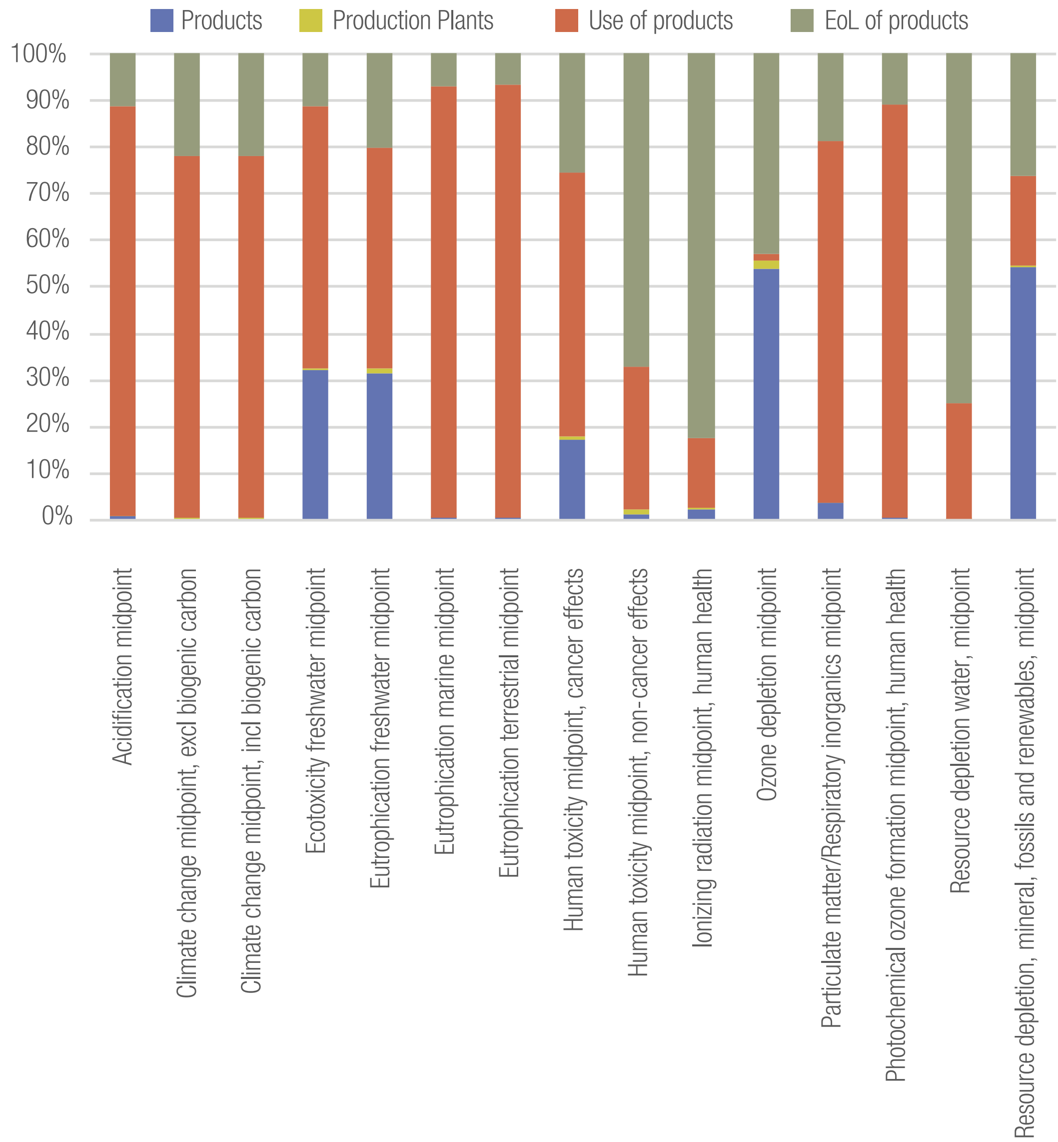


Figure 16: Maschio Gaspardo – Impacts assessment results for 2012

The use and end-of-life of products are the most relevant phases (Figure 16). These are followed by the Products stage, particularly the provision of raw materials – mainly structural steel, due to its predominant use in all agricultural machineries, and electronic components – needed for the production of the products sold. The production plants stage is especially relevant in relation to waste production and commuting activities.

A recommended action emanating from the study is to carry out a detailed product LCA of reference equipment, and through this, identify strategies for improving the environmental performance of the product portfolio.

The main shortcomings and needed improvements include the completeness of the study, for example, inclusion of plants and processes excluded from the current O-LCA; improvement to the simple modelling of the use phase and the product portfolio so as to avoid making assumptions; increased granularity of the data collected on energy consumption.

Limitations and options for improvement

The inclusion of the whole basket of products sold provides a new key input for strategic management, and insights for optimization at the supply chain level.

Moreover, O-LCA supported the organization in identifying hotspots, considering a broader perspective than the one usually adopted either in environmental management systems and in the carbon footprint already carried out. This exercise clearly pointed out the need for further investigation of downstream activities, especially the use phase, which can be strongly affected during the design process.

Strengths and opportunities yielded by the O-LCA study

The report is intended to be used internally. A partial disclosure of results in the form of a scientific publication is planned.

Documentation

3.10 Natura Cosméticos

Cosmetics, fragrances and toiletry, Brazil

Typification of the road tester

Name: NATURA Cosméticos

Number of employees: 7,700

Sector: Cosmetics, Fragrances, Toiletry

Region (country): Brazil

Study leader(s): Ines Francke (NATURA, Scientific Manager) and André Camargo (MACJEN, LCA external expert)

Description of the organization

NATURA is a cosmetics manufacturer based in Brazil and plays a significant role in the direct sales sector. Sustainable development has been the company's guiding principle since it was founded in 1969. NATURA has operations in seven countries: Brazil, Argentina, Chile, Mexico, Peru, Colombia and France.

Environmental approach of the organization

For more than four decades, NATURA has been strongly committed to leveraging sustainability to create value in its entire supply chain, with a balance between economic, social, and environmental impacts. Since the early 1980s the company has launched initiatives to minimize its environmental impacts, such as the use of refill packaging, the Environmental Table (a self-declaration label) for all products, and, since 2007, the Greenhouse Gas (GHG) Emissions Corporate Inventory (including Scope 3).

Experience-based pathway(s)

Pathway 4: Based on previous experience, data availability and in accordance with the O-LCA Guidance.

Motivation and goals

The next step for NATURA's corporate strategy is to internally manage the environmental impacts of each individual product, in all about 2,600 different products. This study aims to demonstrate whether evolving towards a systematically structured, multi-indicator model that is based on current LCA science to measure the environmental impacts of NATURA's supply chain could help with that task. It is considered as a pilot project to identify gaps (e.g., in the current management tools), efforts and opportunities (e.g., the integration of current environmental inventories), and to inform decisions on future implementation and management using LCA.

Scope: Reporting organization and reporting flow

Scope: Reporting organization and reporting flow

Subject of study: The reporting organization is NATURA Brazil, since its main operations are in Brazil. Excluded are international operations, since they represent a marginal share of the business, and Aesop, which is a recently incorporated business.

Consolidation method: 100% control on financial and operational terms.

Reference period: 2013

Reporting flow: All products sold in the reference period, subdivided into 10 product categories: beard, hair, body, deodorants, makeup, body oil, perfumery, sun protection, face care and soap.

NATURA considers the complete life cycle of products, starting from raw materials extraction (cradle), industrial production stage, distribution, use and disposal of final products (grave). Figure 17 presents the structure of activities and operations proposed for NATURA's O-LCA.

Scope: System boundary

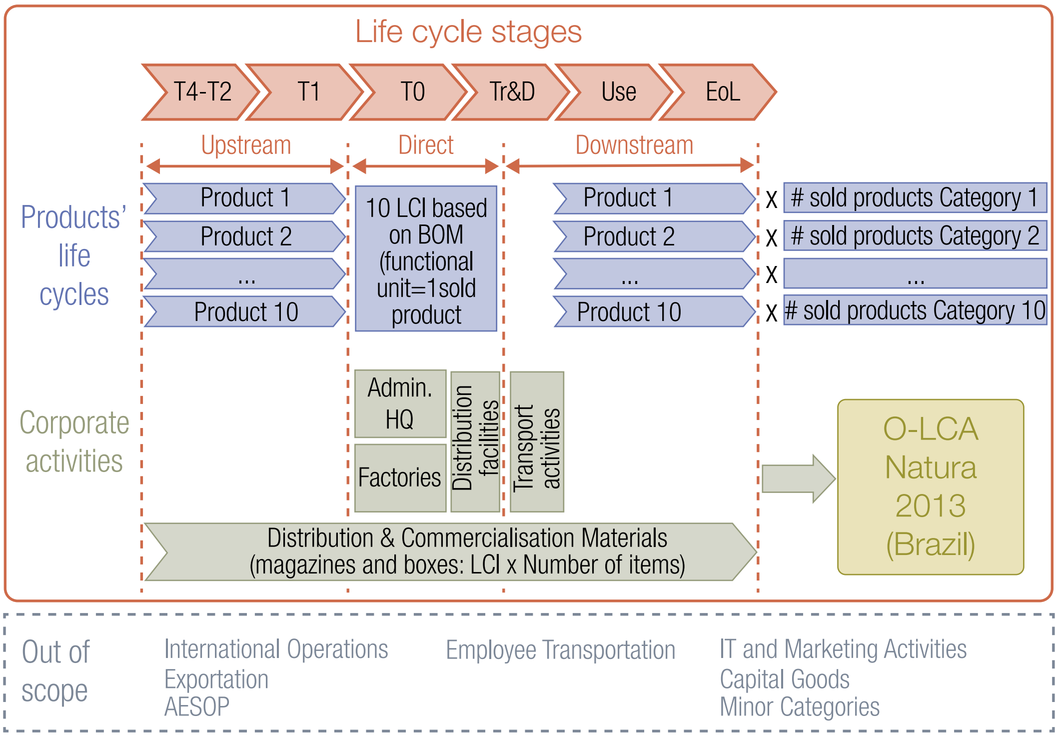


Figure 17 Natura Cosméticos –System boundary

The proposed structure for modelling the activities and operations for NATURA O-LCA is shown in Figure 17, divided in two parts: (i) bottom-up approach for LCA impacts of products in their life cycle, including the upstream supply chain processes (Tiers 4, 3, 2 and 1) and the downstream activities (transport activities, use phase and end-of-life phases and scenarios); (ii) top-down approach for LCA impacts of corporate activities, which are not easily connected and/or divided into individual products. In order to model the LCA impact of all products in NATURA's portfolio, one representative product (the best seller) was modelled for each of the ten cosmetic categories and considered as representative of the rest. They were modelled based on their packaging and ingredient bill of materials (BOM).

Inventory: Data collection approach

The data sources are NATURA´s processes and databases, direct and/or indirect data gathered from suppliers, estimates from mass and energy balances, and current life cycle databases (Ecoinvent v2.2). The approach to acquire direct data or use life cycle databases depends on the representativeness of each raw material or packaging, which is directly related to their amount consumed.

Inventory: Data sources

The life cycle impact assessment method ReCiPe Endpoint (H) v1.06 / World ReCiPe H/H, is applied because NATURA already uses this for simulations and internal studies. The LCA software used is SimaPro v7.3.3.

The identified hotspots are: Land use for ingredients of plant origin in supply chain activities (T4-T1), use phase (water and energy consumption) and fossil depletion due to use for product transportation. The main action to be taken in the future is to develop site specific models for ingredients (particularly for organic ethanol and agroforestry system cultivation of palm oil). Apart from the results at the organizational level, individual results for product best-sellers were included in the report.

