Prosjektet Smart Sirkulær By i regi av Byen som Regional Motor (BRM)

Delprosjekt 3: Kompetansebygging - Smart Sirkulær By Guidelines for implementering

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Postadresse: 6009 Ålesund

Title: Delprosjekt 3: Kompetansebygging - Smart Sirkulær By / guidelines for implementering	Project no NTNU-90375803
Project: Smart Sirkulær By i regi av Byen som Regional Motor (BRM)	Date: 24.01.2020
Author: Shannon Truloff / Annik Magerholm Fet, NTNU	Signature:
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Summary:

The project is a collaboration between Ålesund kommune, Årim, Tafjord Kraftvarme AS, Bingsa Gjennvinning AS og NTNU, and it is financed by 'Byen som regional motor'.
The project arose because of Ålesund municipalitiy needs to have an overview of the solid waste volumes it has today and what it can expect in the coming years. The municipality wanted to be well prepared for sustainability challenges. To be able to implement appropriate solutions from an economic, environmental and technological perspective where important social considerations are considered with increasing population and a larger municipal structure following the amalgamations. The goal has therefore been to help develop new and future solutions based on smart circular models.
The project consists of three sub-projects; 1) Waste Target 2030 – Ålesund Region; 2) Digital models for analysis, simulation and optimization of smart circular city; 3) Competence building - Smart Circular City and a Roadmap for implementation.

The Report explains the concepts and visions behind the circular economy and aims to increase awareness of issues around circular economy, highlighting potential strategies and actions, along with intended impacts for smart sustainable cities. A framework for guiding Ålesund towards being a smart sustainable circular city is provided

Key words:

Distribution/access: Open

Forord

Prosjektet **Smart Sirkulær By** er et samarbeidsprosjekt mellom Ålesund kommune, ÅRIM, Tafjord Kraftvarme, Bingsa Gjenvinning AS, og NTNU. Det er finansiert 50 % gjennom programmet **Byen som Regional Motor (BRM)** i regi av Møre og Romsdal fylkeskommune. De resterende 50 % er finansiert gjennom egenfinansiering blant samarbeidspartnere.

Prosjektet er gjennomført i tre delprosjekter:

1. Målbilde avfall 2030 – Ålesundregionen
2. Digitale modeller for analyse, simulering og optimalisering av Smart Sirkulær By
3. Kompetansebygging - Smart Sirkulær By og Veikart for implementering

Prosjektet er forankret i Ålesund kommune, og med NTNU som faglig koordinator.

Dette er rapporten for delprosjekt 3: Kompetansebygging - Smart Sirkulær By , Guidelines for implementering, og er ledet av Shannon Truloff, NTNU.

Prosjektperioden har vært 1.01.2019 til 31.12.2019. Sekretær for prosjektet har vært Kirsti Brekke.

Ålesund 24.01.2020

Shannon Truloff Annik Magerholm Fet

Innhold

1. Mål, gjennomførte aktiviteter og resultat

Dette delprosjektet er forankret under NTNU strategiske satsing BTSD-Business Transition to Sustainable Development, ved Institutt for internasjonal forretningsdrift (IIF). Prosjektansvarlig for dette delprosjektet har vært Shannon Truloff i samarbeid med Annik Magerholm Fet, NTNU.

Bakgrunn og målsetting

Dette delprosjektet handler om å bygge kompetanse og tilrettelegge initiativer som passer direkte inn i smart by-tilnærmingen under modellen for Universitetskommune 3.0. Dette kan gjøres gjennom et helhetlig perspektiv og samarbeid mellom forskning og utdanning, industrielle aktører og offentlig sektor (Ålesund kommune).

Målet for dette delprosjektet er å styrke og øke innovasjonskapasiteten rundt ressurseffektivitet gjennom samarbeid, forskning og teknologisk utvikling innenfor avfallssektoren. Dette prosjektet vil legge til rette for strategier for sirkulær økonomi for kommunen og samtidig bygge kompetanse i samspillet med NTNU. Det er et nytt fagfelt som vil bidra inn i utdanningen ved NTNU og vil inngå i ulike utdanningsløp.

Gjennomførte aktiviteter

Planlagte oppgaver i dette delprosjektet:

1. Analyser av best practice for sirkulære modeller
2. Tilpasse veikart for Smart Sirkulær By, uttesting
3. Handlingsplan for implementering av Universitetskommune 3.0

Hovedoppgaver utført:

- Analyser av sirkulære modeller på forretnings-, sektor-, by- og regionalt nivå.
- Analyser av internasjonale tilnærminger til både smart og sirkulær byplanlegging, veikart og strategier.
- Gjennomgang av standarder for indikatorer for måling og oppfølging av både smart og sirkulær økonomi, først og fremst på bynivå.
- Innledende skisse til prosjekt som bidrag til pilarer Smart bærekraftig samfunn under modell for Universitetskommune 3.0.

Resultater

Resultater fra delprosjektene 1 og 2 har bidratt til en felles handlingsplan og tilpasset veikart for implementering av nye løsninger for håndtering av materialstrømmer etter sirkulære prinsipper. Dette danner også grunnlag for implementering av nye løsninger under arbeidet med Universitetskommune 3.0 – Smarte bærekraftige samfunn.

Gjennom prosjektet er det etablert et nettverk blant forskningsmiljøer som er aktive innen sirkulær økonomi. Dette er nettverk som vil bidra til å støtte opp under de løsninger som blir videreført. Det tas sikte på at det etablerte nettverket vil fortsette å fungere som en motor etter prosjektets slutt for å tilby eksperttjenester, gjøre vurderinger og studier, og formidle

resultater og beste praksis til andre aktører i regionen. Prosjektet har vært koblet opp mot Nettverk for Grønn Vekst, et næringsrettet nettverk med støtte fra Norges Forskningsråd, samt nettverket for Business Models for Sustainability (BMS).

Hovedleveranser ved avslutning er

1. Oversikt over Business Models for Sustainability (BMS).
2. Indikatorrammeverk for sirkulære modeller
3. Utkast til Veikart for en smart bærekraftig sirkulær kommune
4. Opplæringsmateriell med powerpoint-slides om sirkulære modeller

1. Oversikt over Business Models for Sustainability (BMS).

Forskning viser at det er mulig å forene bærekraft og lønnsomhet. Det finnes en rekke eksempler på bærekraftige løsninger som gir konkurransefortrinn. Bedrifter trenger en verktøykasse for å anlyser og vurdere hvilke tiltak som gir de beste løsningene. I denne delen av arbeidet er det laget en enkel oversikt over ulike typer modeller, over hvilke utfordringer de ulike modellene imøtekommer, og hvordan de kan bidra inn mot bærekraftsmål nr 12: Ansvarlig forbruk og produksjon. En oversikt over analysen som er gjennomført, er gitt i Vedlegg 1 til denne rapporten.

2. Indikatorrammeverk for sirkulære modeller

For tiden er det ingen standardisert måte å måle hvor effektiv en by er ved overgangen til en sirkulær økonomi. Eksisterende indikatorer fokuserer på materialstrømsanalyse, herunder materialbruk, produksjon og utslipp. Denne tilnærmingen er begrenset fordi den ikke klarer å fange initiativer som deling, gjenbruk og reparasjon. Hensikten med arbeidsdokumentet om Circular Economy-indikatorer er å lukke dette kunnskapsgapet ved å sette i gang utviklingen av et sett med sirkulære indikatorer spesielt for bruk i Ålesundsregionen. Et overvåkningsrammeverk, så vel som spesifikke indikatorer, i første omgang skissert innen sektor for fast avfall, vil kunne bidra til beslutninger for utvikling av Ålesundsregionen på en systematisk måte. Et slikt rammeverk vil gi svar på politiske spørsmål som dekker alle relevante forhold ved en overgang til sirkulære endringer. På grunn av den komplekse dynamikken som styrer endringene, må utviklingen av overvåkingsrammeverket være fleksibel, noe som gjør det mulig å tilpasse indikatorer til spesielt fokuserte områder ved overgangen til smartere og mer bærekraftige samfunn. For mer informasjon, se Vedlegg 2 til denne rapporten.

