Advanced management of noise with the renewed proved Information system industrial noise-I\textsuperscript{2}

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ABSTRACT

The information system” I\textsuperscript{2}” is part of the organization with the same name ”I\textsuperscript{2}”. Involved parties are participants of the environmental protection agency (EPA) of the greater Rotterdam area, together with the Port of Rotterdam (PoR). The system efficiently supports the tasks licensing, advising spatial development and monitoring of the complex noise situation in the industrialized area where also one million inhabitants live. The same I\textsuperscript{2} enables authorities, EPA and PoR to plan and manage the noise space in an efficient way. The first version of the I\textsuperscript{2} system was well developed in the late 1980’s and the principles behind it still hold. To be able to adapt new possibilities, extra requirements and technologies, the complete system is modernized in 2015 by DGMR consulting engineers. The new I\textsuperscript{2} is built around the Geomilieu noise assessment software of DGMR which is broadly used in the Netherlands and as Predictor-Lima worldwide. This results in a state-of-the-art noise management system that integrates the specific tasks with advanced modelling, data management, calculations and reporting. The new I\textsuperscript{2} preserves a proved system, allows profits of new developments, provides a better accessibility and makes noise management prepared for the future.

1. INTRODUCTION

From 1996 a zone management instrument is running at DCMR EPA, further abbreviated as DCMR, and the Rotterdam Port Authorities. These partners run this instrument, called Information system Industrial noise or shortly I\textsuperscript{2} (I-square), in order to safeguard the zones and limit values established by the governmental bodies responsible. These governmental bodies are the province of South Holland and the municipalities in the Rotterdam Metropolitan Region. They delegated this task to DCMR and DGMR consultants to design and develop I\textsuperscript{2} using the huge amount of data that became available during the zoning and remediation of industrial areas (1). I\textsuperscript{2} makes it possible to manage the noise produced by industries situated in zoned areas in such a way that the acoustic space, available within those zones can be assigned to enterprises in an optimized way when it comes to settlements, enlargements and subsequently issuing environmental permits (2 and 3). With the user friendly interface, it is possible to retrieve the stored information from the I\textsuperscript{2} database. The database mainly contains acoustic, geographic, administrative and meta data like acoustic power levels, coordinates of sources, screens, and receptors. I\textsuperscript{2} does not only supports the process of issuing environmental permits but it also is used to monitor, provide advises and it is also the instrument to set up the industrial noise maps according to directive 2002/49 EU (4). Updating data takes place by putting in new data provided by acoustic reports that are requested when issuing environmental permits or investigations meant for spatial planning such as spatial plans, Environmental Impact Assessments. In 2015 it was decided to
renew the existing $I^2$ system for several reasons. In April 2016 the renewed system was completed by DGMR, who built the new $I^2$, handed over to DCMR and subsequently the migration and conversion of the existing models and data started, led by DCMR. In August 2016 the migration and conversion will be completed and subsequently the system shall go into production. In this paper an introduction of the system by describing the why and the philosophy of $I^2$ but also the reasons for renewing the system. This paper ends with the new elements introduced in the new $I^2$ system and some conclusions.

2. WHY SYSTEM $I^2$?

In the eighties of the previous century the Dutch Noise Act obliged competent authorities to establish acoustic zones around major industrial areas with enterprises that produced a lot of noise (big noise emitents). These zones should limit the noise caused by the settled companies taking into account enlargements of those companies and settlements of new companies. On the other hand, the zoning system limits the realization of new houses and sensitive buildings in those zones. The zoning regime introduced also a remediation instrument for those situations where high noise levels above 55 dB(A) were found. The Dutch Noise Act contains a system of limit values for these situations. During the processes of zoning and remediation a lot of data became available and by DCMR the idea was born that these data was valuable and could be used for numerous purposes when storing the data in a database, keeping these data up-to-date and linking the data to an interface. This led to the realization of system $I^2$. The system designed and built in the eighties and also the renewed $I^2$ are supporting the processes mentioned below. However, it should be noted that the renewed $I^2$ is processing this in a far more advanced way.