Impact assessment results

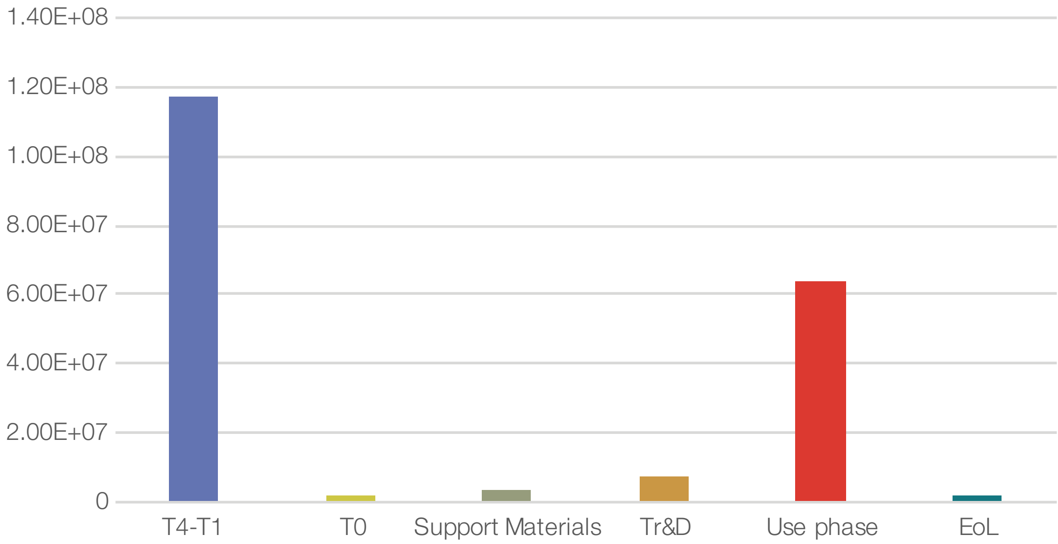


Figure 18: NATURA Cosméticos – Impact assessment results for 2013 (Pt)

Limitations and options for improvement

Even though this study was built on existing practices and previous knowledge in modelling environmental impacts of products and corporate activities, it represents a challenge for NATURA due to the large amount of data involved, and this translates into a high level of management complexity. Due to the lack of regional life cycle inventory database availability, LCA studies may not reflect the actual regional conditions and supply chain of the products.

Strengths and opportunities yielded by the O-LCA study

The study confirmed the feasibility of the O-LCA NATURA model, considering several dimensions such as data quality and availability, and addressed operational issues such as LCA software and data management. The result demonstrates NATURA's lessons learned through experience on how to gather data from suppliers, but at the same time, displays the lack of regionalized life cycle inventory data for Brazil to fulfil the existing gaps. O-LCA studies performed by any Brazilian company will contribute to a consolidated national life cycle inventory dataset.

Documentation

The full report is intended to be used internally. A partial disclosure of results in form of a scientific publication is planned.

3.11 Thanakorn Vegetable Oil Products

Vegetable oil producers, Thailand

บริษัท ธนากรผลิตภัณฑ์น้ำมันพืช จำกัด
Thanakorn Vegetable Oil Products Co.,Ltd.

Typification of the road tester

Name: Thanakorn Vegetable Oil Products Co., Ltd.

Number of employees: 200

Sector: Food

Region (country): Thailand

Study leader(s): Adul Premprasert (Thanakorn Vegetable Oil Products, Managing director) and Rattanawan Mungkung (Kasetsart University, Project advisor)

Description of the organization

Thanakorn was established in 1974 in Phra Samut Chedi District, Samut Prakan Province to produce vegetable oil and animal feed ingredients under the brand "COOK". It operates with the vision to be a leader in the vegetable oil industry in the Association of Southeast Asian Nations, with excellence in quality, corporate social responsibility and healthy environment.

Environmental approach of the organization

Thanakorn has previous experience with LCA through the application of carbon footprints for ten of its products, leading to the certification and verification for carbon labels (i.e., carbon footprint label, carbon footprint reduction label and carbon neutral label). The company also implemented a corporate carbon footprint as preparation for GHG emissions reporting to the government, and to demonstrate its commitment to continual environmental performance improvement. Through applying LCA, the company has placed GHG emissions mitigation as an issue in their green business strategy roadmap. Currently the company is applying the Smart Factory 4.0 Roadmap to enhance its business activity efficiency.

Experience-based pathway(s)

A combination of Pathway 3 and Pathway 4: Based on previous experience, data availability, basically carbon footprint of products and corporate, and according to the O-LCA Guidance.

Motivation and goals

The company aims to explore on the potential use of O-LCA to identify further improvement opportunities, not only associated with their direct activities, but also indirect activities along the whole supply chain. The results of O-LCA are expected to broaden understanding of potential risks along the whole life cycle while strengthening strategic environmental management, as well as to complement the knowledge gained through the corporate carbon footprint. The ultimate goal is to identify hotspots, reduce the environmental impacts of the entire organization, and through this, generally achieve more sustainable operations.

Scope: Reporting organization and reporting flow

Subject of study: The reporting organization is the whole company Thanakorn Vegetable Oil Products, including its production plant at Samut Prakan province (Thailand).

Consolidation method: Operational control

Reference period: 2014

Reporting flow: The annual production of Thanakorn in 2014 (47,176,822 kg for soybean oil and 3,032,832 kg for sunflower oil).

Scope: System boundary

The system boundary includes all activities operated under the control of Thanakorn (i.e., extraction and warehouse, refinery, packing and utility activities) which is based on a cradle-to-grave approach, including direct activities, indirect upstream activities, and indirect downstream activities (Figure 19).

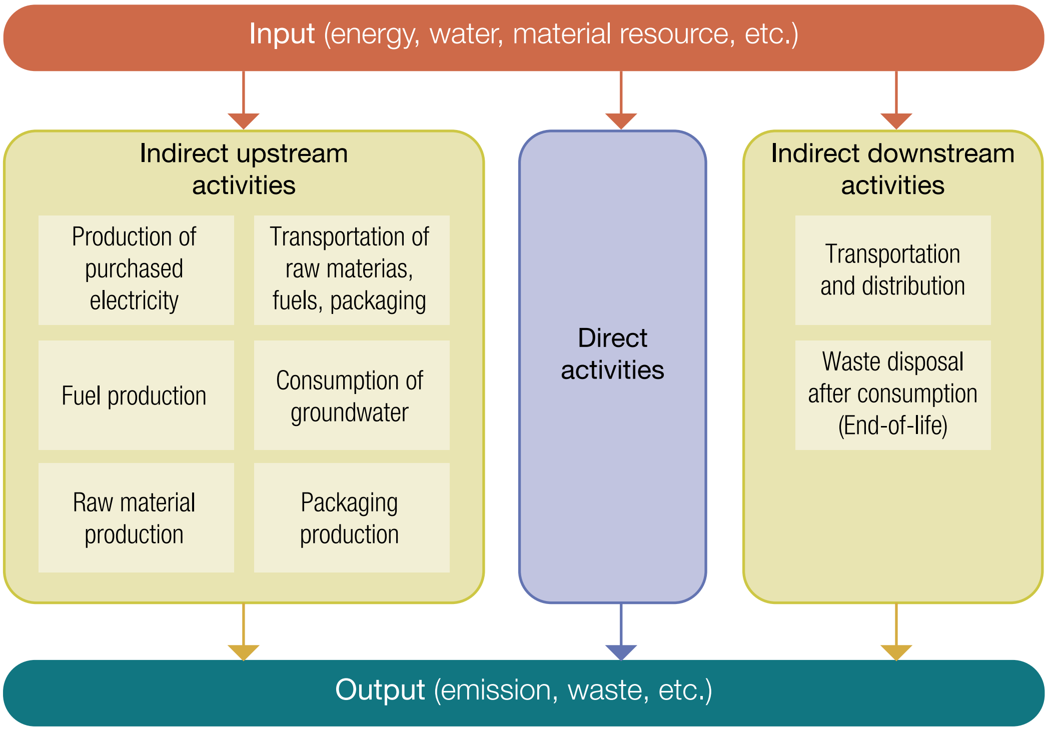


Figure 19: Thanakorn – System boundary

Inventory: Data collection approach

Data collection follows a top-down approach. The collected input and output data associated with the organization's activities are based on the annual production in 2014 (January to December).

Inventory: Data sources

Activity data are sourced from primary data via the environmental accounting systems, as well as from records, mainly, but not exclusively from the production and engineering departments. While secondary data (background systems), for example for the electricity production, are sourced from international databases (Ecoinvent), as well as the national life cycle inventory databases.

The key inventory data (raw materials) are given in Table 10.

Inventory results

Inputs (unit)	Quantity
Soybean	216,758,659
Hexane	18,039,741
Sunflower seed	8,569,576
Citric acid	544,408
White oil	317,815
Bleaching powder	269,800
Phosphoric acid	128,467
Sodium hydroxide	10,712
Filter aid	3,861

Table 10: Thanakorn – Key inventory data (kg)

Impact assessment results

The midpoint impact categories were selected based on the potential impacts associated with the inventory data and the company's interest for environmental management systems. The life cycle impact assessment is based on ReCiPe method.

Overall, raw material production is the key hot spot contributing to significant impacts in most of the categories considered (Table 11), with the exception of the impact on marine ecotoxicity and water depletion, which were largely related to the combustion of fuel associated with raw materials transport. When considering the impacts associated with direct activities, the combustion of biomass, fuel oil and diesel is the major contributor. For the indirect upstream activities, soy bean production is the key hotspot, significantly contributing to all impacts due to the use of fertilizer and herbicides in soybean production. For the indirect downstream activities, the distribution (by truck) is the key hotspot.

Impact category	Unit	Total	Direct activities	Indirect upstream activities	Indirect downstream activities
Climate change	kg CO_2 eq	567,765,245	3,696,814	562,621,010	1,447,421
Terrestrial acidification	kg SO_2 eq	2,936,966	59,941	2,873,093	3,931
Freshwater eutrophication	kg P eq	118,141	-	118,076	65
Marine eutrophication	kg N eq	2,456,803	2,497	2,449,360	4,946
Marine ecotoxicity	Kg 1,4-DB eq	153,916	-	153,188	728
Water depletion	m3	297,700,183	-	296,765,630	934,553
Fossil depletion	kg oil eq	418,025	314,714	103,103	208

Table 11: Thanakorn – Impact assessment results for 2014

Limitations and options for improvement	The improvements proposed are: • Calculating the environmental impacts of soybean production and transport from various sources, and taking this into account in purchasing decisions • Changing the trucks from EURO-3 to EURO-5 • Changing the fuel (involved in production processes) to be 100% biomass-based and through this, to establish a fossil-fuel-free factory • Changing packaging materials to be biodegradable plastic and reduce the impact of the disposal phase • Creating sustainable value chains by organizing a seminar to transfer the knowledge on LCA, O-LCA, Carbon Footprint of Product/Organization, including ISO 14001, to first-tier suppliers
Strengths and opportunities yielded by the O-LCA study	The results of O-LCA were used to inform strategic environmental management and further improve the company's environmental performance.
Documentation	The report is intended to be used internally.

3.12 Tuzla Belediyesi

Public institution of Istanbul, Turkey

Name: Tuzla Belediyesi

Number of employees: 335

Sector: Municipality

Region (country): Turkey

Study leader(s): Nesli Terzi Savaș (Tuzla Municipality, Executive Assistant to the Mayor) and Sebla Önder (Metsims Sustainability Consulting, external expert)

Typification of the road tester

Tuzla Municipality is one of 39 local governments within the Istanbul Metropole in Turkey. It is located on the Asian side of the City with a population of 235,000. The Municipality is well known for its industrial zones and ports with active shipbuilding operations.

Description of the organization

Tuzla Municipality gives high importance to international quality standards, thus its services have been certified to ISO 9001:2008, ISO 14001:2004 and OHSAS 18001:2007. With five industrial zones within the Municipality, air pollution and ecology are the main environmental priorities.

Environmental approach of the organization

Pathway 1: Limited initial environmental experience and information

Experience-based pathway(s)

The aim of the study is to establish a basis for sustainability practices and a plan for future actions that will reduce the environmental burden of the Municipality's service portfolio. The focus is on climate change impacts and energy use reduction, in line with relevant government initiatives. The results will be used for policy making and for communication to the local public, as well as via the Carbon Disclosure Project (CDP) for Cities (2017) and Covenant of Mayors Initiative to a worldwide audience.

Motivation and goals

Subject of study: The reporting organization is Tuzla Municipality including its 24 directorates, as well as the Mayor's office, all of which carry out the public services in Tuzla City Hall.

Consolidation method: Operational and financial control

Reference period: 2015

Reporting flow: The total services provided by the Municipality in 2015. The municipal budget of Tuzla Municipality was approximately USD 91 million.

Scope: Reporting organization and reporting flow

The system boundary (Figure 20) is from cradle-to-gate. It covers fuels, goods and services purchased by the organization, purchased electricity including production and distribution, employee commuting, personnel travel and transportation of goods/ services using vehicles owned/controlled by the organization, treatment of waste generated from organizational activities and natural gas consumption related to organizational activities.

