Review Article

Outcomes of Public Procurement in Technology Development of Medical Devices: A Narrative Review

Reza Rezaee[1], Javad Noori[2], Seyed Mohammad Mahmoudi[1], Reza Masaeli[3]

[1]Department of Industrial and Technology Management, University of Tehran, [2]Research Institute for Science, Technology and Industry Policy, Sharif University of Technology, [3]Department of Dental Biomaterials, Tehran University of Medical Sciences, Tehran, Iran

ORCID:

Reza Rezaee: https://orcid.org/0000-0003-0011-908X

Javad Noori: https://orcid.org/0000-0003-3191-6831

Abstract

Introduction and Aim: Public procurement is a demand-side policy of technology and a significant section of the economy, the development of which requires understanding the conditions and accessing valid information. The present study has extracted the evidence-based public procurement outcomes in technology development of medical devices. **Materials and Methods:** Using narrative review method, 262 evidence were selected among the 787 evidence found, including books, articles, national and international reports and theses from Google Scholar, Elsevier, Emerald, Taylor and Francis, Wiley Online Library including books, articles, reports made by national and international documents and theses, and 52 were cited considering the need and the content. **Results:** Based on extracted concepts, the aspects of the effect of public procurement of medical devices were categorized into five categories, including technology and innovation development, technology diffusion and transfer, demand-oriented policy development, centralized procurement promotion, and local product development. **Conclusion:** The role of the government in the technology development of the medical devices requires more attention because the proper design and implementation of centralized public procurement policy of medical devices by creating competition among producers can lead to technology development and promotion. However, it may mutually increase the price of medical devices and limit the use of these devices and hinder innovation and the introduction of the new technologies.

Keywords: Health technology, medical devices, public procurement, technology diffusion and innovation

Introduction

Policy development is based on understanding the current conditions and valid information; moreover, based on the transparent and clear foresight, the technology path is created like a roadmap.[1] Public procurement is among the demand side of technology policies[2] recognized as a tool for achieving a more sustained community and economy,[3] which is monitored through regulative and policy methods in most countries.[4] Medical devices technology is among the important technologies in the countries, and public procurement is an effective policy on this technology. Medical devices include any goods, devices, tools, accessories, machinery, implants, materials, laboratory calibrators, and software supply by the producer for humans (solely or combined with other related items) to achieve goals such as recognizing, monitoring, preventing, treating, or mitigating the disease.[5] They can be categorized into the two groups of treatment and diagnosis[6] or fall into hazard groups or classes based on their rate of damage to the patient or user,[7] though, and there is no general standard approach to cover all the medical devices class.[8]

It should be noted that the medical devices industry includes those companies that manufacture and develop medical diagnoses and devices.[9] The United States is the largest worldwide seller of the products of the medical devices

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Address for correspondence: Dr. Javad Noori, Research Institute for Science, Technology and Industry Policy, Sharif University of Technology, Tehran, Iran.
E-mail: j.noori@sharif.edu

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industry and held 45% of the world's $302 billion markets by selling about $136 billion in 2014. Europe and China are the second and third in the medical devices market.[10] Estimations indicate that the annual world increase by 5% will roughly increase the sale of this industry by up to $800 billion by 2030.[11] Small- and medium-sized enterprises (SMEs) comprise the major part of the medical devices industry,[12] i.e., despite the presence of large players in this industry, small businesses play a significant role in this sector.[13] Venture capital, debt, initial public offering, and stock trading are the main methods of financing in the medical devices industry.[10]

Also, the knowledge of medical devices and supervision and planning systems enable officials to enhance their local decision-making processes to achieve the goals of long-term economic balance and a higher quality of health-care services for the citizens.[14] In this regard, the Iran government 's resistive economy headquarters approved a law to support the technology transition and promote internal technological capabilities in several fields such as health, which includes medicine and medical devices, called the law of "technology annex and the development of local capabilities in international contracts and important national projects."[15] Thus, the authors decided to collect the outcomes of public procurement on the technology development of medical devices mentioned sporadically in different literature to make it available to policymakers and researchers of health and technology.