3. Utkast til Veikart for en smart bærekraftig sirkulær kommune

Målet med veikartet er å støtte beslutningstakere på regionalt og bynivå for å utvikle og implementere strategi og tiltak mot en smart bærekraftig sirkulær by. Det er bygget opp rundt en 4-stegs model basert på 1) Forståelse av den lokale konteksten og potensialet, 2) Prioritere og formulere visjon og mål for tiltak, 3) Involvere innbyggerne og implemetere tiltak for å nå målene, 4) Etablere et rammeverk for å støtte opp om politiske beslutninger. Denen modellen vil sikre en omfattende og inkluderende tilnærming til en smart sirkulær byutvikling. Det kan brukes som grunnlag for diskusjoner knyttet til utforming av nye strategier, politiske dokumenter, prosjekter og tjenester. Det fungerer som grunnlag for samskapingsprosessene fra kommuner sammen med innbyggere, gründere, akademikere og andre interessenter. Veikartet foreligger i en ferdig versjon for uttesting.

4. Et sett med power-point slides for undervisningsmoduler i smart, sirkulær og bærekraftig utvikling.

Det er utviklet opplæringsmateriell som er beregnet for bruk i ulike brukergruppe, som f.eks. i workshops i kommunen, og innenfor studieprogrammer i universitet og høyskoler som angår utdanning om smart, bærekraftig og sirkulær utvikling. Opplæringsmaterialet er fleksibelt og kan tilpasses flere brukerbehov.

Opplæringsmaterialet dekker følgende emner og vil bli gjort åpent tilgjengelig ved neste revisjon:

- Fra lineær til sirkulær overgang
- Sirkulær økonomi fordeler, utfordringer og muligheter
- Forretningsmodeller for sirkulær økonomi og bærekraft
- Oppskalering av sirkulær økonomi til by og regionalt nivå
- Prestasjonsindikatorer ved overgang til sirkulære samfunn
- Beste praksis og veikart for sirkulær transformasjon

Vurderinger i forhold til målet med delprosjektet

Resultatmål

- Øke kompetansen hos samarbeidspartene og i regionen for øvrig.

Materiellet som er utviklet oppfyller dette resultatmålet.

Måleindikatorer

Følgende måleindikatorer er satt for å måle progresjonen i prosjektet

- Utviklet sirkulære modeller for avfallshåndtering.

Gjennom det opplæringsmateriellet som er utviklet, så bidrar det til denne måleindikatoren. Denne kunnskapen vil også bidra til å øke andelen avfall som går til ulike former for material- og energigjenvinning.

2. Forslag til oppfølgingstiltak delprosjekt 3

Hvert av delprosjektene i prosjektet Smart Sirkulær By har gitt nyttige resultater i seg selv, og det er flere områder som kan følges opp.

Delprosjekt 3 har hatt fokus på kompetansebygging og forståelse for de utfordringer som ligger i smarte løsninger for sirkulærøkonomi. Det er lagt vekt på tilpasse opplæringsmateriell samt å utvikle en guideline/et veikart for implementering av smarte bærekraftige løsninger.

Hovedtema i veikartet er:
1. Hvorfor trenger vi en sirkulær økonomi?
2 Muligheter for en bærekraftig utvikling
3 Sirkulær økonomi for ulike systemnivåer - prinsipper og strategier
4 Smart Bærekraftig By – visjon og 8 prinsipper
5 Veien mot en kommunal policy for Smart Sirkulær Ålesund – en stegvis modell med stakeholder involvering (4-stegs modell)

Med utgangspunkt i intensjonsavtale 9.mai 2019 mellom NTNU og Ålesund kommune, var det satt et mål om at en samarbeidsavtale skulle være inngått innen 01.01.2020. Modell for Universitetskommune 3.0 er etablert med 2 hovedpilarer; 1. Smarte bærekraftige samfunn, og 2. Smart helse og velferd**.** I tillegg skal en i Universitetskommune-modellen legge vekt på bærekraft, digitalisering, simulering og nyskaping, se figuren nedenfor.

Resultatene i dette delprosjektet er et viktig redskap ved utvikling av Universitetskommune 3.0, se figur, spesielt under de tiltakene som representerer venstre pilar – Smarte bærekraftige samfunn.

Veikartet utviklet under delprosjekt 3 vil være et viktig bidrag ved utvikling av handlingsplanen for implementering av Universitetskommune 3.0.

Som en del av uttestingen vil også indikatorrammeverkene blir vurdert og tilpasset. I dag rapporterer Ålesund kommune på indikatorene i U4SSC-programmet, men som vist i vedlegg 2 til denne rapporten eksisterer flere indikatorssett. Tabell 7 i vedlegget viser et fullt sett av Key Performace Indicators (KPI) for avfall. Dette settet inkludere både kjerneindikatorer og støtteindikatorer. Intensjonen er å bruke disse for å måle den faktiske situasjonen, samt for å utvikle en sirkulær avfallsstrategi.

Som en del av uttestingen av veikartet vil KPI-settet i Tabell 7 bli tilpasset situasjonen i Ålesund kommune. Interessentinvolvering gjennom workshops med deltagere fra avfallsselskap, fra kommunen og avfallsleverandører vil vektlegges for å finne et optimalt sett med indikatorer for sirkulær økonomi.

Plan for videreføring

Kompetansebygging og uttesting av veikartet, med ca 6 - 8 månedsverk for et pilotprosjekt for gjennomføring av følgende tiltak i tråd med de fire stegene som er beskrevet i Veikartet:

1. Invitasjon til møter med stakeholdergrupper
2. Gjennomføring av workshops med fokus på prinsipper som er beskrevet i veikartet.
3. Utvikle plan for uttesting av veikartet og indikatorsettet for sirkulære avfallsløsninger for noen brukergruppe
4. Justering av veikartet basert på tilbakemelding fra brukergruppene og uttestingen.

Oppdatering av opplæringsmateriellet, videreutvikling til etter- og videreutdanningskurs for bedrifter og kommune vil være en integrert del av arbeidet.

Samarbeid med Ålesund kommune er viktig for å sette strategiske prioriteringer for en smart sirkulære Ålesundsregion.

I tillegg til å kjenne til den kontekstuelle situasjonen i byen, er det også viktig å forstå barriere og drivere i Ålesundsregionen. Vurdering av den lokale konteksten gjør det mulig å definere områdene med det høyeste potensialet.

En videreføring av delprosjekt 3 vil bidra til å utvikle opplæringsmateriale. Det vil også bidra til utvikling av bærekraftige ledelsesmodeller (Sustainable Business Models) der prinsipper fra sirkulær økonomi vil være sentrale (se Vedlegg 1 til denne rapporten om ulike ledelsesmodeller der bærekraftperspektivet er sentralt). Dette vil også involvere næringslivet i regionen. Det er etablert et samarbeid mellom NTNU, HiVolda, HiMolde, med næringslivsklyngene og noen bedrifter (inkl Tafjord energiarena) for å utvikle en regional kompetanseHub for bærekraftige forretningsmodeller. Gjennom nettverksprogrammet støttet av næringsavdelingen i fylket, skal det gjennomføres noen samlinger i 2020 for å øke bevisstheten rundt dette feltet. Et styrket samspill mellom næringsliv, kompetansemiljøer og Ålesund kommune vil bidra til en akselerering av overgangen til mer sirkulære løsninger. Oppfølgingstiltaket fra delprosjekt 3 vil bidra inn i utviklingen av pilaren Smarte Bærekraftige Samfunn som vist i figuren for Universitetskommune.

En detaljert fremdriftsplan vil bli utviklet.

3. Avsluttende kommentarer

Resultater fra delprosjektene 1 og 2 vil bidra til en felles handlingsplan og tilpassede veikart for implementering av nye løsninger for håndtering av materialstrømmer etter sirkulære prinsipper. Dette vil danne grunnlag for implementering av Universitetskommune 3.0 som en direkte oppfølging av Delprosjekt 3.

