



LIFE E-VIA

“Electric Vehicle noise control by Assessment and optimisation of tyre/road interaction”

LIFE18 ENV/IT/000201

Deliverable	After Life Plan
Content	After LIFE Plan containing Exploitation Plan
Action/Sub-action	E2: After LIFE Plan
Status - date	31/01/2023
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1 Introduction

Noise represents a major environmental problem, especially in urban areas. A growing body of research has highlighted the detrimental effects of exposure to high levels of noise on human physiological and psychological health and wellbeing. As an illustration, the European Environmental Agency (EEA) report “Environmental noise in Europe – 2020” [1]¹ points out that at least 20% of the population during the day-evening-night period, and 15% during the night-time period, are estimated to be exposed to high levels of road traffic noise.

A wide array of actions and strategies is being implemented to reduce traffic noise in populated areas. Indeed, it is increasingly acknowledged that in order to reduce noise pollution a combination of measures needs to be implemented, including for example urban planning measures, the improvement of road surfaces and noise barriers installation. Noise policies aiming at reducing noise exposure are based on recent scientific evidence and data on exposure and increasingly seek the collaboration of private and public actors at different governance levels (e.g. transport and health sectors).

According to WHO guidelines (2018), measures such as road surface and/or tyre improvements should be tested; LIFE E-VIA project tackles noise from road traffic, focusing on reducing noise in densely populated urban areas, in a future perspective in which electric/hybrid vehicles will be a consistent portion of flow, testing optimized solutions for reducing noise and Life Cycle Cost (LCC) with respect to actual best practices.

2 Partners

Coordinating Beneficiary: Florence Municipality

Associated Beneficiaries:

Continental Reifen Deutschland

Ipool S.r.l.

Université Gustave Eiffel

University of Reggio Calabria

Vie en.ro.se Ingegneria S.r.l

¹ [1] EEA (2020) Environmental noise in Europe EEA Report No 22/2019

3 Summary of key project's achievements (including transferable results)

- ✓ A complete literature review on EVs and their noise emission, on the best scientific and practical bases to design the tracks including in-lab tests, and on the role of the tyre in the context of EV vs. ICE vehicles (ICEV) with respect to rolling noise and related target conflicts has been carried out (https://life-avia.eu/wp-content/uploads/2020/07/LIFE_E-VIA_A1_deliverable_final_version_20200612.pdf) .
- ✓ More than 150 solutions for bituminous mixtures have been analyzed. Then 9 mixtures have been selected according to acoustic response (as built and over time), expected life by referring to mechanistic properties, permeability, friction, satisfactory expected life, ENDt (Estimated Noise Difference Due to Texture) value sufficiently low. Based on additional considerations, 2 mixtures (with and without Crumb Rubber - CR) have been designed for further testing.
(https://life-avia.eu/wp-content/uploads/2023/03/Report_B1_LIFE_UNIRC_correzioni-CINEA_07-03-2023_f.pdf)
- ✓ A mitigation measure aimed at optimizing road surfaces and tyres of EVs to reduce noise for roads inside very populated urban areas has been developed. Two road surfaces, 5 different EV types, one reference ICEV and 6 tyre versions per vehicle type (including tyres specifically designed for EVs) have been tested. Specifically, in Nantes two versions (with and without crumb rubber) of the final prototype developed by UNIRC partner have been tested by UNI-EIFFEL partner. Finally, the prototype with crumb rubber has been laid in the pilot case in Florence.
(https://life-avia.eu/wp-content/uploads/2022/05/LIFE_E_VIA_B2_deliverable_final_version_20220513_compressed.pdf)
(https://life-avia.eu/wp-content/uploads/2023/03/LIFE_E-VIA_B3_deliverable_final_19042022_Annexes.pdf)
- ✓ LCPX measurements were carried out by I-POOL partner during the last year, from October 2021 to October 2022 to assess the behaviour of the pavements right after they were laid and with a significant traffic load. This parameter is measured nearby the contact point between a special reference wheel and the road, essentially evaluating the noise contribution of the road alone, so not including other possible noise sources as the engine or the exhaust pipe. The Green Public Procurement Criteria for Road Design, Construction and Maintenance issued by the European Commission gives some reference value that newly laid pavements have to observe to reflect higher environmental standards that the EU is striving to achieve, firstly to directly benefit its citizens: a 93 dBA reference value is imposed for LCPX road emission at 50 km/h within its first 5 years of duty. The last measurement session gave the following results for the E-VIA pavements: 90.4 dBA (with about 1 dBA uncertainty) for the reference pavement and 89.3 dBA (with about 1 dBA uncertainty) for the E-VIA pavements that includes crumb rubber, giving a further environmental advantage in the recycle and reuse of exhausted tyres. Ageing effects were observed in subsequent testing sessions.
- ✓ The sound absorption was studied by I-POOL with a sampling of both center lane and wheel track of the reference and the new pavement. This allowed to evaluate the homogeneity of the layings and, by repeating the tests for a year, the changing behaviour induced by the ageing process. Both employed techniques confirmed the low absorption of the pavements accomplishing the design expectation and