Scope: System boundary

Scope: System boundary (continued)

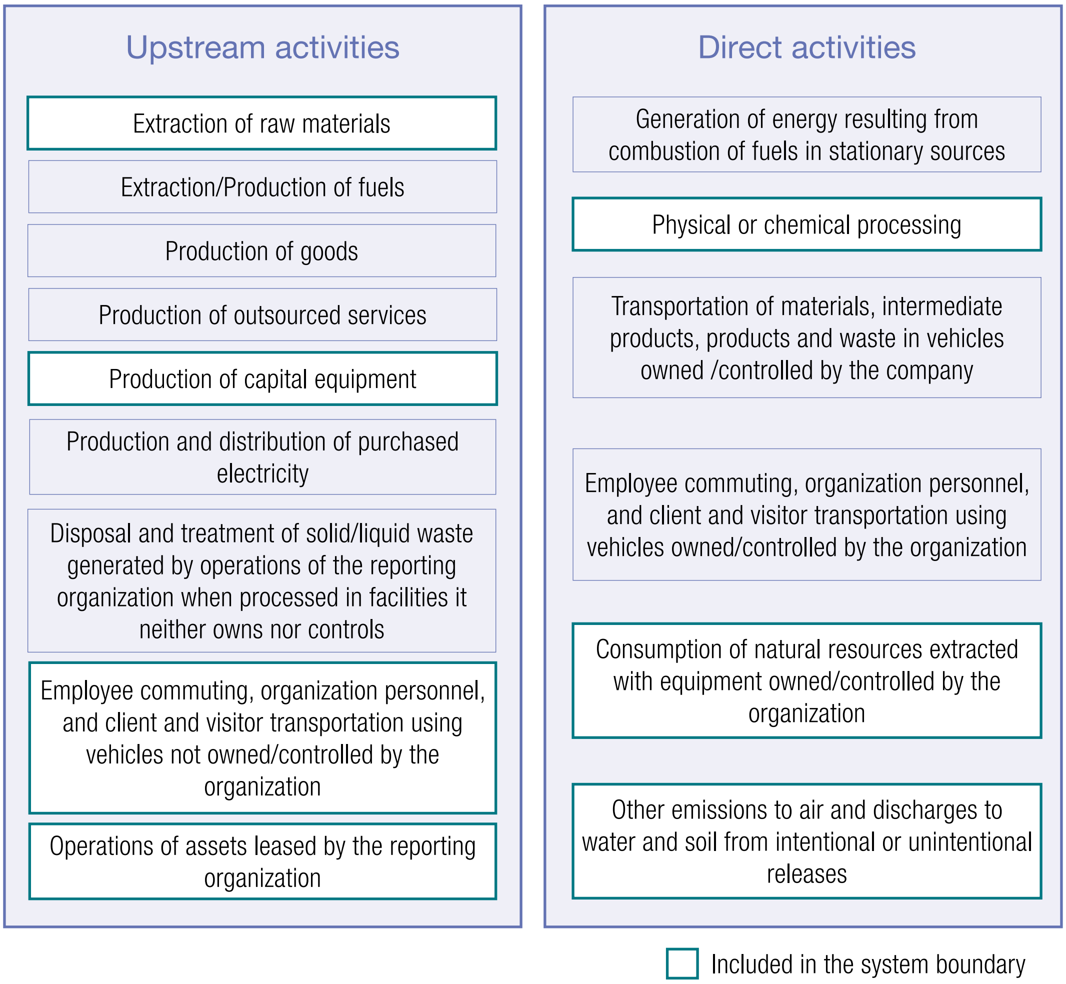


Figure 20: Tuzla Belediyesi – System boundary

Inventory: Data collection approach

A top-down data collection approach is applied for the primary data collection. All operational data from the organization are for the year 2015. Data for purchased goods and services are collected per Directorate/Unit; while electricity and fuel consumption are measured at the organizational level. The recorded inventory on purchases was not descriptive enough to capture the quantity and/or amount of each product and service. In addition, the information available is in monetary values. Therefore, an environmentally extended input-output database was used that expresses goods and services in US dollars. The Purchasing Power Parity was used to translate this into Turkish Lira.

Inventory: Data sources

Primary data are captured mainly from purchasing records of the Directorate of Financial Services. The environmental impacts from the upstream supply chain of goods and services production are modelled with the USA Input-Output Database in the form of value-based environmental impacts. For organizational waste treatment activities, EU & DK Input-Output database, for national electricity and natural gas mixes, Turkish Life Cycle Inventory Database (TLCID), and for the remaining activities, Ecoinvent database, are used as secondary data sources.

Initially, the environmental impact categories analyzed are those included in CML-IA baseline (v4.2), as well as Cumulative Energy Demand (v1.09) for total energy requirement method, and the IPCC 2013 GWP 100a (v1.03) for global warming potential (GWP). Certain gaps and concordance problems are detected between the life cycle inventory databases used and the CML impact method. Moreover, municipalities across the world are currently very much interested in energy consumption and climate change. Therefore, although the recommendation of the O-LCA Guidance to include a comprehensive set of environmental issues, the results to be shared in this summary focus on those two indicators (Figure 21).

Purchased goods are the major hotspot for both climate change and (embodied) energy demand. It is recommended that the Municipality develops a green purchasing policy. As such, purchasing decisions should not only be based on the price and quality, but also towards pursuit of environmental impact reduction. Particularly for construction products, which are by far the largest segment contributing to the environmental impacts of the Municipality, there is a locally established purchasing system that takes into account the environmental labels and declarations of the ISO 14025. In addition, the EPD Turkey and environmental product declarations are widely available on many construction products, making this a clear opportunity to initiate the new purchasing policy.

Impact assessment results

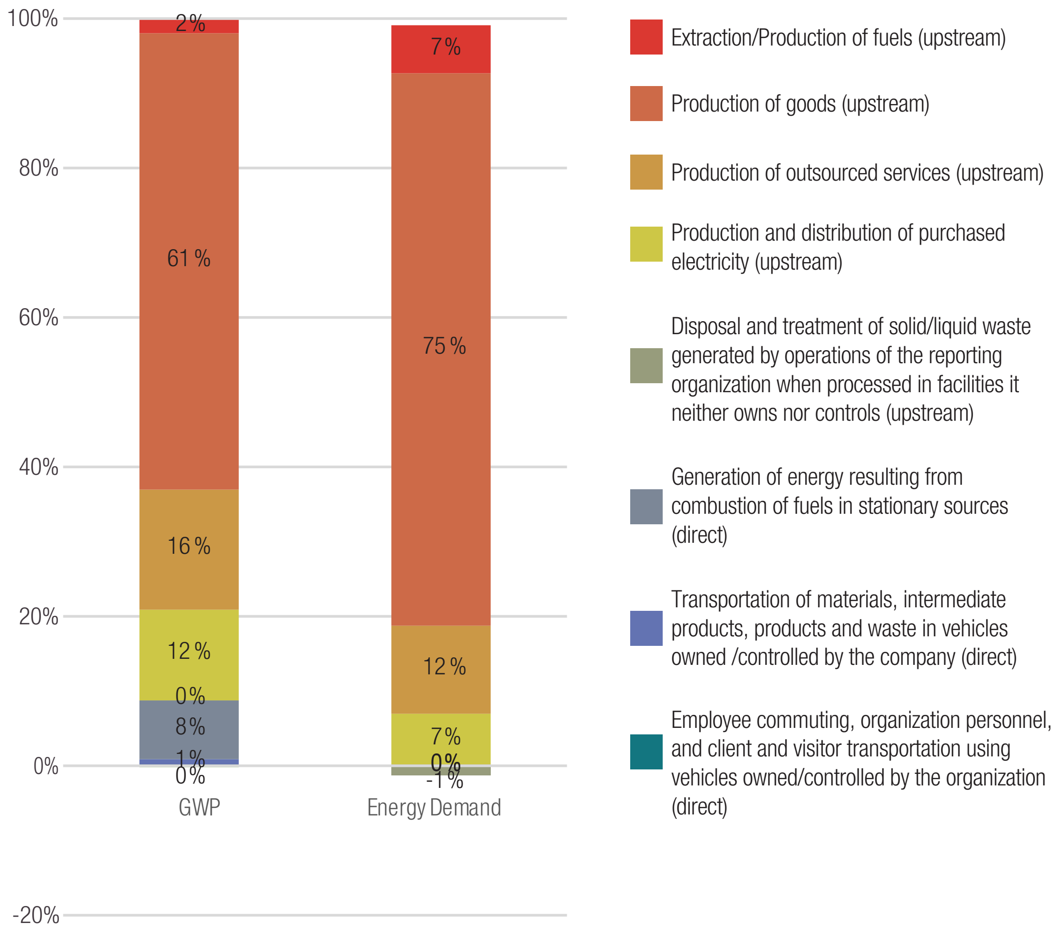


Figure 21: Tuzla Belediyesi – Impact assessment results for 2015

Limitations and options for improvement

The data for purchased goods and services was not available at a product-specific level (i.e., itemized billing was not available). This undermined the use of available life cycle inventory datasets at the product level and obliged the use of input-output databases, resulting in a higher level of uncertainty. This also compromised the reliability of the environmental impact results for categories beyond climate change and energy demand.

In the future, the Municipality is also considering broadening the scope of the LCA study to the community level (i.e., using geographical boundary) that would include all activities (e.g., domestic and industrial) in addition to public services.

Strengths and opportunities yielded by the O-LCA study

- Science-based assessment to develop strategies to reduce climate change and energy demand.
- Opportunity to focus on hotspots relevant to the Municipality
- Being the first Municipality worldwide to conduct O-LCA
- Quantitative assessment to base future sustainability reporting and disclosures such as Carbon Disclosure Project and the European Union Covenant of Mayor Initiative
- Communicate quantitative environmental impact results relevant to the municipalities

Documentation

The full report is intended to be used internally. A summary report is planned to be published on the Municipality's website.

CHAPTER

4. Road testers' experiences and lessons learned

The road testers presented in Section 3 responded to an anonymous survey after completing their O-LCA study. The survey was intended to identify cross-cutting benefits and challenges, help assessing the applicability of the O-LCA method, and gauge the usefulness of the O-LCA Guidance. Furthermore, gaps, as well as further needs for research and application for particularly challenging elements could be identified.

All 12 road testers demonstrated their commitment to improve the O-LCA method in an active and participatory manner by providing their comprehensive feedback on several issues related to the method and the road-testing process itself. Besides the general information about the organizations presented in Section 3, the road testers were asked about their study background (their motivation for enrolling in the road-testing process and the composition of the team carrying out the O-LCA study), their previous experience with environmental tools and how it streamlined the O-LCA study, the costs and benefits of the O-LCA study, the usefulness of the O-LCA Guidance, the main challenges posed by the method, how the study results will be communicated, and planned future steps within their respective organization.

4.1 Goals and motivation

At the outset of joining the road-testing phase, the participating organizations had a broad set of analytical, managerial, and societal goals. The main motivation for joining the road testing was the opportunity to identify environmental hotspots and track the organization's environmental performance. Also, managerial goals such as improving managerial decisions and showing environmental awareness for marketing purposes played an important role for applying O-LCA. Moreover, the willingness to contribute to the reduction of environmental pressure was a decisive motivation to carry out an O-LCA study (Figure 22).

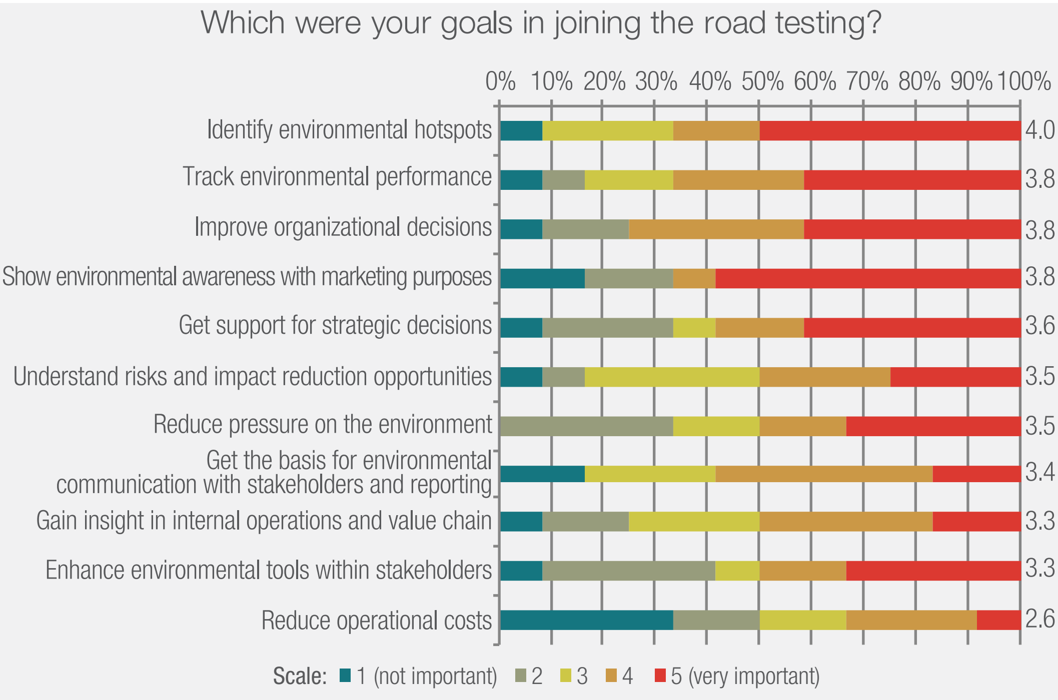


Figure 22: Importance of different goals for participating in the road testing

Note: 100% corresponds to the 12 road testers.