Prosjektet Smart Circular City har startet de første trinnene med å analysere det lokale potensialet, ressursene, tapte ressurser og evner som kan være medvirkende til å oppnå visjonen. Arbeidet bør fortsette med ytterligere analyse av regional og nasjonal statistikk; benchmarking mot internasjonale standarder; og konsultasjon med interessenter (intervjuer, fokusgrupper, undersøkelser, workshops). Samarbeid mellom forskere og kommune er essensielt, og arbeidet kan strekke seg utover kommunens avfallssektor.

Kompetansen innen sirkulære modeller, systemanalyser, miljøeffektvurderinger, miljøledelse, kommunikasjon ved hjelp av indikatorer, visualisering gjennom digitale løsningen mm, bør utnyttes i nært samarbeid mellom forskere ved NTNU og Ålesund kommune. Teknologi som data mining som gir informasjon i sanntid og visualisering og kunne være et godt case for Sustainability Analytics, noe som kan bringes inn som er viktig utviklingstema under paraplyen Universitetskommune 3.0.

4. Vedlegg

Vedlegg 1: Oversikt bedriftsmodeller for bærekraft og sirkularitet

RESEARCH EMERGING SUSTAINABLE BUSINESS MODELS (SBM)/CLOSED LOOP BUSINESS MODEL (CLBM)

Developed by Shannon Truloff, 2019

Questions:

1. What is the state of the art?
2. What is the challenge?
3. How to use the SDG nr 12 to implement a Sustainable and Closed Loop Business Model?
4. What are the future innovative SBM that will achieve SDG 12?

Sustanable Development Goal nr 12: Responsible consumption and production - To ensure sustainable consumption and production patterns. The SDG illustrate Circular Economy.

Research programs BIA – Norwegian Research Council

- No thematic restrictions.
- Will result in new products, processes and services in or across a variety of sectors.
- New business models and/or management strategies, preferably in combination with technology for a more sustainable business sector that assumes broader social responsibility.
- All projects must promote the development of a competitive norwegian business sector.

Cluster – who

- http://ikuben.no/
- http://www.norwegianrooms.no/
- http://gcenode.no/ Global Centre of Expertise (Norway)
- https://www.gcesubsea.no/
- http://www.legasea.no/

STATE-OF-THE-ART SUSTAINABLE BUSINESS MODELS to REACH SDGs

Consider:

1. Role of role of **technology advancement** and level of innovation.
2. The application of a **systems perspective.**
3. Introducing innovative approaches to **collaboration**.
4. Need for **education** and raising awareness to facilitate successful adoption of sustainable business models.

Current thinking summary:

- Achievement of SDGs require a switch in focus from 'corporate social responsibility' and 'shared value' approaches, to '**system change' strategies based on big ambitions, new technologies, new business models, and active market shaping**.
- Sustainable business models can serve to coordinate technological and social innovations with **system-level sustainability.** Systems thinking identifies the interactions between different parts of a system – a city, a society, a sector – and ensures they deliver more than the sum of the parts. For SDGs to shift the whole system onto a sustainable path, there is increased need for joined-up thinking that goes deeper to address underlying causes. Successfully delivering the SDGs requires a strong systems approach.
- Circular thinking and Sustainable business models include a **wide range of stakeholders** and consider the environment and society as stakeholders.
- Business models in highly **dynamic business networks** that ensure fairly shared business benefits among all stakeholders in the value chain, are more complex, open, collective and evolutionary.
- **Business model innovations for sustainability** are defined as: Innovations that create significant positive and/or significantly reduced negative impacts for the environment and/or society, through changes in the way the organisation and its value-network create, deliver value and capture value (i.e. create economic value) or change their value propositions.
- Innovations needs to introduce change at the **core of the business model** to tackle unsustainability at its source rather than as an add-on to counter-act negative outcomes of business.
- Shift in focus away from the business case and towards the role of business models in delivering **multiple forms of value.**
- Upgrading the **value network position is one emerging business possibility for many marine sector companies**. This involves management of the change process from, for example, component provider to subsystem provider, from subsystem provider to solutions provider, or from solutions provider to asset management.
- The required approach must go beyond measuring and reducing negative impacts, to **Identifying and delivering on unmet needs.**

Reference to theory:

Business model innovation involves changing 'the way you do business', rather than 'what you do' and hence must go beyond process and products (Amit and Zott, 2012).

Johnson and Suskewicz (2009) suggest business model innovation represents shifting the focus away from developing individual technologies towards creating new systems.

Sommer (2012) emphasises that a business model does not only have a company focus, but involves a wider set of stakeholders, necessitating a broader value-network perspective for innovating and transforming the business model.

Beattie and Smith (2013) and Zott et al. (2011) describe the business model as extending beyond the entity of the firm, its customers and shareholders, and also including value captured for key stakeholders (e.g. suppliers).

Sustainable business models capture economic, social and environmental value for a wide range of stakeholders (Bocken et al., 2013).

OPPORTUNITY to DEVELOP NEW SUSTAINABLE BUSINESS MODELS

Disruptive Technologies for Sustainability:

Technologies that have the potential to disrupt industries and, in the process, create opportunities for sustainable performance. These include technologies of:

- Big Data
- Artificial Intelligence
- Internet of Things
- Autonomous Vehicles
- 3d Printing
- Synthetic Biology
- Drones
- Virtual Reality
- Robotics
- Nanotechnology
- Low Carbon Technology
- Solar Energy
- Smart Grid
- Geoengineering
- Blockchain

Companies that champion breakthrough innovation to deliver more sustainable business models and products will not only help meet the **Global Sustainability Goals** but will win in new **emerging business opportunities**.

INNOVATIVE SBM MODELS AIM to:

- Shift from old business strategies to cut negative impacts and externalities, to new ones designed to boost positive impacts and externalities.
- Business models that more explicitly link profit to social and environmental performance.

MARITIME INDUSTRY BENEFIT FROM DIGITAL TECHNOLOGIES by:

- Closer cooperation across the value chain into onshore industries. Sharing relevant data in a “maritime cloud” to increase efficiency and enable the internet of things on sea with new services.
- More data gathered from the ocean will improve simulation tools for voyage planning and climate models. Offshore wind farms will be build, operated and maintained with lower cost.
- Overall, by the huge size of the global maritime industry digitization could improve also significantly its relevant carbon footprint.
- Waste could be reduced by a synchronized intermodal transport and logistics based on real-time demand by autonomous technologies both for trucks and vessels.
- Harvesting marine mineral resources from the ultra-deep sea will require autonomous vehicles and will supply crucial elements for high-tech products and batteries.
- Digital technologies might even support to solving one of the biggest challenges of our time – plastic waste in the oceans. Large ocean garbage patches are a global issue that already today seriously impacts the entire food chain.
- Digital technologies are offering new ways of performing joint industry projects. By sharing data, operators, suppliers and service providers can evaluate together how new technology can increase efficiency and reduce cost, e.g. by introducing liquefied natural gas (LNG) as a new type of environ-mental friendly fuel or to monitor emissions during voyage.
- Another example is how drones could be used across the industry to monitor and inspect assets or even deliver spare parts. As drones are totally new for the industry, it makes a lot of sense to work closely together in an open innovation set up.
- Testbed to be used across the industry will make qualification more independent from running operations and thereby an innovation ecosystem can emerge.
- DigitalHubs.

SOURCE: https://innoboard.de/innovation-management/steffen-knodt-german-association-marine-technology-gmt/

An Interesting case:

Pacific Garbage Screening initiative in Aachen. The project is aiming to build a large floating platform to convert ocean plastic waste into sustainable energy.

BROAD CHALLENGES to DEVELOP NEW SUSTAINABLE BUSINESS MODELS

How to harness an evolving set of business model features to deliver on the Sustainable Development Goals? Especially SDG 12 with focuses on production and consumption and including target on adopting sustainable business practices and reporting.

