Integration of tech mining into technology roadmapping: advanced tools for creating, validating and updating technology roadmaps

Background and purpose of the study

The creation of technology roadmaps is mainly based on the combination of qualitative and quantitative methods that complement each other. Along with extensive use of expert procedures (surveys, interviews, citizen surveys, etc.), automated and semi-automated techniques for extracting relevant information are increasingly being developed. A great demand for such methods is caused by the need for validation of expert assessments with empirical evidence, which can be obtained through searching for implicit signs of technological change in large amounts of textual data. Tech mining instruments for "big data" analytics could help generate competitive technical intelligence using specialized software (Vantage Point, VOSviewer, WordNet, etc.) in order to improve the process of technology roadmapping.

This study explores the possibilities of using tech mining tools for creating, validating, and updating technology roadmaps taking the aviation area as an example. To achieve this goal it identifies the main trends, markets, technologies, and technological products in the aviation area using qualitative (expert procedures) and quantitative (bibliometrics) techniques; verifies these results with a help of tech mining software (Vantage Point, VOSviewer); and analyzes the potentials for using tech mining methods on different stages of technology roadmapping. The results of this research can be interesting for policy makers financing roadmapping activities in order to set priorities in science and technology; for practitioners scanning disruptive innovations in the most important markets to support their corporate strategies; and also for the scientific community contributing to further integration of qualitative and quantitative foresight methods.

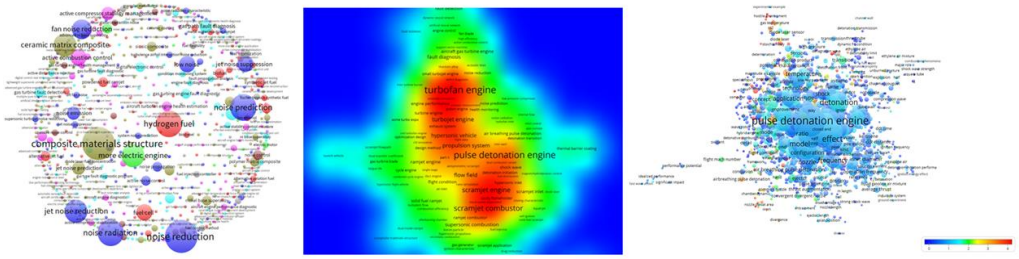
Methodology

The methodology of this study consists of three stages. First, the initial list of technology trends for the roadmap is created using quantitative (bibliometric analysis, etc.), and qualitative (surveys, interviews, consultations with aviation specialists) methods. Second, the quantitative analysis of Web of Science (WoS) publications in the aviation area in recent 10 years (2006-2015) is conducted. The collection of publications (created by using keywords provided by the experts and retrieved from WoS) is processed (cleaned and grouped), analyzed (based on the keywords co-occurrence), and visualized with the help of Vantage Point and VOSviewer. Finally, the results of quantitative analysis are used for validating the expert list of technology trends, markets, technologies, and technological products. The analysis is conducted through 3 rounds of discussions with experts.

Findings, discussion and conclusions

As a result of quantitative procedures, the information about the possible technology trends, markets, technologies, and technological products in the aviation area for the period 2006-2015 was retrieved from the collection of WoS publications in order to validate the roadmap (Figure 1). Using these data, the technology products proposed but the experts were verified (f.e., small-size turbojet engines, wankel engines, monitoring and diagnosis systems for power plants, engines for hypersonic aircrafts, variable cycle engines, etc.).

Figure 1: The examples of the maps created in VOSviewer



The examples of technology trends verified in the framework of the study are presented in Table 1.

Table 1. The examples of technology trends related to the aviation engines

Trend name	**Result of validation**
Further development of the concept of aircraft "electrification"	validated
Wide dissemination of the modular principle of the assembly of the aircraft's components	not validated
Switching to alternative, more environmentally friendly fuels (aviation condensed fuel, biofuels, hydrogen, etc.)	validated
Expansion and diversification of the air route network, primarily through the development of small and regional aviation	validated
Growing use of the materials with special properties for airframes, engines, aircraft systems and equipment	validated
Increasing diversity of the airline business models (the further expansion of low-cost airlines, the emergence of "individual" aircrafts, etc.)	not validated
Transition to "double innovations" (aircrafts applicable in civil and defence sector)	not validated
The introduction of structural improvements aimed at increasing the reliability and durability of the aircraft engines, systems and components	validated
Development of new types of engines for small aircrafts	validated
Development of the 5th generation of aircrafts (multi-functionality, automated control system, supermanoeuvrability, etc.)	validated

The possibilities of employing tech mining tools on different stages of roadmapping were explored and analysed. It was concluded, that the following factors should be taken into account in using them: the time horizon of the study (f.e., strategic documents and international reports can be more useful for understanding long-term technology trends, etc.); the stage of the roadmap development (pre-roadmapping, desk research, expert procedures, creative analysis, interactive discussion); the type of the information needed (f.e., emerging technologies, research fronts, disruptive technologies); the sort of information sources (publications, patents, web-content), and others. Further research will be devoted to the detailed analysis of these factors, as well as to development of more systemic methodology for integrating tech mining tools into technology roadmapping.

References

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REVIEW

Evaluation

Overall evaluation (*).
__ accept as is
__ conditional (see recommendations)
__ reject

Reviewer's confidence (*).
__ 5: (expert)
__ 4: (high)
__ 3: (medium)
__ 2: (low)
__ 1: (none)

Review

Review (*). GTM strives for a quality, impactful program. For your review, please read the most recent EXTENDED ABSTRACT available as an attachment to the submission. Please provide suggestions to ensure presentation appropriately addresses topic AND/OR list key questions that must be addressed/answered. This field is required unless you provide via an attachment.

Confidential remarks for the program committee. If you wish to add any remarks intended only for PC members please write them below. These remarks will only be seen by the PC members having access to reviews for this submission. They will not be sent to the authors. This field is optional.