4.2 The O-LCA road-testing teams

To better understand the work processes behind the O-LCA studies, it is important to get to know the profile of the authors, co-authors and supporters of the study within the road-testing organizations or in close cooperation with them.

In only three cases the study was carried out exclusively by members of the organizations (Figure 23). Most studies were performed or supported by external consulting companies, NGOs, research institutes or universities.

Road testers' feedback

"We think it is a powerful methodology for supporting strategic management within an organization, as it looks both at the products and at the organization activities the company is more familiar with."

-Maschio Gaspardo

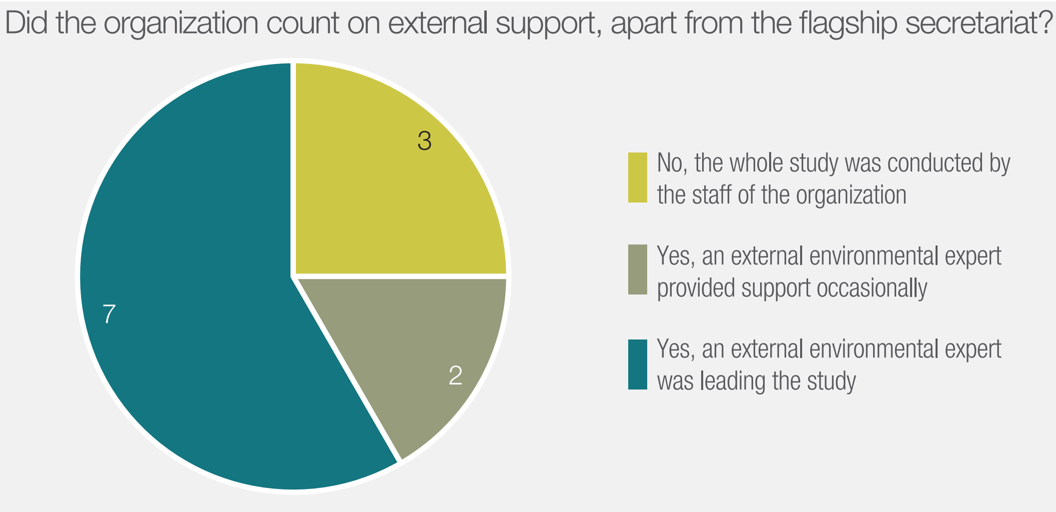


Figure 23: Reliance on external support

O-LCA was often applied in direct cooperation with the organization's environmental department or management team (Figure 24). In the other cases, the energy manager, industrial engineering department, members of company-related foundations or NGO members led the study (Figure 23). Further organizational units supported the study in some cases (Figure 24). Almost all main authors reported that they enjoyed a fruitful support within the organization (Figure 26), which is a relevant success factor due to the comprehensive nature of O-LCA studies.

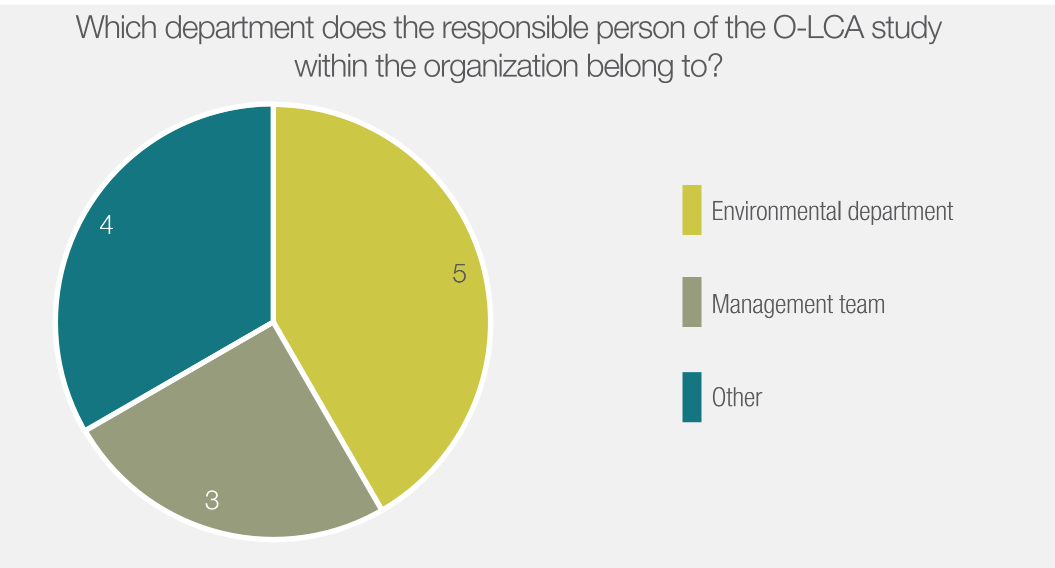


Figure 24: Responsibilities within the organization

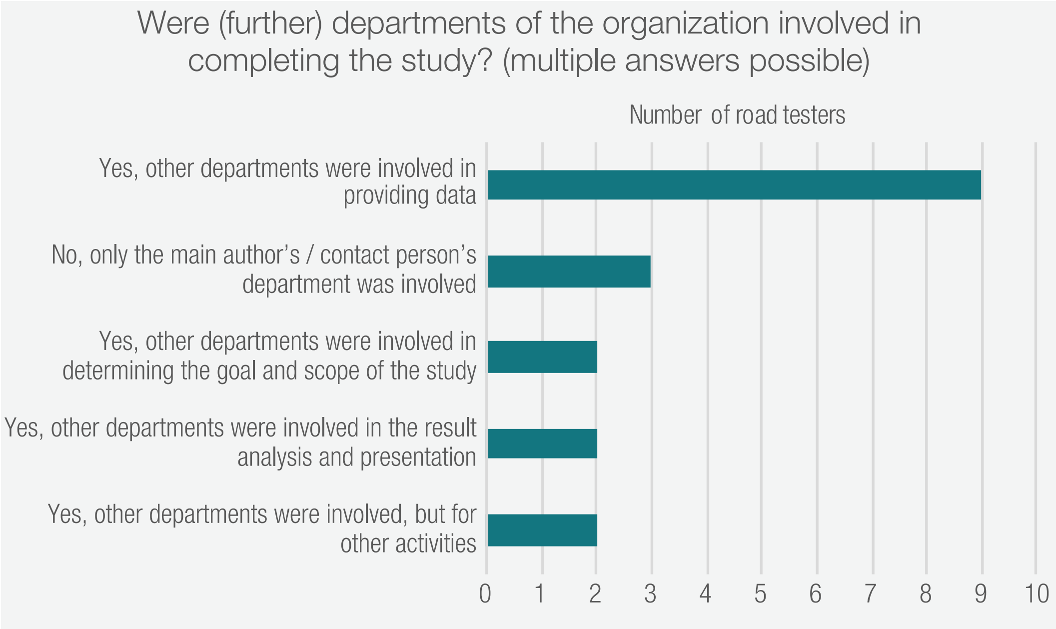


Figure 25: Involvement of organizational departments in the O-LCA study

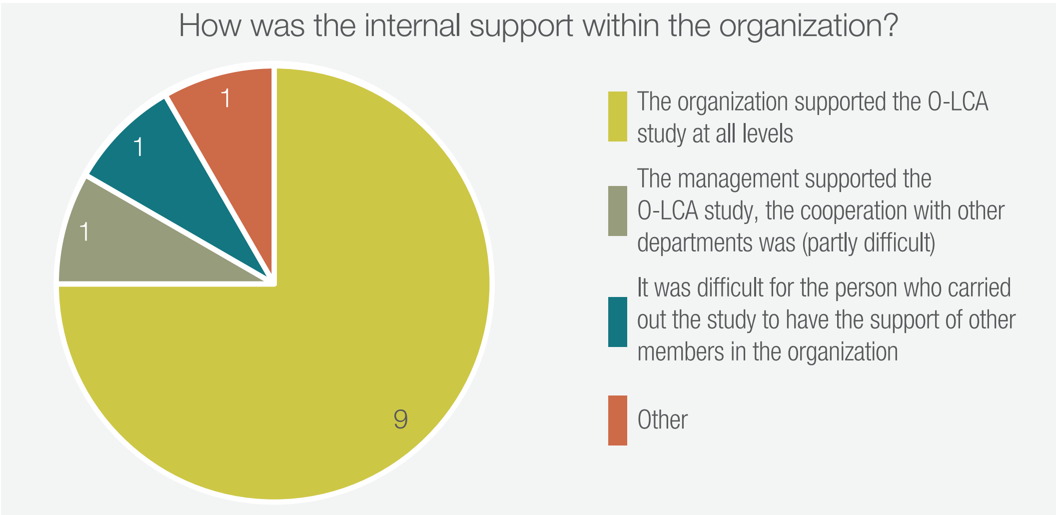


Figure 26: Organizations' internal support of the O-LCA study

4.3 Previous experience of the organizations with environmental tools

Due to the different organizational sizes, focuses and capacities, the road testers' previous experience with environmental tools was quite different, i.e. from basically non-existent to a high-level use of several environmental management tools (see Figure 27).

The O-LCA Guidance identifies four experience-based pathways for the application of O-LCA. The aim of the pathways is to show how organizations can benefit from their previous experience with environmental assessment methods and the data collected to apply O-LCA. The distribution of the pathways by the road testers can be seen in Figure 28 and details for each road tester on the pathway selection can be found in Section 3.

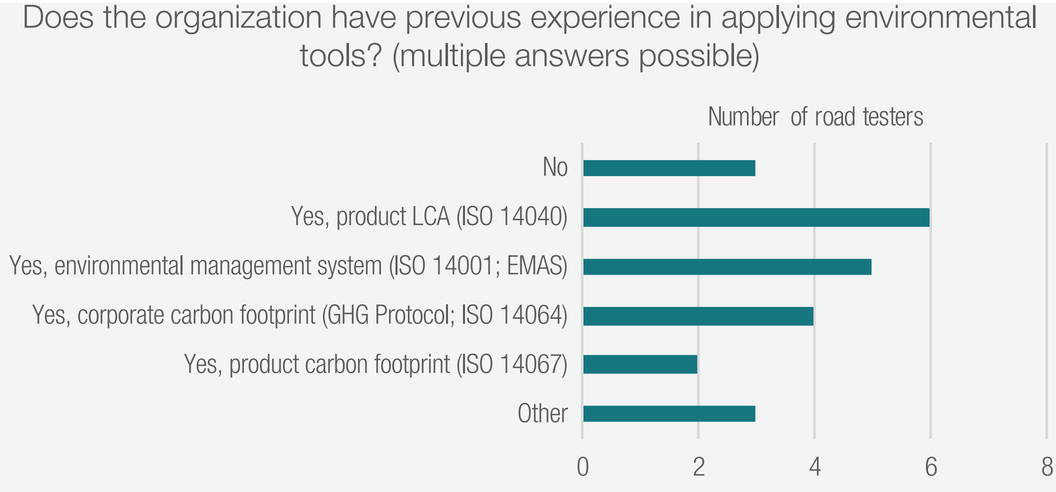


Figure 27: Road tester's experience with environmental tools

> **Road testers' feedback**
>
> *"We think O-LCA is an important initiative to motivate companies to use LCA perspective on their products and/or services."*
>
> *- Natura Cosméticos*