- Solutions which meet the scale and speed of change of globally challenges with sustainable innovation needs to go into the design of the business model.
- Must create business models that connects it with what the market wants.
- Companies must shift from considering the business case for action, to evolving the business models which will be at the heart of tomorrow's economy.
- Risk that Personalisation Business Models will drive a rising demand for goods, and a corresponding increase in production. However, Personalisation Business Models, when coupled with other servitization models (including Asset-Sharing and Usage-Based Pricing), as well as Closed-Loop models, has the potential to result in more responsible production and consumption (SDG 12), and ultimately, more sustainable cities and communities (SDG 11).

  Servitization is the innovation of organisation's capabilities and processes to better create mutual value through a shift from selling product to selling Product-Service Systems

- "Lean" achievements may compromise "Social" targets
- "Integrated" solutions may not automatically be "Circular".

INDUSTRY 4.0 and SBM - (name for the current trend of automation and data exchange in manufacturing technologies. It includes cyber-physical systems, the Internet of things, cloud computing and cognitive computing).

It comes from a technological perspective of machine learning, algorithms, smart sensors, and connected assets, all which have impact on company business models.

The business models for Industry 4.0 assign great significance to the creation of value from generated data and see a more central role for end-users (customers) and networks that enable value creation. This is due to data generated from value chains that can improve automation and operational effectiveness, enabling optimized value creation structures and networks.

SOURCE: Prause, Gunnar. (2015). Sustainable business models and structures for industry 4.0. Journal of Security and Sustainability Issues. 5. 159-169. 10.9770/jssi.2015.5.2(3). https://www.researchgate.net/publication/287387194_Sustainable_business_models_and_structures_for_industry_40 [accessed May 07 2018].

IDEAS BEHIND MORE SUSTAINABLE BUSINESS MODELS

To achieve the SDGs, business models must be designed from the outset to deliver positive social and environmental outcomes at an increasing scale and accelerating pace.

Outline of promising and potentially more sustainable business models made possible by breakthrough innovation and digitalization. The ideas behind them:

- platform and network models
- everything is connected
- circular, collaboration and sharing economies
- shift from products to services
- on-demand offerings
- consumer facing

ELEMENTS OF INNOVATIVE SUSTAINABLE BUSINESS MODELS

To meet the objectives outlined by the SDGs, new sustainable business models must have these elements: (see next page for more details on elements).

- be social
- be lean
- be integrated
- be circular

Innovative sustainable business models will optimise the use of all forms of capital:

- physical
- financial
- human
- intellectual
- social
- natural

***Social:** Delivering both financial and extra-financial value through positive impacts for people in the present and the future. (Contributing to a healthier, safer and better-educated populace as a direct result of their business models).

***Lean:** Optimising the use of all forms of capital, from physical and financial through human and intellectual to social and natural. Tomorrow's business models must use resources effectively, creating no waste and maximizing value across entire value networks.

***Integrated:** Managing financial and extra-financial value creation across economic, social and environmental systems.

Businesses must integrate into their models an understanding of the needs of present and future generations, for multiple capitals and across entire value networks.

Business must measure and managing the financial and extra-financial impacts of a company's value creation processes (its business models).

It involves re-examining externalities—positive and negative, tangible and intangible—and internalizing the.

A company creates restorative value for society and the environment, while seeking to eliminate any activities that undermine ability to thrive into the future.

The active consideration of how system-level operating conditions can be changed for the better.

***Circular:** Sustaining inputs and outputs at their highest value in both technical and biological cycles.

All businesses must strive to become completely circular, their operations designed to sustain products, components, and material inputs and outputs at their highest utility and value at key points in the cycle.

The discipline of biomimicry is in focus to ensuring business neither creates waste, nor undermines essential material and nutrient cycles, or wider ecological and social systems.

> *Biomimicry - the design and production of materials, structures, and systems that are modelled on biological entities and processes.*

6 INNOVATIVE SUSTAINABLE BUSINESS MODELS - SUMMARIZED

Are a mix of:

1. **Agile SBM**
2. **Closed-Loop SBM**
3. **Collaborative Ecosystem SBM**
4. **Personalisation SBM**
5. **Asset Sharing SBM**
6. **Usage-Based Pricing SBM**

1 - AGILE SBM

Today: The normal Agile Business Model (BM)

An agile and adaptive organisation

- Where the use of technology helps organisations make decisions that better reflect market needs, allowing real-time adaptation to change in those needs
- Often results in greater value for customers and lower cost for companies

The Future Innovative Agile Sustainable Business Model (SMB)

... is more resilient to failures in trialling novel business models

- Where achieving the SDGs will require intense cycles of trial and error of new business models.
- Organisations need to nurture the mindsets and cultures to stimulate innovation, while building-in levels of redundancy to accommodate necessary failures.

What Is It?

- The ability to create new markets, fast.

Businesses to become "market makers", redefining markets not just by launching a new product, but by creating a new demand and future market reality. To do so, businesses need to start quickly, make mistakes, learn, and critically, 'pivot' the business to where the best opportunities lie.

Within business models, agility is represented through the ability for a business to respond and meet the specific demands of customers (both current and potential).

"hyperawareness" – a company's ability to detect and monitor changes in its internal and external business environment.

What's Driving It? - Real-time, anytime

The key is the rapidly evolving ability to access and process real-time information on user experiences and market conditions, which in turn, is informing business decisions continuously.

Key drivers include:

- tracking technologies such as GPS
- connected devices (the Internet of Things),
- sensors allowing data to be captured in new ways,
- use of Big Data and Artificial Intelligence to process data into meaningful decision-ready information and intelligence.

On the production side, businesses create basic prototypes through CAD (Computer Aided Design) software and technologies such as Additive Manufacturing.

2 – CLOSED LOOP SBM

Today: The normal Closed Loop BM

- Where a linear consumption process is replaced with a closed loop in which used products are recovered and recycled.
- Reduces overall resource costs for companies.

The Future Innovative Closed Loop SMB

... that seeks to do more with less

- Where the creation and consumption of new products is reduced (shifting from products to services is one approach).
- Closing the loop across a product's lifecycle across companies, industries and geographies is key.

What is it? - From linear to circular thinking

Under the heading 'Circular Economy', closed-loop systems keep products, components and materials at their highest utility and value – reducing the need for extracting and processing new resources and, in the process, cutting the related impacts on the environment.

The Closed-Loop business model provides opportunity for growth that is restorative and regenerative (sustainable).

Well-designed and managed closed-loop systems can help businesses capture untapped value – where collaboration across the value chain, and the wider ecosystem, is a critical success factor.

Related business models that are working to close the loop include:

- Circular Supplies:
  - Using renewable, bio-based or fully recyclable materials to replace single-lifecycle inputs.
- Resource Recovery:
  - Recover useful resources/energy out of disposed products or by-products.
- Product Life Extension:
  - Extend the working lifecycle of products and components by repairing, upgrading and reselling.
- Sharing Platforms:
  - Enable increased utilisation rate of products by making possible shared access.
- Product as a Service:
  - Offer access or outcomes, while retaining product ownership.

What's driving it? - Intelligence across the value chain.

New technologies enabling recovery of critical materials from waste are key to enabling Closed-Loop business models.

In addition, tracking 'waste' across the value chain is critical.

Existing technologies:

- RFID (radiofrequency identification)
- chips
- GPS (global positioning systems)

New technologies: to enable much greater tracking power, data security and precision.

- Nano-sensors connected to the Internet of Things (IoT)
- Blockchain.

Novel applications of materials formerly understood as waste, now viewed as a valued input in numerous value chains, are also transforming the production of goods, whilst creating fewer by-products.

Internet-based platforms and marketplaces are enabling the matching of demand and supply across the wider market. Eg FLOOW2, a business-to-business sharing marketplace for companies to share equipment, services and personnel.

What are the opportunities and risks? - From efficiency to effectiveness.

New Sustainable Business Models are moving from eco-efficiency (that only slows the processes of over-exploitation, pollution and waste), to eco-effectiveness (seen as part of the circular economy approach).

New partnerships across the value chain, and in different industries, sectors or geographies help to collectively allow businesses to close the loop. This enables the cost-effective collection, treatment and redeployment of used or surplus resources.