reported a slight reduction over time, probably due to surface pore clogging and compaction of the material.

- ✓ CPB measurements were carried out by I-POOL for making a comparison of the performance of vehicles and tyres combination, turning out to be very useful in terms of noise emission. Due to the fact that the two pavements were one after the other, passages could be measured consecutively reducing the error space, weather conditions and repeatability. In wide band, the E-VIA pavement is 2.1 dB(A) less noisy than the reference pavement.
- ✓ To assess the benefits of the use of the optimized asphalt the following activities were carried out by VIENROSE partner in the pilot area: (i) soundwalks and binaural listening of audio recordings inside a vehicle, (ii) interviews on an electric vehicle, (iii) ante and post-operam interviews with residents. Results show a positive assessment of the optimized asphalt performance. In particular, 30% of the subjects evaluated the soundscape inside an EV passing on the optimized asphalt as “good” while the percentage is just 10% as regards the sound perceived inside an ICEV and an EV crossing a stretch with standard asphalt. Also, 70% of the interviewees inside the electric taxi indicated the optimized asphalt as the one with the best performance in terms of acoustic comfort, compared to new but standard asphalt and the worn one. Survey administered to residents, living in the street section repaved with the optimized asphalt, demonstrate that the intervention improved the quality of the soundscape and reduced the perceived traffic noise: according to 61% of the respondents traffic noise has decreased after the intervention and 77% assessed the intervention as positive.
- ✓ According to acoustic measurements carried out at receivers roadside by VIENROSE and I-POOL about one year after the intervention implementation, a reduction of 4.4 dB(A) in terms of L_{night} (in the night period from 10 p.m. to 6 a.m.) has been measured. This benefit affects about 2.000 residents of the pilot area. About 16 months after the pilot intervention realization, a new noise measurement campaign has been carried out in order to verify asphalt performances overtime. Between the second and the third noise measurement campaign, a difference of 2.9 dB(A) in terms of L_{night} was still measured.
(https://life-evia.eu/wp-content/uploads/2023/03/Report-EVIA_B5.pdf)
- ✓ A new tool has been developed by I-POOL to evaluate the acoustic impact of a new kind of mobility, defined by the switching from internal combustion engine vehicles to electrical ones and supported by the laying of new kind of pavements that can guarantee very good noise emission performances alongside promoting the recycling of waste materials such as exhausted tyre crumb rubber. Its final aim is to promote the use of such new approaches for improving of the mobility and noise reduction, thus providing knowledge and tools to public administrations which deal with urban planning. In particular, experimental results obtained on the two test tracks laid in Florence were used for:
 - calculating the rolling noise coefficients of the CNOSSOS model for EV for the reference road surface;
 - estimating the road surface correction factor on rolling noise emission ($\Delta L_{WR,road}$) for the CNOSSOS model that takes into account the acoustic performance of the E-VIA pavement for the EVs;
 - evaluating the acoustic benefit to the receivers offered both by an increasing percentage of EVs in the circulating vehicle fleet and by the use of the E-VIA new road surface.
- ✓ Compared to state-of-the art premium summer tires, the noise optimized tyre for electric vehicles developed by CRD led to a reduction of rolling noise of 0.8 dB(A) under typical urban driving conditions. During the noise tests, the robustness of the provided noise optimisations was proven by relatively consistent noise reductions on a variety of road surfaces, at a different number of speeds, and using a