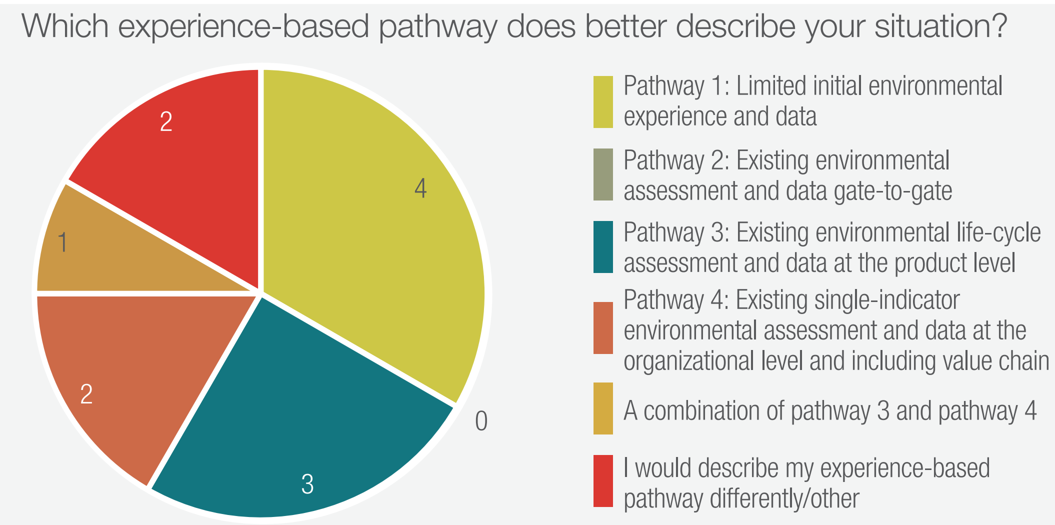


Figure 28: Experience-based pathways followed by the road testers

Road testers with previous experience with environmental tools stated that existing assessments eased the O-LCA implementation, especially for identifying the reporting organization and defining the reporting flow, identifying the processes involved in each activity, and collecting primary data.

4.4 Costs and benefits of O-LCA implementation

Carrying out an O-LCA study requires competence, time and monetary resources. The estimated project duration was between 2 and 18 months. The median value of needed working hours by the whole team is 450. Apart from personnel resources, further resources such as databases and software were also necessary for completing the O-LCA studies.

Most road testers are confident that the familiarity with the O-LCA method gained during the road testing, (e.g., establishing a data collection routine and designing an appropriate tool (Figure 29)), would reduce the time needed for a future study by 10%-50% (Figure 30).

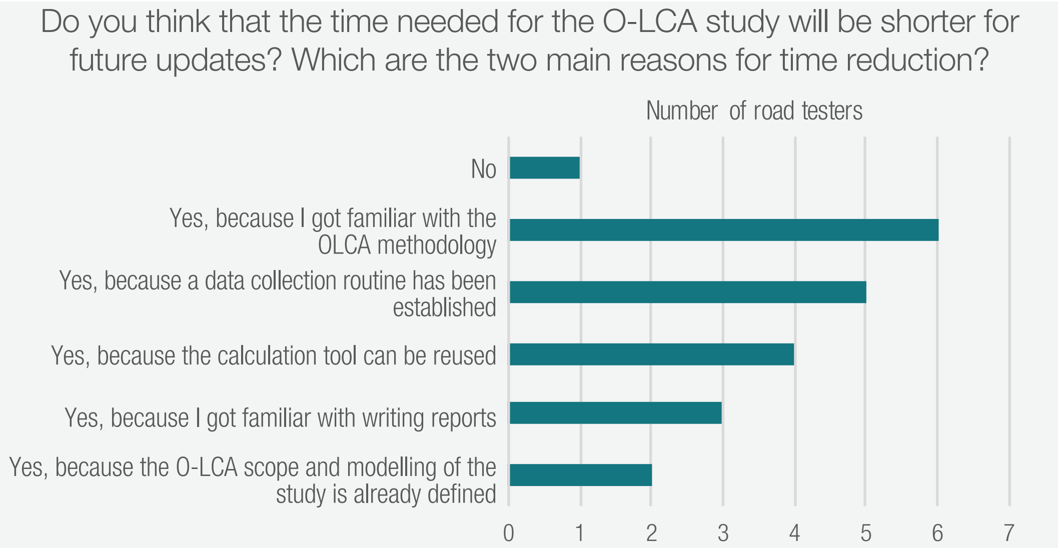


Figure 29: Reasons why future O-LCA studies are expected to require less time

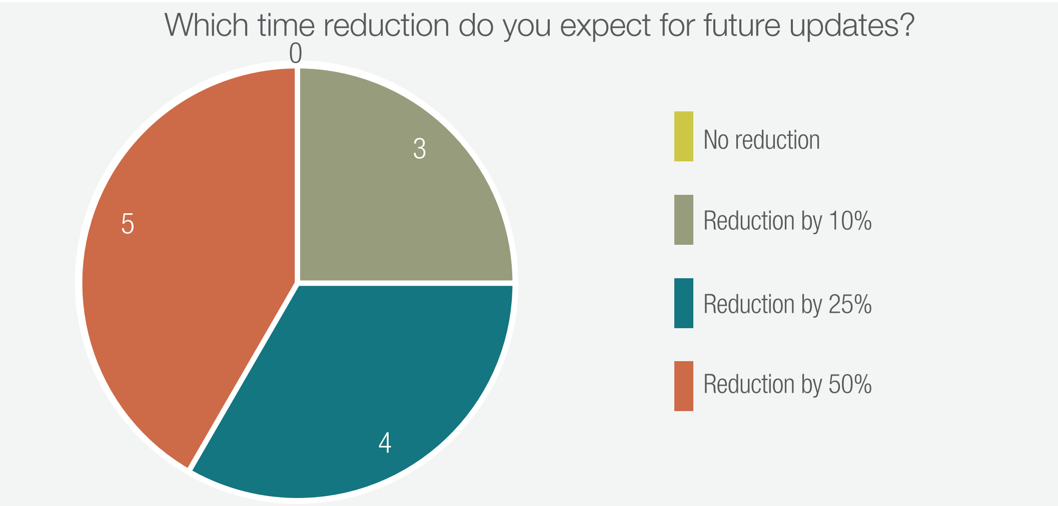


Figure 30: Expected time reduction for further O-LCA studies[1]

Road testers' feedback

"We believe that O-LCA gives the companies an opportunity to review all potential environmental impacts. Therefore, it can be treated as full baseline environmental assessment for an organization which any potential improvement or emission reduction target must be based on."

- Hüdai Kara,

Metsims Sustainability Consulting

1 Note that one road tester response in Figure 29 indicating that "no" time will be saved when undertaking updates in the future is inconsistent with responses to question in Figure 30, to which all of the road testers indicated a time reduction percentage.

Notwithstanding the required deployment of time and resources, the road testers find that the information gain mostly justified the overall effort, especially regarding the opportunity to track environmental performance, identify environmental hotspots and understand risks and impact reduction opportunities (Figure 31).

Those goals rated by road testers as not having been met (e.g., redefine the strategy of the organization, involve stakeholders, or reduce environmental impacts and costs) can, under normal circumstances, only be achieved over a longer time period. First, informed by the O-LCA results, actions need to be planned and implemented by the organization.

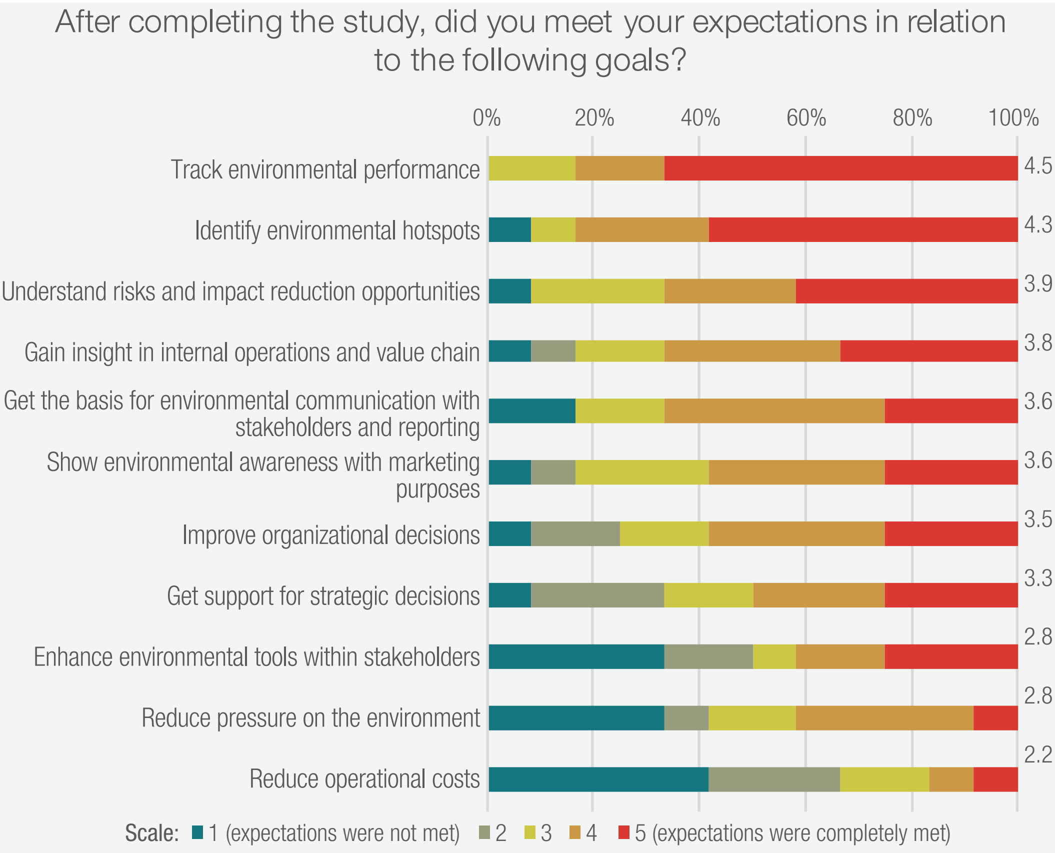


Figure 31: Achievement of road testers' initial goals

Note: 100% corresponds to the 12 road testers.

Road testers' feedback

"Quantitative information of environmental risks relevant to value chains of our business activities was gained by performing the O-LCA study. The information is useful for future strategic planning to reduce the pressures on the environment."

- Azbil Corporation

4.5 Usefulness of the O-LCA Guidance and the road testing

The O-LCA Guidance was the main document used to perform the O-LCA study. The road testers identified the main strengths of the document as showed in Figure 32. The O-LCA Guidance was deemed as particularly useful to define those issues that are specific to product LCA and different from product LCA (like the scoping elements). Nevertheless, other challenging issues that are shared with product LCA (like assessing data quality) were not well supported by the O-LCA Guidance. In fact, the publication was not designed to provide this support. Section 5 presents some future actions to deal with the identified challenges and difficulties.