Impact on SDGs

Closed-Loop business models has the potential to impact a large number of the SDGs, including those related to the environment such as Climate Action (SDG 13), Life Below Water (SDG 14), Life on Land (SDG 15), as well as those more closely related to wellbeing and livelihoods because of the new economic opportunities they will create (SDG 8 – Decent Work and Economic Growth and SDG 9 – Industry, Innovation and Infrastructure).

Concerning SDG 12 - Individual businesses cannot close the loop on their own. Consumers must be brought along on the journey and equipped and incentivised to consume responsibly (SDG 12).

Examples Closed Loop Sustainable Business Models

Danone (France; multinational corporation)

The company treats three key resources - water, milk and plastic - as part of closed loop: in the milk cycle, for example, the company is finding new uses internally for acid whey, one of the by-products in making Greek Yogurt, both in its early life nutrition products as well as a feedstock for animal feeds, fertilisers and energy. In plastic, Danone is working closely with Veolia to build plants with zero liquid discharge and is working towards using 100% biosourced second generation plastic, as well as achieving 100% rates of recycled materials in packaging.

Fairphone (The Netherlands; small/medium enterprise)

One of its key value propositions is an extended usable life span made possible by the ease of repairing the phone, thanks to its various modular components. In addition to its responsible and ethical sourcing policy, Fairphone is beginning to incorporate recycled metals from its various e-waste programmes into its supply chain, with the end goal of ensuring that Fairphones are returned and completely recycled at the end of their lives.

Miniwiz (Taiwan, with offices in Germany; small/medium enterprise)

The technology-focused company specialises in repurposing multiple forms of waste into valuable products and materials across multiple categories – from architecture and building materials, to transportation, consumer goods and furniture – and at industrial scale. Waste plastic is transformed into a curtain wall system used in buildings, whilst discarded rice husks is transformed into new iPhone casings.

3 - COLLABORATIVE ECOSYSTEM SMB

Today –The normal Collaborative Ecosystem BM

- By improving collaboration with supply chain partners (usually through new technology), it helps allocate risks more appropriately and reduce costs for companies.
- Traditional value chains: creating value “based on the production of goods and services”.

The Future Innovative Collaborative Ecosystem SMB

...that focuses on systemic impact and change – to drive system change.

The future is in Value Webs, to create value "based on knowledge exchange that drives proactive production of goods and services", through various collaborative processes.

- Beyond the traditional supply chain, companies can create and scale system-level impact by working with non-traditional partners – e.g. competitors, other industries and sectors.
- Companies develop a strong ecosystem of partners across the customer value chain, and beyond.

What is it? - From value chains to value webs.

The ecosystem is defined as *"a company's competitiveness network: an increasingly global, multi-industry nexus of partners (suppliers, institutions, customers) and stakeholders through which business problems are solved and outcomes are shaped".*

New ways of collaborating include:

- Pooling resources, reducing costs:

Models include industrial symbiosis, where companies share services, utility, and by-product resources among industries in order to improve resource efficiency, to other types of partnerships (eg. Toyota and Suzuki's combine latest technology to develop next generation vehicles).

- Creating new, added value for customers:

Customers are demanding more sophisticated, complete solutions that can be beyond the capability and capacity of one company.

Eg ARM Holdings, a major supplier of semi-conductors underpinning computing technologies, business model is based on "creating a partnership with customers and broader community of third parties to enable the creation of end products more efficiently through ARM than from any other source".

- Stimulating complementary investments:

To drive interest amongst complementary partners, companies need to reduce uncertainty and provide their collaborators with a clear vision of what they intend.

- Looking beyond the customer value chain:

Case Autonomous vehicles - Thinking beyond obvious collaborators to envision a new 'mobility ecosystem' comprising for example city planners, energy players, public transportation providers, regulators, infrastructure companies, insurance firms and peer-to-peer networks.

- Harnessing the wisdom of crowds:

Crowdsourcing insight and talent is a new competitive advantage for companies. Also known as Open Innovation.

Eg. Unilever's Open Innovation platform which invites practical innovation ideas from suppliers, start-ups, academics, designers and individuals that can help it achieve their Sustainable Living Plan.

What's driving it? - Connectivity at all levels, and directions.

Digitalisation, the Internet of Things and Big Data are among the innovations enabling connectivity – between things, people and organisations, across traditional boundaries of company, industry and geography.

Blockchain - providing an unhackable virtual record – will also add a layer of transparency on interactions across the value chain, and web, as interactions become more complex.

What are the opportunities and risks? - Ecosystem collaboration, for Systemic Impact.

To achieve **systemic impact** and change, companies need to tune into opportunities for pre-competitive collaboration, and at the same time, effectively manage Intellectual Property (IP) and other legal considerations that are likely to emerge.

Example, Levi's spent 9 years perfecting techniques radically reducing the water used to make a pair of jeans or denim jacket. In early 2016, it invited 20 of its competitors to its Eureka Innovation Lab to learn from and co-evolve the approach. With the potential for 50 billion liters of water in savings across the industry, Levi's made the decision to open source its production techniques, acknowledging the importance of industry-wide action.

Consider:

- What are the most challenging issues your organisation is dealing with – who else in your ecosystem (or outside it) can you potentially partner with?
- What systemic issues is your organisation able to influence. Who can you work with maximise collective impact – and what models are there in other sectors or markets?

Examples:

Nike (United States; multinational company)

*Over the past decade, Nike has addressed problems in the sports and apparel industry at a **broader systems level.** One recent initiative is a partnership with MIT, where Nike has opened a portal within MIT's Climate CoLab, a crowdsourcing platform where citizens work with experts and each other to create, analyse, and select detailed proposals for what to do about climate change. This work builds on Nike's other attempts to drive system change - including its involvement in the Zero Discharge of Hazardous Chemicals (ZDHC) initiative, its partnership with NASA and USAID on the Launch platform to identify game-changing innovations, and its Making App, which opens-up to designers Nike's data on the climate credentials of individual materials and fabrics.*

4 - Personalisation in SBM

Today: The normal Personalisation BM

…. is about delivering personalised product or service.

- Where products and services are better tailored to customers' individual immediate needs.
- Technology is often leveraged to achieve this at a competitive price.

The Future Innovative Personalisation SMB

...will meet an unmet need **identified by the SDGs**

- Not just serving existing customers, but also potential customer segments experiencing real world problems and unmet needs.
- Also recognising and addressing customers not just as individuals, but also as part of families, communities, cultures, cities and, ultimately, the biosphere.

What is it? - Meeting individual needs, at mass scale.

Key here are business models that tailor products and services to customers' individual and immediate needs, in a manner that allows them to access the solutions to achieve mass scale.

What's driving it? - From Digitalization to 3D Printing to Drones.

Digitalisation is the key driver behind Personalisation as a business model, enabling consumers to get involved in different ways through the product lifecycle.

Example, consumer data can now be tapped to give businesses deeper insight into customers' needs and preferences – via social networks, the Internet of Things (and sensors), and Big Data as well as growing capabilities in the fields of Artificial Intelligence and Machine Learning.

E-commerce and the digitalisation of transactions have also made it easier for businesses to interact with customers in new ways.

Additive manufacturing (e.g. 3D printing) and other forms of localised, flexible manufacturing systems, as well as distribution technologies (e.g. drones and autonomous road vehicles) are shaping Personalisation Sustainable Business Models at new scale.

What are the opportunities and risks? - Meeting needs that matter and have a positive impact.

Innovators should develop products "people want to pull into their lives". Businesses need to integrate as many elements of the value chain as possible to overcome challenges.

Opportunity to explore co-creation with current and future customers, in problem solving and defining new products and defining new markets and unmet needs to grow into.

5 - Asset Sharing SBS

Today: Asset Sharing BM

Sharing of assets across individuals and groups …

- Where the cost of costly assets is shared across users.
- In the context of platform businesses, asset sharing unlocks value for multiple sides of the platform.
- Increasing the chance of success by reducing the entry barriers to an industry.

The Future Innovative Asset Sharing SMB

... unlocks value across multiple dimensions. “Sharing Economy”.

- Where value is created by maximising existing capacity and encouraging effectiveness over efficiency.
- And where value is created across diverse domains from financial, to societal to environmental, both for the business and its value chain, as well as for non-traditional stakeholders

What is it? - Creating more value, using existing resources.