number of different test vehicles. Especially good results were obtained with the two LIFE E-VIA surfaces tested in Nantes, highlighting the combined efficiency of the LIFE E-VIA solutions. The very good noise performance of the LIFE E-VIA tyre is combined with a very balanced and competitive portfolio of non-noise related performances. For the most important criteria the already very good performance levels of the reference tyre could be maintained, if not slightly improved. Especially, there was no negative impact on rolling resistance and wet grip performance, and even an expected increase in mileage, which highlights the ecological, economical and safe design of the final tyre.

- ✓ Regarding the project website, more than 12.000 visits have taken place with more than 2.500 users interacting. Regarding socials, on the Facebook page more than 280 sessions have taken place as well as more than 100 sessions on the LinkedIn page. Moreover, more than 15 scientific papers have been published and more than 20 presentations have been given during conferences (about 900 people reached), together with more than 20 brief articles on Italian magazines mainly concerning the pilot case. An overall number of about 60 students has been directly informed about project activities.
(https://life-evia.eu/wp-content/uploads/2023/03/LIFE_E-VIA_C1_report_FINALE.pdf)
- ✓ A LCA and LCC analysis has been carried out by UNIRC.
(https://life-evia.eu/wp-content/uploads/2023/03/Report_C2_LIFE_UNIRC.pdf)
- ✓ Concerning replication actions, asphalts of the same type as those tested in the E-VIA project will be proposed by FIRENZE for infrastructures with similar characteristics to those of Paisiello street. Specifically, more than 25,000 m² of asphalt with technical characteristics analogous to those of the E-VIA project will be laid in Florence in 2023. VIENROSE will propose the use of the optimised asphalt proposed by the LIFE E-VIA project to its customers, for whom contracts have already been awarded for the IV round of updating of the agglomerations' Action Plans as the implemented database and the coefficients for electric vehicles and asphalt, processed and tested on Via Paisiello, will certainly be used in the IV Round of Action Plans. Moreover, a fourth round of CPX measurements will be carried out in 2024 by I-POOL/VIENROSE, to estimate the efficiency of pavements after 3 years of surfaces realization and UNI EIFFEL will monitor the CPX noise levels on the prototype in Nantes at least once a year during a period of 5 years after the project.
(https://life-evia.eu/wp-content/uploads/2023/03/Report-EVIA_B8.pdf)

4 Strategy for continuing to disseminate results

4.1 Technical activities

Activity	Expected results	Rationale and technical details	Risks and mitigating factors	Anticipated costs and financing	Responsible for implementing	Reference KPI / Project indicator
Laying of the new pavement in more sites of the Municipality of Florence	<i>After the project's conclusion, FIRENZE will lay the new pavement for at least 500 m in 3 different sites in five years.</i>	As part of the ordinary road maintenance programs, which the municipality of Florence schedules every three years, asphalts of the same type as those tested in the E-VIA project will be proposed for infrastructures with similar characteristics to those of via Paisiello (pilot case, slip road in densely populated urban area). More than 25,000 mq (about 2.500 m) of asphalt with technical characteristics analogous to those of the E-VIA project will be laid in Florence in 2023	No particular risk is highlighted because the asphalts will be proposed on urban roads of the same type as in the pilot case, in densely populated areas	The Municipality of Florence has already earmarked over 1.6Mln euro for the laying of these asphalts as part of the Noise Mitigation Plan. Of this, EUR 1 million will be used to pay for the resurfacing of the two stretches of road that were scheduled to be resurfaced during the project (Via Bolognese and Via Senese, which were not carried out due to work on the underground utilities), while € 667,000 has been earmarked to complete the resurfacing of the remaining stretch of Via Paisiello, to resurface Via delle Cascine, Via delle Porte Nuove and Via del Ponte alle Mosse	FIRENZE	KPI: 1.5. Project area/length KPI: 14.2 Capital costs
3 Project-based Action Plans	<i>After the project's end, in the frame of the implementation of Action Plans for</i>	Following the postponement of the deadlines for the implementation of the action plans (UE	No particular risk is highlighted because the asphalts will be proposed on	There are no direct costs for Vie en.ro.se., which will only have to propose the asphalts in its customers' Action Plans,	VIENROSE	Project indicator: REPLICATION / TRANSFER (RT5)