Materials and Methods

This is a narrative review. The search strategy included studies investigating public procurement in the field of medical devices. In the next step, using the keyword "medical devices" along with keywords "public procurement" and "public purchase" and without time constraint, the published studies and articles available in Persian and English, until 2019, were extracted from Google Scholar, Elsevier, Emerald, Taylor and Francis, Wiley Online Library including books, articles, reports made by national and international documents and theses. The research team focused on achieving the maximum available studies at this stage; therefore, all the 787 evidences were initially investigated. By removing repetitive studies, 262 evidences containing keywords related to the subject remained and after a review by a second researcher, entered the next phase in which, after reviewing the abstracts, excluding irrelevant ones which didn't include the policy making of medical device technology development through public procurement and even studying relevant references of the evidences, 52 studies were selected. Then, the content of the finalized evidences was analyzed and the semantic codes were extracted through summarization. Subsequently, different aspects, mentioned in the codes, were evaluated and analyzed on the thematic basis of the outcome of public procurement of medical devices, and the thematic classes constructed through content analysis. The extracted semantic units were reviewed repeatedly to extract all the possible themes, and in rare cases which contained unclear aspects were reviewed by the research team and their thematic class was determined.

Results

Through the analysis of 52 literatures, 5 themes and 13 subthemes were extracted, which are summarized in Table 1, with themes being the outcomes of public procurement on the technology development of medical devices.

Below, some of literature's meaning units have been employed to explain and depict the extracted themes.

Technology and innovation development

Undoubtedly, improving the quality of human life depends on innovative medical solutions,[8] and success in the medical device industry is solely the result of innovation.[16] Innovation in medical devices refers not only to the invention of new devices but also to the gradual adjustments or improvements to the existing equipment and clinical practice.[17] Furthermore, processes such as product development and technology development are intangible resources for firms, skill-based incorporate-specific, nonmarketable, and endogenous.[18] Nowadays, many of the positive factors in medical device innovation have largely emerged due to technology, such as the emergence of new materials, electronics, biotechnology, genome, and communication technology.[19] The role of innovation in promoting competition and growth has also become more evident,[20] and medical devices, usually replaced every 18–24 months by an improved version, are recognized by their rapid innovation cycle,[21] and because of this rapid innovation cycle, the medical device industry is highly competitive.[22]

The traditional innovation literature includes a limited view of the environment in which innovation occurs and particularly ignores the role of the government that helps this process through direct contribution to the production sector or creating demand by making major procurements.[23] While public procurement has been recognized as a major motive for innovation.[3]

Medical device innovations, as they develop through public procurement, generally affect health-care costs in two ways. Some innovations improve costs by increasing performance, while other forms of innovation decrease cost by increasing productivity.[24] However, many technological innovations increase both performance and cost[25] or the price of equipment.[26]

Many innovations have potential benefits for patients and the health care system, though their expansion can cause problems when resources are limited.[27] It can be said that balancing efficiency and cost-effectiveness on the one hand and innovation on the other often leads to conflict.[28]

How technology and technology development policies are achieved are also key elements of the corporate-level technology strategy.[29] Most countries have developed various

Table 1: Themes of findings

Themes	Subthemes	Cods
Technology and innovation development	Funding and procurement policies	Public or private procurement
		Risk and financing
	Training and education policies	Training
		Education
Technology diffusion and transfer	Technology transfer	Producer/provider side transfer
		Consumer/recipient side transfer
	Technology diffusion	Producer/provider side diffusion
		Consumer/recipient side diffusion
Demand side technology policy development	Regulations	Economic regulation
		Social regulation
		Administrative regulation
	Information provision	Awareness campaigns
		Technology demonstration projects
		Trade fair
	Standardization	Standardization by "going it alone"
		Standardization by "alliance"
		Timing of Standardization
	Support to open innovation and user-centered innovation	Open innovation
		User-centered innovation
Centralized procurement promotion	Centralized procurement	Competition
		Pricing
		Procurement frameworks
	Kinds of public procurement	General public procurement
		Innovation-oriented public procurement
		Catalytic procurement
		Precommercial strategic (or innovative) procurement
Local production development	Encouragement to SMEs	Helping individual firms overcome barriers to entering new markets
		Helping firms build internationalization capabilities
	Subsidies/incentives	Demand subsidies
		Tariffs
		Quotas
	Taxation	Tax credits for consumers' purchase
		Tax incentives and tax subsidies