Asset sharing connects spare capacity and demand, allowing consumers access, rather than forcing ownership, of a product or asset.

There is a growing range of Asset Sharing business models. Some of the common points of differentiation include:

- Market-based alternative or free transactions:

  Eg. Some models enable demand-based pricing, such as Uber, with alternative models including that adopted by Yerdle, a P2P (Peer to peer) service for exchanging used goods.

- Optimization of resources, new or used:

  Zipcar, for example, manages, and optimizes a fleet of newly acquired vehicles amongst a community of users.

  BlaBlaCar (a ride-sharing platform) optimizes under-utilized resources amongst peers. This approach is known as Peer-to-Peer (P2P).

  P2P models such as Airbnb have become synonymous with the Sharing Economy.

- From p2p to new types of b2b platform:

B2B (business-to-business) models examples including FLOOW2, https://www.floow2.com/sharing-marketplace.html a new sharing marketplace allowing businesses to share business equipment.

- Crowdsourcing financial, human, and intellectual capital:

Crowdsourcing models range from Massive Open Online Courses (MOOCs) such as Coursera and Udacity which pool intellectual capital from various education providers.

Crowdfunding sites such as Kickstarter pool financial capital across users in new and innovative ways.

What's driving it? - Digitalisation is lowering the cost to transact and share information.

- Information has become more readily available.
- cost of coordinating sharing activities has fallen.
- Technology has been the critical driver in connecting users and enabling transactions to be completed online.

In the future technologies including the Internet of Things using sensors, Autonomous Vehicles, and Artificial Intelligence and Robotics will enable more sharing of assets based on capacity and needs.

What are the opportunities and risks? - Democratising access and enabling a sustainable future.

Impacts on SDG 12 – Responsible Consumption and Production:

The sharing of assets both at the P2P and B2B level has a great impact on the environment, in terms of energy savings and waste reductions through the need for less products (or less journeys made etc) and through the lengthening of product lifespans.

Huge potential for Asset Sharing models to translate into positive societal impact in terms of democratising access to various assets – in food production (SDG 2), health and other consumer products (SDG 3), education (SDG 4) and in other domains. Cities such as Seoul in South Korea (https://techcrunch.com/2015/08/14/lessons-from-seouls-two-sharing-economies/) is designing and facilitating asset sharing in areas such as transportation and other public infrastructure (SDG 9) and by enabling the crowdsourcing of social services (SDG 10 – Reduced Inequalities).

Think on -

- Current asset base –that could be shared.
- Access to a product, without need to own it.
- Facilitate new connections in marketplace.

6 - Usage-Based Pricing SBM

Today: Usage Based Pricing BM

- Customers benefit being charged only when they use a product or service, rather than having to buy something outright,
- Companies can also benefit from growing their customer base.

The Future Innovative Usage Based Pricing SMB

... incentivises positive, lean access.

- People are ensured affordability and accessibility to essential products and services.
- People are incentivised to behave positively and waste less.

What is it? - Paying only when using.

Today, Usage-based Pricing can be a model where customers pay for the actual usage of a product or service, rather than paying up-front.

Historically, access-based pricing model tended to take the form of subscriptions, rentals or timeshare coupled with large or fixed usage increments, and based on expected need, rather than actual usage.

What's driving it? – Data and information collection.

Sensors and the Internet of Things are enabling businesses to monitor usage more accurately.

What are the opportunities and risks? - Rewarding behaviour change.

Cities are deploying usage-based pricing models to encourage, or discourage, behaviours – with initiatives ranging from congestion road charging to scarcity-based water pricing.

Think on -

- Could you sell a service rather than a product to address a need?
- Product/ service provided in smaller increments in a responsive manner.

Examples:

Kaer (Singapore; small/medium enterprise)

An air-conditioning systems specialist in Singapore, Kaer designs, builds and operates air-conditioning systems for commercial and industrial buildings on behalf of customers. Building owners buy chilled water from Kaer at a fixed rate on a pay per use basis. Kaer then shifts the responsibility of reducing energy consumption away from building operators and owners by taking over and optimising the building's air conditioning system. It takes on all future costs related to operations and maintenance, including water, electricity, and repair bills. In the process, Kaer cuts costs to building owners, while potentially increasing their profit by lowering the rate of energy consumption using a remotely operated monitoring and verification system.

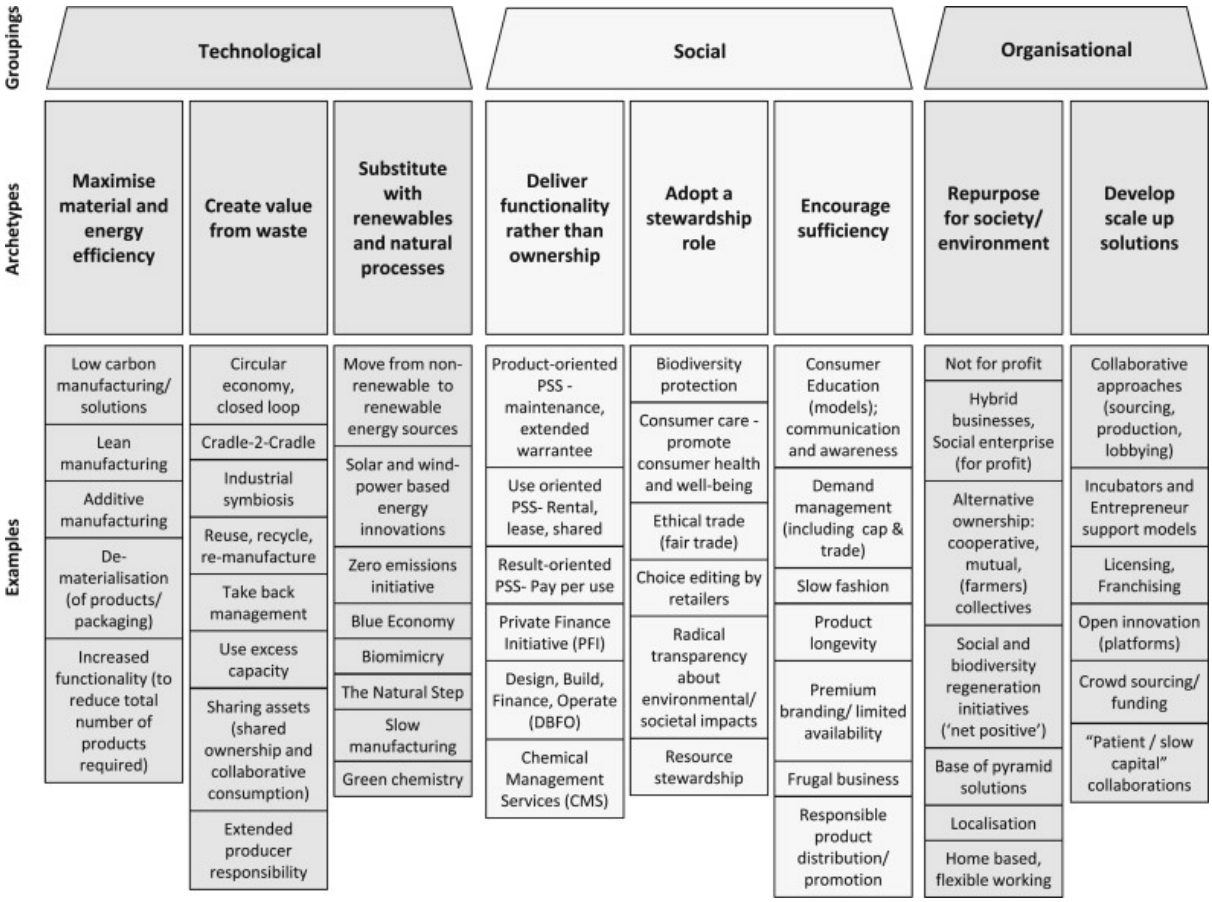
THE SUSTAINABLE BUSINESS MODEL ARCHETYPES – SEE CapSEM Presentation on USB

Source: BOCKEN, NMP, ET AL. (2014) "A literature and practice review to develop sustainable business model archetypes," Journal of Cleaner Production, Vol. 65, p. 42-56

Categorisation of eight business model archetypes, for linking the theoretical concept of business model innovation to the practical transformation mechanisms emerging for delivering industrial sustainability.