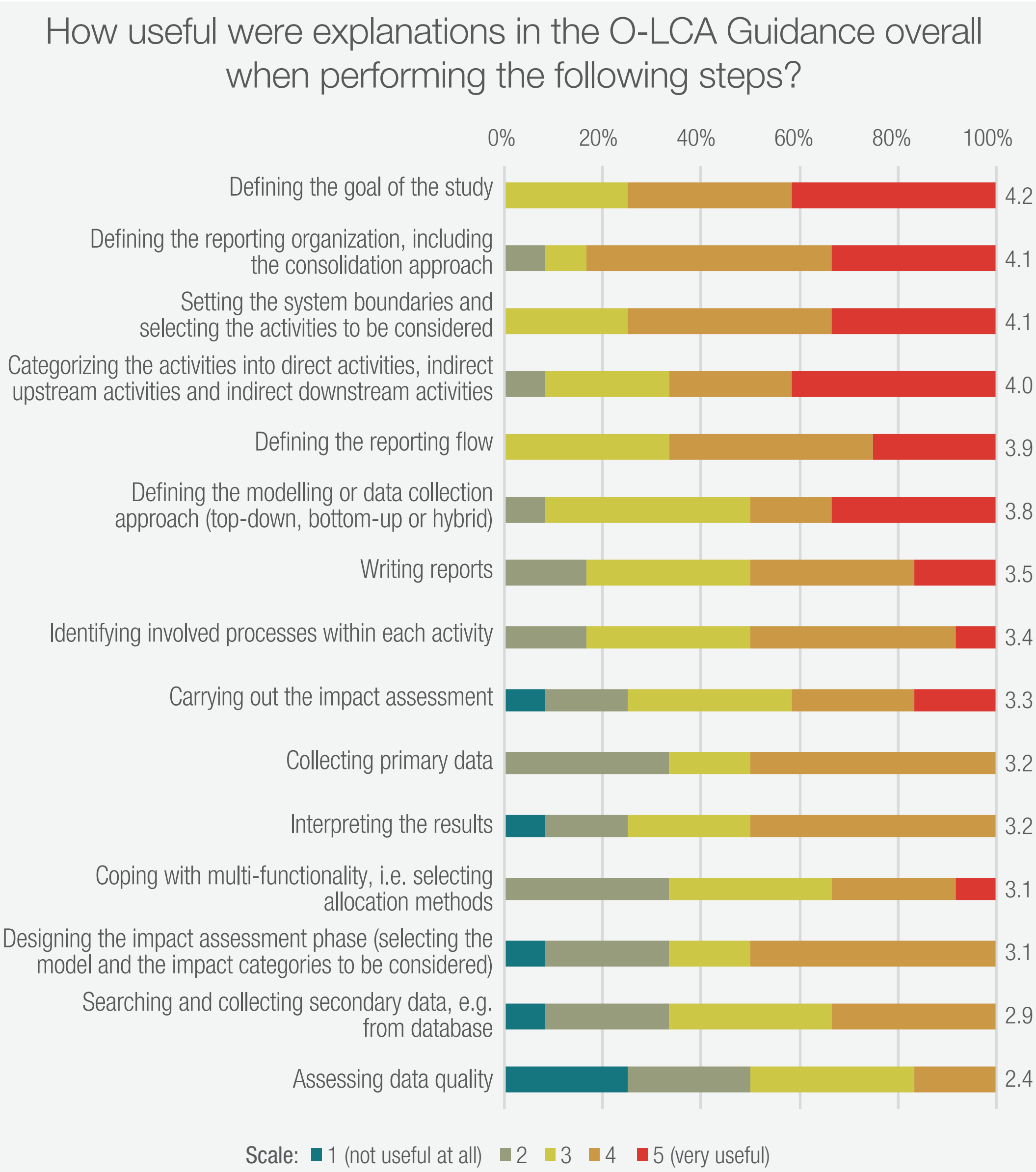


Figure 32: Reported usefulness of the O-LCA Guidance for different steps of the method application

Note: 100% corresponds to the 12 road testers.

Road testers' feedback

"Using the O-LCA Guidance greatly facilitates the understanding of how the organization should be organized, what kind of technical support should be discussed, what maturity requires, the level of data difficulty and finding, and especially how to make information in a more standardized format for interested parts."

- Demarchi Industrial Complex - BASF

All road testers would recommend other organizations to perform O-LCA and to use the O-LCA Guidance (Figure 33); although one third would suggest using further integrative documents (e.g., ISO 14040, ISO 14044, ISO 14067, ISO/TS 14072, the Organisation Environmental Footprint Guide and/or the GHG Protocol standards).

The road-testing phase reached its goal of promoting the O-LCA method. In fact, the opportunity to join the road-testing process motivated two thirds of the road testers to apply the method, even though this was either not planned or not foreseen for future years (Figure 34). Only one third of the O-LCA studies had already been planned as the road-testing process was initiated. This testifies to the success of the road-testing phase in promoting this new assessment method.

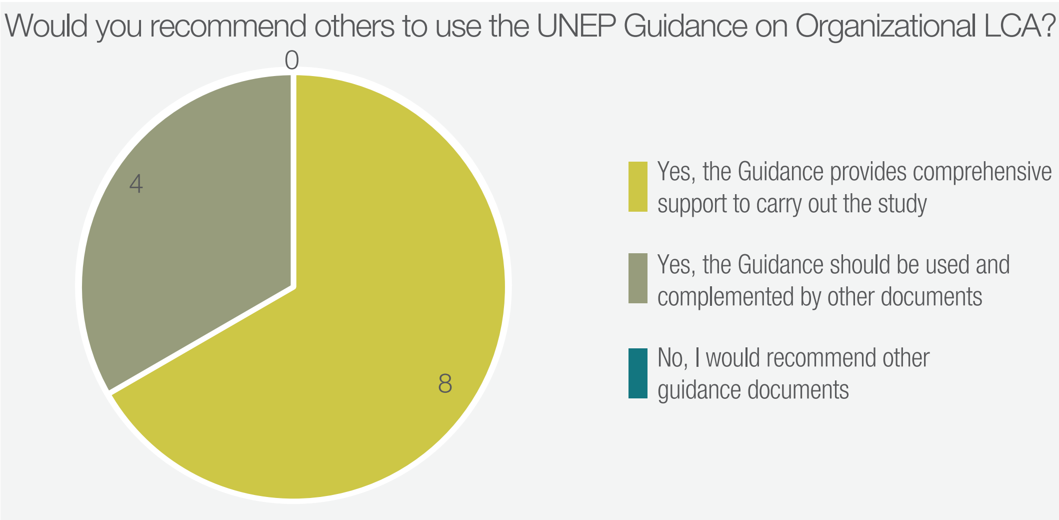


Figure 33 Road testers recommend the O-LCA Guidance

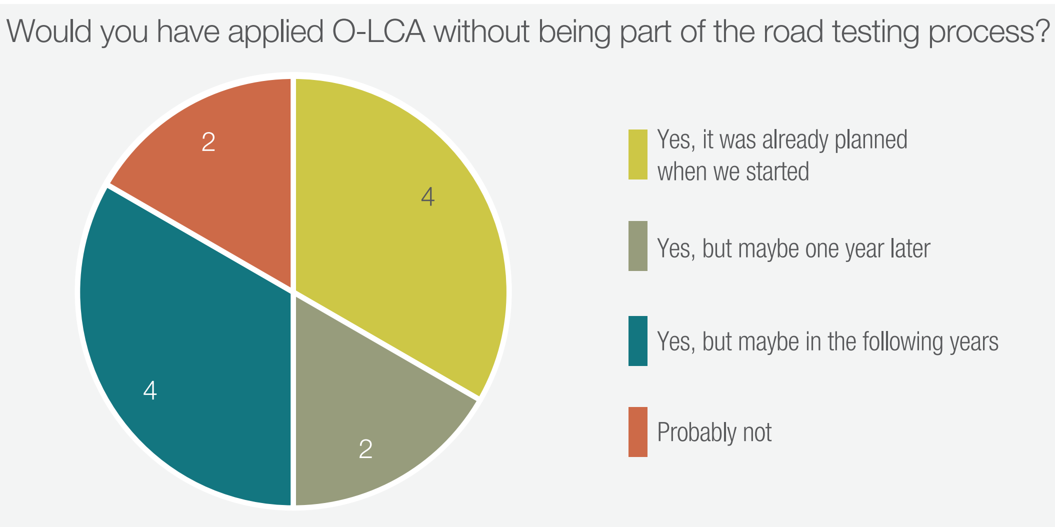


Figure 34: Influence of the road-testing process on the method application

4.6 Main challenges and potential improvements

The road testers provided detailed feedback on the level of difficulty and time intensity they encountered at different stages of the O-LCA study (Figure 35 and Figure 36).

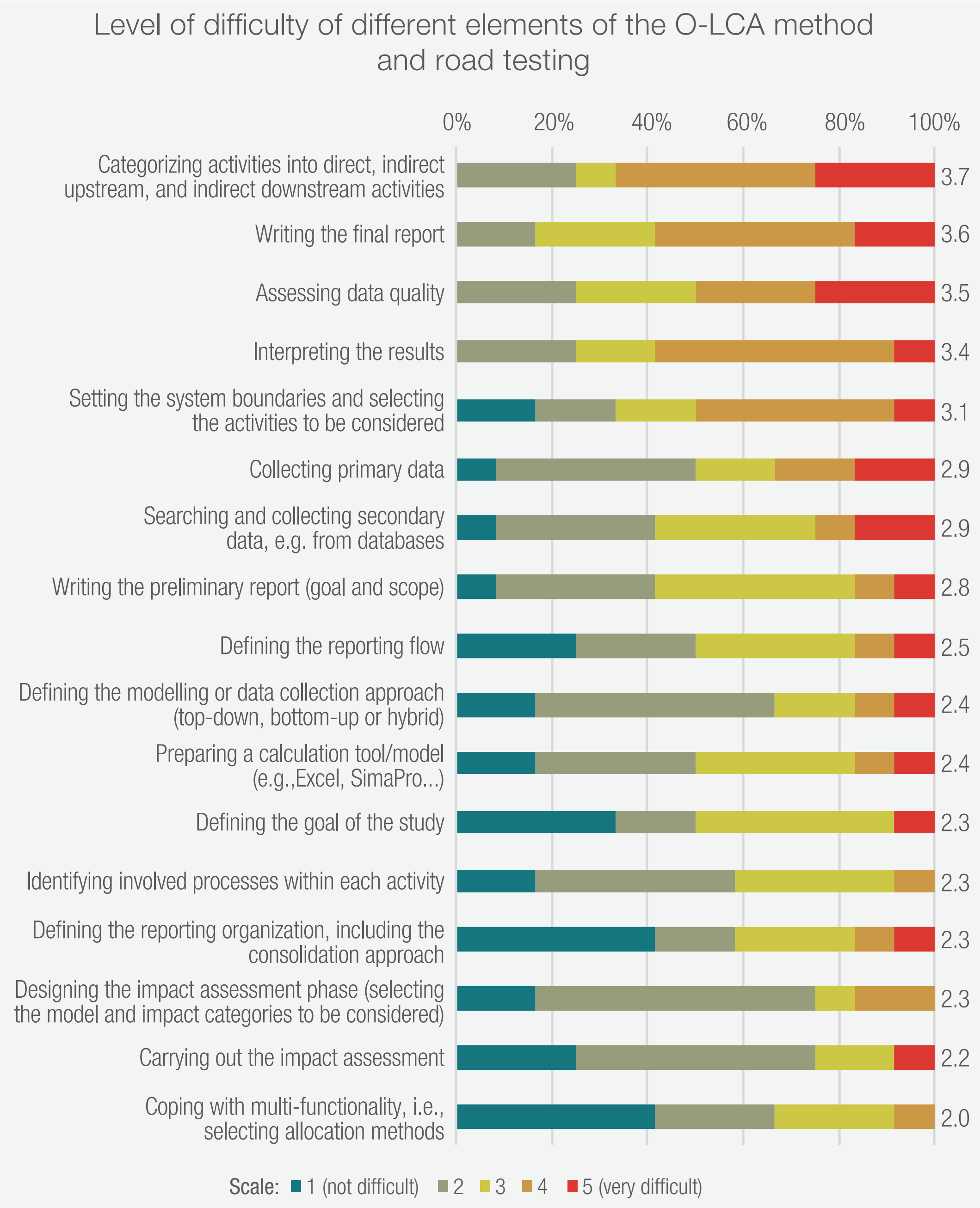


Figure 35: Different elements of the O-LCA study and the road testing ranked according to the average level of difficulty estimated by the road testers

Note: 100% corresponds to the 12 road testers.