SMEs: Small and medium-sized enterprises

direct and indirect monitoring and policy-making methods to influence or control procurement practices, ranging from the list of equipment for procurement and operation to changes in financial systems to mitigate the effects of rising costs and to provide greater access to health care.[30] In any case, procurement policy significantly affects innovation, and changes in reimbursement policies will usually affect the procurement procedure.[31]

Technology diffusion and transfer

Based on the definition provided by the World Health Organization, technology transfer in medical products means the transfer of technical information, implicit knowledge, functional skills, and technical materials or devices, alone or in combination with one another to create the technological and manufacturing capabilities of technology recipients. The transfer of medical device technology demonstrates the collaboration of knowledge and resources towards the useful development of medical devices that responds to community health needs.[32] Most studies on medical devices have given much attention to the research, design, and deployment of the equipment themselves, but few were addressed considering the challenges of technology transfer and commercialization.[33]

Analysts often point to the advancement of medical technology and its diffusion across health systems as a major motive for increasing costs.[34] Therefore, understanding the effects of financing methods on technology diffusion is an important issue because when determining more appropriate financing policies for health care, immediate attention must be paid to shaping medical technology diffusion at a regional or national level. But when designing medical technology diffusion policies, other factors such as supply and demand variables, as well as the degree of competition between private and public hospitals, should also be taken into consideration.[35]

In other words, national procurement policies and practices may also affect the technology diffusion in the health system

as well as the operating costs. Of course, there are important differences between countries and health systems that affect the efficiency and diffusion of new technologies so that countries with fewer resources tend to disseminate innovations which increase productivity while possessing better resources leads to the diffusion of sophisticated and expensive technologies.[34]

Demand side technology policy development

The business dimensions of a corporate include industry, technology, value chain, product, service, market, and application, which can be divided into two main components of supply and demand. The supply-side emphasizes the intrinsic characteristics of the business such as inputs, processes, value chains and products, while the demand side includes external features of the business such as market, product, and service.[18] Public procurement as part of innovation policy (i.e., a set of laws, policies, and regulations designed to reinforce innovation), often referred to as "Public Technology Procurement," has been the subject of in-depth research.[28]

Increasing demand for specific medical devices is a potential incentive for innovation,[36] i.e., innovation must be more related to the actual needs of the health-care system (the demand side of medical device technology). Products that offer the most value for investment need to be identified and supported, and producers should be rewarded with appropriate reimbursement and pricing plans. This means that innovation is adequately supported by sufficient access to the market for new treatments.[37]

Ample evidence exists regarding attention to the local and foreign demand side in health systems. During the 1980s, politicians and policymakers particularly made additional efforts to systematically evaluate new medical technology to support decision making and improve healthcare.[38] In recent years, EU member states have also developed systems to identify innovations creating the best value.[37] In the demand side, for example, the public policies of many EU member states aim to precisely control the cost of health and affect the cost and benefit of the industry.[21] In the United States, the global medical device market has also provided many opportunities for its manufacturers. Thus, medical technology is a priority of national export initiatives, and the government pursues multilateral efforts for the benefit of the United States exporters, including market research, analysis, and policy formulation.[39]