1. Planning of the available acoustic space.
2. Advising noise limits to individual companies or activities, to be included in environmental permits
3. Providing requirements and limits to be respected when developing spatial plans.
4. Providing information for indicators to be used in monitoring the state of the environment in the Rotterdam Metropolitan Region
5. To support communication towards politicians, policy makers and citizens about industrial noise

Added value of $I^2$ was not only recognized by the partners of that participated in $I^2$ (Port Authorities Rotterdam, Municipality of Rotterdam, Province of South Holland and DCMR) but also by the enterprises settled in the Rotterdam Metropolitan Area and the network of enterprises (Deltalinqs, previous EBB), representing all enterprises in the Rotterdam Metropolitan Area. This because the system used one harmonized assessment method and standardized noise propagation software, called Geonoise (within the same portfolio as Predictor-Lima). When delivering models to third parties such as consultants also a list of model rules accompanied the model requested by the consultant. Thus, the acoustic models were more or less standardized. By backing-up the data and the models available in the database $I^2$ was able to reproduce the noise levels calculated previously at any time and any place.

2.1 Planning the acoustic space

By zoning an industrial area, the acoustic space for enterprises and activities is limited. Outside the zone no level higher than 50 dB 24-hour level may occur. This means that the acoustic space is scarce and issuing of this space should take place in an efficient way. By dividing the total available acoustic space over the lots available on the zoned industrial area in an optimized way, meaning noisy activities as much as possible on the lots located in the center of that industrial area, the most noise in terms of sound power, can be accommodated on that industrial area. This is done by means of a plan or vision that is established by the Port Authorities of Rotterdam. The planning is done in surface related decibels (dB/m²) well known as “key indicators”. This method is limited due to the fact that e.g. for logistic reasons container terminals must be located on the riverside or a harbour. Limitations are also available when enterprises are already settled on an industrial area. Then the possibilities to move noise budgets between lots are more limited compared to an empty industrial area with empty lots. This means that optimization of the acoustic space has its limits too. Another limitation of this instrument is that this is not backed by a legal base. This instrument of planning has been shown very helpful when accommodating new companies or when already settled companies explored to enlarge
or intensify their activities. By using this instrument, the company knows how much noise they may emit (sum of the noise emissions of the lots that are obtained or hired from the Port Authorities’) and on the other hand, the Port Authorities have issued the noise emission (or lots) in a very efficient way. The tool to execute this work is included in the old and the new I^2 and is called the B-model or the planning module or E-model, for an explanation see elsewhere in this paper.

![Figure 1: empty lots and occupied lots on industrial area](image)

2.2 Advising noise limits to be included in environmental permits

After negotiations between a new to be settled company and the Rotterdam Port Authorities about the lots to be hired by the company and all kind of requirements to be fulfilled the company should send in a formal request for an environmental permit. This request should be send to the DCMR which is the environmental permit authority in the Rotterdam Metropolitan Area. DCMR already knows from the Port Authorities that the acoustic space needed to accommodate the company is available which means also that the limit values according to the zoning regime can be respected. When sending in a request for an environmental permit an acoustic report and the underlying acoustic model should also be handed over to DCMR. This acoustic model is sent electronically and was previously derived from the central model in I^2. After checking the report, the model and if the company has planned to realize their activities according to the Best Practices, the DCMR sets the limit values for that activity and other obligations to fulfil. After approval of the model received from the company or this acoustic consultant it is integrated in the central I^2 model. The acoustic items are just a part of the environmental permit because also air quality, safety, odor, soil and many other issues are also regulated in the environmental permit. The model to determine the noise limits in the permit is called the A-model, (the actual model).