The eight archetypes developed are:

1. Maximise material and energy efficiency
2. Create value from 'waste'
3. Substitute with renewables and natural processes
4. Deliver functionality, rather than ownership
5. Adopt a stewardship role
6. Encourage sufficiency
7. Re-purpose the business for society/environment
8. Develop scale-up solutions



Vedlegg 2: Arbeidsdokument for sirkulære indikatorer for håndtering av avfall

DRAFT Working paper for circular economy indicators in solid waste management for Ålesund Region

Authors: Arron Wilde Tippett, Shannon Truloff, Erlend Homme Falklev 19.12.2019

At present, there is no standard recognized way of measuring how effective a city is in making the transition to a circular economy. And existing indicators focus on material inputs, production and emissions. This approach is limited because it fails to capture initiatives such as sharing, reusing and repairing.

We try to close this knowledge gap by initiating the development of a set of circular indicators specifically for use by Ålesund Region. Establishing a monitoring framework, as well as individual indicators, in the first instance in solid waste sector, and then more widely across multiple levels and sectors, will facilitate Ålesund Region's policy development. Such a framework will provide meaningful answers to policy questions covering all relevant dimensions of circular transition: resource use and material flows, environmental impacts, economic parameters, social well-being, financing flows and policy effectiveness. Because of the complex dynamics governing the transition, development of the monitoring framework needs to be flexible, allowing the adaptation of indicators and focus areas, in order to maintain its effectiveness throughout the evolution of Ålesund transition to a more sustainable city.

For the purposes of this Roadmap, the project team has studied the existing U4SSC KIP framework[1] currently adopted by Ålesund Kommune, designed for the measurement of smart sustainable cities. In doing so, it became clear that there is a significant difference between indicator (frameworks) developed for smart sustainable cities and those which can best measure and guide the developed of a circular city. That is circular indicators are primarily concerned with the flow of material within a system: the flow of waste, the flow of energy, the flow of raw materials. While smart sustainable indicators are addressing "quality of life, efficiency of urban operations and services, competitiveness.".

The two types of frameworks: smart and circular, do have some overlaps. However, are not complete in themselves as a comprehensive tool for measurement and guidance in the transition to a smart and circular city. To capture the scope of circular transition, and monitor progress, the development of an additional set of indicators is necessary.

Sustainability Key Performance Indicators are initially used to set a baseline and then to assess performance around certain themes. City level KPIs are generally organised around a wide

[1] https://www.unece.org/fileadmin/DAM/hlm/documents/Publications/U4SSC-CollectionMethodologyforKPIfoSSC-2017.pdf

range of themes, including education, crime, equality and many more. They are also contained within a framework, for example: U4SSC; CIRCTER[2]; or ISO37120:2018.[3]

An assessment has been undertaken on the solid waste indicator sets published in the Urban Agenda for the EU (2019) report alongside the U4SSC indicator set. In addition, a boarder gap analysis was carried out on the U4SSC Indicators which identified that there was potentially 38 of 91 U4SSC KPIs that could be considered to cover some measure of circularity. However, when considering only solid waste management there were some 3 KPIs in U4SSC measuring the circularity of solid waste, and this could be split out to 7 KPIs. (See table 3)

Solid Waste KPIs are organised by categories of 'core'[4] and 'supporting[5] ' in the report published May 2019 under the Framework of the Urban Agenda and the Partnership on Circular Economy[6]. The Issues and mapping paper on indicators for circular economy transition in cities presents the results of the mapping exercise and consolidates all input on CE indicators in Europe at the time. In this Roadmap, we will be using the terminology of category type: 'core' and 'supporting', and the related themes or waste generation… etc (see table 1).

Table 1: Solid Waste Categories from the Urban Agenda for the EU (2019) Report.

Solid Waste KPI Category	KPI Category Type
Contribution of recycled materials to raw material demand	Supporting
Food Waste	Core
Overall recycling rates	Core
Patents	Supporting
Recycling rates for specific waste streams	Core
Waste generation	Core

[2] https://www.espon.eu/circular-economy

[3] *ISO 37120:2018 - Sustainable cities and communities — Indicators for city services and quality of life*

[4] Core indicators are those that should be able to be reported on by all cities, provide a basic outline of smartness and sustainability and higher levels of performance can generally be achievable.

[5] Supporing indicators are those that support the core indicators in data collecting

[6] *Framework of the Urban Agenda and the Partnership on Circular Economy, Indicators for circular economy (CE) transition in cities - Issues and mapping paper, (Version 4), Brussels 03/05/2019*

Aim and scope for circular indicator development

In this Roadmap the aim is to initiate the development of a set of both core and supporting Solid Waste KPIs which cover the following themes:

- *main solid waste streams in a city (Core);*
- *circularity within waste management (Core and Supporting);*
- *policies and strategies used to improve management (Supporting); and*
- *innovation (Supporting).*

Goals and methodology for circular indicator development

In the Roadmap the goal has been to identify and develop a set of core circular city indicators from existing indicator sets which cover a wide range of waste streams.

The approach taken to categorise an indicator as a 'core' KPIs has been its fulfilment of two criteria. That it covers the main solid waste streams of a city, and that the data has high availability.

To determine whether existing sets of KPIs within each framework (U4SSC, CIRCTER, ISO37120 etc.) met the requirements, criteria was ranked as set out in Table 2 below. The highest performing framework was then identified and used as a base for building core KPIs upon. KPIs from lower ranked frameworks were then used to compliment this base set to include the widest range of solid waste streams possible.

Table 2: Ranking Criteria for Solid Waste Key Performance Indicator Frameworks for Cities.

Ranking Criteria	Description - Each KPI Framework was
Number of KPIs within each framework	ranked based on number of **RELEVANT SOLID WASTE** KPIs.
Core categories (table 1) covered by each framework	ranked based on number of **CATEGORIES** covered by each framework.
Supporting categories (table 1) covered by each framework	ranked based on number of **HIGH RATED CATEGORIES**
Data availability	ranked according to **AVAILABILITY OF DATA** sets required to feed into the KPIs (high medium, low)
Framework – ease of use	rated in terms of user interface/ **EASE OF USE** (high, medium, low)

To develop a new set of supporting solid waste KPIs that meet the requirements set out in the aims, a focus group of experts from the project team identify appropriate supporting solid waste KPIs.

Ranking of indicator frameworks that measure circularity at city scale

Number of KPIs, ease of use, and date availability

The ISO 37120 [7]standard was found to cover the most solid waste KPIs for cities (Table 3), compared with other frameworks in the Urban Agenda for the EU (2019) report. The ISO framework includes more KPIs than the U4SSC framework, as ISO 37120 KPIs include KPIs for hazardous waste.

Table 3: Ranking criteria assessment results for main frameworks reviewed.

Framework	Count of KPIs	Data availability (average)	Framework's ease of use
ISO 37120	10	High	High
CIRCTER	9	Medium	Low
U4SSC	7	High	High
Urban Audit Reference Guide	7	High	Low

KPI core and supporting categories

The CIRCTER[8] framework and the Indicators for a Circular Economy Transition in Cities – Workshop (12 September 2018) Framework, incorporate the most solid waste KPI categories (see Table 4), identified in Table 1.

Table 4: Core and Supporting Categories of Solid Waste KPIs included in the top performing frameworks.

Framework	Core	Supporting
CIRCTER	3	1
Indicators for a Circular Economy Transition in Cities – Workshop (12 September 2018)	3	1
EC monitoring framework for the Circular Economy	2	1
ISO 37120	2	0

[7] *ISO 37120:2018 - Sustainable cities and communities — Indicators for city services and quality of life*

[8] https://www.espon.eu/circular-economy

Proposed set of core circular city indicators form existing frameworks

To meet the goal of developing a set of core indicators from existing indicator sets which cover a wide range of waste streams, the applied analysis highlighted that the ISO 37120 framework covers the most solid waste KPIs and has high data availability for those KPIs.