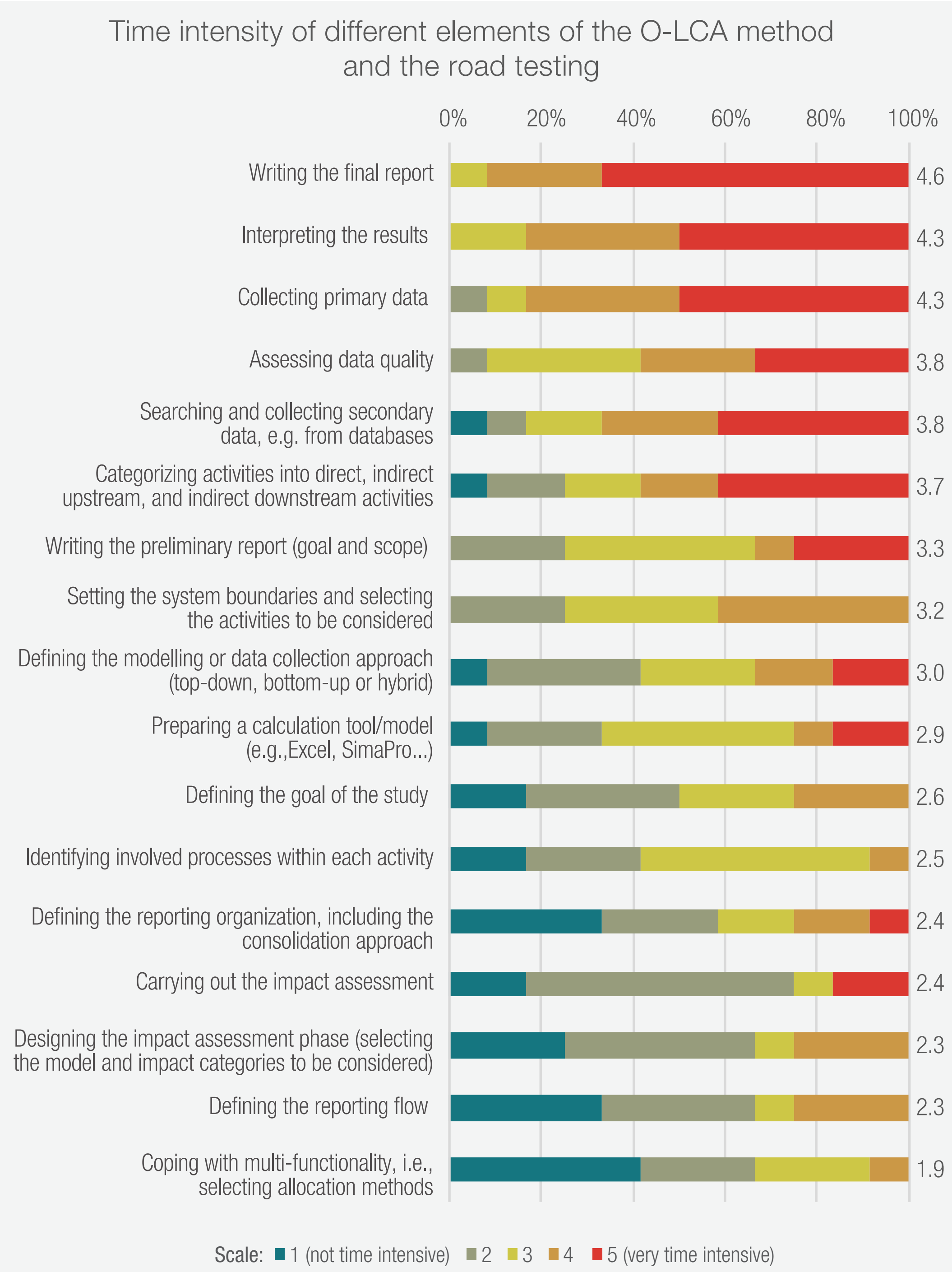


Figure 36: Different elements of the O-LCA study and the road testing ranked according to the time intensity estimated by the road testers

Note: 100% corresponds to the 12 road testers.

Overall, the road testers identified the following as the most challenging tasks of the O-LCA method: setting the system boundary, data collection, the definition of data quality criteria for diverse datasets, and the results interpretation. The detailed challenges encountered during the performance of each of these tasks or steps are listed in Table 12.

According to the road testers, among others, additional guidance and examples might be useful for categorizing activities into direct, indirect upstream and indirect downstream activities. Moreover, a detailed scheme for data quality assessment might have been helpful for carrying out the study. For road testers with no previous LCA experience, interpreting the results represented a particular challenge, so more detailed practical advice for this step should be provided in the future. In addition, some road testers wished for (sector-specific) case studies and examples to be made available. Future O-LCA studies will clearly profit from the pioneering work of the road testers and their willingness to share their experience.

Tasks of the O-LCA method	Main challenges encountered
Setting system boundary	Identifying all activities within the organization
	Deciding whether to include indirect downstream activities
	Deciding which activities to include based on data availability
	Defining activities for the service sector
Collecting data	Mapping the data need
	Coordinating on-site data collection (primary data)
	Assessing data availability (secondary data)
Assessing data quality	Developing own data quality criteria
	Coping with lacking consensus methods
Interpreting results	Lacking familiarity with ISO standards
	Coping with huge amount of results
	Proofing consistency
	Making the interpretation understandable for a non-expert audience

Table 12: Main challenges encountered by the O-LCA road testers

4.7 Communication and future steps

After completing the study, two of the twelve road testers plan to make their full final report public, while most road testers will publish a summary with all the results or a part thereof (see Section 5). The main audiences include societal stakeholders, other members of the supply chain and the local community. In all organizations, the O-LCA results will be deployed in internal communication procedures and in most cases the whole organizational staff will have access to the study.

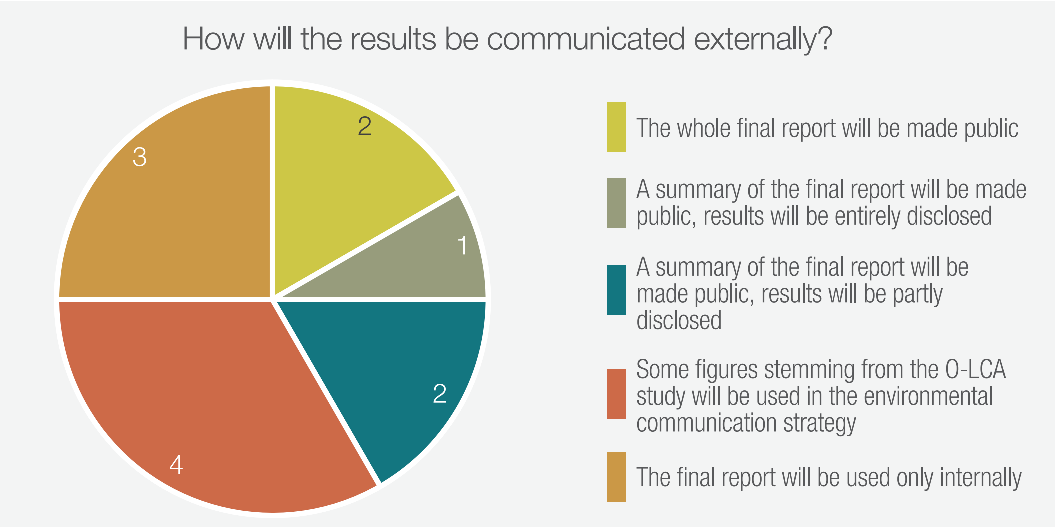


Figure 37: Planned external communication of the study results

The road testers plan to integrate the results obtained through the O-LCA study into the organization's strategy, (e.g., for establishing an enhanced environmental data collection system, setting reduction targets and tracking the organization's performance towards them, or putting in place mitigation measures (Figure 38). Some follow-up studies are also likely to be initiated, either at the product level or for suppliers that were identified as hotspots.

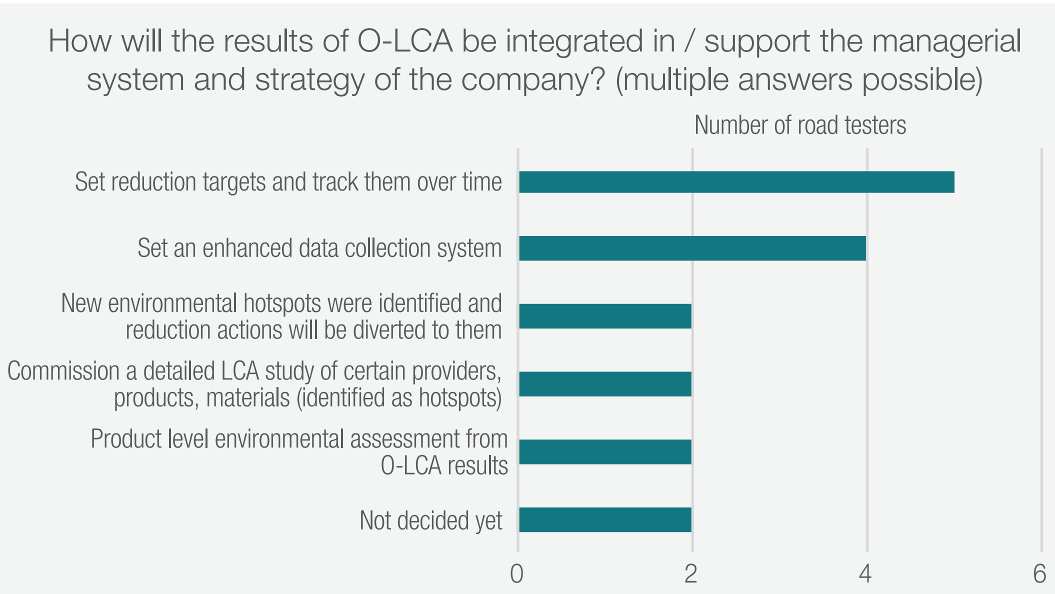


Figure 38: Use of the O-LCA results within the organizations' strategy

Road testers' feedback

"Sharing experience and results with clients and stakeholders should be emphasized [as a relevant outcome of O-LCA implementation]."

- Rob Sianchuk, Junk That Funk

Road testers' feedback

"O-LCA could be used to identify materiality in GRI Sustainability Reporting."

Jessica Hanafi & team, Industrial Engineering Dept, Universitas Pelita Harapan

Five road testers already committed to carry out O-LCA studies in the coming years, and more are considering it within their organization (Figure 39). There is also great interest in widening, within the next years, the scope of the studies that have, so far, assessed only one part of the organization (Figure 40). In this way, O-LCA has the potential to become a core environmental assessment activity within organizations and contribute to the reduction of their environmental impacts.

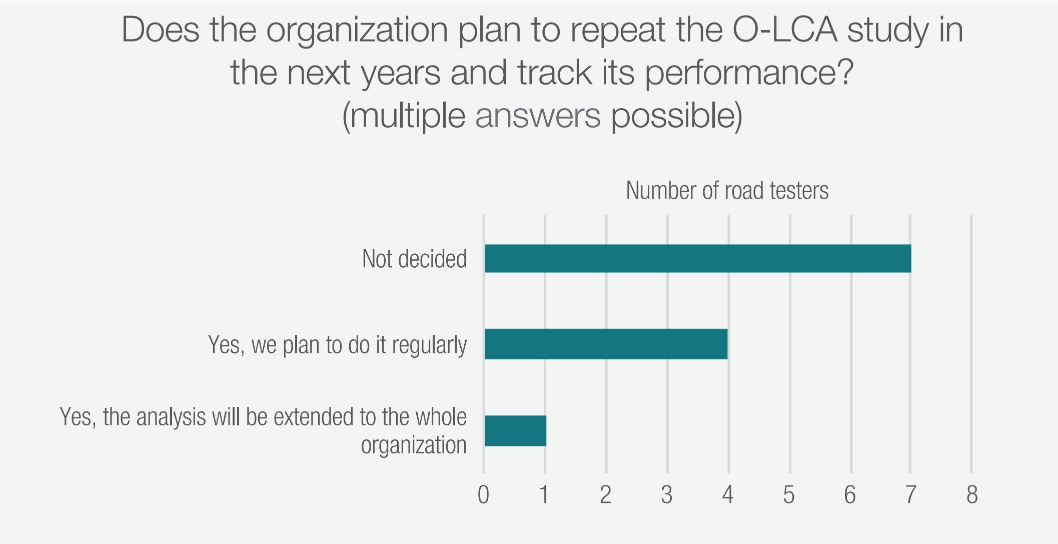


Figure 39: Road testers' plans for future O-LCA studies

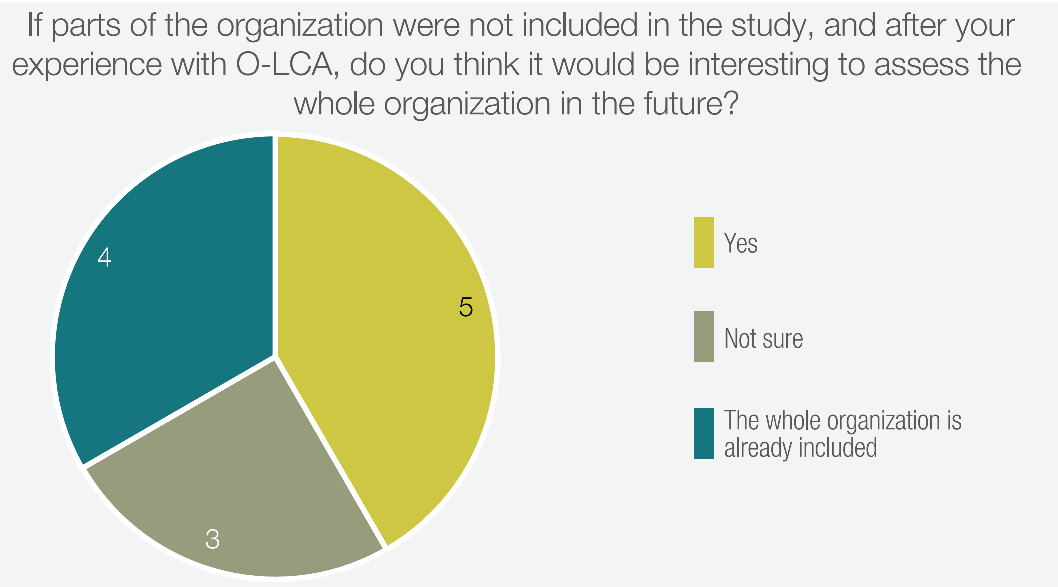


Figure 40: Interest in widening the scope of future O-LCA studies

CHAPTER

5. Conclusions and outlook

This document disentangles the characteristics of O-LCA method application. The road-testing experiences (Section 3) and the feedback collected (Section 4) show that O-LCA is a valuable tool that can reveal environmental hotspots where the organization should focus energies and intervention. Through the O-LCA studies, the road testers were able to detect risks and impact reduction opportunities along the value chain. Moreover, by applying O-LCA, some of the road testers already tracked environmental performance over time, while others showed great interest to do so in the future.