2.3 Requirements and limits for spatial plans

According to legislation noise should be considered in spatial plans in order to avoid too much noise in residential areas, sensitive areas or individual objects. This means that developing spatial plans for new or expanding infrastructure (roads, railways, airports, industrial areas, etc.) spatial planners are obliged to take the noise and noise limit values into consideration. The Dutch Noise Act has set noise limit values to be taken into account. Also when new residential districts are planned or a permit is issued for building new houses or other sensitive objects (hospitals, schools, etc.) noise limit values should be taken into consideration. DCMR is often asked to provide spatial planners with the requirements or the noise assessments needed when these plans are developed in the Rotterdam Metropolitan Area. Using I^2 this information can be provided.
2.4 Providing information for indicators

Annually, a report on the state of environment in the Rotterdam Metropolitan Area is published. This report is based on a collection of indicators. Many partners dealing with environmental issues in the Rotterdam Metropolitan Area are involved (5 and 6). By $I^2$ these noise indicators can be provided. These indicators are part of the policy cycle. Besides delivering indicators to the so called MOI report (previously MSR report) $I^2$ can provide indicators such as number of noise exposed houses, annoyed or sleep disturbed people, etc. on demand. Trend monitoring is also part of this activity.

2.5 Supporting communication

Politicians and policy makers but also citizens or other parties can send in a request for information asking for the noise levels in a certain area or how much acoustical space remains at a certain point. When it comes to industrial noise, system $I^2$ can provide this almost instantly.

3. PHILOSOPHY OF SYSTEM $I^2$

System $I^2$ does not only exist of hardware (servers, computers, etc.), software, netware and dataware but it also comprises “orgware”. The orgware exist of a management team that is responsible for the exploitation of $I^2$. Partners involved in $I^2$ being the Rotterdam Port Authorities, the municipality of Rotterdam, the Province of South Holland and DCMR are represented in this management team. They are deciding over the financial and the strategical issues of $I^2$. The daily work is a responsibility of and done by a system manager, a daily manager and an application manager. However, the system is used (end users) by the noise experts of the Rotterdam Port Authorities and the DCMR. All tasks, roles and responsibilities of the management, the managers mentioned above and the noise experts meant are described in a document that guarantees the quality and continuity of $I^2$. Also the work processes carried out by the noise experts using $I^2$ are laid down in a handbook.

As already mentioned above, $I^2$ supports an optimal planning of the acoustic space available within the zone around an industrial area and it communicates the final designation of the lots with their noise emission or immission via the system to the other users of $I^2$. By distributing a part of the $I^2$ model to acoustic consultants and others, supporting companies or spatial planners with noise assessments and subsequently, after approval, integrating the model, modified by them, in $I^2$ the central stored and managed data model of $I^2$ is always up-to-date. This is depicted in figure 1.

![Figure 2: life cycle $I^2$ data](image-url)
4. REASONS FOR RENEWING SYSTEM I²

The reasons for renewing I² are numerous; the most important reasons will be reported here. As from the introduction can be derived, the system was developed in the late eighties of last century which means that I² is almost 20 years old. Although some modifications took place in the past, the backbone of the system remained. The system was based on Geonoise which was no longer supported by DGMR, the licensor.

Another reason to renew I² was induced by a new instrument introduced recently in managing spatial plans. The tool that was used in planning noise emissions from lots on industrial areas was not a legal tool but a management tool. Recently, spatial planning legislation which makes it possible to give lots also an acoustic destiny on a legal base. Consideration within the Rotterdam Port Authorities led to an improved planning instrument as part of the I² configuration.

The hardware and application software was, after so many years, obsolete and by the users and the management team it was felt that this needed an update. Further, the system I² only was used in the Rotterdam Metropolitan Area. The management team I² undertook several actions to market I² but, unfortunately it failed mainly due to the limited application of the current system and the availability of other noise management software. Marketing is not the key task and certainly a skill of the management team that is composed of governmental organizations. As only the partners mentioned afore worked with I² it was concluded that the annual costs in relation to the limited number of users was quite high and more users would be desirable. The management team was seeking for a partner having an outstanding and proven reputation in bringing this type of expert systems to the market. This partner was found in DGMR consultants.