	<p><i>Agglomerations and Major Roads as indicated in the Environmental Noise Directive 2002/49/EC, VIENROSE will adapt and propose as possible solutions to mitigate noise in the cities and major roads, the ones developed in the frame of the LIFE E-VIA project. At least three action plans of Italian cities/major roads will test output of LIFE E-VIA project.</i></p>	<p>Regulation 2019/1010 of European Parliament, dated 5/6/2019) redefined as follows:</p> <ul style="list-style-type: none"> - Agglomerations and major roads not falling within agglomerations: from 18/4/2023 to 18/4/2024; - Major infrastructures of national interest or of interest to several regions: from 18/7/2023 to 18/7/2024; - Major infrastructures falling within agglomerations, from 18/10/2022 to 18/6/2023, <p>Vienrose will propose the use of the optimised asphalt proposed by the LIFE E-VIA project to its customers, for whom contracts have already been awarded for the IV round of updating of the agglomerations' Action Plans.</p> <p>This goes beyond the perspectives defined in the proposal phase (3) as, at the date of writing</p>	<p>urban roads of the same type as in the Florence pilot case, in densely populated areas</p>	<p>demonstrating the acoustic effectiveness of the pavements and showing the results of LCA and LCC analyses</p>		<p>KPI: 14.4.1 Entry into new entities/projects</p>
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		of this document, the contracts already acquired are 6 (Municipality of Modena, Parma, Napoli, Milano and Monza, Perugia, Padova)				
Cnossos improved data base for strategic noise mapping	<i>After the project's end it is expected that the coefficients derived into the project will permit the noise prediction. As a consequence, 3 further applications of the CNOSSOS improved database will be made for strategic mapping.</i>	The implemented database and the coefficients for electric vehicles and asphalt, processed and tested on Via Paisiello, will certainly be used in the IV Round of Action Plans, as the switch to electric vehicles will certainly be used in the action plans of several managers of public transport, particularly in agglomerations.	The only risk is that in the implementation of Round IV of the action plans, data on the number of electric vehicles in circulation in relation to the car fleet will not be available, and therefore the database will not be usable. It will certainly be in any case at least in the next round of mapping (2027), considering that the new legislation sets the path to zero CO2 emissions for new passenger cars and light commercial vehicles in 2035. Interim emission reduction targets for 2030 are set	Costs will be borne from own funds	VIENROSE, I-POOL	KPI: 14.4.1 Entry into new entities/projects

			at 55 per cent for passenger cars and 50 per cent for vans			
Fourth monitoring campaign	<i>A fourth (Sept. 2021-Jan. and Oct. 2022-2024) monitoring campaign will be performed to estimate the efficiency of pavements after 3 years of surfaces realization</i>	CPX measurements	The risk is that the asphalt will be less performing due not to the wear and tear caused by passing vehicles, but to works carried out for the installation of sub-services, works not currently planned	Costs will be borne from own funds. Considering the estimated effort of personnel and instruments, the monitoring traffic and noise campaign will cost about € 10.000	I-POOL	Project indicator: REPLICATION / TRANSFER (RT5) KPI: 14.1 Running costs/operating costs
CPX/CPB monitoring campaign	<i>A yearly monitoring campaign will be performed to estimate the efficiency of pavements in the prototypal test section</i>	UNI EIFFEL will monitor the CPX noise levels on the prototype in Nantes at least once a year during a period of 5 years after the project. Moreover, based on new EV models available in UNI EIFFEL vehicle fleet, CBP noise measurements on EVs will be continued on impervious tests sections of the reference test track in Nantes after the project.	- change of CPX measurement system; the system used during the LIFE E-VIA project will be probably available in the next five years but then completely abandoned. Mitigation action: the CPX monitoring on the prototype will be carried out for 5 years. In parallel a new monitoring when the new system	Costs will be borne from own funds Estimated cost: - CPX noise levels on the prototype in Nantes at least once a year during a period of 5 years after the project: 5 k€ per year = 25.000 € - EV CPB noise measurements on impervious tests sections of the reference test track in Nantes: 5 k€ per EV tested = 30.000 € based on 6 EV models	UNI EIFFEL	Project indicator: REPLICATION / TRANSFER (RT5) KPI: 14.1 Running costs/operating costs

