

Further, “a marketplace is needed to encourage startups in this space and related big data application.” SMEs stand to benefit as both adopters of smart -manufacturing technology and as providers of smart-manufacturing services. The study identifies potential new business models and public-private partnerships as a potential route to overcome these barriers.

Finally, interviewees indicated that there are critical complementarities across the identified gaps in the technical infrastructure. For example, enhanced sensing capabilities will only add value if they are accompanied by cost-effective and secure transmission of the information. “Similarly, the growth and availability of real-time digital information on manufacturing activities is only as valuable as the ability to analyze the information. Thus, in many ways the value of smart- manufacturing systems is a function of the weakest link in the chain.” Consequently, unbalanced investment, closing select technical gaps while leaving other needs unmet, would likely fail to fully realize economic impact.

References

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- [3] Link A Scott J (2011) The theory and practice of public-sector R&D economic impact analysis. (NIST, Gaithersburg, MD) *Planning Report 11-1*.
<https://www.nist.gov/sites/default/files/documents/director/planning/report11-1.pdf>.
- [4] Tassef G (2007) *The Technology Imperative*. (Edward Elgar, Cheltenham).

¹ See Gallaher *et al.* [2].

² Technology infrastructure includes infratechnologies and technology platforms. Infratechnologies are technical tools, such as measurement and test methods, reference materials, scientific and engineering databases, process models, and the technical basis for physical and functional interfaces between individual components of both cyber and physical systems technologies. Technology platforms are precompetitive proofs of concept that demonstrate the potential commercial viability of multiple new or improved products, processes, or services. Technology infrastructure shares many common feature with tangible infrastructure. Namely, it is difficult and even undesirable to exclude potential users implementing the technology and usage of the technology infrastructure by a particular organization does not does not preclude others from benefiting to much the same extent. See Anderson [1], Link and Scott [3] and Tassef [4] for a richer discussion of the public good nature of technology infrastructure.

³ A market failure is a situation where free markets do not allocate resources efficiently. In particular, the study finds evidence that market failures such as network externalities, high technical risk, uncertainty and asymmetric information, and economies of scope all impact research in smart manufacturing technology infrastructure. The result is that markets invest too few resources in R&D.