5. WHAT IS NEW IN I²?

The renewed I² operates more models than the old version which has only two models, the A model which is used when setting noise limit values for environmental permitting, see paragraph 2.2, and the B-model which is used for planning purposes, see paragraph 2.1. The new version of I² even has six models. These models are depicted in figure 3.

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Figure 3: models in I²
The A and the B model and the principle of the data cycle remained too. However, now the E-model, the Q-model, the O-model and the MVG-model are introduced. This for the following reasons, the purpose for the A and B model was already explained above. The O-model is the modeling of the surrounding areas outside the industrial area, comprising buildings, barriers, height lines, ground polygons absorbing or reflecting and green strips with plants or shrubs, etc. This is done to eliminate the effects mutations (new or disappearing of objects) in the surroundings outside the industrial premises and is already future proof, complying with future legislation. The E-model was introduced to work with those lots having a noise emission based on dB/m². It should be noted that not all industrial areas have this planning instrument, only the industrial port areas have. So the industrial areas that are under the competence of the Rotterdam Port Authorities will be served by the E-model and the other areas, not having this lot related planning instrument are served by the so called B-model which was used previously in the port areas too. Working with the E-model one has the option to work with two surface related noise emissions (key indicators), a high and a lower one (bandwidth). The MVG model is a model that is derived from the A-model and contains only the data that is needed for an acoustic consultant to make an acoustic prognosis for a company that wants to settle or to expand its activities. The new introduced Q-model is a model is a static model that is based on the limit values that are set for the whole industrial area that is zoned. It represents the maximum allowed noise levels to be produced by all the activities on that industrial area.

As already mentioned above a new noise propagation model (Geomilieu) as depicted in figure 4 is replacing the Geonoise software that is no longer supported by the licensor. This software package offers more options, is more sophisticated and connects I² better with the acoustic consultants that often work with the same software. No conversions from Geomilieu to Geonoise are needed anymore.

A last new item is that the management team I² that owned the I² decided to outsource the application software, the server and database to DGMR. This opens the possibility for DGMR to start marketing of I² at other environmental protection agencies which will probably more successful than the attempts of the management team I². However, the Rotterdam data in the data base is not owned by DGMR, it is owned by the I² partners already mentioned afore.

6. Future developments

The new I² is provided to DCMR and the Rotterdam Port Authorities as ‘Software as a Service’ That means that the I² system can be used based on a yearly subscription (even for others). To be able to easily adapt the system to new legislations, adapt to new/specific user requirements and to be able to
integrate with other noise and planning related information systems, it is built as an ‘open extensible system’. To comply the Dutch legislations, the new I² uses the proven and accepted DGMR Geomilieu software to perform all industrial noise calculations. This also improves the exchange of acoustic data between DCMR, Rotterdam Port Authorities and commercial acoustic consultants.

The I² system is the new standard for managing noise at industrial areas. A first version is available for DCMR and Rotterdam Port Authorities. Several future developments are foreseen in the feature:

- Extend the workflow of I² to acoustic consultants and advisors by providing them direct access to I²
- Implementation of the new European noise assessment method CNOSSOS EU
- Further integration with the INSPIRE framework
- Extend the options for reporting, management information and big data
- Adaptation to new approaches on noise planning and management (internationally)

7. CONCLUSIONS

The renewed I² offers a lot of new functionalities and facilities needed to deal with the changed planning approach in the Rotterdam port areas. The old I² system has proven to be reliable and accurate and embraced by the umbrella of enterprises in the Rotterdam Metropolitan Area and municipalities located in this area. By outsourcing a part of the I² system new opportunities will be found to market this system among other parties.

ACKNOWLEDGEMENTS

Authors acknowledge Ms. A.M. van Wijk for her advises and contributions when preparing this paper. Ms. van Wijk has been the application manager of I² previously and was involved in the organizational issues of the renewed I².

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