			<p>will be available could be foreseen but at the moment it is still under development. - for CPB measurement of new EVs, the action is limited by the budget. (a part of the staff and equipment are in Lyon and the measurement are performed in Nantes)</p>			
<p>Possible future development of tyre product lines</p>	<p><i>Use of the newly developed tyres and or the applied solutions or the future development of tyre product lines</i></p>	<p>For possible future tyre development processes, CRD will exploit both of two main enablers deriving from the project activities: the additional know-how gained during action B7 on how to incorporate accelerated pass-by noise testing into the tyre development process in the best way and the adaption of development processes to the special requirements of the holistic noise optimised EV tyre.</p>	<p>A significant business risk is associated with the test variation which is observed for any type of tyre performance testing, including (accelerated) pass-by noise testing. Especially for outdoor testing, not all sources of test variation can be fully controlled at all times</p>	<p>Approximate additional annual and total costs per tyre development project and as sum for all projects for the supplementary noise testing with acceleration/torque has been estimated (and quantified in Report of Action B8, confidential). Costs for further development testing and implementation will be sustained by CRD</p>	<p>CRD</p>	<p>Project indicator: REPLICATION / TRANSFER (RT3) KPI: 14.4.1 Entry into new entities/projects</p>

4.2 Dissemination activities

audience, channels of communication and ways of evaluating the impact of actions, responsible for implementing.

Activity	Expected results	Rationale and technical details	Risks and mitigating factors	Anticipated costs and financing	Responsible for implementing	Reference KPI / Project indicator
Maintenance of project website	Maintenance for 3 years (2023,2024,2025)	The site will be kept active and will continue to be updated with any publications or events dedicated to the LIFE-E-VIA project	No particular risks envisaged	Costs will be borne from VIENROSE own funds (Expected about € 1.500,00)	VIENROSE. Although it was planned that the site would be maintained by FLORENCE, this activity will be managed by VIENROSE, because FIRENZE cannot currently allocate necessary funds	KPI 14.2.2 Operating expenses KPI 14.3 Future funding Project indicator: Dissemination and awareness raising (€)
After the project's end, organization of an event to disseminate E-VIA results	FIRENZE will continue to promote EV mobility and to improve good behaviors and noise awareness.	In October 2023 a technical session dedicated to the LIFE E-VIA outcomes will be planned in the frame of <i>Beautiful sounds</i> conference organized by FIRENZE.	No particular risks envisaged	The venue of the conference is in the premises of FIRENZE (Palazzo Vecchio), so no additional costs are foreseen	FIRENZE	KPI 14.3 Future funding
Presentation of E-VIA project results during Eurocities meetings	Being Florence a member of Eurocities, training and awareness raising among	Participation in the following Eurocities Noise Working Group meetings:	No particular	Costs will be borne	FIRENZE / VIENROSE	KPI 14.2.2 Operating expenses