For many of the road testers, the impacts upstream and downstream in the value chain played a highly relevant role for most, if not all, the impact categories. Very often material and energy resources were assigned the dominant contribution, but the relative weight of the use phase and the end-of-life on the global impacts was also relevant for some of them. This shows how far the multi-impact life cycle perspective can unveil new impact reduction opportunities, beyond direct impacts and for a broader set of environmental burdens than CO_2 emissions accounting. Moreover, the inclusion of supporting activities, apart from those directly related to the provision of the portfolio, also promoted lateral thinking in the search for mitigation alternatives.

Additionally, the road-testing process also confirmed that the method can be useful for different organization sizes and types, SME or multinational, companies or public bodies, from diverse economic sectors, providing products or services, with different degree of vertical integration, with no or advanced experience with environmental tools, and from all over the world. On the basis of the O-LCA Guidance, every organization found its own way to apply the methodology, for instance by already analyzing the whole organization or by starting with a pilot that focused on a part thereof, like a country or a brand. Some decided to consider the whole life cycle while others preferred to disregard the use phase and end-of-life. Based on prior experience, structure of the organization, and existing data collection systems, every road tester designed the most suitable data collection approach and set of data sources. Moreover, the road testers applied a broad range of established impact assessment methods and life cycle inventory databases according to their experience, region and preferences.

In most case studies, environmental departments were involved in the project, mainly supported by other units, for example during data collection activities. Only one quarter of the road testers experienced difficulties and challenges in establishing support and data provision internally. In several cases external experts provided support. In spite of the considerable resources needed for O-LCA application, the effort was mainly considered to be justified by the resultant information provided by the O-LCA study. Additionally, most practitioners expect that the lessons learned will yield positive effects on subsequent iterations of O-LCA.

All road testers can recommend other organizations to use O-LCA. Furthermore, they found that the O-LCA Guidance is a suitable document for the application of the methodology, and some would suggest applying O-LCA with other relevant background documents (e.g., ISO 14040 or GHG Protocol standards), which are referenced throughout the O-LCA Guidance as foundations for the method. The potential of O-LCA to even be a catalyst or motivation to start environmental assessments was confirmed by the fact that one quarter of the road testers did not have any previous experience with either LCA or any other environmental management tool.

According to the evaluation of the road-testing experience and the direct feedback from the road testers, the O-LCA flagship project secretariat does not need to plan immediate updates to the O-LCA Guidance. Nevertheless, some further priority action areas were identified in order to streamline the application of O-LCA in the future.

Some road testers did not use the categorization of the activities into direct, indirect upstream and indirect downstream as proposed by the O-LCA Guidance, which is also in line with GHG Protocol Standards. This was due to two main reasons: the aggregation of the collected data did not make it possible, and/or the classification was perceived as artificial and remote by the organization. For instance, many road testers had difficulties in understanding why fuels use should be divided into direct emissions (combustion) and indirect emissions (production); or why the management of the waste generated at the organization's sites is classified as an indirect activity, when it is a subsequent stage from a chronological point of view. We still recommend using this categorization, but more explanation about why these distinctions are helpful and additional examples are needed to increase acceptance among organizations. As the categorization is shared with corporate GHG standards, it is expected that it would facilitate the universalization of the concept. Harmonization would be reinforced by a default list of activities for O-LCA that is fully aligned and structured as the corporate GHG standards.

The road testers also identified the need for more detailed practical advice on how to handle and interpret the large amount of results of an O-LCA study, particularly for large and complex organizations. In fact, such studies usually deliver findings for a broad range of activities and impact categories, and, according to the study design, also product groups or facilities. It is important to provide appropriate support in the future so that practitioners understand the results of the existing life cycle impact assessment methods, and to spot the most useful findings, without getting lost in a jungle of results.

According to the road testers' feedback, mapping the data needed and effective data collection are also very clear areas of struggle. Coordinating the collection of on-site data for direct activities and specific data for indirect activities requires the involvement of many departments and external partners. In fact, obtaining indirect data from suppliers is very difficult in most cases, if it is available at all. Since the road testing was carried out by a diverse set of examples, other organizations can profit from this experience to find the right data collection model. Organization's purchases might cover a myriad of materials, intermediate products and processes that cannot be modelled only with specific data, therefore it is recommended to keep promoting the development of new and local life cycle inventory databases. Moreover, a detailed, simplified and internationally agreed scheme for data quality assessment would be helpful for fulfilling the requirement from both organizational, and product LCA studies.

Writing the report was perceived by the road testers as difficult and very time intensive. This might be related to the high reporting standards followed by some of the road testers and/or be due to a general lack of reporting experience in other cases. Moreover, since the O-LCA method is relatively new, no examples were available to the road-testers, which might have caused additional conceptual work. However, complete and detailed full reports are fundamental for reproducibility and transparency. To facilitate practitioners' work, recommendations on how to prepare a comprehensive, yet readable and concise final report are needed. Reporting templates would also encourage public disclosure and, at the same time, add some consistency to the reports.

Another issue identified by the flagship project secretariat is the need of further recommendations and detailed requirements for the definition of the reporting flow to operatively facilitate performance tracking. For an effective comparison of environmental performance over time, a unit of intensity or activity should be defined and impacts presented against it.

Although the road testing was the last phase of the Life Cycle Initiative's flagship project "LCA of Organizations", the needs highlighted by the road testers should be addressed in the future by the LCA community, in the form of targeted practitioner support, templates for reporting, and through additional guidelines or scientific work. In that sense, beyond the dissemination of the outcomes and main learnings of the road-testing process in this publication, several scientific publications are planned that will exhaustively analyze the results of the survey, the learnings of the road-testing project, and derive targeted recommendations for the future. Moreover, some road testers intend to present their case studies in detail.

On the top of the road-testing case studies, since the launch of the O-LCA Guidance, some additional examples of O-LCA implementation for other sectors have been published. Manzardo et al. (2015) discussed the use of O-LCA for the packaging sector and presented a first implementation example. A full organisation environmental footprint for an operator of 240 canteens in Switzerland was presented in Jungbluth et al. (2016). Tailored O-LCA methodological approaches for the textile and higher educational sectors were proposed by Resta et al. (2016) and Lo-Iacono-Ferreira et al (2017), respectively. Neppach et al. (2017) examined whether this type of approach could be readily applied to construction companies, as well as the corresponding costs and benefits, through a case study. Two of the companies presented as 'first movers' in the O-LCA Guidance, Accor and Unilever, were presented in more detail in Martínez-Blanco et al. (2016). Finally, the Organizational Environmental Footprint Pilot Phase, led by the European Commission, included the assessment of several retailers and copper producers and some related publications may be available in the coming future. All of these examples, not to forget the first movers introduced in the O-LCA Guidance, already represent a valuable pool of examples for O-LCA implementation in a broad set of sectors, regions and types of organizations. The authors hope that growing body of case studies will promote O-LCA's further use and have a snowball effect on the spread of the methodology.

Furthermore, the O-LCA approach can also be promising for assessing further sustainability dimensions, like social aspects. As a first step, Martínez-Blanco et al. (2015b) demonstrate and discuss how a social organizational LCA approach can overcome some of the methodological and practical challenges of the more product-related social LCA.

Finally, we wish to acknowledge the remarkably open, cooperative, constructive and productive attitude in the O-LCA road tester's community, and to thank the participating organizations and all practitioners for their enthusiastic work and pioneering spirit in this field. We are also grateful for the large and continued interest in the O-LCA Guidance publication that has been already downloaded more than 10,000 times. We hope that this report on the O-LCA road-testing process with its case studies, in combination with the O-LCA Guidance, will contribute to an on-going diffusion and application of the methodology, and a growing realization of the benefits of performing O-LCA.

Acronyms

CDP	Carbon Disclosure Project
CF	Carbon footprint
EoL	End-of-life
GHG	Greenhouse gas
GRI	Global Reporting Initiative
ISO	International Organization for Standardization
LCA	Life cycle assessment
LCI	Life cycle inventory
LCIA	Life cycle impact assessment
OEF	Organisation environmental footprint
O-LCA	Organizational life cycle assessment
SME	Small and medium-sized enterprise
SETAC	Society of Environmental Toxicology and Chemistry
TS	Technical specification
UN	United Nations
UNEP	United Nations Environment Programme

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About the Life Cycle Initiative

The Life Cycle Initiative is a public-private, multi-stakeholder partnership that facilitates the application of life cycle knowledge in the global sustainable development agenda in order to achieve global goals faster and more efficiently.

Hosted by UN Environment, the Life Cycle Initiative is at the interface between users and experts of life cycle approaches. It provides a global forum to ensure a science-based, consensus-building process to support decisions and policies towards the shared vision of sustainability as a public good. It delivers authoritative opinion on sound tools and approaches by engaging its multi-stakeholder partnership (including governments, businesses, scientific and civil society organizations).

The target audiences for the Life Cycle Initiative include high-level decision makers (policy makers and regulators; business strategists) as well as LCA practitioners. The Initiative provides stewardship of the use of life cycle knowledge in specific applications, and supports life cycle assessment application through consensus on data and indicators.

With its new strategy, the Life Cycle Initiative will deliver programmes across three main areas: technical and policy advice, capacity development, and knowledge. By 2022, the Initiative will, crucially, mainstream the use of life cycle thinking into at least four global areas of policy making and decision making for sustainable development, through partnerships in at least 15 countries and 30 companies. the initiative will also train at least 2,500 policy makers, business decision makers and life cycle assessment practitioners, in addition to offering a solution to access life cycle assessment databases and impact assessment characterisation factors in an interoperable way.

The Initiative's work programme will primarily be delivered through its multi-stakeholder partnership, which includes governments, businesses, scientific and civil society organizations, and experts in the field. Aligning with the Initiative's new governance model, we encourage these institutional groups, as well as individuals, to become members of the Life Cycle Initiative and join us and actively contribute to achieving the Initiative's goals.

Get more details:

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LCA of organizations is becoming of increasing interest not only as a complement to product-based analyses, but also as a stand-alone methodology. In 2015, the United Nations Environment Program (UN Environment) and the Society of Environmental Toxicology and Chemistry (SETAC) partnership Life Cycle Initiative launched the flagship project "LCA of Organizations", whose main outcome was the document *Guidance on Organizational Life Cycle Assessment* (O-LCA Guidance).

After the successful launch of the *O-LCA Guidance* (with more than 10,000 downloads to date), the LCA of Organizations flagship project embarked on an ambitious piloting process. O-LCA was applied by 12 organizations from around the world – the so-called O-LCA road testers – exhibiting a broad range of characteristics in terms of geographical region, sector, size, and prior experience with environmental tools.

This publication complements the *O-LCA Guidance* in that it offers more in-depth insights into O-LCA application, developed from the outcomes of the road testing. It presents the main features of O-LCA to set the context for the road testing, the executive summaries of the O-LCA road testers' case studies, high-level results and challenges experienced, as well as the results of a comprehensive survey through which the road testers share their experience, feedback and lessons learned.

The O-LCA case studies in this publication represent an important contribution to the existing body of examples and guidelines, which the authors hope will promote and inspire further application of O-LCA, more use of the O-LCA Guidance, and on-going enhancement of the O-LCA methodology.

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