The ISO 37120 framework is also published in a user-friendly format and can be obtained, at a small cost, directly from Standard Norge. Therefore, ISO 37120 can be viewed as an appropriate base core indicator set from which to build upon.

Table 5 shows the proposed core solid waste KPIs selected based on ranking criteria derived from existing frameworks.

Framework (ISO Standard)	Indicators	Type of KPI
ISO 37120	% of the city's hazardous waste that is recycled	Core
ISO 37120	Percentage of the city's solid waste that is recycled	Core
ISO 37120	Total collected municipal solid waste per capita	Core
ISO 37120	Hazardous Waste Generation per capita	Core
ISO 37120	% of city population with regular solid waste collection (residential)	Core
ISO 37120	% of the city's solid waste that is burned openly	Core
ISO 37120	% of the city's solid waste that is disposed of by other means	Core
ISO 37120	% of the city's solid waste that is disposed of in a sanitary landfill	Core
ISO 37120	% of the city's solid waste that is disposed of in an incinerator	Core
ISO 37120	% of the city's solid waste that is disposed of in an open dump	Core
Flanders - Inventory of Circular Economy indicators	Waste Electrical & Electronic Equipment (WEEE) Generation	Core
EC monitoring framework for the Circular Economy	Generation of food waste	Core

Proposed set of supporting circular city indicators from existing frameworks

The focus group identified seven appropriate solid waste supporting KPIs alongside several KPIs that required further development before they can be included as supporting KPIs (see Table 6).

Table 6: Proposed set of Supporting Solid Waste Key Performance Indicators (KPIs) and those that require further development.

Framework	Indicators	Type of KPI
CIRCTER Indicators	Organisations that are implementing LCA schemes, EPR, Eco-label etc..	Supporting
CIRCTER Indicators	Level of public awareness for circular economy and waste prevention	Supporting
EC monitoring framework for the Circular Economy	Circular material use rate in local industrial/economic processes	Supporting
EC monitoring framework for the Circular Economy	Contribution of recycled materials to raw materials demand - End-of-life recycling input rates	Supporting
EC monitoring framework for the Circular Economy	Patents related to recycling and secondary raw materials	Supporting
European Green City Index	Waste reduction policies	Supporting
Eurostat [env_waselee]	Waste electrical and electronic equipment (WEEE) concerning waste management operations	Supporting
Indicators for a Circular Economy Transition in Cities – Workshop (12 September 2018)	Activities performed by cities that encourage the implementation of eco- design measures	For further development
SCREEN Project	Mass of waste resources recovered and re-introduced in a production cycle as secondary raw material (kg/year)	For further development
Various Initiatives	Initiatives/awareness campaigns at city level for the reduction of food waste generation	For further development

Recommended full set of circular city indicator for Ålesund Region

The proposed full set of solid waste KPIs is documented In Table 7. The set includes both core and supporting solid waste key performance indicators for Ålesund city. It is intended to be utilised for both the measurement of performance and for strategy setting on smart circular waste management.

The proposed full set of solid waste KPIs is documented In Table 7 requires development with stakeholders in waste management, sustainability, and the municipality. Additional workshops are needed and more resources in terms of time and funding to continue establishing the indicator framework in circular economy for Ålesund.

Table 7: Final Set of Solid Waste Key Performance Indicators for Cities.

Framework	Type of KPI	Category	Indicators	Units of measurement	Data availability
ISO 37120	Core	Recycling rates for specific waste streams	Percentage of the city's hazardous waste that is recycled	Unit % of total hazardous waste	Data: Low availability
ISO 37120	Core	Recycling rates for specific waste streams	Percentage of the city's solid waste that is recycled	% of total solid waste	Data: High availability
ISO 37120	Core	Waste Generation	Total collected municipal solid waste per capita	Unit: Tonnes of waste	Data: High availability
ISO 37120	Core	Waste generation	Hazardous Waste Generation per capita	Unit: Tonnes of waste	Data: High availability
ISO 37120	Core	Waste Generation	Percentage of city population with regular solid waste collection (residential)	% of total households	Data: High availability
ISO 37120	Core	Waste Generation	Percentage of the city's solid waste that is burned openly	% of total solid waste	Data: High availability

ISO 37120	Core	Waste Generation	Percentage of the city's solid waste that is disposed of by other means	% of total solid waste	Data: High availability
ISO 37120	Core	Waste Generation	Percentage of the city's solid waste that is disposed of in a sanitary landfill	% of total solid waste	Data: High availability
ISO 37120	Core	Waste Generation	Percentage of the city's solid waste that is disposed of in an incinerator	% of total solid waste	Data: High availability
ISO 37120	Core	Waste Generation	Percentage of the city's solid waste that is disposed of in an open dump	% of total solid waste	Data: High availability
Flanders - Inventory of Circular Economy indicators	Core	Waste generation	Waste Electrical & Electronic Equipment (WEEE) Generation	Unit: Tonnes of waste collected	Data: High availability at Bingsa, low for at the companies
EC monitoring framework for the Circular Economy	Core	Food Waste	Generation of food waste	Unit: total food waste generated (for households), or total food waste collected by separate collection, or share of food waste in residual waste	Data: High availability . Sample analysis of residual waste
Eurostat [env_waselee]	Supporting	Recycling rates for specific waste streams	Waste electrical and electronic equipment (WEEE) concerning waste management operations	Unit: Recovery (tonne/percentage), Recycling and reuse (tonne/percentage), Reuse (tonne/percentage)	Data: Medium availability – available from Eurostat, but not at city level

European Green City Index	Supporting	Waste Generation	Waste reduction policies	Unit: Number	Data: High availability
EC monitoring framework for the Circular Economy	Supporting	Contribution of recycled materials to raw materials demand	Circular material use rate in local industrial/economic processes	Unit: % of total material use	Data: Very low / no data
EC monitoring framework for the Circular Economy	Supporting	Contribution of recycled materials to raw materials demand	Contribution of recycled materials to raw materials demand - End-of-life recycling input rates	Unit: %	Data: Low availability
EC monitoring framework for the Circular Economy	Supporting	Patents	Patents related to recycling and secondary raw materials	Unit: Number	Data: N/A
CIRCTER Indicators	Supporting	Contribution of recycled materials to raw materials demand	Organisations that are implementing LCA schemes, EPR, Eco-label etc..	Unit: Number or share (data from miljøfyrtårn)	Data: Medium availability
CIRCTER Indicators	Supporting	Waste generation	Level of public awareness for circular economy and waste prevention	Unit: % of people	Data: Low availability (requires surveys)
Various Initiatives	For further development	Food Waste	Initiatives/awareness campaigns at city level for the reduction of food waste generation	Unit: Number	Data: Medium availability

SCREEN Project	For further development	Contribution of recycled materials to raw materials demand	Mass of waste resources recovered and re-introduced in a production cycle as secondary raw material (kg/year)	Unit: kg/year	Data: low availability
Indicators for a Circular Economy Transition in Cities – Workshop (12 September 2018)	For further development	Contribution of recycled materials to raw materials demand	Activities performed by cities that encourage the implementation of eco- design measures	Unit: Number of measures (e.g. promoting extended product lifetime, ability to re-use components or recycle materials from products at end-of-life, use of re-used components and/or recycled materials in products)	Data: Medium availability
CIRCTER Indicators	For further development	Overall recycling rates			

The proposed indicator set is the most effective way of measuring the developmental progress of the circular economy in Ålesund.

Some notable limitations are listed here for further work:

- Recycling Rates: No framework has a clear methodology for collecting data on recycling/recovery for different waste streams, this should be addressed quickly as these are integral for any Circularity Assessment.
- Plastic and other materials: None of the frameworks provide adequate Core or supporting indicators for the types of materials that are managed. This could be addressed by KPIs for each of the main types of waste in a city:
- Household and Industry Levels: Generally, the solid waste KPIs are only appropriate for the household level. This is limitation as many of the waste streams from industry are unaccounted for.

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