Centralized procurement promotion

Medical technologies (MTs) play one of the biggest roles in the growth of health care costs[40] and affect healthcare more than many other factors.[41] As medical technologies are a major contributor to the increase in financial costs in Organization for Economic Co-operation and Development countries[42] and in the United States, despite the highly competitive market that keeps prices down, medical and diagnostic equipment over the years 1989–2010 accounted for 6% of national health costs in a relatively constant manner.[22]

Historically, European countries used different ways to achieve this goal, such as reference pricing, price discounting, price reduction, and centralized procurement.[43] Therefore, collective supply and management systems are one of the key regulating factors linked to international trade and increasing global supply chain segmentation;[44] therefore, procurement in the health care sector is being increasingly accumulated[45] and expanded, thereby a number of governments have achieved significant price reductions[46] and the benefits of accumulating the procurement of medical devices have been such that numerous evidence of the development of centralized procurements were reported through the creation of procurement groups or consortia.[30] However, unintended consequences, including the collusion of medical technology providers, must be limited by increased competition and transparency.[47]

It is noteworthy that centralized procurements in the health sector occur in both developed and developing countries, and both public and private sectors (for example, a group of private hospitals that have a shared procurement system) use this mechanism at different levels. In the public sector, many low-income countries have created central procurement agencies to manage the common needs of the health system. By leveraging larger orders, they can achieve economies of scale and procurement at reasonable prices.[44]

Reports indicate numerous examples of centralized procurement of medical devices in developed countries, such as the Procurement and Supply Agency, and the National Health Service in the United Kingdom, or Collaborative Procurement Hubs in the United States,[45] the group procurement and distribution of hospitals and other public agencies in Canada[39] and in Italy.[14] In developing countries, there have also been numerous reports of the promotion of centralized procurement and the benefits of this approach, for example, in Brazil[48] and Malaysia[39] through the re-establishment of the Health Procurement Committee (EPY) in Greece.[4]

Local production development

Developing countries are eager to build medical devices and reinforce the local industry,[49] because local technology production is one of the potential ways to increase access to medical devices[32] and trends also indicate that with national efforts and numerous regional and international initiatives, local production of medical devices in low- and middle-income countries is growing and diversifying.[44] Various factors affect local production, including technology transfer and intellectual property, internal governance and regulation, internal business capabilities as well as health financing methods.[32] Thus, public procurement as a financing method facilitates the local production development of medical devices and the transfer of related technology.[44]

Regarding the regional economy, local production of public goods is also significant as it increases the income of the country, and each region seeks to increase its share of public

goods production, such as medical devices in the field of health.[50] Benefits of local production include focusing on local health needs, cost-effectiveness and utilization of local knowledge, and building local capacity to solve problems,[32] ensuring equipment supply trends, reducing foreign imports, and developing export capacity.[49] In contrast, start-up costs, international competition, bureaucracy, lack of confidence in local production, shortage of skilled and trained staff, lack of raw materials, and limited legal protection are listed as barriers to local production.[51]

However, despite the difficulties of local production of medical devices in developing countries, multinational companies are trying to control it, and it seems that by imposing strict standards, the international community is restricting local producers rather than provoking innovation.[52]

Conclusion

The public procurement of medical devices is one of the health system policies of each country. Because providing public health is dependent on the availability of advanced diagnostic and treatment devices.

It is often assumed by the traditional theorists that the development of the medical device technologies is driven solely by the private sector, but the role of government as a major customer of technology and innovation in this issue must also be noted.

Even though the local production is one of the potential ways to increase access to medical devices, determining the effect of this production on technology diffusion and the amount of access the vulnerable and disadvantaged groups have to its benefits, requires more research.

Based on the results of this study, if the public procurement policy of medical devices is properly designed and implemented considering the expected outcomes, it can promote and develop technology through creating competition among manufacturers, and reduce unintended consequences, including suppliers' collusion, and control corruption in the public procurement system. It is also suggested to conduct a proper study to design the policy-making framework and executive structure in the country's health system body for the appropriate management of the retrieved outcomes in this research.

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Conflicts of interest

There are no conflicts of interest.

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