	cities will be guaranteed during the Eurocities meetings	<ul style="list-style-type: none"> - April 2023 (Gent) - October 2023 (location tbd) - April 2024 (location tbd) 	risks envisaged	from own funds. Each travel will cost about € 2.000 (total costs about € 6.000)		KPI 14.3 Future funding
Presentation in conferences	<p>Project final results will be presented in the following events:</p> <ol style="list-style-type: none"> 1) Forum Acusticum 2023 (Turin, Italy) (VIENROSE) 2) Congress of Italian society of acoustics 2023 (Ferrara, Italy) (VIENROSE, FIRENZE) 3) LIFE Cool-and-Low Noise asphalts final seminar in April 2023 (FIRENZE, VIENROSE, UNI EIFFEL) 4) a next edition of the French "Journées Techniques Acoustique et Vibrations" (JTAV) (UNI EIFFEL) 	<p>Title of the papers:</p> <ul style="list-style-type: none"> - LIFE E-VIA and LIFE SNEAK projects outcomes: examples of combined study and application actions for noise mitigation in urban areas in the city of Florence. (Forum Acusticum) - Low-noise asphalts and innovative tyres: the LIFE E-VIA and LIFE SNEAK projects (LIFE Cool-and-Low Noise asphalts final seminar) - Life E-VIA: general overview (UNI EIFFEL) - Tbd (all the others) 	No particular risks envisaged	Costs will be borne from own funds, apart from the participation in final event of LIFE Cool-and-Low Noise asphalts, where hotel costs will be reimbursed by City of Paris (travel and subsistence costs foreseen about € 1.000).	VIENROSE / FIRENZE/ UNIEIFFEL	KPI 14.2.2 Operating expenses KPI 14.3 Future funding
Presentation in scientific journals	<ol style="list-style-type: none"> 1) Sustainability (https://www.mdpi.com/journal/sustainability) 2) Applied Acoustic journal (https://www.scienced 	<ol style="list-style-type: none"> 1 - Adjusted Controlled Pass-By (CPB) method for urban road traffic noise assessment 2 - CNOSSOS-EU coefficients for electric vehicle noise emission 	No particular risks envisaged	Costs will be borne from own funds (Costs foreseen	I-POOL / UNIRC	KPI 14.2.2 Operating expenses KPI 14.3 Future funding

	<p>irect.com/journal/applied-acoustics)</p> <p>3) Construction and Building Materials journal (https://www.sciencedirect.com/journal/construction-and-building-materials)</p> <p>4) tbd</p>	<p>3 - Road pavements' dynamic stiffness measurements by means of impact hammer in a non-resonant configuration.</p> <p>4 - Influence on dynamic stiffness of crumb rubber introduction in pavements</p>		about € 3.000)		
Dissemination via ARPATNEWS, the newsletter of the Tuscany Regional Agency for Environment Protection (ARPAT)	ARPAT has being involved in the dissemination phase; news and project updates, as well as results in the after life period will be disseminated through the agency website and its newsletter ARPATNEWS, distributed online to 80.000 stakeholders in Italy for more than 200 editions/ year.	<p>A brief article about the LIFE E-VIA final results will be published on ARPATNEWS in spring 2023</p> <p>The publication of additional brief articles will be evaluated in 2023</p>	The risk is that ARPAT will not publish the data in the newsletter; risk mitigation will be addressed by periodically soliciting ARPAT and submitting publication-ready contributions	No costs for project partners	ARPAT	KPI 14.3 Future funding
3 initiatives for disseminating results of CR-low noise pavements with Ecopneus https://www.ecopneus.it/en/	Presentation of CR-based asphalt performance results in at least three events with the presence of Ecopneus	Ecopneus is a partner in the LIFE SNEAK project together with the Municipality of Florence, the University of Reggio Calabria and Vienrose. In this context, optimised asphalts are being tested for urban areas where the presence of vibrations is relevant.	No particular risks are highlighted because the events are planned as part of the dissemination activities	The costs will be borne within the LIFE20-SNEAK project, by Ecopneus and FIRENZE	FIRENZE / ECOPNEUS	N/A

		<p>Three dissemination events are planned within the LIFE SNEAK project: in all these events Ecopneus will also promote the results of the E-VIA project, in which the optimised asphalt laid in the pilot area contained a part of recycled rubber powder. First event was held on 27th March 2023, in the framework of an online meeting about the replication activities of LIFE SNEAK</p>	<p>also of the LIFE20-SNEAK project</p>			
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5 Exploitation plan

5.1 Asphalt market analysis and tentative business plan

When dealing with the exploitation plan of the asphalt solutions set up in the LIFE E-VIA, the following main financial markets have been considered:

- Asphalt/road market:
 - Asphalt components (e.g., bitumen, aggregates, and additives). Indeed, UNIRC focused on these components.
 - Asphalt plants. Indeed, the introduction of crumb rubber could have consequences also on asphalt plants.
 - Crumb rubber and tyres. Indeed, UNIRC focused on the introduction of crumb rubber according to the dry method.

Asphalt market

Based on [1], the global asphalt market size is expected to reach **USD 321.5 million** by 2027, exhibiting a Compound Annual Growth Rate (CAGR) of 4.8% during the forecast period. About 70% of the bitumen is used in road construction which is likely to cause an uptrend in market growth. Increasing construction of the paving asphalt, along with favourable funding, awareness to improve the ageing of the infrastructure, and advances in non-building construction activities, such as highway and street segments are the key attributes driving the market trend [1]. Rapid urbanization across the globe is one of the key factors driving the growth of the market. The increasing usage of reclaimed asphalt pavements (RAP) in residential and commercial driveways, parking lots, schools, and playground blacktops is catalysing the market growth [2].

Crumb rubber market

Based on [4], the huge amount of tires produced, the tire's longevity, and the tire's environmental impact are all problematic components in the tire, making it a difficult source of trash. Due to the tire's great durability and lack of biodegradability, valuable landfill space may be wasted. Therefore, the rising awareness about environmental conservation, tire recycling has become a top priority. Also, one of the most significant waste sources is worn-out tires and tire recycling is required to combat this waste. Apart from core rubber, additional by-products such as steel, wire-free chips, rubber & so on are obtained from tire shredding and may be utilized fuel additive or as fuel feedstock [3].

The global crumb rubber market was valued over **USD 1.4 Bn** in 2020. It is estimated to expand at a Compound Annual Growth Rate (CAGR) of 4.8% from 2021 to 2031. The global crumb rubber market is expected to cross the value of **USD 2.4 Bn** by the end of 2031. Understanding the segments helps in identifying the importance of different factors that aid the market growth [4].

Asphalt plant market

For asphalt plants, there are a few big players. Based on [5], the asphalt plant market revenue is expected to grow to **USD 2.47 Bn** by the year **2027**. This represents a Compound Annual Growth Rate (CAGR) of 2.8% from the year 2019 to 2027.

Whereas, in terms of volume, the market was valued at 4,127 units in 2018 and is anticipated to reach 4,831 units by 2027 thereby registering a CAGR growth rate of 1.8% from 2019 to 2027. The global asphalt plant market is experiencing exponential growth owing to the growing number of highway development projects. The companies operating in the asphalt plant market are focusing on offering technologically advanced products that meet the varying demands of the customers. Another factor supporting the growth of the asphalt plant market is urbanization, which is supporting the increasing demand for modern infrastructures such as new roads and highways [6].

The market for asphalt mixing plants is anticipated to increase as a result of the recent significant rise in the construction and transportation industries. The global Asphalt Mixing Plants Market is anticipated to rise as a result of an increase in demand from various industries, including the construction of bridges, tunnels, and buildings. Road construction employs the utilization of asphalt mixing plants. As a result, it is anticipated that increased investment in the construction of roads and infrastructure will fuel the expansion of the global Asphalt Mixing Plants Market. Additionally, a spike in commercial and passenger vehicle sales is predicted to fuel market growth [6].

Business plan

Based on the above, this business plan is tentatively referred to the creation of a spin-off, with as main objective the supply of a valid and timely offer to the demand for low-noise pavements for cities and current transport infrastructures. A spin off was proposed at the department DIIES of UNIRC. The extract of the Department Council Minutes No. 103 of 20/7/2021 has been provided, as an annex to final report. Specifically, the services and products offered by the Spin-off concern the design of innovative bituminous conglomerate mixtures, hopefully using CR-based solutions. The target market of the products is that of cities and infrastructures and has an international extension, given that the solutions that the Spin-off wants to propose can be adapted to any territorial context (e.g. different climatic and/or environmental conditions, different methods construction and management, etc). The market growth trend is positive, given that the need for innovative and sustainable solutions which respect the environment and improve human health (for example reducing noise pollution from road traffic noise), is rapidly and continuously increasing. The possible competitors of the Spin-off are those companies that design and/or test mixtures in bituminous conglomerate with innovative and/or recycled materials.

The main marketing, logistics, operative, and financial plan steps are patenting; setting up processes; designing the required machines; having this solution included in the major Italian contract specifications; commercialising the product.

References

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